SUBMITTED TO:
HDR Engineering, Inc.
1600 Broadway, Suite 3400
Denver, CO 80202

BY:
Shannon & Wilson
5900 W. 38th Avenue
Wheat Ridge, CO 80212

(303)825-3800
www.shannonwilson.com

GEOTECHNICAL AND PAVEMENT DESIGN REPORT

El Paso County Pedestrian Crossings

EL PASO COUNTY, COLORADO

SHANNON & WILSON

March 2025

Shannon & Wilson No: 113421-001

Submitted To: HDR Engineering, Inc.
1600 Broadway, Suite 3400
Denver, CO 80202
Attn: Adam Borsch, PE

Subject: GEOTECHNICAL AND PAVEMENT DESIGN REPORT, EL PASO COUNTY PEDESTRIAN CROSSINGS, EL PASO COUNTY, COLORADO

This report presents the results of our geotechnical study and recommendations for improvements to several intersections in El Paso County. The report was prepared by Shannon & Wilson as a subconsultant to HDR Engineering, Inc.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON, INC.

David Asunskis, PE
Associate

DAV:DAA/jma

CONTENTS

CONTENTS

Exhibits

Figures

Appendices

1 INTRODUCTION

This report presents our geotechnical and pavement design recommendations for El Paso County's proposed improvements to several pedestrian crossings. The following report summarizes our subsurface explorations and laboratory testing, presents recommendations for signal pole and pavement design, and presents construction considerations associated with the geotechnical and pavement aspects of the project. Our services were conducted in general accordance with our June 4, 2024 subconsultant agreement with HDR Engineering, Inc. (HDR).

2 SCOPE OF SERVICES

We understand that up to 36 sites within El Paso County will have improvements to the existing pedestrian crossings. Of these proposed pedestrian crossing improvement areas, El Paso County and HDR selected ten sites for a subsurface investigation and geotechnical evaluation, which are addressed herein. This report should not be used for other purposes without Shannon & Wilson's review. Our scope of services included:

- Observing and logging of borings at the proposed intersection.
- Conducting laboratory testing of selected soil/rock samples,
- Developing geotechnical engineering and pavement design recommendations, and
- Preparing this report.

The objective of our geotechnical study was to provide geotechnical and pavement design recommendations and construction considerations, as presented herein, for the proposed pedestrian crossing improvements. The authorized scope of services was based on this objective and this report should not be used for other purposes without Shannon & Wilson's review. If a service is not specifically indicated in this report, do not assume that it was performed.

3 SITE AND PROJECT DESCRIPTION

Refer to Figure 2 for a site plan of the proposed improvements for each of the ten sites. Based on discussions with HDR, we understand the improvements to the existing site pavement could be reduced to localized patching around the pedestrian crossing improvement with functional overlays. Below is a summary of the proposed improvements.

- *Site 1: Black Forest Road (Rd.) & Shoup Rd.* – Proposed improvements consist of either a mill and overlay or full reconstruction of the existing intersection. Improvements will also include the replacement of the existing traffic signals.
- *Site 2: Constitution Avenue (Ave.) & Piros Drive (Dr.)* – Proposed improvements consist of full reconstruction of the intersection. An extension of the northwest and southeast corners raised medians curbs (bulb-out) are proposed. Along Constitution Avenue, raised medians between the eastbound and westbound traffic are proposed. New traffic signals could be installed.
- *Site 3: Galley Rd. & Hathaway Dr.* – Proposed improvements consist of full depth pavement reconstruction with proposed bulb-outs on each corner and the elimination of the WB to SB dedicated right turn lane. New traffic signals could be installed.
- *Site 4: B St. & Crestridge Ave.* – Proposed improvements consist of full reconstruction of the intersection with new crossing ramps on all corners and widening the private access driveway south of the intersection. New traffic signals could be installed.
- *Site 5: Main St. & Leta Dr.* – Proposed improvements consist of full reconstruction of the intersection with the installation of bulb-outs on the NE, SE, and SW corners. Pedestrian crossings will be orientated parallel and perpendicular to Main St. New traffic signals could be installed.
- *Site 6: Fontaine Boulevard (Blvd.) & Dartmouth St.* – Proposed improvements consist of full reconstruction of the intersection with the installation of bulb-outs to Dartmouth St.
- *Site 7: Main St. & Norman Dr.* – Proposed improvements consist of full reconstruction of the intersection with bulb-outs in all but the SE corner.
- *Site 8: Palmer Park Blvd. at Winnebago Rd.* – Proposed improvements consist of installation of high intensity activated crosswalk (HAWK) of Palmer Park Blvd. A raised median will be located between the EB and WB traffic on Palmer Park Blvd. The existing pavement for Palmer Park Blvd. will be milled and overlayed.
- *Site 9: Peterson Rd. at Sequoyah Way* – Proposed improvements consist of the removal of the existing Peterson Road signal crossing (located 150 feet southeast) and installation of a new HAWK crossing north of Sequoyah Way intersection. A raised median will be installed between the NB and SB traffic at the HAWK crossing. Bulb-outs will be installed at the Sequoyah Way crossing. The existing pavement for Peterson Rd will be milled and overlayed.
- *Site 10: Main St. at Marquette Dr.* – Proposed improvements const of installing a mid-block signalized crossing of Main St. (near the existing bus stop on Main St.) and installing a raised median between the NB and SB traffic. The existing pavement for Main Street will be milled and overlayed

4 FIELD EXPLORATIONS AND LABORATORY TESTING

Shannon & Wilson conducted a subsurface exploration program over seven days between August 19, 2024 and October 2, 2024. The subsurface investigation consisted of drilling and sampling a total of 26 borings at 10 sites. The borings designations were numerically offset by site location (for example, SW-01 is located at Site 1, and SW-11 is located at Site 2). Refer to Figures 2 through 10 for locations of our subsurface explorations at each site.

Appendix A presents a discussion of the drilling, sampling, and testing procedures used in completing the borings. Appendix A also presents individual exploration logs and an explanation of the symbols and terminology used.

Geotechnical laboratory tests were completed on selected samples retrieved from the borings to estimate index and engineering properties. Tests included natural water content, grain size distribution, Atterberg limits, one-dimensional swell/consolidation, Hveem Stabilometer (R-value), and corrosion. Laboratory test methods and results are provided in Appendix B. The natural water content, fines content, and Atterberg limits are also shown on the individual boring logs included in Appendix A.

5 SUBSURFACE CONDITIONS

5.1 Geologic Setting

Regional geologic maps of the Colorado Springs area indicate the following geologic conditions at each of the project sites:

- *Site 1 and 3:* – Surficial Dawson Formation bedrock (Thorson, 2003), (Madole and Thorson, 2003).
- *Sites 2, 8, and 9:* – Eolian and alluvium overlying Dawson Formation bedrock (Madole and Thorson, 2003).
- *Site 4, 5, 6, 7, and 10:* – Eolian and alluvium overlying Pierre Shale Bedrock (Carroll and Crawford, 2000; Madole and Thorson, 2003; White and others, 2017).

Subsurface conditions encountered in our explorations were generally similar to the geologic mapping referenced above with the exception of alluvial soils observed at Site 3.

5.2 Signal Pole Foundations

One boring located at each of the 10 sites was extended to a depth 25 feet to characterize subsurface conditions for the design of signal pole foundations. The exception is boring

SW-91 at Site 9 which was terminated at a depth of 6.5 feet. Generally, subsurface conditions consist of overburden sands or clays and residuum (completely weathered Dawson Formation Bedrock) at Site 1. A description of the subsurface conditions is provided in the individual boring logs, and a generalized summary of subsurface and groundwater conditions encountered in our borings is provided in Exhibit 5-1. It should be noted that groundwater level fluctuations are possible and depend on many factors, including seasonal variations and local precipitation.

Exhibit 5-1: Signal Pole Subsurface Conditions

Site	Boring	GW Depth	Generalized Subsurface Conditions
1	SW-01	NE	Hard silt residuum to 4 ft overlying Dawson Formation sandstone and claystone bedrock.
2	SW-13	NE	Medium stiff to stiff, lean clay with sand to 5.7 ft over loose to medium dense, silty sand.
3	SW-22	NE	Medium dense, silty, clayey sand to 5 ft over medium dense, poorly graded sand to 18.2 ft over medium stiff to stiff, sandy lean clay.
4	SW-31	NE	Medium dense, clayey sand to medium stiff to stiff, sandy lean clay.
5	SW-41	25 ft	Loose to medium dense, silty sand to 5 ft over very loose to loose, poorly graded sand to clayey sand.
6	SW-51B	NE	Loose, silty sand to 7 ft over loose to medium dense, poorly graded sand.
7	SW-62	NE	Loose to medium dense, silty to clayey sand to 23 ft over medium dense, poorly Graded Sand.
8	SW-71	NE	Loose, clayey sand to 9.2 ft over medium dense, well-graded sand with silt.
9	SW-81	NE	Loose, clayey sand to 9.5 ft over medium dense, poorly graded sand and gravel.
10	SW-91	NE	Loose to medium dense, silty sand.

NOTE:
ft = feet; GW = Groundwater; NE = Not Encountered

5.3 Existing Pavement Section

Existing pavement thicknesses were measured from the bore hole annulus at each boring location. Exhibit A-1 in Appendix A summarizes the observed pavement thickness and the existing lane where the boring was located.

5.4 Pavement Subgrade

Subgrade materials below the existing pavements generally consisted of alluvial clayey sand to sandy lean clay and eolian silty to poorly graded sand. Exhibit 5-2 summarizes the unified soil classification system (USCS) and the AASHTO soil classifications for subgrade materials observed below the existing pavement sections.

Exhibit 5-2: Summary of Pavement Subgrade Conditions

Location	Borings	Observed Subgrade Conditions	
		USCS	AASHTO Soil Classification
Site 1: Black Forest Rd. & Shoup Rd.	SW-01 through SW-05	SC, ML	A-2-6, A-2-4, A-7-6
Site 2: Constitution Ave. & Piros Dr.	SW-11 through SW-13	SC, CL	A-2-4, A-2-6, A-4, A-6
Site 3: Galley Rd. & Hathaway Dr.	SW-21 through SW-23	SM, SP-SM, SC-SM, SW-SM	A-1-b, A-2-4
Site 4: B St. & Crestridge Ave.	SW-31 through SW-33	SC, SW, SW-SC, CL	A-2-4, A-2-6, A-6
Site 5: Main St. & Leta Dr.	SW-41 & SW-42	SM, SP-SM, SP-SC, SC	A-1-b, A-2-4, A-2-6
Site 6: Fontaine Blvd. & Dartmouth St.	SW-51A through SW-52	SM, SP-SM, SP-SC, SC-SM	A-1-b, A-2-4
Site 7: Main St. & Norman Dr.	SW-61 through SW-63	SM, SP-SM, SC, SP	A-1-b, A-2-4, A-2-6
Site 8: Palmer Park Blvd. at Winnebago Rd.	SW-71	SC	A-6
Site 9: Peterson Rd. at Sequoyah Way	SW-81 & SW-82	SC, SM	A-2-4
Site 10: Main St. at Marquette Dr.	SW-91	SM	A-2-4

NOTES:

1 Refer to the Log Key for USCS Definitions.

AASHTO = American Association of State Highway and Transportation Officials; USCS = Unified Soil Classification System.

6 GEOTECHNICAL RECOMMENDATIONS

6.1 Traffic Signal Design

6.1.1 Foundation Soil Strength

We understand CDOT standard plans S-614-14, S-614-40, S-614-40A, S-614-41, S-614-44, S-614-50 and S-614-60 (CDOT, 2019) may be used for signal pole foundation design. The standard plans have subsurface requirements consisting of:

- *Medium Dense Cohesionless Soil:* Unit Weight of 110 pounds per cubic foot (pcf), an effective soil friction angle of 30 degrees with no cohesion. (Plan S-614-50 reduces the required effective friction angle to 28 degrees.)
- *Medium Stiff Cohesive Soil:* Unit Weight of 110 pcf with an undrained strength (cohesion) of 750 pounds per square foot (psf). (Plan S-614-50 reduces the undrained strength to 500 psf.)

Based on our explorations, subsurface conditions encountered at each of the ten sites meet CDOT's minimum subsurface requirements indicated on the standard plans referenced above. For the foundation drilled shaft length in standard plan S-614-40A, we recommend

using the 'clay' foundation length for Sites 3 and 4. For all other sites, the 'sand' designations should be used.

For Site 10 (Main St. at Marquette Dr.), boring SW-91 was terminated at a depth of 6.5 feet, but we understand CDOT plan S-614-14 is being considered which indicates a foundation depth from 4.5 to 6 feet below existing grade. In our opinion, boring SW-91 indicates subsurface conditions that meet or exceed CDOT's subsurface requirements described above.

6.1.2 Other Considerations

The CDOT (2019) standard signal pole foundation plans indicate that the engineer should be contacted if any of the following soil conditions are encountered during drilling:

- Signals will not be installed within the roadway earthwork prism;
- The soil has a high organic content or consists of saturated silt and clay;
- The site will not support the weight of the drilling rig;
- The foundation soils are not homogenous;
- Groundwater is encountered; or
- Firm bedrock is encountered.

Based on our explorations, the drilled shafts will likely encounter foundation soils that are non-homogenous, and bedrock will likely be encountered at Site 1. We do not anticipate that these ground conditions will be detrimental to the foundation design such that the CDOT standard designs would not be adequate.

6.2 Pavements

Depending on the intersection, the proposed pavement improvements consist of either (a) full roadway-width reconstruction, or (b) saw-cutting and installing bulb-outs, medians, and replacement traffic signals, with patching existing pavement adjacent to new curb and gutter, and possibly performing a functional mill and overlay of the existing pavement to improve the intersection driving surface.

Our pavement analysis was completed in accordance with the 2016 El Paso County Engineering Criteria Manual (ECM). Roadway classifications for each intersection and cross street were provided by HDR and are summarized in Exhibit 6-1.

Exhibit 6-1: Roadway Classifications

Site	Zoning	Roadway-1		Roadway-2	
		Road	Classification	Road	Classification
1	Rural	Black Forest Rd.	Collector	Shoup Rd.	Collector
2	Urban	Constitution Ave.	Principle Art.	Piros Dr.	Local
3	Urban	Galley Rd.	Minor Art.	Hathaway Dr.	Collector
4	Urban	B St.	Minor Art.	Crestridge Ave.	Collector
5	Urban	Main St.	Collector	Leta Dr.	Local
6	Urban	Fontaine Blvd.	Minor Art.	Dartmouth St.	Local
7	Urban	Main St.	Collector	Norman Dr.	Local
8	Urban	Palmer Park	Principle Art.	at Winnebago Rd.	Local
9	Urban	Peterson Rd.	Minor Art.	at Sequoyah Way	Local
10	Urban	Main St.	Collector	at Marquette Dr.	Local

NOTE:
Art. = Arterial; Ave. = Avenue; Blvd = Boulevard; Dr. = Drive; Rd = Road; St. = Street

6.2.1 Design Subgrade Strength

Subgrade strength at each site was evaluated by R-value testing in accordance with the ECM design criteria (El Paso County, 2016). R-value testing is summarized in Exhibit 6-2.

Exhibit 6-2: Summary of R-value Test Results

Location	Boring	USCS	AASHTO Soil Classification	R-value Test Result
Site 1: Black Forest Rd. & Shoup Rd.	SW-03	SC	A-2-6 (2)	22.7
Site 2: Constitution Ave. & Piros Dr.	SW-13	CL	A-6 (11)	15.0
Site 3: Galley Rd. & Hathaway Dr.	SW-22	SC-SM	A-1-b (0)	24.2
Site 4: B St. & Crestridge Ave.	SW-33	CL	A-6 (6)	9.0
Site 5: Main St. & Leta Dr.	SW-41	SM	A-2-4 (0)	42.8
Site 6: Fontaine Blvd. & Dartmouth St.	SW-51	SC-SM	A-2-4 (0)	45.6
Site 7: Main St. & Norman Dr.	SW-62	SM	A-2-4 (0)	58.3(1)
Site 8: Palmer Park Blvd. at Winnebago Rd.	SW-71	SC	A-6 (4)	24.0
Site 9: Peterson Rd. at Sequoyah Way	SW-81	SC	A-2-4 (0)	33.2
Site 10: Main St. at Marquette Dr.	SW-91	SM	A-1-b (0)	63.5(1)

NOTE:
1 For the pavement design, the R-value was limited to a value of 50.
USCS = Unified Soil Classification System

6.2.2 Subgrade Treatment

Expansive and collapsable soils are commonly encountered along the Front Range of Colorado. To assist us in determining the swell and collapse potential at the site, we reviewed a published geologic map of potentially swelling soil and rock of the Colorado Springs area developed by Hart (1974). The map indicates that the surficial soil consists of windblown sand or clay, which are categorized as generally low swell potential. However, windblown soil deposits can be susceptible to hydrocompaction, which occurs when loose, partially cemented, windblown sand deposits are inundated with water; dissolving a naturally occurring cementation in the soil (such calcite), resulting in subsidence. Swell potential for each of the sites as indicated by mapping by Hart (1974) is summarized in Exhibit 6-3.

Exhibit 6-3: Wind Blown Deposits and Swell Potential Mapping

Site	Swell Potential	Wind Blown Deposit
Site 1: Black Forest Rd. & Shoup Rd.	Low	No
Site 2: Constitution Ave. & Piros Dr.	Low	Yes
Site 3: Galley Rd. & Hathaway Dr.	Low	No
Site 4: B St. & Crestridge Ave.	High	No
Site 5: Main St. & Leta Dr.	Low	Yes
Site 6: Fontaine Blvd. & Dartmouth St.	Moderate	No
Site 7: Main St. & Norman Dr.	Moderate	No
Site 8: Palmer Park at Winnebago Rd.	Low	Yes
Site 9: Peterson Rd. at Sequoyah Way	Low	Yes
Site 10: Main St. at Marquette Dr.	Moderate	No

NOTES:
1 Swell potential and geologic mapping by Hart (1974).

In addition to reviewing geologic mapping, we performed swell/collapse testing from five subgrade samples to better evaluate the swell/collapse potential at the project site. The test results indicated relatively minor collapse or expansion (generally less than 1% swell or collapse). Based on these results, there is a relatively low risk of swell or collapse adversely affecting the proposed improvements, and we recommend implementing standard CDOT subgrade preparation (refer to Section 7.1.1 for our subgrade preparation recommendations.)

6.2.3 Traffic Loading

For our pavement analysis, HDR provided design traffic volume for each intersection. Using the data provided in Exhibit 6-4, we estimated a 20-year design life 18-kip equivalent

single axle loading (ESAL) for the design of full-width reconstruction at each site. For mill and overlay analysis, we assumed a 10-year design life. ESAL calculations are provided in Appendix C.

Exhibit 6-4: Pavement Design Traffic Loading

Site	Roadway-1	Roadway-2	Design[4] Truck %	Roadway-1 Design AADT	Roadway-1 DD	Roadway-1 DL	Roadway-2 Design AADT	Roadway-2 DD	Roadway-2 DL	20-Year DL 18-kip ESAL
1	Black Forest Rd.	Shoup Rd.	5.0	10,000	0.5	1.0	10,000	0.5	1.0	1,567,000
2	Constitution Ave.	Piros Dr.	8.0	40,000	0.5	0.9	3,000	0.5	1.0	5,256,000[4]
3	Galley Rd.	Hathaway Dr.	6.0	20,000	0.5	1.0	10,000	0.5	1.0	2,748,000
4	B St.	Crestridge Ave.	6.0	20,000	0.5	0.9[5]	10,000	0.5	1.0	2,565,000
5	Main St.	Leta Dr.	5.0	10,000	0.5	1.0	3,000	0.5	1.0	1,019,000
6	Fontaine Blvd.	Dartmouth St.	6.0	20,000	0.5	1.0	3,000	0.5	1.0	2,107,000
7	Main St.	Norman Dr.	5.0	10,000	0.5	1.0	3,000	0.5	1.0	1,019,000
8	Palmer Park	at Winnebago Rd.	8.0	40,000	0.5	0.9	-	-	-	5,256,000[4]
9	Peterson Rd.	at Sequoyah Way	6.0	20,000	0.5	1.0	-	-	-	1,832,000
10	Main St.	at Marquette Dr.	5.0	10,000	0.5	1.0	-	-	-	821,000[4]

NOTES:

1 An annually compounded growth rate of 1% assumed in analysis.

2 Based on discussions with HDR, a truck distribution of 90% single-unit and 10% combination trucks was assumed.

3 The intersection Design ESALs were determined by combining each cross street directional AADT

4 El Paso County design minimum value.

5 Indicates a modification to the EPC design criteria due to an increase in the number of design lanes.

AADT = Average Annual Daily Traffic; DD = Directional Distribution Factor; DL = Lane Distribution Factor;
ESAL = Equivalent Single Axle Load;

6.2.4 Recommended Reconstruction Pavement Sections

Exhibit 6-5 provides composite (HMA over ABC) reconstruction pavement sections in accordance with ECM guidelines. Although El Paso County prohibits full-depth HMA pavement sections, nine of the project sites were constructed with full-depth HMA pavement section. If the intersections are to be reconstructed, installing a composite pavement section in a patch or the relatively small paving area (bounded by full depth HMA) will prevent lateral drainage of the ABC. In our opinion, reconstructing intersections at locations with existing full-depth HMA is appropriate. Therefore, we have provided pavement sections for both composite and full-depth pavement sections as appropriate.

Exhibit 6-5: Recommended Reconstruction Pavement Sections

Site	Pavement Section	Full Depth HMA
Site 1: Black Forest Rd. & Shoup Rd.	7.5 in. HMA[1, 3] over 6 in. ABC	9.5 in. HMA[1, 3, 4]
Site 2: Constitution Ave. & Piros Dr.	10.5 in. HMA[1, 2] over 8 in. ABC	-
Site 3: Galley Rd. & Hathaway Dr.	8.0 in. HMA[1, 3] over 8 in. ABC	10.0 in. HMA[1, 3, 4]
Site 4: B St. & Crestridge Ave.	10 in. HMA[1, 3] over 8 in. ABC	12.0 in. HMA[1, 3, 4]
Site 5: Main St. & Leta Dr.	5.0 in. HMA[1, 3] over 8 in. ABC	7.0 in. HMA[1, 3, 4]
Site 6: Fontaine Blvd. & Dartmouth St.	5.5 in. HMA[1, 3] over 8 in. ABC	7.5 in. HMA[1, 3, 4]
Site 7: Main St. & Norman Dr.	4.5 in. HMA[1, 3] over 8 in. ABC	6.5 in. HMA[1, 3, 4]
Site 8: Palmer Park at Winnebago Rd.	9.5 in. HMA[1, 3] over 8 in. ABC	11.5 in. HMA[1, 3, 4]
Site 9: Peterson Rd. at Sequoyah Way	6.5 in. HMA[1, 2] over 8 in. ABC	8.5 in. HMA[1, 2, 4]
Site 10: Main St. at Marquette Dr.	4.5 in. HMA[1, 3] over 8 in. ABC	6.5 in. HMA[1, 3, 4]

NOTES:

1 Lift thickness for Grade S HMA mixes should be 2-1/4 inches to 4 inches.

2 The top 2-inches of HMA should consist of PG 64-28 Gr SX (75) over PG 64-22, Gr S (75)

3 The top 2-inches of HMA should consist of PG 64-22 Gr SX (75) over PG 64-22, Gr S (75)

4 Full-depth HMA pavement sections are prohibited by El Paso County, but a full-depth paving alternative is provided where the existing roadway intersections is constructed with an existing full-depth HMA pavement section.

ABC = Aggregate Base Course, HMA = Hot Mix Asphalt

6.2.5 Proposed Mill and Overlays

Where utilized, functional mill and overlays will consist of removing the upper 2-inches of HMA and overlaying new HMA to improve the driving surface. This type of rehabilitation is typically adequate for preventative maintenance but will not provide a significant extension of the pavement service life. Structural overlays add structure to the pavement section by increasing the overall pavement section thickness (raising grades) to accommodate a 10-year (or longer) design life. Structural overlays were not considered for this project. However, Shannon & Wilson estimated the design life for a 2- or a 3-inch mill and overlay, as applicable. Exhibit 6-6 summarizes our rehabilitation analysis based on the existing pavement section thicknesses provided in Table A-1.

Exhibit 6-6: Feasible Mill & Overlay Rehabilitation

Site	Pavement Section	Estimated Design Life	Notes
Site 1: Black Forest Rd. & Shoup Rd.	2 in. Mill, 2 in HMA(1) OL	10 yrs	
Site 2: Constitution Ave. & Piros Dr.	Mill & OL Not Recommended	< 1 yr	Existing HMA ≤ 4.5 in.
Site 3: Galley Rd. & Hathaway Dr.	OL Not Proposed	-	
Site 4: B St. & Crestridge Ave.	Mill & OL Not Recommended	< 1 yr	
Site 5: Main St. & Leta Dr.	OL Not Proposed	-	
Site 6: Fontaine Blvd. & Dartmouth St.	OL Not Proposed	-	
Site 7: Main St. & Norman Dr.	OL Not Proposed	-	
Site 8: Palmer Park at Winnebago Rd.	Mill & OL Not Recommended	< 1 yr	Existing HMA ≤ 3.5 in
Site 9: Peterson Rd. at Sequoyah Way	3 in. Mill, 3 in HMA(1) OL	< 5 yrs	Sequoyah Way HMA = 4 in.
Site 10: Main St. at Marquette Dr.	2 in. Mill, 2 in HMA(1) OL	10 yrs	

NOTES:

1 Overlay HMA should consist of a PG 64-22 Gr SX (75)

ABC = Aggregate Base Course, HMA = Hot Mix Asphalt; OL = Overlay

For our analysis, we considered increasing the mill and overlay (up to 3 inches) to add additional design life, where appropriate. Locations where overlays are not recommended are based on (a) the proposed mill and overlay has a nominal design life (less than one year), and/or (b) the existing pavement thickness is 4.5 inches or less. Existing pavement becomes brittle over time, and locations with thin and relatively old HMA could result in the removal of the HMA in its entirety during the milling process. If the HMA is fully removed, additional costs would be required for subgrade or base course reconditioning, and additional HMA quantities would be required. For these areas of relatively thin HMA, we recommend full pavement replacement. In addition, boring located in the cross streets (refer to Appendix A, Table A-1) could have relatively thin HMA thicknesses (for example, Sequoyah Way pavement section was observed to be 4-inches thick), and there is additional risk that these cross street could be full removed (as described above) during milling.

6.2.6 Roadway Patching/Repair

Prior to placing the overlay, areas of distress should be identified where the pavement should be repaired. In our opinion, the repair areas should be identified prior to milling and then re-evaluated after the milling process. Repairs completed prior to a functional mill and overlay (see below) should consist of:

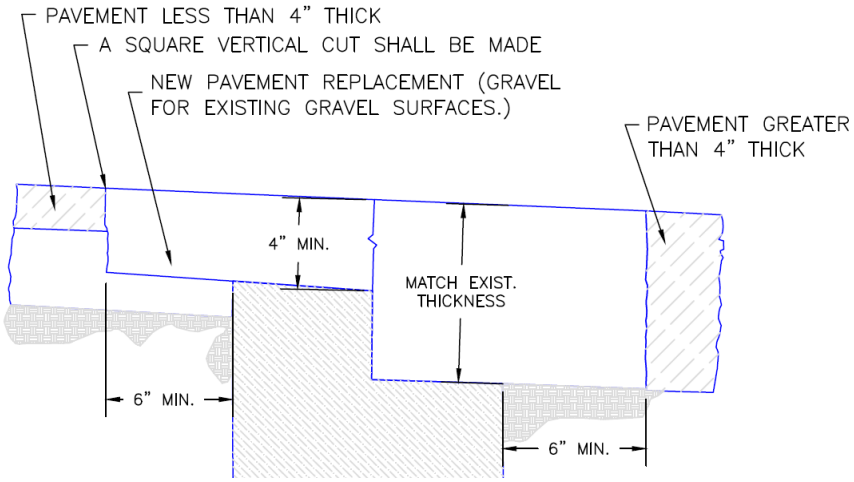
- *Fatigue (Alligator) Cracking:* Replace all areas with high-severity levels. High-severity levels are areas of moderately or severely spalled interconnected cracks forming a complete pattern. Refer to 2014 FHWA Distress Identification Manual for the definitions of crack pattern distress levels.

- *Linear (Longitudinal and Transverse) Cracking:* High-severity linear cracks should be patched. Crack opening is greater than 1/8 inch should be sealed with a flexible sealant prior to overlay. Available products consist of asphalt rubber, rubberized asphalt, low-modulus rubberized asphalt, and self-leveling silicone crack filler.
- *Rutting:* Existing ruts are anticipated to be removed by the milling process.

In narrow pavement patches adjacent to curb and gutter improvements, compaction of the HMA will be difficult and require the use of narrow handheld equipment to compact the individual HMA lifts. The size of handheld equipment available may require enlarging the size of the pavement repair patch.

Pavement replacement patches to repair damaged pavements should be saw cut into rectangular areas. The longitudinal saw cuts (relative to the direction of traffic) should be located along the edge of the proposed lane or in the center of the lane. If necessary, we recommend widening the patch to relocate the patch off the proposed lanes wheel paths for improved long-term performance of the patch. Patching of pavements should be completed in accordance with El Paso County Standard Drawing SD 4-23 (refer to Exhibit 6-7) which indicates existing HMA thicknesses should be replaced in-kind with a minimum thickness of 4 inches.

Exhibit 6-7: El Paso County Roadway Cut Patching Detail



After the HMA and ABC layers are removed, the subgrade treatment will be dictated by the patch area and the proposed constructed equipment used to perform the repair. For these relatively small, isolated patches, conventional roadway construction equipment may be too large for the proposed repair area and smaller, handheld equipment will be required. We recommend proof rolling the exposed subgrade (if possible) to identify soft, wet, or yielding subgrade areas. If the repair area is too small to perform a proof roll, we recommend probing the subgrade with a 'T' probe to identify soft, wet, or yielding subgrade areas.

All soft, wet, or yielding subgrade areas should be overexcavated, removed, and replaced. The subgrade overexcavation should be made in a relatively uniform thickness across the patch. If firm subgrade is exposed, we recommend scarifying the exposed subgrade 8 inches and compacting the subgrade in accordance with Section 7.1.1. If soft subgrade is encountered after 24 inches of subgrade overexcavation, we recommend placing a geogrid (refer to Section 7.1.2) at the base of the excavation before backfilling with ABC.

6.3 Sulfates and Corrosion

The soil and bedrock materials in Colorado area can be corrosive to substructure elements. To assist in estimating the corrosion potential at the site, select samples were tested for pH, resistivity, water soluble sulfates, and chlorides. The results are presented in Table B-1 in Appendix B. Based on correlations developed by Roberge (2012) in Exhibit 6-8, Exhibit 6-9 summarizes the corrosivity rating at each of the project sites.

Exhibit 6-8: Corrosivity Ratings Based on Soil Resistivity

Soil Resistivity (Ohm-cm)	Corrosivity Rating
> 20,000	Essentially noncorrosive
10,000 – 20,000	Mildly corrosive
5,000 – 10,000	Moderately corrosive
3,000 – 5,000	Corrosive
1,000 – 3,000	Highly corrosive
< 1,000	Extremely corrosive

Exhibit 6-9: Site Specific Corrosivity Rating

Site	Corrosivity Rating
Site 1: Black Forest Rd. & Shoup Rd.	Corrosive to highly corrosive
Site 2: Constitution Ave. & Piros Dr.	Highly corrosive
Site 3: Galley Rd. & Hathaway Dr.	Moderately corrosive
Site 4: B St. & Crestridge Ave.	Mildly corrosive
Site 5: Main St. & Leta Dr.	Mildly corrosive
Site 6: Fontaine Blvd. & Dartmouth St.	Moderately corrosive
Site 7: Main St. & Norman Dr.	Corrosive
Site 8: Palmer Park at Winnebago Rd.	Highly corrosive
Site 9: Peterson Rd. at Sequoyah Way	Moderately corrosive
Site 10: Main St. at Marquette Dr.	Mildly to moderately corrosive

The concentration of water-soluble sulfates was tested on three samples each indicating a concentration varying from 0.1% or less. Appendix D of the ECM indicates Type II cement should be utilized.

The test results and the above discussion are provided to assist the designer in the selection of project materials, concrete type, or other features with respect to corrosion. As appropriate, the designer should consider protective measures, such as coatings, upsizing for section loss, or using alternative materials to reduce the corrosion potential.

7 CONSTRUCTION CONSIDERATIONS

The applicability of the above design parameters is contingent on good construction practice. Poor construction techniques may alter conditions from those upon which our recommendations are based, and therefore result in poor performance. Our analyses assumed that the project is constructed according to El Paso County, Pikes Peak Region, and CDOT Standards Specifications for Road and Bridge Construction (CDOT Standard Specifications) (2023). The following sections provide additional construction considerations for this project.

7.1 Earthwork

7.1.1 Subgrade Preparation and Compaction

Proper subgrade preparation is required for adequate pavement performance. The exposed pavement subgrade should be free of organics, contaminants, debris, and rock fragments larger than 3 inches and then scarified a depth of 8 inches, moisture treated, and compacted in accordance with CDOT Standard Specifications Section 203.07 (2023). In particular:

- Sandy clay and clay subgrade soils classified as AASHTO A-6 and A-7 soils should be moisture treated between 0 and 2% above optimum moisture content and compacted to a firm and unyielding condition at least 95% of the maximum dry density determined in accordance with AASHTO T99 (standard compaction effort).
- Clayey sand (AASHTO A-2-6 and A-2-7 soils) should be compacted within 2% of the optimum moisture content and to a dense and unyielding condition and at least 95% of the maximum dry density determined in accordance with AASHTO T99.
- All other soil soils (AASHTO A-1, A-2-4, A-2-5, and A-3 soils) should be compacted within 2% of the optimum moisture content and to a dense and unyielding condition and at least 95% of maximum dry density determined in accordance with AASHTO T180 (modified compaction effort).

7.1.2 Proof Roll

After reaching subgrade levels in cut areas or prior to placing fill, the exposed subgrade should be proof-rolled as described below. If loose, soft, or yielding soils are encountered after over-excavating 3 feet, a geogrid (Tensar biaxial grid BX1200, Tensar triaxial TX5, or equivalent product) should be installed at the base of the excavation before backfilling).

In addition, the compacted surface of each fill lift should be proof-rolled with a fully-loaded, tandem-axle, 10-yard dump truck or equivalent in accordance with CDOT Standard Specification Section 203.07. Areas that are identified as being loose, soft, or yielding during proof-rolling should be compacted in place, removed and reconditioned, or replaced with Low Permeable Fill (refer to Section 9.1.6). Care should be taken during proof-rolling and subgrade preparation to avoid disturbing subgrade soils and supporting soils that will remain in place, as they can rut and pump under repeated construction traffic. Additionally, subgrades should be protected from drying or wetting in excess of what is required to achieve the specified compaction requirements.

7.2 Paving Materials

7.2.1 Hot Mix Asphalt

We understand that El Paso County follows the Pikes Peak Region Asphalt Paving Specifications (2022) for HMA paving material mix design standards. Based on the anticipated traffic loading, the pavement mix design the recommended paving materials are indicated in Exhibit 6-5 and 6-6. We recommend a gyratory number of 75 be used for the mix design. In addition, we recommend lift thicknesses for Grade SX (½-inch nominal maximum aggregate size [NMAS]) and Grade S (¾-inch NMAS) be in accordance with Pikes Peak Region Asphalt Paving Specifications and be between 3 and 6 times the NMAS and not exceed a total lift thickness of 4-inches. A tack coat should be placed between subsequent lifts.

7.2.2 Aggregate Base Course (ABC) Materials

The El Paso County Engineering Criteria Manual (2016) references CDOT Section 703.03 for the ABC material. The ABC material should be placed in maximum 6-inch-thick lifts and compacted to a dense and unyielding condition and to at least 95% of the maximum dry density (AASHTO T180).

8 PLAN REVIEW AND CONSTRUCTION OBSERVATION

8.1 Plan Review

We recommend that we be retained to review the geotechnical aspects of the plans and specifications prior to bidding the work to determine that they are in accordance with our recommendations. While this step is often skipped in design document preparation, our experience is that the review can find discrepancies or misinterpretations and correct them before bidding, thus avoiding potential change orders during construction.

8.2 Construction Monitoring

We recommend that we be retained to observe geotechnical construction activities and confirm the adequacy of our recommendations in this report. Our involvement will help with developing alternative recommendations if conditions observed during construction are different from those assumed in this report. As a minimum, our support services should include review of the Contractor's geotechnical-related submittals, observation of pavement subgrades and permanent cut slopes, and as-needed support to clarify related issues.

9 LIMITATIONS

This report has been prepared for the exclusive use of HDR Engineering and El Paso County for the purpose of providing recommendations for the El Paso County Pedestrian Crossings project. This geotechnical design report should not be used without our approval if any of the following occurs:

- Assumptions stated in this report have changed.
- Project details change or new information becomes available such that our analyses and recommendations may be affected.
- A substantial period of time has passed since the date of this report.

If any of these occur, we should be retained to review the applicability of our analyses and recommendations.

Within the limitations of scope, schedule and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical and geological principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by a limited boring and testing program. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

10 REFERENCES

Carroll, C.J. and Crawford, T.A., 2000, Geologic map of the Colorado Springs quadrangle, El Paso County, Colorado, Colorado Geological Survey, Open-File Report OF-00-03, 1:24,000.

Colorado Department of Transportation (CDOT), 2023, Standard Specifications for Road and Bridge Construction, available: https://www.codot.gov/business/designsupport/cdot-construction-specifications/2023-construction-specifications/2023-specs-book

CDOT, 2019, Standard Plans 614-14, S-614-40, S-614-40A, S-614-41, S-614-44, S-614-50 and S-614-60; available: https://www.codot.gov/safety/traffic-safety/design/s-standards

El Paso County, 2016, Engineering Criteria Manual, Adopted December 23, 2004, Revised December, 13, 2016, Revision 6; available: https://epc-assets.elpasoco.com/wp-content/uploads/sites/13/Documents/EngineeringCriteriaManual.pdf

Federal Highway Administration (FHWA), 2014, Distress Identification Manual for the Long-Term Pavement Performance Program (Fifth Revised Edition), dated May, 2014; available: https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/13092/13092.pdf

Hart, S.S., 1974, Potentially swelling soil and rock in the front range urban corridor, Colorado: Colorado Geological Survey, Denver, Colorado, 4 sheets.

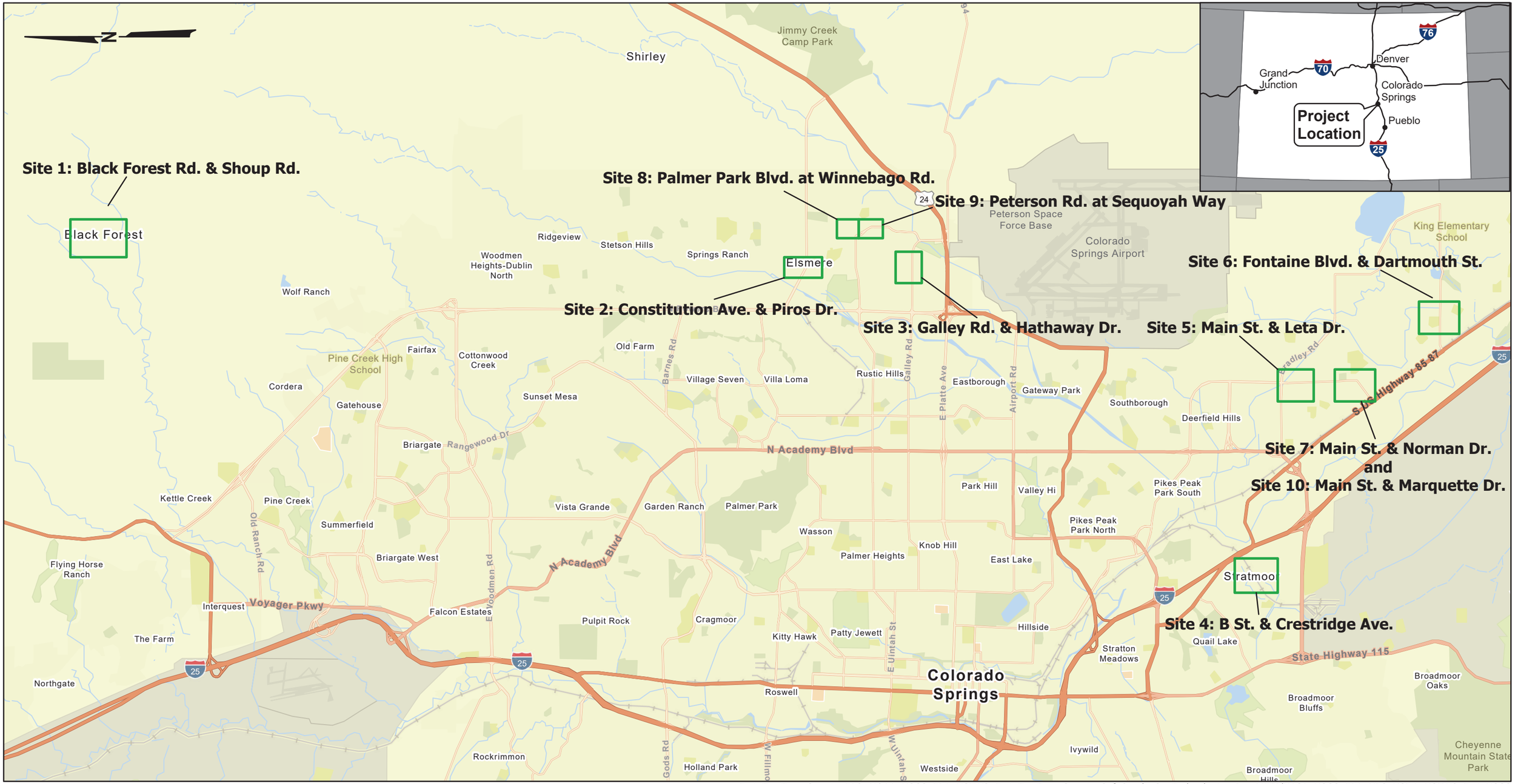
Madole, R.F. and Thorson, J.P., 2003, Geologic Map of the Elsmere 7.5 Minute Quadrangle, El Paso County, Colorado, Colorado Geological Survey, Open-File Report OF-02-02, 1:24,000.

Pikes Peak Region Asphalt Paving Specifications, 2022, Version 6, dated March 20, available: https://epc-assets.elpasoco.com/wp-content/uploads/sites/13/Documents/Pikes-Peak-Region-Asphalt-Paving-Specs-Version-6-March-2022.pdf

Roberge, P.R., 2012, Handbook of Corrosion Engineering, McGraw-Hill, P. 103.

Thorson, J.P., 2003, Geologic Map of the Black Forest Quadrangle, El Paso County, Colorado, Colorado Geological Survey, Open-File Report OF-03-06, 1:24,000.

White, J.L., Lindsey, K.O., Morgan, M.L., and Mahan, S.A., 2017, Geologic Map of the Fountain Quadrangle, El Paso County, Colorado, Colorado Geological Survey, Open-File Report OF-17-05,



Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS, Esri, USGS

0 2 4

Scale in Miles

Legend

Project Sites -Refer to Figure 2

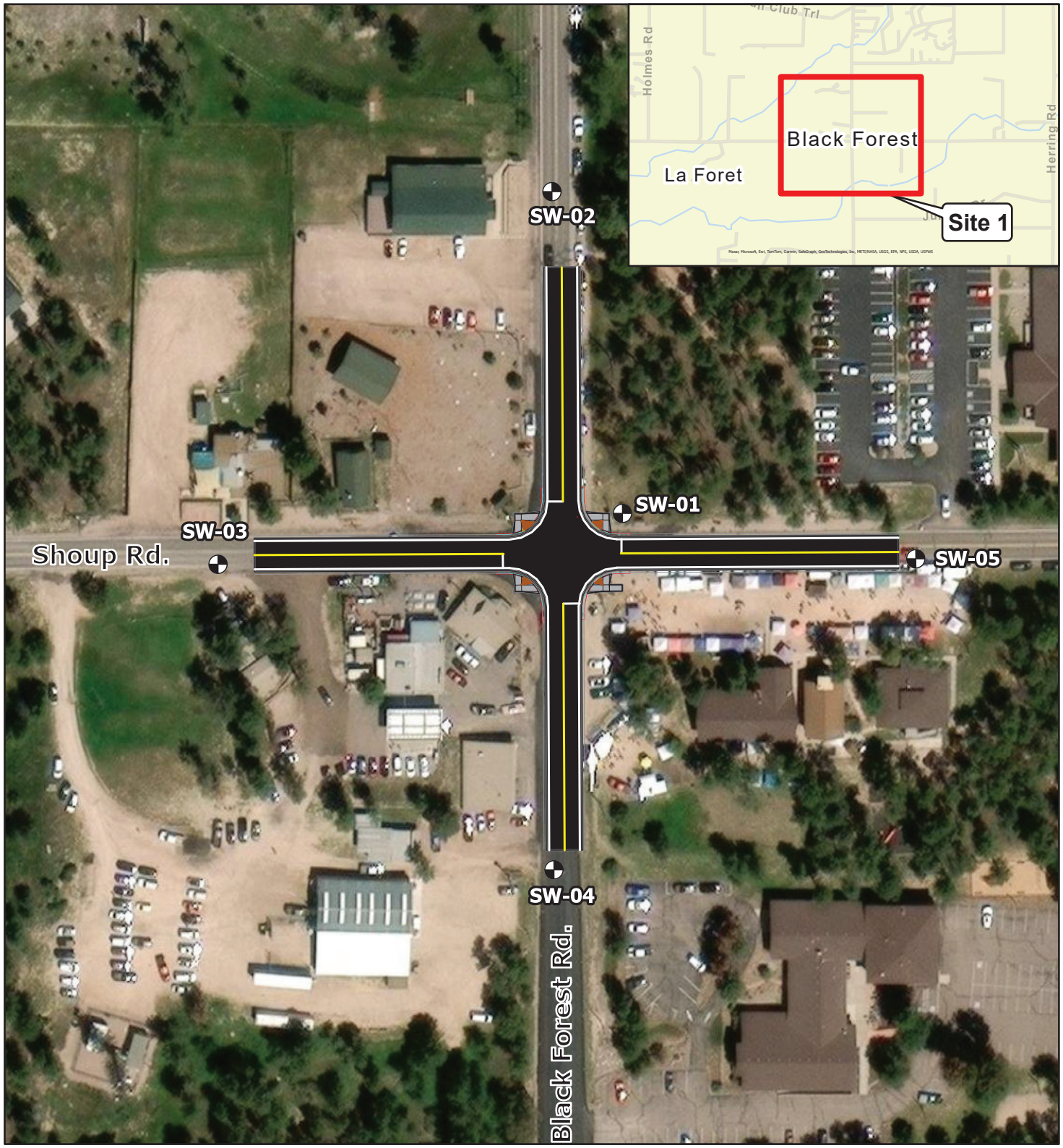
El Paso County Pedestrian Crossings
El Paso County, Colorado

VICINITY MAP

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 1



LEGEND

S&W Boring Designation and Approximate Location

Site 1 Location

0 200

Scale in Feet

N

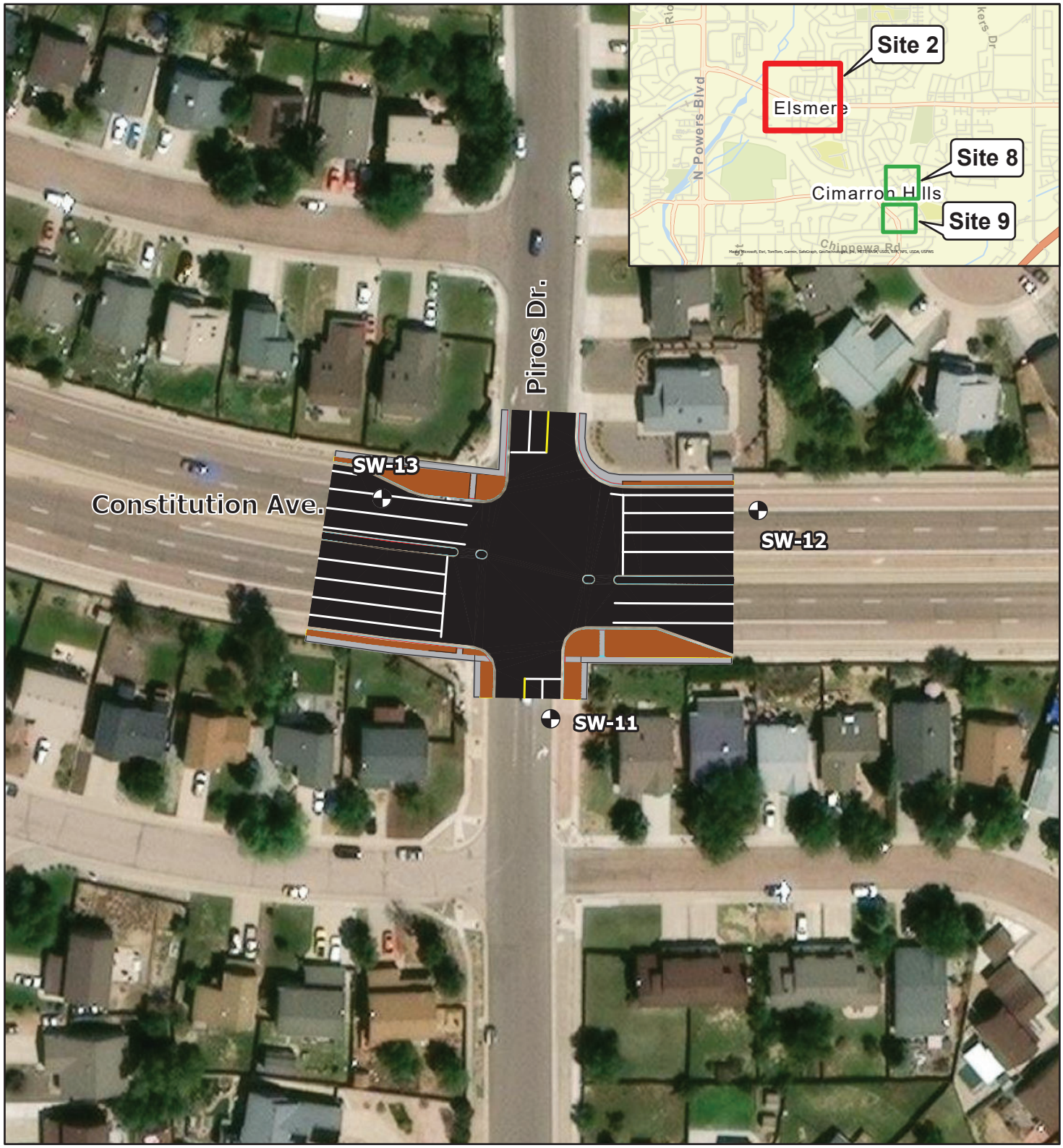
El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITE 1

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2



LEGEND

- S&W Boring Designation and Approximate Location
- Site 2 Location
- Adjacent Site Locations

0 200

Scale in Feet

N

El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITE 2

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 3

LEGEND

- S&W Boring Designation and Approximate Location
- Site 3 Location
- Adjacent Site Locations

0 200

Scale in Feet

N

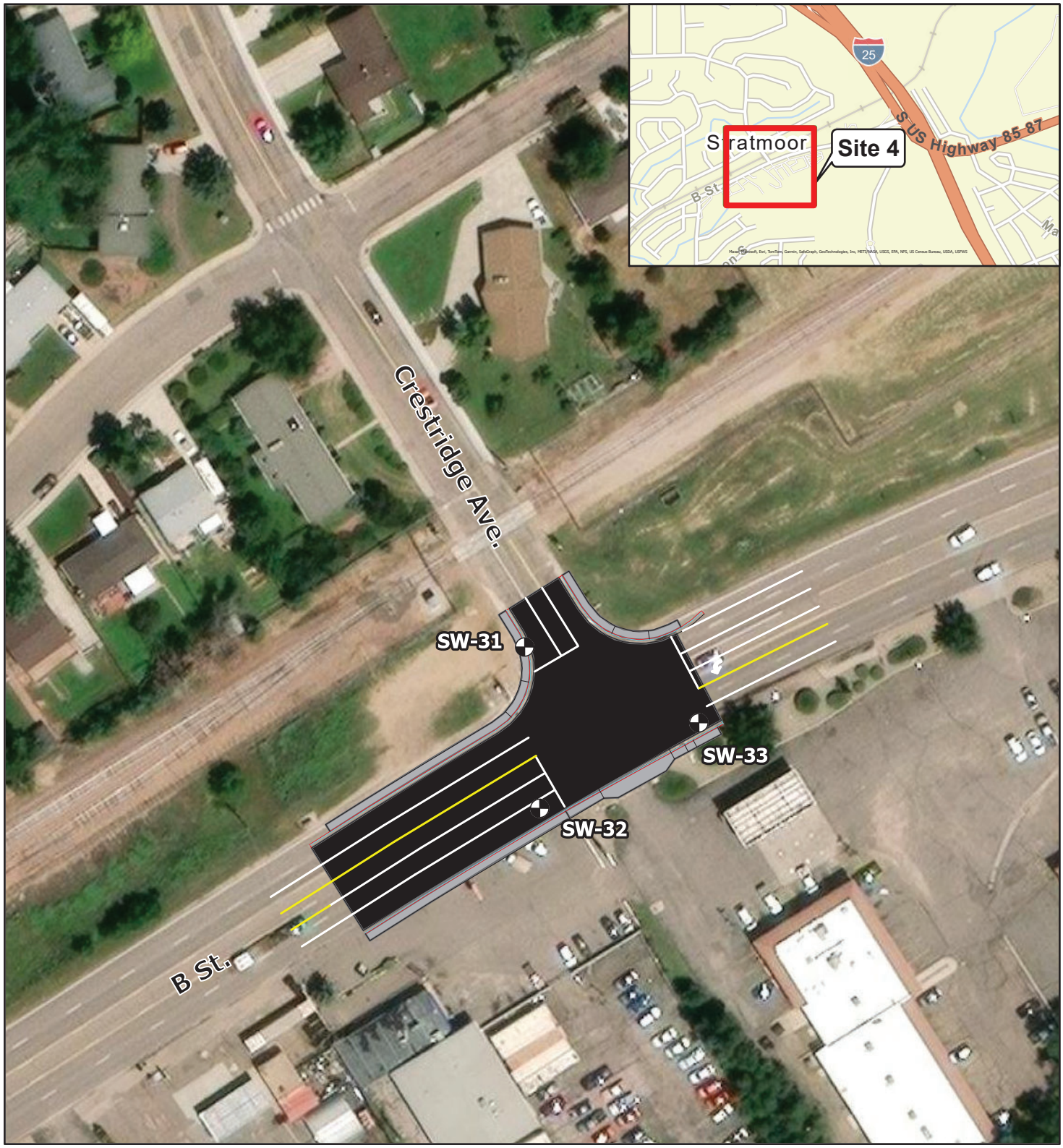
El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITE 3

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 4



LEGEND

S&W Boring Designation and Approximate Location

Site 4 Location

0 200

Scale in Feet

N

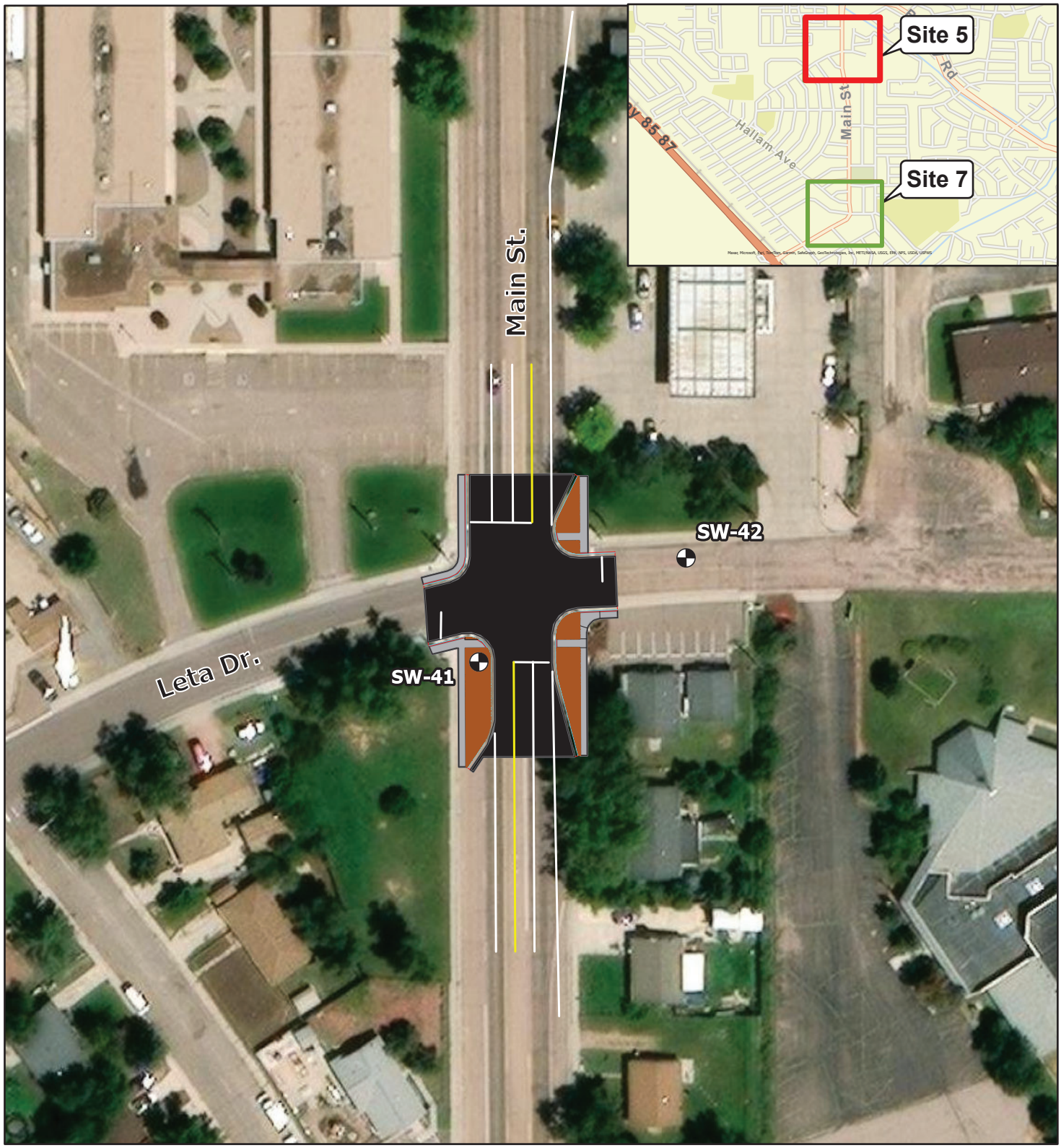
El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITE 4

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 5



LEGEND

- S&W Boring Designation and Approximate Location
- Site 5 Location
- Adjacent Site Locations

0 200

Scale in Feet

N

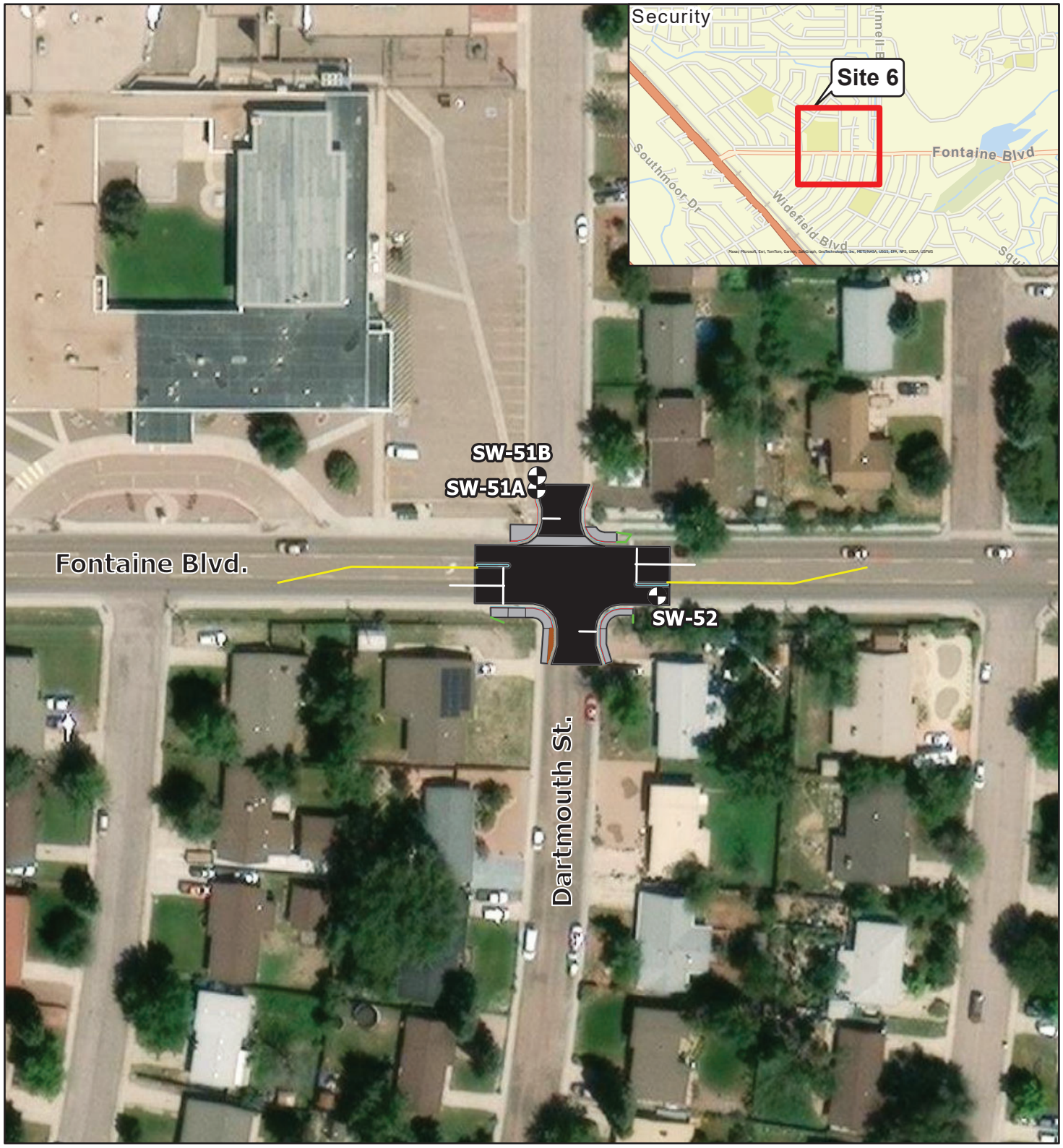
El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITE 5

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 6



LEGEND

S&W Boring Designation and Approximate Location

Site 6 Location

0 200

Scale in Feet

N

El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITE 6

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 7

LEGEND

S&W Boring Designation and Approximate Location

Sites 7 & 10 Location

0 200

Scale in Feet

N

El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITES 7 & 10

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 8

LEGEND

- S&W Boring Designation and Approximate Location
- Site 8 Location
- Adjacent Site Locations

0 200

Scale in Feet

N

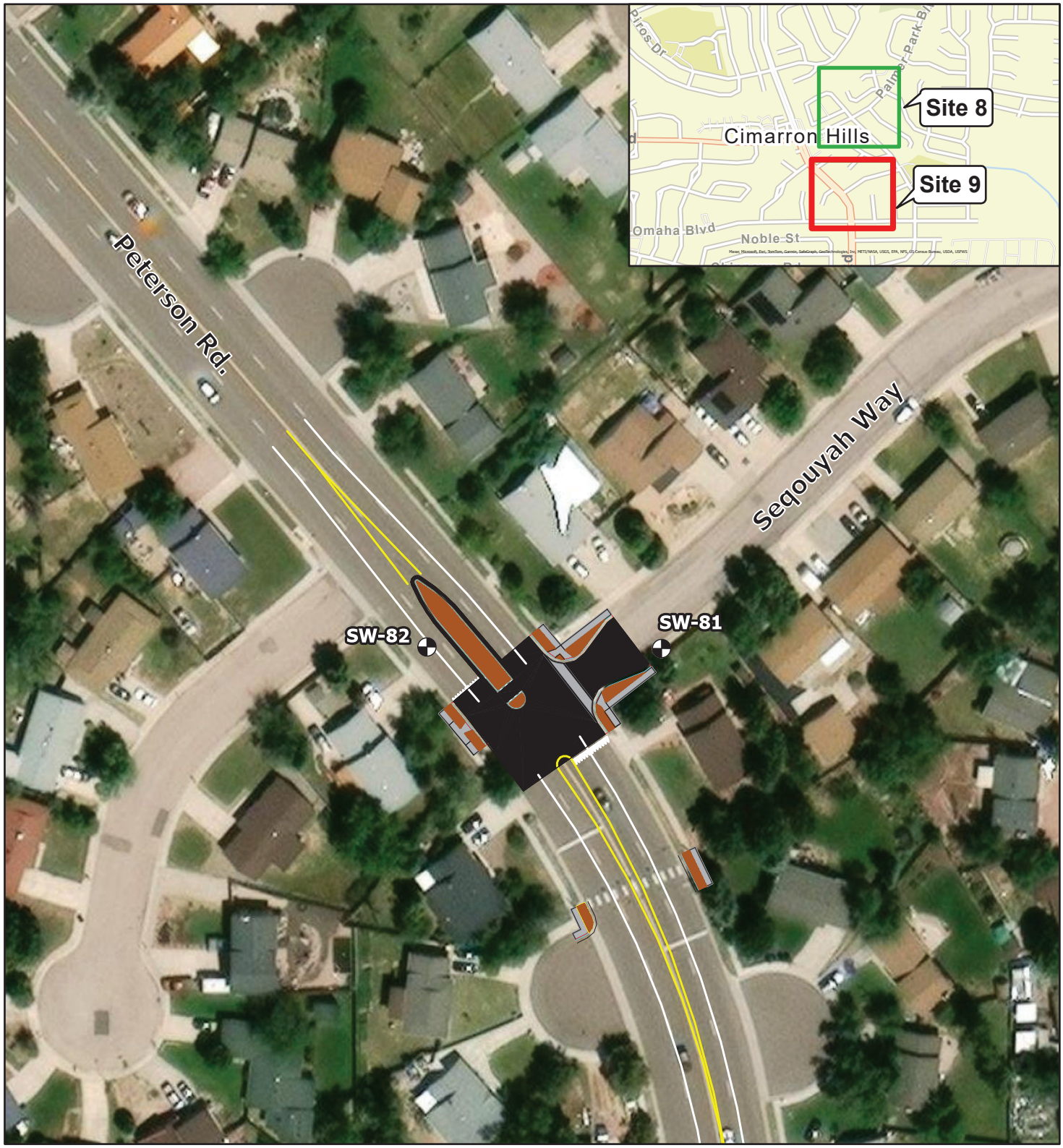
El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITE 8

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 9



LEGEND

- S&W Boring Designation and Approximate Location
- Site 9 Location
- Adjacent Site Locations

0 200

Scale in Feet

N

El Paso County Pedestrian Crossings
El Paso County, Colorado

SITE AND EXPLORATION PLAN
SITE 9

March 2025 113421-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 10

APPENDIX A: SUBSURFACE EXPLORATIONS

Appendix A

Subsurface Explorations

CONTENTS

Table

Figures

APPENDIX A: SUBSURFACE EXPLORATIONS

A.1 INTRODUCTION

Shannon & Wilson's field exploration program was conducted between August 19, 2024 and October 2, 2024 and consisted of drilling and sampling a total 26 borings at 10 sites; refer to Figures 1 and 2. The methods used to conduct the field exploration program are described below.

A.2 BORINGS

The borings were coordinated (including subcontractor coordination, permitting, traffic control, and utility locates) and observed by a representative from Shannon & Wilson. The individual exploration boring logs represent our interpretation of the contents of the field logs and results of select laboratory testing. The borings were drilled by Entech Engineering, Inc. of Colorado Springs, Colorado (under subcontract to Shannon & Wilson) using a SIMCO 2800 truck mounted drill rig or a CME 45 truck mounted drill rig. The borings were advanced with 4-inch outside diameter solid-stem augers and sampled to depths ranging from approximately 5 to 25 feet below existing grade. Due to the presence of buried utilities, boring SW-32 was completed to a depth of 1.6 feet using a hand auger. From the borehole annulus, the existing pavement thickness was measured and indicated on the individual boring log and summarized in Table A-1. Where groundwater was encountered, our field representative measured the approximate depth to groundwater using an electronic water level indicator. On completion of drilling, the borings were backfilled with flow fill and patched with hot-mix asphalt to match the existing pavement. SW-01 was drilled adjacent to the roadway and was backfilled using drill cuttings.

Boring locations were measured by Shannon & Wilson with a hand-held recreational grade global positioning system (GPS) unit. The GPS coordinates are indicated on the individual boring logs and should be and are considered accurate to the degree implied by the method used.

A.2.1 Soil and Rock Classification System

During drilling, the Shannon & Wilson representative collected soil samples and prepared a field log of each boring. Soil classifications were based on ASTM International (ASTM) Designation: D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), and ASTM Designation: D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). The system is referred to as the Unified Soil Classification System and is summarized in the Log Key.

The Shannon & Wilson representative classified rock samples in general accordance with the International Society of Rock Mechanics (ISRM) classification method. According to this system, rocks are classified based on the stratigraphic structure, rock strength, degree of weathering, and other properties and is summarized in the Log Key.

Consistent with other locations in Colorado, the bedrock encountered in the explorations was found to be hard when considered as a lithified soil material. However, when compared with other types of bedrock using the ISRM classification of rock strength, some of the material resembles a very low strength rock. Therefore, where it is appropriate, the exploration logs included in Appendix A contain dual descriptions of the bedrock using the Unified Soil Classification System and the ISRM classification system.

A.2.2 Standard Penetration Test (SPT)

Disturbed samples were obtained in the borings in general accordance with the Standard Penetration Test (SPT) (ASTM Designation: D1586). The SPT consists of driving a 2-inch outside diameter, 1.375-inch inside diameter split-spoon sampler a distance of 18 inches with a 140-pound hammer free-falling a distance of 30 inches. An automatic hammer system was used to advance the samplers. During sampling, the Shannon & Wilson field representative recorded the number of blows for each 6-inch increment of penetration and summed the blow counts for the last two 6-inch increments. This sum is recorded as the penetration resistance number, or N-value. If high penetration resistance prevented driving the entire 18 inches, the Shannon & Wilson field representative recorded the partial penetration depth and blow count. The N-values provide a means for evaluating the relative density or compactness of cohesionless (granular) soils and consistency or stiffness of cohesive (fine-grained) soils (see Log Key). The raw N-values are shown on the individual boring logs. Representative portions of the split-spoon sample obtained in conjunction with the SPT were placed in a screw-top plastic jar and transported to our laboratory.

A.2.3 Modified California (MC) Test and Sampling

Samples were also obtained using a Modified California (MC) barrel sampler. The MC test procedure is similar to the SPT, except the sample barrel is larger (2½-inch O.D.) and lined with 2-inch-diameter brass tubing. The MC sampler is only driven 12 inches. During sampling, the Shannon & Wilson field representative recorded the number of blows for each 6-inch increment of penetration. As a result of the larger diameter, the MC sampler yields slightly higher raw blow count numbers when compared to SPT N-values for similar soils. Because the difference in blow counts does not significantly impact our evaluation, we used the field MC blow counts over the 12-inch increment to define the relative density and consistency/stiffness of the subsurface materials following SPT terminology. Representative

samples were sealed in the brass liner tubes with plastic caps and transported to our laboratory for further testing.

A.2.4 Pocket Penetrometer

Select cohesive soil samples were also tested in the field using a pocket penetrometer. The penetrometer estimates the unconfined compressive strength of clay soil samples by penetrating the clay with a one-quarter-inch-diameter penetrometer and measuring the resistance (in units of tons per square foot [tsf]) with a calibrated spring. Measurements can be taken to the nearest 0.25 tsf increment. The field measurements from the pocket penetrometer are listed on the boring logs.

A.2.5 Bulk Sampling

A bulk soil sample was obtained by collecting the drill cuttings. Approximately 20 to 30 pounds of cuttings from each location were placed in a plastic bag and transported to our laboratory for further evaluation and testing. The bulk samples are composite samples sometimes spanning over several soil layers. For this reason, the USCS classification of the composite bulk samples is not included on the boring logs.

A.2.6 Damage to Existing Utility at Boring SW-52

During drilling at boring SW-52, PVC and a thin foil layer were observed in the modified California barrel sampler when the sampler was at a depth of approximately 4 feet below the ground surface. Drilling excavation was terminated and damage to an existing utility was reported to the Utility Notification Center of Colorado and the project design team. From the discussion on September 11, 2024 with a damage investigator from Century Link, we understand the utility conduit is likely theirs.

Table A-1 - Existing Pavement Thickness Summary

Site	Boring Location	Roadway & Lane	Pavement Section
Site 1: Black Forest Rd. & Shoup Rd.	SW-01	-	-
	SW-02	SB Black Forrest Rd.	15 in. HMA
	SW-03	EB Shoup Rd.	24 in. HMA[(2)]
	SW-04	SB Black Forrest Rd.	14 in. HMA
	SW-05	EB Shoup Rd.	11 in. HMA
Site 2: Constitution Ave. & Piros Dr.	SW-11	NB Piros Dr. Rt. Tn. Ln.	4 in. HMA over 3 in. ABC
	SW-12	WB Constitution Ave. Rt. Tn. Ln.	4 in. HMA over 12 in. ABC
	SW-13	WB Constitution Ave. Rt. Tn. Ln.	4.5 in. HMA over 12 in. ABC
Site 3: Galley Rd. & Hathaway Dr.	SW-21	EB Galley Rd. Rt. Tn. Ln.	4 in. HMA
	SW-22	EB Galley Rd. Ln.	4 in. HMA
	SW-23	NB Hathaway Dr. Ln	4 in. HMA
Site 4: B St. & Crestridge Ave.	SW-31	SB Crestridge Ave. Rt. Shr.	10 in. HMA
	SW-32	EB B St. Rt. Ln.	7 in. HMA
	SW-33	EB Rt Ln. B St.	9.5 in. HMA
Site 5: Main St. & Leta Dr.	SW-41	SB Main St. Rt. Ln.	8 in. HMA
	SW-42	WB Leta Dr.	5 in. HMA
Site 6: Fontaine Blvd. & Dartmouth St.	SW-51A	SB Dartmouth St. Ln.	6.5 in. HMA
	SW-51B	SB Dartmouth St. Ln.	7.0 in. HMA
	SW-52	EB Fontaine Blvd. Ln.	10 in. HMA
Site 7: Main St. & Norman Dr.	SW-61	NB Main St. Rt. Shr.	8 in. HMA
	SW-62	WB Norman Dr. Ln.	5 in. HMA
	SW-63	NB Main St. Rt. Tn. Ln.	10 in. HMA
Site 8: Palmer Park Blvd. at Winnebago Rd.	SW-71	EB-WB Center Median	3.5 in. HMA
Site 9: Peterson Rd. at Sequoyah Way	SW-81	EB Sequoyah Way Ln.	4 in. HMA
	SW-82	SB Peterson Rd Ln.	8 in. HMA
Site 10: Main St. at Marquette Dr.	SW-91	NB Main St. Rt. Ln.	12 in. HMA

NOTES
1. Pavement thickness measured from the bore hole annulus.
2. Bottom 11 inches of HMA consist of deteriorated HMA or HMA millings.

EB = Eastbound; HMA = Hot Mix Asphalt; in. = inches; Ln = Lane; NB = Northbound; Shr. = Shoulder; SB = Southbound; Tn = Turn; WB = Westbound

SOIL CLASSIFICATION

Shannon & Wilson uses a soil identification system modified from the Unified Soil Classification System (USCS) as described on this Key. Soil descriptions are based on visual-manual procedures (ASTM D2488) and available laboratory index test results (ASTM D2487).

Exhibit A: Unified Soil Classification System (USCS)[1]

Major Divisions			Symbol	Graphic	Typical Identifications (USCS Group Names)[2,4]
COARSE-GRAINED SOILS *(> 50% of soil is retained on the No. 200 sieve[3])*	**GRAVELS** *(> 50% of coarse fraction retained on the No. 4 sieve[3])*	**Gravel** *(< 5% fines[3])*	GW		Well-graded Gravel; Well-Graded Gravel with Sand
			GP		Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(> 12% fines[3])*	GM		Silty Gravel; Silty Gravel with Sand
			GC		Clayey Gravel; Clayey Gravel with Sand
	SANDS *(≥ 50% of coarse fraction passes the No. 4 sieve[3])*	**Sand** *(< 5% fines[3])*	SW		Well-graded Sand; Well-graded Sand with Gravel
			SP		Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(> 12% fines[3])*	SM		Silty Sand; Silty Sand with Gravel
			SC		Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(≥ 50% of soil passes the No. 200 sieve[3])*	**SILTS AND CLAYS** *(liquid limit < 50)*	**Inorganic**	ML		Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL		Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly, Lean Clay
		Organic	OL		Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly, Organic Silt or Clay
	SILTS AND CLAYS *(liquid limit ≥ 50)*	**Inorganic**	MH		Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly, Elastic Silt
			CH		Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly, Fat Clay
		Organic	OH		Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly, Organic Silt or Clay
HIGHLY ORGANIC SOILS	*Primarily organic matter, dark in color, and organic odor*		PT		Peat or other Highly Organic Soils (see ASTM D4427)

NOTE: *For gravels and sands with 5 to 12% fines[3], the following are added to the Group Name:* with Silt and/or Clay or Silty Clay. *Dual Symbols are used:* GW-GM, GP-GM, SW-SM, SP-SM GW-GC, GP-GC, SW-SC, SP-SC

EXHIBIT A NOTES:
1. Adapted, with permission, from USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488.
2. Borderline symbols (symbols separated by a slash) indicate that the soil characteristics are close to the defining boundary between two groups (e.g., CL/ML = Lean Clay to Silt; SP-SM/SM = Sand with Silt to Silty Sand).
3. No. 4 size = 4.75 millimeters (mm) = 0.187 inch; No. 200 sieve size = 0.075 mm = 0.003 inch. Particles smaller 0.075 mm are termed "fines".
4. Poorly graded indicates a narrow range or missing grain sizes. Well-graded indicates a full-range and even distribution of grain sizes.
5. If cobbles and/or boulders are observed, "with cobbles" or "with boulders" or "with cobbles and boulders" is added to the Group Name.

Exhibit B-1: Standard Penetration Test (SPT)

Term	Description
Hammer	140-pound weight with a 30-inch free fall. Hammer types vary (e.g., automatic, rope and cathead). If available, the hammer type and energy ratio (E-ratio) is noted on the boring log.
Sampler	Barrel I.D. / O.D. = 1.5 inches / 2 inches (liner not used) Barrel Length = 30 inches; Shoe I.D. = 1.375 inches
N-Value (N)[1]	Sum of the count of hammer blows to penetrate the second and third 6-inch increments in blows per foot (bpf). **Refusal**: 50 blows for 6 inches or less or 10 blows for 0 inch.

EXHIBIT B NOTES:
1. N-values shown on boring logs are as recorded in the field and have not been corrected for hammer energy, overburden, or other factors. Where the hammer E-ratio is available, the N-value normalized to a ratio of 60% (N_{60}) is listed.
2. Based on ASTM Standard D1586. Relative densities/consistencies noted on the boring logs are based on uncorrected N-values.
3. PP = pocket penetrometer; TV = torvane, tsf = tons per square foot. Correlations based on experience and multiple published references.

Exhibit B-2: Relative Consistency of Cohesive Soils

Term	N[2] (bpf)	PP[3] (tsf)	TV[3] (tsf)
Very Soft	0 - 2	0 - 0.25	0 - 0.12
Soft	2 - 4	0.25 - 0.5	0.12 - 0.25
Medium Stiff	4 - 8	0.5 - 1	0.25 - 0.5
Stiff	8 - 15	1 - 2	0.5 - 1
Very Stiff	15 - 30	2 - 4	1 - 2
Hard	> 30	> 4	> 2

Exhibit B-3: Relative Density of Cohesionless Soils

Term	N[2] (bpf)
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

Exhibit C: Soil Structure[1]

Term	Description
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Fissured	Breaks along definite planes or fractures with little resistance.
Homogeneous	Same color and appearance throughout.
Interbedded	Alternating layers at least 1/4 inch thick of varying material or color. *Singular: bed*
Laminated	Alternating layers less than 1/4 inch thick of varying material or color. *Singular: lamination*
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.

EXHIBIT C NOTE:
1. Adapted, with permission, from ASTM D2488.

Exhibit D: Soil Plasticity[1]

Term	Description
Nonplastic	Cannot roll a 1/8-inch thread at any water content.
Low Plasticity	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.
Medium Plasticity	A thread is easy to roll and not much time in rolling is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.
High Plasticity	It takes considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.

EXHIBIT D NOTE:
1. Adapted, with permission, from ASTM D2488.

Exhibit E: Soil Moisture Content[1]

Term	Description
Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp but no visible water.
Wet	Visible free water, from below water table.

EXHIBIT E NOTE:
1. Adapted, with permission, from ASTM D2488 (Figure 2).

Exhibit F: Soil Cementation[1]

Term	Description
Weak	Crumbles or breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

EXHIBIT F NOTE:
1. Adapted, with permission, from ASTM D2488.

Exhibit G: Percentages

Term	Percent[1]
Trace	<5
Few	5 to 10
Little	15 to 25
Some	30 to 45
Mostly	>50

EXHIBIT G NOTE:
1. Percent estimated by weight for sand and gravel, and by volume for cobbles, organics, and other non-soil material (e.g., rubble, debris).

SOIL CLASSIFICATION *(continued)*

See Page 1 for Soil Classification Exhibits A through G

Exhibit H: Particle Angularity and Shape[1]

Term	Description
Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width to thickness ratio > 3.
Elongated	Width to thickness ratio < 3.

EXHIBIT H NOTE:
1. Adapted, with permission, from ASTM D2488.

Exhibit I: Additional Descriptive Terms

Term	Description
Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling action.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

SOIL CLASSIFICATION REFERENCES:

ASTM International, [current edition], Annual book of standards, v. 04.08, soil and rock (I): D420 - D5876, available: www.astm.org.

U.S. Army Corps of Engineers, 1953, The unified soil classification system: Vicksburg, Miss., Waterways Experiment Station, Technical Memorandum 3-357, 2 v., March.

SYMBOLOGY AND GRAPHICS

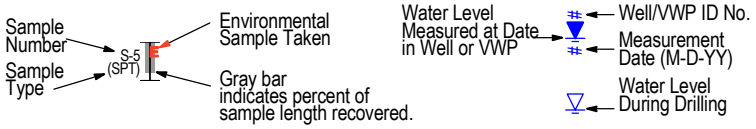
Exhibit J: Sample and Run Graphics

Graphic	Description	Graphic	Description	Graphic	Description
	SPT split spoon (2-inch OD)		Split spoon (SS) (diameters vary)		Core run (typically rock)
	Grab (GB) from cuttings or excavation		Modified California (MC) sampler		Sheath (SH) (used for geoprobes)
	Tube (TB) (e.g., Shelby, piston)		Sonic core (SC) run (typically soil)		

Exhibit K: Hole Backfill and Instrument Graphics

Graphic	Description	Graphic	Description	Graphic	Description
	Bentonite-cement grout		Surface cement seal		Blank pipe or instrument casing
	Bentonite grout		Sand filter pack		Perforated or slotted pipe
	Bentonite chips		Slough *(hole caved)*		VWP and electric lead

Exhibit L: Other Log Symbols



ROCK CLASSIFICATION

Shannon & Wilson uses a rock classification system modified from the system recommended by the International Society for Rock Mechanics (ISRM). Copyright limitations prevent us from reproducing summary tables from the ISRM system on this Key. General descriptions are provided in Exhibit M.

Exhibit M: General Rock Descriptive Terms - ISRM

Term	General Description
Strength	Ranges from extremely weak (q_u = 36 to 135 psi) to extremely strong (q_u > 36,250 psi), and is based on the ability to break the rock with a hammer or scrape the rock with a knife.
Weathering	Ranges from fresh (no visible signs of weathering) to completely weathered, based on observed degree of discoloration, decomposition, and/or disintegration. When the rock material has completely converted to soil, it is termed a residual soil.
Fabric	Describes the rock structure based on observed layering, tendency to break, and distribution of minerals (e.g., massive, bedded, foliated).
Roughness	For discontinuities: Includes rough, smooth, and slickensided, and includes other descriptive terms (e.g., stepped, undular, irregular, planar).
Spacing	For discontinuities: Ranges from extremely close (< 1 inch) to extremely wide (> 20 feet).
Persistence	For discontinuities: Ranges from very low to very high.
Other	Description of discontinuities (joints, fractures, bedding planes, etc.), observations of potential displacement, gouge, shear, etc.

REFERENCE: Brown, E. T., ed., 1981, Rock characterization, testing & monitoring: International Society of Rock Mechanics (ISRM) suggested methods: Oxford, Pergamon Press, 211 p.

Exhibit N: Rock Name Graphics

Graphic	Description	Graphic	Description
	Sandstone		
	Claystone		

Exhibit O: Recovery and RQD Equations[1]

Term	Equation
Core Recovery (REC) in %	$100\% \times \frac{\text{Length of Core Recovered}}{\text{Length of Core Run}}$
Rock Quality Designation (RQD) in %	$100\% \times \frac{\text{Length of Core in Pieces} > 4 \text{ in}}{\text{Length of Core Run}}$

REFERENCE: Loehr, J. E.; Lutenegger, A.; Rosenblad, B.; and Boeckmann, A., 2016, Geotechnical site characterization: U.S. Federal Highway Administration Report FHWA NHI-16-072, Geotechnical Engineering Circular no. 5, 1 v.

ACRONYMS AND ABBREVIATIONS

ATD	at time of drilling	N	field (uncorrected) SPT N-value	REF	refusal
bpf	blows per foot	N_{60}	SPT N-value corrected for 60% ETR	RQD	rock quality designation (ASTM D6032)
dia, diam	diameter	NA, n/a	not applicable or not available	SC	sonic core
Elev.	elevation	NE	northeast	SE	southeast
ENV	environmental sample	NP	nonplastic	SPT	Standard Penetration Test (ASTM D1586)
ETR	energy transfer ratio (hammer)	NR	no recovery	SW	southwest
FC	fines content (< 0.075 mm)	NW	northwest	TP	test pit
FeO	iron oxide	OC	organic content	tsf	tons per square foot
ft or '	foot or feet	OD	outside diameter	TV	tor vane reading
gal	gallons	OW	observation well	UCS, q_u	unconfined compressive strength
GP	geoprobe	pcf	pounds per cubic foot	USCS	Unified Soil Classification System
GWT	groundwater table	PI	plasticity index	VST	vane shear test
HSA	hollow-stem auger	PID	photoionization detector	VWP	vibrating wire piezometer
ID	inside diameter or identification	PL	plastic limit	WC	natural water content
in or "	inch	PMT	pressuremeter test	WOH	weight of hammer
incl	inclinometer	PP	pocket penetrometer reading	WOR	weight of rods
ksf	kips per square foot	ppm	parts per million		
lbs	pounds	psi	pounds per square inch		
LL	liquid limit	PT	nonstandard penetration test N-value		
mm	millimeter	REC	recovery		

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-01
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*25.9 feet*
Top Elevation:	*~7804 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 39.0129 degrees*
Longitude:	*~ -104.7004 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 2, 2024*
Hole Finish Date:	*October 2, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
7800	0	Hard, brown to light gray, ***SILT*** (ML); moist; fine sand. [A-7-6] Residuum			Bulk 1 (GB) S-1 (SPT)	N = 6,19,26 (45 bpf)	WC=17% FC=66% LL/PI=47/19		
		SANDSTONE: very weak, brown to light gray, highly to moderately weathered; iron oxide staining. Dawson Formation [Very dense, ***CLAYEY SAND*** (SC); moist to dry; trace gravel]		4.0	S-2 (MC12)	PT = 50/3" (50/3" bpf)	WC=13% FC=63%		
7795	5				S-3 (MC12)	PT = 50/5" (50/5" bpf)	WC=11% RES=3000 OhmCm		5
	10	*-Hydrocarbon odor observed in samples S-4 through S-8.*			S-4 (SPT)	N = 35,50/6" (50/6" bpf)			10
7790					S-5 (SPT)	N = 45,50/5" (50/5" bpf)			
	15	***CLAYSTONE***: very weak, brown to light gray, highly weathered. Dawson Formation [Hard, ***SANDY LEAN CLAY*** (CL); moist]		15.5	S-6 (SPT)	N = 35,50/5" (50/5" bpf)			15
7785		***SANDSTONE***: very weak, brown to light gray, highly weathered. Dawson Formation [Very dense, ***CLAYEY SAND*** (SC); moist; few gravel]		18.0					
	20				S-7 (SPT)	N = 46,50/3" (50/3" bpf)			20
7780									
	25				S-8 (SPT)	N = 44,50/5" (50/5" bpf)			25
	25.9	BOTTOM OF HOLE AT 25.9 FEET		25.9					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

SHANNON & WILSON | 5900 WEST 38TH AVENUE | WHEAT RIDGE, COLORADO 80212 | 303-825-3800 | www.shannonwilson.com

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-02
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.0 feet*
Top Elevation:	*~7936 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 39.0136 degrees*
Longitude:	*~ -104.7006 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 2, 2024*
Hole Finish Date:	*October 2, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type: S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
7935	0	***ASPHALT;*** 15 inches.							
		Medium dense, yellow to dark brown, ***CLAYEY SAND*** (SC); moist; trace to few gravel. [A-2-4] Residuum		1.3	S-1 (SPT)	N = 12,14,15 (29 bpf)	WC=6% FC=22% LL/PI=27/10		
					Bulk 1 (GB)				
					S-2 (MC12)	PT = 16,10 (26 bpf)	WC=6% WC=11%		
					Bulk 2 (GB)				
7930	5	Loose, brown to light-gray, ***WELL-GRADED SAND WITH CLAY*** (SW-SC); moist; trace gravel. Residuum		4.5	S-3 (MC12)	PT = 4,5 (9 bpf)	WC=9%		5
	6	BOTTOM OF HOLE AT 6 FEET		6.0					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-03

EXPLORATION INFORMATION

Total Depth:	*5.9 feet*
Top Elevation:	*~7936 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 39.0128 degrees*
Longitude:	*~ -104.7015 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 2, 2024*
Hole Finish Date:	*October 2, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type: S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling: ▽

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
7935		***ASPHALT;*** 24 inches. *-Bottom 11 inches of HMA consists of deteriorated HMA or HMA milling.*							
		Loose to medium dense, dark brown to light-gray, ***CLAYEY SAND*** (SC); moist; few gravel. [A-2-6] Residuum		2.0	S-1 (SPT) Bulk 1 (GB) S-2 (MC12) Bulk 2 (GB)	N = 32,16,9 (25 bpf) PT = 4,5 (9 bpf) PP = 3.25 tsf	WC=3% WC=12% FC=34% LL/PI=40/23 R-Value=22.7	● ▲ ● ◇	
5		***SANDSTONE***: very weak, brown to red-yellow, highly weathered. Dawson Formation		4.0					
5.9		[Very dense, ***WELL GRADED SAND WITH CLAY*** (SW-SC); moist; trace gravel]		5.9	S-3 (MC12)	PT = 30,50/5" (80/11" bpf)	WC=8%	● >>	5
		BOTTOM OF HOLE AT 5.9 FEET							

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-04
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.0 feet*
Top Elevation:	*~8122 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 39.0122 degrees*
Longitude:	*~ -104.7006 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 2, 2024*
Hole Finish Date:	*October 2, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type: S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
8120	0	***ASPHALT;*** 14 inches.							
		Dense to very dense, red-yellow to brown, ***CLAYEY SAND*** (SC); moist; few gravel. [A-2-6] Residuum		1.2	S-1 (SPT)	N = 12,18,24 (42 bpf)	WC=9% FC=21% LL/PI=38/16		
					Bulk (GB) S-2 (MC12)	PT = 25,45 (70 bpf)	WC=5%		
	5	***SANDSTONE***: very weak, brown to red-brown, highly weathered. Dawson Formation [Very dense, ***WELL GRADED SAND WITH CLAY*** (SW-SC); moist; trace gravel]		4.5	S-3 (MC12)	PT = 42,50/2" (92/8" bpf)	WC=9%	>>	5
	6	BOTTOM OF HOLE AT 6 FEET		6.0					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-05
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~8122 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 39.0128 degrees*
Longitude:	*~ -104.6996 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 2, 2024*
Hole Finish Date:	*October 2, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
8120	0	***ASPHALT;*** 11 inches.							
		Medium dense to dense, dark brown to yellow-brown, ***CLAYEY SAND*** (SC); moist; few gravel. [A-2-6] Residuum		0.9	Bulk 1 (GB) S-1 (SPT) S-2 (MC12) Bulk 2 (GB)	N = 18,18,14 (32 bpf) PT = 15,12 (27 bpf)	WC=7% FC=21% LL/PI=31/15 WC=7%	● ◇ ▲	
	5	***SANDSTONE***: very weak, yellow-brown, highly weathered. Dawson Formation [Very dense, ***WELL GRADED SAND WITH CLAY and GRAVEL*** (SW-SC); moist]		4.0	S-3 (SPT)	N = 25,35,45 (80 bpf)	WC=10%	●	5
	6.5	BOTTOM OF HOLE AT 6.5 FEET		6.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-11
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~6500 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8677 degrees*
Longitude:	*~ -104.7078 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 3, 2024*
Hole Finish Date:	*September 3, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
6495	0	***ASPHALT;*** 4 inches.		0.3					
		Medium dense, red-brown, ***POORLY GRADED SAND WITH SILT AND GRAVEL*** (SP-SM); moist. [A-1-b] Base Course		0.6					
	5	Loose to medium dense, light brown, ***CLAYEY SAND*** (SC); moist. [A-2-6 to A-4] Eolian			S-1 (SPT)	N = 6,6,6 (12 bpf)	S-1A : WC=2% FC=10% S-1B : WC=9% FC=24% LL/PI=31/11		
					S-2 (SPT)	N = 3,4,3 (7 bpf)	WC=15% FC=36% LL/PI=28/8		
					S-3 (MC12)	PT = 6,8 (14 bpf)	WC=16% WD=124 pcf Swell=- 0.5 %		
	6.5	BOTTOM OF HOLE AT 6.5 FEET		6.5					5

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-12
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*5.0 feet*
Top Elevation:	*~6504 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8681 degrees*
Longitude:	*~ -104.7074 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*August 19, 2024*
Hole Finish Date:	*August 19, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
6500	0	***ASPHALT;*** 4 inches.		0.3					
		Loose to medium dense, red-brown, ***POORLY GRADED SAND WITH SILT AND GRAVEL*** (SP-SM); moist. [A-1-b] Base Course		1.3	S-1 (SPT)	N = 10,6,3 (9 bpf) PP = 1 tsf	S-1A : WC=3% FC=11%		
					S-2 (MC12) Bulk (GB)	PT = 2,3 (5 bpf) PP = 1 tsf	S-1B : WC=14% FC=36% WC=14% FC=44% LL/PI=32/16		
	5	Loose, light brown to dark brown, ***CLAYEY SAND*** (SC); moist; trace gravel. [A-2-4] Eolian		5.0	S-3 (MC12)	PT = 2,2 (4 bpf)	WC=16% WD=117 pcf Swell=- 0.7 %		5
		BOTTOM OF HOLE AT 5 FEET							

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-13
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*26.5 feet*
Top Elevation:	*~6495 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8681 degrees*
Longitude:	*~ -104.7082 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*August 19, 2024*
Hole Finish Date:	*August 19, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data
		ASPHALT; 4.5 inches.		0.4			
		Loose, red-brown, ***POORLY GRADED SAND WITH SILT AND GRAVEL*** (SP-SM); moist. [A-1-b] Base Course		1.3			
6490	5	Stiff, dark brown, ***LEAN CLAY WITH SAND*** (CL); moist; trace gravel. [A-6] Eolian		5.7			
6485	10	Loose to medium dense, light brown, ***SILTY SAND*** (SM); moist. Eolian					
6480	15						
6475	20						
6470	25						
26.5		BOTTOM OF HOLE AT 26.5 FEET		26.5			

No Observed Groundwater

Samples	Field Data	Lab Data
S-1 (SPT)	N = 8,3,3 (6 bpf)	S-1A : WC=6% FC=20% FC=71% LL/PI=35/19 RES=1500 OhmCm R-Value=15.0 S-1B : WC=19% FC=59% WC=18% WD=124 pcf Swell=0 % WC=21% WC=15%
S-2 (MC12) Bulk (GB)	PT = 4,6 (10 bpf) PP = 1 tsf	
S-3 (MC12)	PT = 5,4 (9 bpf) PP = 1.25 tsf	
S-4 (MC12)	PT = 3,2 (5 bpf)	
S-5 (MC12)	PT = 11,10 (21 bpf)	WC=5%
S-6 (SPT)	N = 6,6,6 (12 bpf)	WC=7% FC=17% LL/PI=NP/NP
S-7 (SPT)	N = 5,6,6 (12 bpf)	WC=9%
S-8 (SPT)	N = 7,9,8 (17 bpf)	WC=5%
S-9 (SPT)	N = 8,8,10 (18 bpf)	WC=6%

Multiple Items Plotted *(see bottom legend on Page 1)*: 0 — 50 — 100

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-21
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~6337 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8461 degrees*
Longitude:	*~ -104.7086 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 3, 2024*
Hole Finish Date:	*September 3, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
6335	0	***ASPHALT;*** 4 inches.		0.3					
		Medium dense, red-brown, ***SILTY SAND WITH GRAVEL*** (SM); dry. [A-2-4] Alluvium		2.0	S-1 (SPT)	N = 8,6,7 (13 bpf)	S-1A : WC=5% FC=14% S-1B : WC=9%		
	5	Medium dense, light brown, ***POORLY GRADED SAND WITH SILT*** (SP-SM); moist; few gravel. [A-1-b] Alluvium			Bulk (GB) S-2 (SPT)	N = 7,8,9 (17 bpf)	WC=6% FC=9%		5
					S-3 (SPT)	N = 8,11,11 (22 bpf)	WC=37%		
	6.5	BOTTOM OF HOLE AT 6.5 FEET		6.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-22
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*26.5 feet*
Top Elevation:	*~6338 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8462 degrees*
Longitude:	*~ -104.7081 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 3, 2024*
Hole Finish Date:	*September 3, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
6335	0	***ASPHALT;*** 4 inches.		0.3					0
		Medium dense, light brown, ***SILTY, CLAYEY SAND*** (SC-SM); moist; trace gravel. [A-1-b] Alluvium			S-1 (SPT)	N = 9,10,12 (22 bpf)	WC=6% FC=17% LL/PI=22/5 RES=7600 OhmCm R-value=24.2		
					Bulk (GB)				
					S-2 (SPT)	N = 7,8,7 (15 bpf)	WC=6%		
6330	5	Medium dense, light brown, ***POORLY GRADED SAND WITH SILT*** (SP-SM); moist; trace to few gravel. Alluvium		5.0	S-3 (SPT)	N = 7,9,11 (20 bpf)	WC=6% FC=9%		5
					S-4 (SPT)	N = 8,9,11 (20 bpf)	WC=4%		
6325	10				S-5 (SPT)	N = 9,9,10 (19 bpf)	WC=8%		10
					S-6 (SPT)	N = 9,9,8 (17 bpf)	WC=7%		
6320	15				S-7 (SPT)	N = 10,7,9 (16 bpf)	WC=7%		15
		Medium stiff to stiff, light brown, ***SANDY LEAN CLAY*** (CL); moist. Alluvium		18.2					
	20				S-8 (SPT)	N = 4,3,4 (7 bpf)	WC=21% FC=68% LL/PI=31/12		20
6315	25				S-9 (MC12)	PT = 6,7 (13 bpf)	WC=29% WD=124 pcf		25
	26.5	BOTTOM OF HOLE AT 26.5 FEET		26.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

SHANNON & WILSON | 5900 WEST 38TH AVENUE | WHEAT RIDGE, COLORADO 80212 | 303-825-3800 | www.shannonwilson.com

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-23
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~6341 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8461 degrees*
Longitude:	*~ -104.7083 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 3, 2024*
Hole Finish Date:	*September 3, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
6340	0	***ASPHALT;*** 4 inches.		0.3					
		Very loose to medium dense, light brown, ***WELL-GRADED SAND WITH SILT*** (SW-SM); moist; few gravel. [A-1-b] Alluvium			S-1 (SPT)	N = 9,9,7 (16 bpf)	WC=5%	●	
					Bulk (GB) S-2 (SPT)	N = 3,2,1 (3 bpf)	WC=4% FC=11% LL/PI=23/3	◇ H	
6335	5				S-3 (SPT)	N = 1,2,7 (9 bpf)	WC=5%	●	5
	6.5	BOTTOM OF HOLE AT 6.5 FEET		6.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-31

EXPLORATION INFORMATION

Total Depth:	*26.5 feet*
Top Elevation:	*~6007 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7756 degrees*
Longitude:	*~ -104.7905 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 1, 2024*
Hole Finish Date:	*October 1, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
6005	0	***ASPHALT;*** 10 inches.		0.8					0
		Medium dense, red-brown to brown, ***CLAYEY SAND WITH GRAVEL*** (SC); moist. [A-2-6] Fill			S-1 (MC12)	PT = 7,11 (18 bpf)	WC=11% FC=34% LL/PI=28/11		
					Bulk (GB) / S-2 (MC12)	PT = 8,7 (15 bpf)	WC=3% RES=10500 OhmCm		
	5	Medium stiff to stiff, brown to dark brown, ***LEAN CLAY*** (CL); moist; few gravel. [A-6] Alluvium		4.0	S-3 (MC12)	PT = 5,7 (12 bpf) PP = 4.5 tsf	WC=12%		5
6000					S-4 (SPT)	N = 3,2,4 (6 bpf)	WC=23% FC=88% LL/PI=45/27		
	10				S-5 (MC12)	PT = 4,4 (8 bpf) PP = 2.75 tsf	WC=11% Swell=0.3 %		10
5995					S-6 (MC12)	PT = 3,5 (8 bpf) PP = 4.5 tsf	WC=13%		
	15				S-7 (MC12)	PT = 3,5 (8 bpf) PP = 4.5 tsf	WC=10%		15
5990									
		Medium dense to dense, red-yellow to dark brown, ***CLAYEY SAND WITH GRAVEL*** (SC); moist. Alluvium		18.0					
	20				S-8 (MC12)	PT = 16,25 (41 bpf)	WC=7%		20
5985									
	25				S-9 (SPT)	N = 3,8,9 (17 bpf)	WC=7%		25
26.5		BOTTOM OF HOLE AT 26.5 FEET		26.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit ——●—— Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-32

EXPLORATION INFORMATION

Total Depth:	*1.6 feet*
Top Elevation:	*~5940 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7753 degrees*
Longitude:	*~ -104.7905 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 1, 2024*
Hole Finish Date:	*October 1, 2024*

DRILLING INFORMATION

Drilling Method:	*Hand Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*Hand Auger*
Hole Size:	*4 inch*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type: S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
		ASPHALT; 7 inches.		0.6	S-1 (GB)		WC=3% FC=5% LL/PI=NP/NP		
	1.6	Red-brown to red, ***WELL-GRADED SAND WITH GRAVEL*** (SW); moist; trace gravel. [A-1-a] Fill		1.6					
		BOTTOM OF HOLE AT 1.6 FEET							

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-33
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.0 feet*
Top Elevation:	*~5848 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7754 degrees*
Longitude:	*~ -104.7901 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 1, 2024*
Hole Finish Date:	*October 1, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type: S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
5845	0	***ASPHALT;*** 9.5 inches.		0.8					
		Medium dense, red-brown to red, ***WELL-GRADED SAND WITH CLAY AND GRAVEL*** (SW-SC); moist. [A-1-b] Fill		2.0	Bulk 1 (GB) S-1 (SPT) S-2 (MC12) Bulk 2 (GB)	N = 13,10,8 (18 bpf) PT = 4,6 (10 bpf) PP = 3.25 tsf	WC=4% FC=55% LL/PI=31/17 R-Value=9 WC=14%	▲ ◇	
5	5	Stiff, dark brown to gray, ***SANDY LEAN CLAY*** (CL); moist; trace gravel. [A-6] Alluvium							5
6	6	BOTTOM OF HOLE AT 6 FEET		6.0	S-3 (SPT)	N = 5,7 PP = 3 tsf	WC=19%	●	

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-41
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*26.5 feet*
Top Elevation:	*~6190 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7663 degrees*
Longitude:	*~ -104.7394 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 10, 2024*
Hole Finish Date:	*September 10, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
		ASPHALT; 8 inches.		0.5					
		Loose to medium dense, red-brown, ***SILTY SAND*** (SM); moist. [A-2-4] Eolian			S-1 (SPT)	N = 6,6,5 (11 bpf)	FC=20% LL/PI=NP/NP RES=10000 OhmCm R-value=42.8		
					Bulk (GB)				
					S-2 (MC12)	PT = 4,4 (8 bpf)	WC=6% WC=7%		
6185	5	Loose, red-yellow to red-brown, ***POORLY GRADED SAND WITH CLAY*** (SP-SC); moist. Alluvium		5.0	S-3 (MC12)	PT = 4,5 (9 bpf)	WC=7%		5
					S-4 (SPT)	N = 3,3,2 (5 bpf)	WC=7%		
6180	10				S-5 (SPT)	N = 3,3,3 (6 bpf)	WC=6% FC=10%		10
					S-6 (SPT)	N = 2,2,2 (4 bpf)	WC=7%		
6175	15	Loose, red-yellow to red-brown, ***POORLY GRADED SAND*** (SP); moist. Alluvium		14.5	S-7 (SPT)	N = 3,4,5 (9 bpf)	WC=6%		15
		Loose, red-yellow to red-brown, ***CLAYEY SAND*** (SC); moist; wet below 25 feet.. Alluvium		18.0					
6170	20				S-8 (SPT)	N = 4,4,4 (8 bpf)	WC=8% FC=23%		20
6165	25				9-10-24 ▽ S-9 (SPT)	N = 4,4,3 (7 bpf)	WC=19%		25
	26.5	BOTTOM OF HOLE AT 26.5 FEET		26.5					

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

SHANNON & WILSON | 5900 WEST 38TH AVENUE | WHEAT RIDGE, COLORADO 80212 | 303-825-3800 | www.shannonwilson.com

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-42

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~6227 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7664 degrees*
Longitude:	*~ -104.7390 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 9, 2024*
Hole Finish Date:	*September 9, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type: S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)*	Depth (feet)
6225	0	***ASPHALT;*** 5 inches.		0.4					
		Medium dense, brown to dark brown, ***POORLY GRADED SAND WITH CLAY*** (SP-SC); moist. [A-1-b] Eolian		2.3	S-1 (SPT)	N = 9,8,11 (19 bpf)	S-1A : WC=3%	0 50 100	
							S-1B : WC=7%		
					Bulk (GB) S-2 (SPT)	N = 6,5,5 (10 bpf)	WC=4% FC=12% LL/PI=NP/NP		
	5	Loose to to medium dense, brown to dark brown, ***POORLY GRADED SAND WITH SILT*** (SP-SM); moist. [A-2-4] Alluvium							5
	6.5			6.5	S-3 (SPT)	N = 3,4,3 (7 bpf)	WC=5%		

No Observed Groundwater

BOTTOM OF HOLE AT 6.5 FEET

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-51A
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.0 feet*
Top Elevation:	*~5714 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7374 degrees*
Longitude:	*~ -104.7219 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 10, 2024*
Hole Finish Date:	*September 10, 2021*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering, Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
5710	0	***ASPHALT;*** 6.5 inches.		0.5					
		Very loose to loose, dark brown to brown, ***SILTY SAND*** (SM); moist; trace gravel. [A-2-4] Alluvium			S-1 (SPT)	N = 4,3,2 (5 bpf)	WC=8% FC=25% LL/PI=19/1 RES=7100 OhmCm R-value=45.6	◇	
					Bulk (GB) S-2 (MC12)	PT = 1,2 (3 bpf)	WC=7%		
	5				S-3 (MC12)	PT = 4,4 (8 bpf)	WC=8%		5
	6	BOTTOM OF HOLE AT 6 FEET		6.0					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-51B
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*26.5 feet*
Top Elevation:	*~5714 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7374 degrees*
Longitude:	*~ -104.7219 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*October 1, 2024*
Hole Finish Date:	*October 1, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
		ASPHALT; 7 inches.		0.6					
5710	5	Loose, dark brown to brown, ***SILTY SAND*** (SM); moist; trace gravel. [A-2-4] Alluvium			S-1 (MC12)	PT = 9,5 (14 bpf)			5
					Bulk (GB)				
					S-2 (MC12)	PT = 3,4 (7 bpf)			
					S-3 (SPT)	N = 3,2,2 (4 bpf)			
5705	10	Loose, yellow-brown to brown, ***WELL-GRADED SAND*** (SW); moist; fine to coarse sand; trace gravel. Eolian		7.0	S-4 (MC12)	PT = 2,4 (6 bpf)	WC=5% FC=13%		10
					S-5 (SPT)	N = 2,2,2 (4 bpf)	WC=3%		
5700	15	Loose, brown to red-brown, ***POORLY GRADED SAND WITH CLAY*** (SP-SC); moist; fine to medium sand. Eolian		12.0	S-6 (MC12)	PT = 2,2 (4 bpf)	WC=5%		15
					S-7 (SPT)	N = 3,3,4 (7 bpf)	WC=6% FC=14%		
5695	20	Medium dense, red-yellow to red-brown, ***POORLY GRADED SAND*** (SP); moist; fine to coarse sand. Eolian		18.0	S-8 (MC12)	PT = 4,7 (11 bpf)	WC=6%		20
5690	25				S-9 (SPT)	N = 8,8,18 (26 bpf)	WC=12%		25
26.5		Medium dense, red-yellow to brown, ***WELL-GRADED SAND WITH GRAVEL*** (SW); moist; trace iron oxide staining. Alluvium		26.1 26.5					
		BOTTOM OF HOLE AT 26.5 FEET							

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-52
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*4.0 feet*
Top Elevation:	*~5717 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7373 degrees*
Longitude:	*~ -104.7217 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 10, 2024*
Hole Finish Date:	*September 10, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
5715	0	***ASPHALT;*** 10 inches.							
		Loose to medium dense, brown, ***SILTY, CLAYEY SAND*** (SC-SM); moist; few gravel. [A-2-4] Alluvium		0.8	S-1 (SPT)	N = 8,6,9 (15 bpf)	WC=9% FC=26% LL/PI=23/6	● ▲ ◇	
					S-2 (SPT)	N = 6,8,10 (18 bpf)	WC=7%	● ▲	
4	4	*-Buried utility encountered at a depth of 4 feet. Drilling advancement was termined.*		4.0					
		BOTTOM OF HOLE AT 4 FEET							

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-61
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~5751 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7547 degrees*
Longitude:	*~ -104.7390 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 9, 2010*
Hole Finish Date:	*September 9, 2010*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
5750		***ASPHALT;*** 8 inches.		0.7					
		Loose, dark brown to dark red brown, ***SILTY SAND*** (SM); moist. [A-2-4] Eolian		2.3	S-1 (SPT)	N = 4,2,2 (4 bpf)	WC=6% FC=23% LL/PI=NP/NP	◇	
		Very loose, brown to yellow brown, ***POORLY GRADED SAND WITH SILT*** (SP-SM); moist. [A-2-4] Eolian			Bulk (GB) S-2 (SPT)	N = 2,1,1 (2 bpf)	WC=6% FC=12% LL/PI=NP/NP	◇	
5745	5				S-3 (SPT)	N = 2,2,1 (3 bpf)	WC=5%		5
	6.5	BOTTOM OF HOLE AT 6.5 FEET		6.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

SHANNON & WILSON | 5900 WEST 38TH AVENUE | WHEAT RIDGE, COLORADO 80212 | 303-825-3800 | www.shannonwilson.com

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-62

EXPLORATION INFORMATION

Total Depth:	26.5 feet
Top Elevation:	~5751 feet
Vertical Datum:	n/a
Latitude:	~ 38.7549 degrees
Longitude:	~ -104.7387 degrees
Horizontal Datum:	WGS [GCS1984]
Hole Start Date:	September 9, 2024
Hole Finish Date:	September 9, 2024

DRILLING INFORMATION

Drilling Method:	Solid Stem Auger
Drilling Company:	Entech Engineering Inc.
Drill Rig Equipment:	SIMCO 2800
Hole Size:	4 inch
Rod Type/Dia.:	n/a
Hammer Wt. / Drop:	140 lbs/30 inches
Hammer ETR:	n/a

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted (see bottom legend on Page 1) 0 50 100	Depth (feet)
5750	0	***ASPHALT;*** 5 inches.		0.5					
		Medium dense, red brown to dark brown, ***CLAYEY SAND WITH GRAVEL*** (SC); moist. [A-2-6] Fill		2.0	S-1 (SPT)	N = 7,8,6 (14 bpf)	FC=22% LL/PI=NP/NP RES=4200 OhmCm R-value=58.3		
		Loose to to medium dense, brown to yellow-brown, ***SILTY SAND*** (SM); moist; trace gravel. [A-2-4] Eolian			Bulk (GB) S-2 (SPT)	N = 4,4,5 (9 bpf)	S-1A : WC=6% S-1B : WC=16% WC=4%		
5745	5				S-3 (SPT)	N = 5,5,6 (11 bpf)	WC=3%		5
		Loose to medium dense, brown to yellow-brown, ***CLAYEY SAND*** (SC); moist; iron oxide staining below 15 feet.. Eolian		7.0	S-4 (SPT)	N = 6,6,6 (12 bpf)	WC=7%		
5740	10				S-5 (SPT)	N = 7,6,7 (13 bpf)	WC=5% FC=32%		10
					S-6 (SPT)	N = 8,9,10 (19 bpf)	WC=4%		
5735	15				S-7 (SPT)	N = 4,6,4 (10 bpf)	WC=5%		15
					S-8 (SPT)	N = 5,5,5 (10 bpf)	WC=5%		
5730	20			23.0					20
		Medium dense, brown to yellow-brown, ***POORLY GRADED SAND WITH GRAVEL*** (SP); moist. Alluvium							
5725	25				S-9 (SPT)	N = 14,16,12 (28 bpf)	WC=2%		25
	26.5	BOTTOM OF HOLE AT 26.5 FEET		26.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

SHANNON & WILSON | 5900 WEST 38TH AVENUE | WHEAT RIDGE, COLORADO 80212 | 303-825-3800 | www.shannonwilson.com

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-63

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~5926 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7546 degrees*
Longitude:	*~ -104.7387 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 30, 2024*
Hole Finish Date:	*September 30, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type: S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
5925	0	***ASPHALT;*** 10 inches.		0.8					
		Medium dense, red-brown to brown, ***POORLY GRADED SAND*** (SP); moist; few gravel. [A-1-b] Fill		1.5	S-1 (MC12)	PT = 12,7 (19 bpf)	WC=1%		
		Loose, red-yellow, ***SILTY SAND*** (SM); moist. [A-2-4] Eolian			Bulk (GB)	PT = 3,5 (8 bpf)	WC=9% FC=24% LL/PI=24/3		
5920	5				S-2 (MC12)				5
					S-3 (SPT)	N = 4,3,4 (7 bpf)	WC=8%		
	6.5	BOTTOM OF HOLE AT 6.5 FEET		6.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-71

EXPLORATION INFORMATION

Total Depth:	*26.5 feet*
Top Elevation:	*~6432 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8590 degrees*
Longitude:	*~ -104.6976 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*August 19, 2024*
Hole Finish Date:	*August 19, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
6430	0	***ASPHALT;*** 3.5 inches.		0.3					0
		Loose, light brown, ***CLAYEY SAND*** (SC); moist. [A-6] Eolian			S-1 (SPT)	N = 4,5,4 (9 bpf)	WC=9% FC=48% LL/PI=33/15 RES=2600 OhmCm R-value=24.0		
					Bulk (GB) S-2 (MC12)	PT = 3,2 (5 bpf)	WC=15% WD=115 pcf Swell=-1.4 %		
6425	5				S-3 (MC12)	PT = 2,2 (4 bpf)	WC=20%		5
					S-4 (MC12)	PT = 2,3 (5 bpf)	WC=13%		
				9.2					
6420	10	Medium dense, light brown, ***WELL-GRADED SAND WITH SILT*** (SW-SM); moist; trace to few gravel.. Alluvium			S-5 (SPT)	N = 6,7,10 (17 bpf)	WC=3%		10
					S-6 (SPT)	N = 10,12,12 (24 bpf)	WC=3% FC=7% LL/PI=NP/NP		
6415	15				S-7 (SPT)	N = 10,12,12 (24 bpf)	WC=5%		15
6410	20				S-8 (SPT)	N = 9,10,13 (23 bpf)	WC=4%		20
	25				S-9 (SPT)	N = 9,11,11 (22 bpf)	WC=7%		25
	26.5	BOTTOM OF HOLE AT 26.5 FEET		26.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY.GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-81
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*26.5 feet*
Top Elevation:	*~6418 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8554 degrees*
Longitude:	*~ -104.6981 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 3, 2024*
Hole Finish Date:	*September 3, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
		ASPHALT; 4 inches.		0.3					
6415		Loose, brown dark brown, ***CLAYEY SAND*** (SC); moist; rootlets in upper foot. [A-2-4] Eolian			S-1 (SPT)	N = 9,5,3 (8 bpf)	FC=27% LL/PI=22/9 RES=5500 OhmCm R-value=33.2		
					Bulk (GB)		WC=5%		
	5				S-2 (SPT)	N = 2,2,2 (4 bpf)	WC=6%		5
6410					S-3 (SPT)	N = 1,2,2 (4 bpf)	WC=8%		
					S-4 (SPT)	N = 3,3,4 (7 bpf)	WC=6%		
	10	Medium dense, light brown, ***POORLY GRADED SAND WITH SILT*** (SP-SM); moist; few gravel. Alluvium		9.5	S-5 (SPT)	N = 3,8,11 (19 bpf)	WC=3% FC=12%		10
6405					S-6 (SPT)	N = 4,7,10 (17 bpf)	S-6A : WC=2%		
		Medium dense, light brown, ***CLAYEY SAND*** (SC); dry. Alluvium		13.6			S-6B : WC=8% FC=48% LL/PI=29/11		
	15			14.5	S-7 (SPT)	N = 8,14,12 (26 bpf)	WC=2% FC=8%		15
6400		Medium dense, light brown, ***POORLY GRADED SAND WITH SILT*** (SP-SM); moist; trace gravel.. Alluvium							
		Medium dense, light brown, ***POORLY GRADED GRAVEL WITH SILT*** (GP-GM); moist; trace to few sands.. Alluvium		18.2					
	20				S-8 (SPT)	N = 11,10,13 (23 bpf)	WC=5%		20
6395									
	25				S-9 (MC12)	PT = 13,15 (28 bpf)	WC=5%		25
26.5		BOTTOM OF HOLE AT 26.5 FEET		26.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-82
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~6417 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.8554 degrees*
Longitude:	*~ -104.6986 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 3, 2024*
Hole Finish Date:	*September 3, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*AWJ 1.75 inch*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type: S-5 (SPT) — Gray bar indicates percent of sample length recovered.

Water Level During Drilling

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
6415	0	***ASPHALT;*** 8 inches.		0.7					
		Medium dense, red-brown, ***POORLY GRADED GRAVEL WITH SILT AND SAND*** (GP-GM); moist. [A-1-b] Base Course		1.0	S-1 (SPT)	N = 6,5,4 (9 bpf)	WC=6%		
		Very loose to loose, dark brown, ***SILTY SAND*** (SM); moist. [A-2-4] Eolian			Bulk (GB) S-2 (SPT)	N = 2,1,2 (3 bpf)	WC=5% FC=20% LL/PI=NP/NP		
5					S-3 (SPT)	N = 2,2,2 (4 bpf)	WC=6%		5
6.5		BOTTOM OF HOLE AT 6.5 FEET		6.5					

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	SFP
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

SHANNON & WILSON

BORING LOG

El Paso County Pedestrian Crossings
El Paso County, Colorado

SW-91
Page 1 of 1

EXPLORATION INFORMATION

Total Depth:	*6.5 feet*
Top Elevation:	*~5926 feet*
Vertical Datum:	*n/a*
Latitude:	*~ 38.7538 degrees*
Longitude:	*~ -104.7396 degrees*
Horizontal Datum:	*WGS [GCS1984]*
Hole Start Date:	*September 30, 2024*
Hole Finish Date:	*September 30, 2024*

DRILLING INFORMATION

Drilling Method:	*Solid Stem Auger*
Drilling Company:	*Entech Engineering Inc.*
Drill Rig Equipment:	*SIMCO 2800*
Hole Size:	*4 inch*
Rod Type/Dia.:	*n/a*
Hammer Wt. / Drop:	*140 lbs/30 inches*
Hammer ETR:	*n/a*

BASIC LEGEND

(See separate LOG KEY for additional symbols, acronyms, and definitions)

Abbreviations

N	Standard Penetration Test (SPT) blows per 6-inch increment
PT	Penetration test (not SPT) blows per 6-inch increment
bpf	Blows per foot for penetration test
WC	Natural water content (%)
FC	Fines content (% grains smaller than 0.075 mm)
PI	Plasticity index (Atterberg Limits)

Symbols

Sample Number / Sample Type → S-5 (SPT) ← Gray bar indicates percent of sample length recovered.

Water Level During Drilling →

Approx. Elev. (feet)	Depth (feet)	Material Description and Other Observations	Graphic	Depth (feet)	Samples	Field Data	Lab Data	Multiple Items Plotted *(see bottom legend on Page 1)* 0 50 100	Depth (feet)
5925	0	***ASPHALT;*** 12 inches.							
		Very dense, red-brown to brown, ***POORLY GRADED SAND WITH GRAVEL*** (SP); moist. [A-1-b] Fill		1.0 2.0	S-1 (MC12) Bulk (GB) S-2 (MC12)	PT = 20,50/5" (70/11" bpf) PT = 5,6 (11 bpf)	FC=16% LL/PI=NP/NP R-Value=63.5 WC=3% WC=7% RES=10000 OhmCm	◇ >>	
	5	Loose to medium dense, red-yellow to brown, ***SILTY SAND*** (SM); moist. [A-2-4] Eolian							5
5920	6.5	BOTTOM OF HOLE AT 6.5 FEET		6.5	S-3 (SPT)	N = 4,4,6 (10 bpf)	WC=10%		

No Observed Groundwater

NOTES:
- Refer to LOG KEY for explanation of symbols, codes, abbreviations, and definitions.
- Groundwater level, if indicated above, is for the date specified and may vary.
- Group symbol is based on visual-manual identification and selected lab testing.
- Report text contains limitations and information needed to contextually understand this log.

▲ Uncorrected N-value, bpf
▼ Uncorrected, Penetration N-value, bpf
● = WC% ◇ = FC%
Plastic Limit — Liquid Limit

FINAL

Logged by:	ZAB
Review by:	DAA
Version:	1

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Rpt: BORING LOG | Library: SW GINT LIBRARY GLB | Date: 11/15/24

APPENDIX B: LABORATORY TEST RESULTS

Appendix B

Laboratory Test Results

CONTENTS

Tables

Figures

APPENDIX B: LABORATORY TEST RESULTS

B.1 INTRODUCTION

Laboratory tests were completed on soil samples retrieved from the site in general accordance with the American Association of State Highway and Transportation Officials (AASHTO), American Society of Testing and Materials International (ASTM), and Colorado Department of Transportation (CDOT) Colorado Procedure - Laboratory (CP-L) testing methods. The laboratory testing program was performed to classify the materials into similar geologic groups and provide data that can be used for design of the project. The geotechnical laboratory testing was performed at our laboratory in Denver, Colorado, and Vivid Engineering Group in Denver, Colorado. A summary of the laboratory test results is presented in Table B-1. The following sections describe the laboratory testing procedures.

B.2 GEOTECHNICAL INDEX TESTS

B.2.1 Water Content

Water content was determined for selected samples in general accordance with AASHTO T265, Laboratory Determination of Moisture Content in Soils. To perform this test, a sample was weighed before and after oven-drying, and the water content was calculated. Water content determinations are shown graphically on the boring logs presented in Appendix A and are also summarized in Table B-1.

B.2.2 Unit Weight

The unit weights or in-place densities of selected modified California (MC) samples were determined in the laboratory. The determination was performed in general accordance with ASTM Designation D2937, Test Method for Density of Soil in Place by the Drive-Cylinder Method and ASTM D7263, Test Method for Laboratory Determination of Density (Unit Weight) of Soil Specimens. To perform this test method, the dimensions of the sample were measured, the sample was weighed, and the moist unit weight was calculated. The results are summarized in Table B-1.

B.2.3 Grain Size Analysis

The grain size distribution of selected samples was determined in general accordance with ASTM D6913, Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis. Results of these analyses are presented as grain size distribution test report.

Selected samples were tested for the percentage of material passing the No. 200 sieve in general accordance with ASTM D1140, Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75-µm) Sieve. The percent fines (silt- and clay-sized particles passing the No. 200 sieve) are shown graphically on the boring logs in Appendix A and the percent fines, sand, and gravel are also summarized in Table B-1.

B.2.4 Atterberg Limits

Soil plasticity was determined by performing Atterberg limits tests on selected fine-grained samples. The tests were completed in general accordance with AASHTO T89, Standard Test Method for Determining the Liquid Limit of Soils and AASHTO T90, Standard Test Method for Determining the Plastic Limit and Plasticity Index of Soils. The Atterberg limits include liquid limit (LL), plastic limit (PL), and plasticity index (PI equals LL minus PL) and are generally used to assist in classification of soils, to indicate soil consistency (when compared to natural water content), and to provide correlation to soil properties. The results of the Atterberg limits tests are plotted on the Atterberg limit test results report figure, shown graphically on the boring logs in Appendix A, and summarized in Table B-1.

B.3 GEOTECHINCAL ENGINEERING PROPERTY TESTS

B.3.1 Corrosion

Corrosion testing of select samples was performed for pH, resistivity, sulfate content, chloride content, and resistivity. Testing for pH was completed in general accordance with AASHTO T289, Standard Method of Test for Determining pH of Soil for use in Corrosion Testing. Testing for resistivity was completed in general accordance with ASTM G57, Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method. Sulfate and chloride content testing were completed in general accordance with CDOT laboratory procedures CP-L 2103, Sulfate Ion Content in Soil, and CP-L 2104, Determining the Chloride Ion Content in Soil, respectively.

B.3.2 Swell/Collapse

One-dimensional swell/collapse tests were performed in general accordance with Method B of ASTM D 4546, Standard Test Methods for One-Dimensional Swell or Collapse of Soils. Relatively undisturbed drive samples were obtained modified California sampler lined with a thin-walled bass tube. The sample was then loaded at field moisture conditions in a fixed-ring consolidometer that measures vertical changes in volume for different loading conditions. During loading, the sample's pore pressures are allowed to drain from both the top and bottom of the sample. At a specified pressure, the sample is inundated with

distilled water and then allowed to reach equilibrium. The vertical volume change caused from the water inundation was then measured and expressed in percent strain. The swell/collapse test reports are provided in the individual Swell/Collapse Test Reports and summarized in Table B-1. The unit weight or in-place density and the water content of the sample, which are determined as part of the test, are also included in Table B-1.

B.3.3 R-Value

Hveem Stabilometer (R-value) test was completed by Vine Laboratories, Inc., on bulk subgrade samples. The tests were completed in general accordance with AASHTO T190, Standard Method of Test for Resistance R-Value and Expansion Pressure of Compacted Soils. The R-value test results are provided in the individual R-value Test Reports and summarized in Table B-1.

Table B-1 - Summary of Laboratory Test Results

SAMPLE DATA				SOIL CLASSIFICATION				GRAIN-SIZE ANALYSES[2]			ATTERBERG LIMITS			CORROSION				SWELL/COLLAPSE		
Boring [Project Site]	Sample	Depth (feet) Top	Depth (feet) Bottom	USCS[1]	AASHTO	Natural Moisture Content (%)	Unit Weight (pcf)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	pH	Resistivity (ohm-cm)	Sulfate Content (%)	Chloride Content (%)	Swell(+) Collapse (-) (%)	Inundation Pressure (psf)	R-Value
SW-01 [Site 1]	S-1	2.5	4.0	ML	A-7-6 (12)	17.3				66	47	28	19							
	S-2	5.0	5.3			12.8		~0	37	63										
	S-3	7.5	7.9			11.1								6.5	3,000	0.01	0.110			
SW-02 [Site 1]	Bulk 1	1.3	3.0																	
	Bulk 2	3.0	5.0			10.6														
	S-1	1.3	2.8	SC	A-2-4 (0)	6.5		6	72	22	27	17	10							
	S-2	3.0	4.0			6.4														
	S-3	5.0	6.0			8.6														
	S-1	0.9	2.4			2.9														
SW-03 [Site 1]	Bulk 1	1.0	3.0																	
	Bulk 2	3.0	5.0	SC	A-2-6 (2)	12.4		3	63	34	40	17	23							22.7
	S-2	2.5	3.5			11.6														
	S-3	5.0	5.9			8.3														
SW-04 [Site 1]	Bulk	1.2	5.0																	
	S-1	1.2	2.7	SC	A-2-6 (0)	9.5		11	68	21	38	22	16							
	S-2	3.0	4.0			4.9														
	S-3	5.0	6.0			9.1														
SW-05 [Site 1]	Bulk 1	0.9	2.0																	
	Bulk 2	2.0	5.0																	
	S-1	0.9	2.4	SC	A-2-6 (0)	6.7		8	70	21	31	16	15							
	S-2	2.5	3.5			7.4														
	S-3	5.0	6.5			10.2														
SW-11 [Site 2]	S-1A	0.3	0.6			2.3		23	67	10										
	S-1B	0.6	1.8	SC	A-2-6 (0)	9.1			76	24	31	20	11							
	S-2	2.5	4.0	SC	A-4 (0)	15.2			64	36	28	20	8							
	S-3	5.0	6.5			15.9	124											-0.5	200	
SW-12 [Site 2]	S-1A	0.3	1.3			3.4		25	63	11										
	S-1B	1.3	1.8			13.7		1	63	36										
	S-2	1.8	2.8	SC	A-6 (3)	13.6				44	32	16	16							
	S-3	4.0	5.0			15.8	117											-0.7	200	

Table B-1 - Summary of Laboratory Test Results

SAMPLE DATA				SOIL CLASSIFICATION				GRAIN-SIZE ANALYSES[2]			ATTERBERG LIMITS			CORROSION				SWELL/COLLAPSE		
Boring [Project Site]	Sample	Depth (feet) Top	Depth (feet) Bottom	USCS[1]	AASHTO	Natural Moisture Content (%)	Unit Weight (pcf)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	pH	Resistivity (ohm-cm)	Sulfate Content (%)	Chloride Content (%)	Swell(+) Collapse (-) (%)	Inundation Pressure (psf)	R-Value
SW-13 [Site 2]	Bulk	0.4	5.0	CL	A-6 (11)			3	26	71	35	16	19	6.1	1,500	<0.01	0.060			15.0
	S-1A	0.4	1.3			6.5		16	64	20										
	S-1B	1.3	1.9			18.5		1	40	59										
	S-2	2.0	3.0			18.5	124											0	200	
	S-3	4.0	5.0			21.3														
	S-4	6.5	7.5			15.0														
	S-5	9.0	10.0			5.0														
	S-6	12.5	14.0	SM	A-2-4 (0)	7.3		0	83	17	NP	NP	NP							
	S-7	15.0	16.5			9.3														
	S-8	20.0	21.5			4.6														
	S-9	25.0	26.5			5.9														
SW-21 [Site 3]	Bulk	0.3	5.0																	
	S-1A	0.3	1.4			4.9		23	62	14										
	S-1B	1.4	1.8			9.3														
	S-2	2.5	4.0			5.8		8	83	9										
	S-3	5.0	6.5			37.0														
SW-22 [Site 3]	Bulk	0.3	5.0	SC-SM	A-1-b (0)			4	79	17	22	17	5	7.5	7,600	0.03	0.068			24.2
	S-1	0.3	1.8			6.2														
	S-2	2.5	4.0			6.2														
	S-3	5.0	6.5			6.1		12	79	9										
	S-4	7.5	9.0			4.2														
	S-5	10.0	11.5			7.7														
	S-6	12.5	14.0			6.9														
	S-7	15.0	16.5			7.0														
	S-8	20.0	21.5	CL	A-6 (6)	21.1				68	31	19	12							
	S-9	25.0	26.0			28.6														
SW-23 [Site 3]	Bulk	0.3	5.0																	
	S-1	0.3	1.8			4.6														
	S-2	2.5	4.0	SW-SM	A-1-b (0)	4.5		11	78	11	23	20	3							
	S-3	5.0	6.5			5.1														

Table B-1 - Summary of Laboratory Test Results

SAMPLE DATA				SOIL CLASSIFICATION				GRAIN-SIZE ANALYSES[2]			ATTERBERG LIMITS			CORROSION				SWELL/COLLAPSE		
Boring [Project Site]	Sample	Depth (feet) Top	Depth (feet) Bottom	USCS[1]	AASHTO	Natural Moisture Content (%)	Unit Weight (pcf)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	pH	Resistivity (ohm-cm)	Sulfate Content (%)	Chloride Content (%)	Swell(+) Collapse (-) (%)	Inundation Pressure (psf)	R-Value
SW-31 [Site 4]	Bulk	0.8	5.0																	
	S-1	0.8	1.8	SC	A-2-6 (0)	11.3		19	47	34	28	17	11							
	S-2	2.5	3.5			3.5								7.7	10,500	0.03	0.065			
	S-3	5.0	6.0			11.9														
	S-4	7.5	9.0	CL	A-7-6 (24)	23.0		0	12	88	45	18	27							
	S-5	10.0	11.0			11.2	125											0.3	1,001	
	S-6	12.5	13.5			13.5														
	S-7	15.0	16.0			10.4														
	S-8	20.0	21.0			6.6														
	S-9	25.0	26.5			7.0														
SW-32 [Site 4]	S-1	0.6	1.6	SP-SM	A-1-a (0)	3.2		47	47	5	NP	NP	NP							
SW-33 [Site 4]	Bulk 1	0.8	2.0																	
	Bulk 2	2.0	5.0	CL	A-6 (6)	14.2		8	38	55	31	14	17							9.0
	S-1	0.8	1.8			4.2														
	S-2	2.5	3.5			13.5														
	S-3	5.0	6.0			18.7														
SW-41 [Site 5]	Bulk	0.5	5.0	SM	A-2-4 (0)			1	79	20	NP	NP	NP	7.9	10,500	0.03	0.056			42.8
	S-1	0.5	2.0			5.7														
	S-2	2.5	3.5			7.3														
	S-3	5.0	6.0			6.9														
	S-4	7.5	9.0			6.8														
	S-5	10.0	11.5			5.6		0	90	10										
	S-6	12.5	14.0			7.4														
	S-7	15.0	16.5			6.1														
	S-8	20.0	21.5			8.2		0	77	23										
	S-9	25.0	26.5			18.8														

Table B-1 - Summary of Laboratory Test Results

SAMPLE DATA				SOIL CLASSIFICATION				GRAIN-SIZE ANALYSES[2]			ATTERBERG LIMITS			CORROSION				SWELL/COLLAPSE		
Boring [Project Site]	Sample	Depth (feet) Top	Depth (feet) Bottom	USCS[1]	AASHTO	Natural Moisture Content (%)	Unit Weight (pcf)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	pH	Resistivity (ohm-cm)	Sulfate Content (%)	Chloride Content (%)	Swell(+) Collapse (-) (%)	Inundation Pressure (psf)	R-Value
SW-42 [Site 5]	Bulk	0.4	5.0																	
	S-1A	0.4	1.3			2.7														
	S-1B	1.3	1.9			6.8														
	S-2	2.5	4.0	SP-SM	A-2-4 (0)	4.2		0	88	12	NP	NP	NP							
	S-3	5.0	6.5			5.2														
SW-51A [Site 6]	Bulk	0.5	5.0	SM	A-2-4 (0)			2	73	25	19	18	1	5.8	7,100	0.01	0.066			45.6
	S-1	0.5	2.0			8.1														
	S-2	2.5	3.5			6.9														
	S-3	5.0	6.0			7.7														
SW-51B [Site 6]	S-4	7.5	8.5			4.7		2	86	13										
	S-5	10.0	11.5			3.2														
	S-6	12.5	13.5			5.3														
	S-7	15.0	16.5			6.0		0	86	14										
	S-8	20.0	21.0			5.8														
	S-9	25.0	26.5			12.5														
SW-52 [Site 6]	S-1	0.8	2.3	SC-SM	A-2-4 (0)	8.5		3	71	26	23	17	6							
	S-2	2.5	4.0			7.2														
SW-61 [Site 7]	Bulk	0.7	5.0																	
	S-1	0.7	2.2	SM	A-2-4 (0)	6.5		0	77	23	NP	NP	NP							
	S-2	2.5	4.0	SP-SM	A-2-4 (0)	6.0		0	88	12	NP	NP	NP							
	S-3	5.0	6.5			5.3														
SW-62 [Site 7]	Bulk	0.5	5.0	SM	A-2-4 (0)			2	76	22	NP	NP	NP	7.5	4,200	0.01	0.096			58.3
	S-1	0.5	1.5			6.0														
	S-1	1.5	2.0			16.5														
	S-2	2.5	4.0			3.7														
	S-3	5.0	6.5			2.9														
	S-4	7.5	9.0			6.9														
	S-5	10.0	11.5			5.0		~0	67	32										
	S-6	12.5	14.0			3.9														
	S-7	15.0	16.5			4.8														
	S-8	20.0	21.5			5.2														
	S-9	25.0	26.5			1.8														

Table B-1 - Summary of Laboratory Test Results

SAMPLE DATA				SOIL CLASSIFICATION				GRAIN-SIZE ANALYSES[2]			ATTERBERG LIMITS			CORROSION				SWELL/COLLAPSE		
Boring [Project Site]	Sample	Depth (feet) Top	Depth (feet) Bottom	USCS[1]	AASHTO	Natural Moisture Content (%)	Unit Weight (pcf)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	pH	Resistivity (ohm-cm)	Sulfate Content (%)	Chloride Content (%)	Swell(+) Collapse (-) (%)	Inundation Pressure (psf)	R-Value
SW-63 [Site 7]	Bulk	0.8	5.0																	
	S-1	0.8	1.8			1.4														
	S-2	2.5	3.5	SM	A-2-4 (0)	8.8		0	76	24	24	21	3							
	S-3	5.0	6.5			7.9														
SW-71 [Site 8]	Bulk	0.3	5.0	SC	A-6 (4)			2	51	48	33	18	15	6.4	2,600	0.10	0.054			24.0
	S-1	0.3	1.8			9.2														
	S-2	2.5	3.5			15.2	115											-1.4	200	
	S-3	5.0	6.0			20.2														
	S-4	7.5	8.5			12.9														
	S-5	10.0	11.5			3.4														
	S-6	12.5	14.0	SW-SM	A-1-b (0)	3.5		11	82	7	NP	NP	NP							
	S-7	15.0	16.5			5.0														
	S-8	20.0	21.5			3.7														
	S-9	25.0	26.5			6.9														
SW-81 [Site 9]	Bulk	0.3	5.0	SC	A-2-4 (0)			3	70	27	22	13	9	7.4	5,500	0.03	0.061			33.2
	S-1	0.3	1.8			4.5														
	S-2	2.5	4.0			6.4														
	S-3	5.0	6.5			7.8														
	S-4	7.5	9.0			5.6														
	S-5	10.0	11.5			2.6		6	83	12										
	S-6	12.5	13.6			1.5														
	S-6	13.6	14.0	SC	A-6 (2)	7.6				48	29	18	11							
	S-7	15.0	16.5			2.1		3	89	8										
	S-8	20.0	21.5			5.3														
	S-9	25.0	26.5			4.7														
SW-82 [Site 9]	Bulk	0.6	5.0																	
	S-1	0.6	2.1			5.9														
	S-2	2.5	4.0	SM	A-2-4 (0)	5.5		0	80	20	NP	NP	NP							
	S-3	5.0	6.5			5.7														

Table B-1 - Summary of Laboratory Test Results

SAMPLE DATA				SOIL CLASSIFICATION				GRAIN-SIZE ANALYSES[2]			ATTERBERG LIMITS			CORROSION				SWELL/COLLAPSE		
Boring [Project Site]	Sample	Depth (feet) Top	Depth (feet) Bottom	USCS[1]	AASHTO	Natural Moisture Content (%)	Unit Weight (pcf)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	pH	Resistivity (ohm-cm)	Sulfate Content (%)	Chloride Content (%)	Swell(+) Collapse (-) (%)	Inundation Pressure (psf)	R-Value
SW-91 [Site 10]	Bulk	1.0	5.0	SM	A-1-b (0)	3.1		12	72	16	NP	NP	NP							63.5
	S-1	1.0	2.0			3.2														
	S-2	2.5	3.5			6.8								8.4	10,000	0.03	0.074			
	S-3	5.0	6.5			9.8														

NOTES:

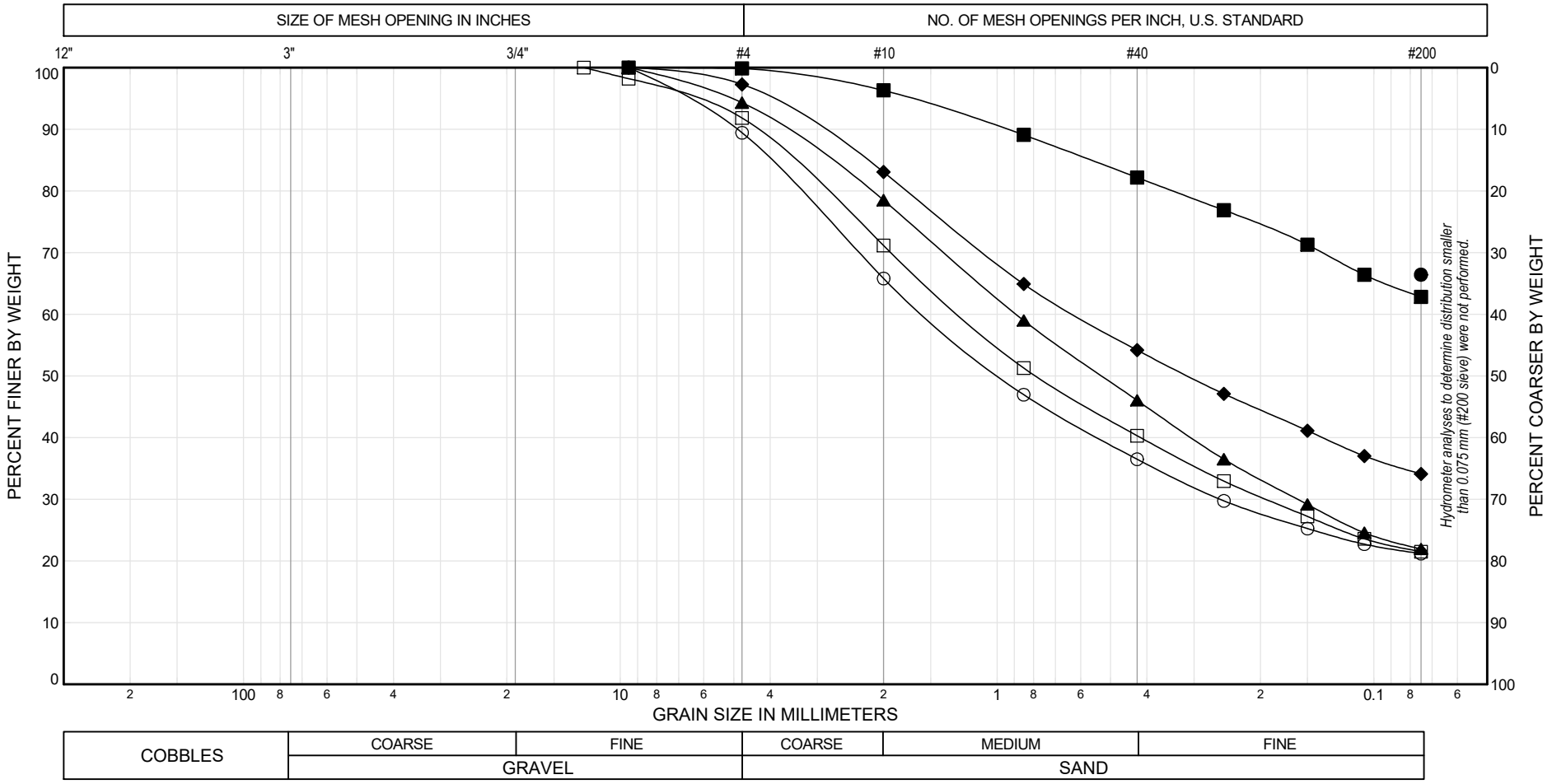
1 Refer to Appendix A, Log Key for definitions.

2 Gravel defined as particles larger than the No. 4 sieve size, Sand as particles between the No. 4 and No. 200 sieve sizes, and Fines as particles passing the No. 200 sieve.

AASHTO = American Association of State Highway and Transportation Officials; LL = Liquid Limit; ohm-cm = ohm centimeters; NP = Non-Plastic; NV = No Values; psf = pounds per square foot; PI = Plasticity Index; PL = Plastic Limit; USCS = Unified Soil Classification System

El Paso County Pedestrian Crossings
El Paso County, Colorado

Gradation Chart

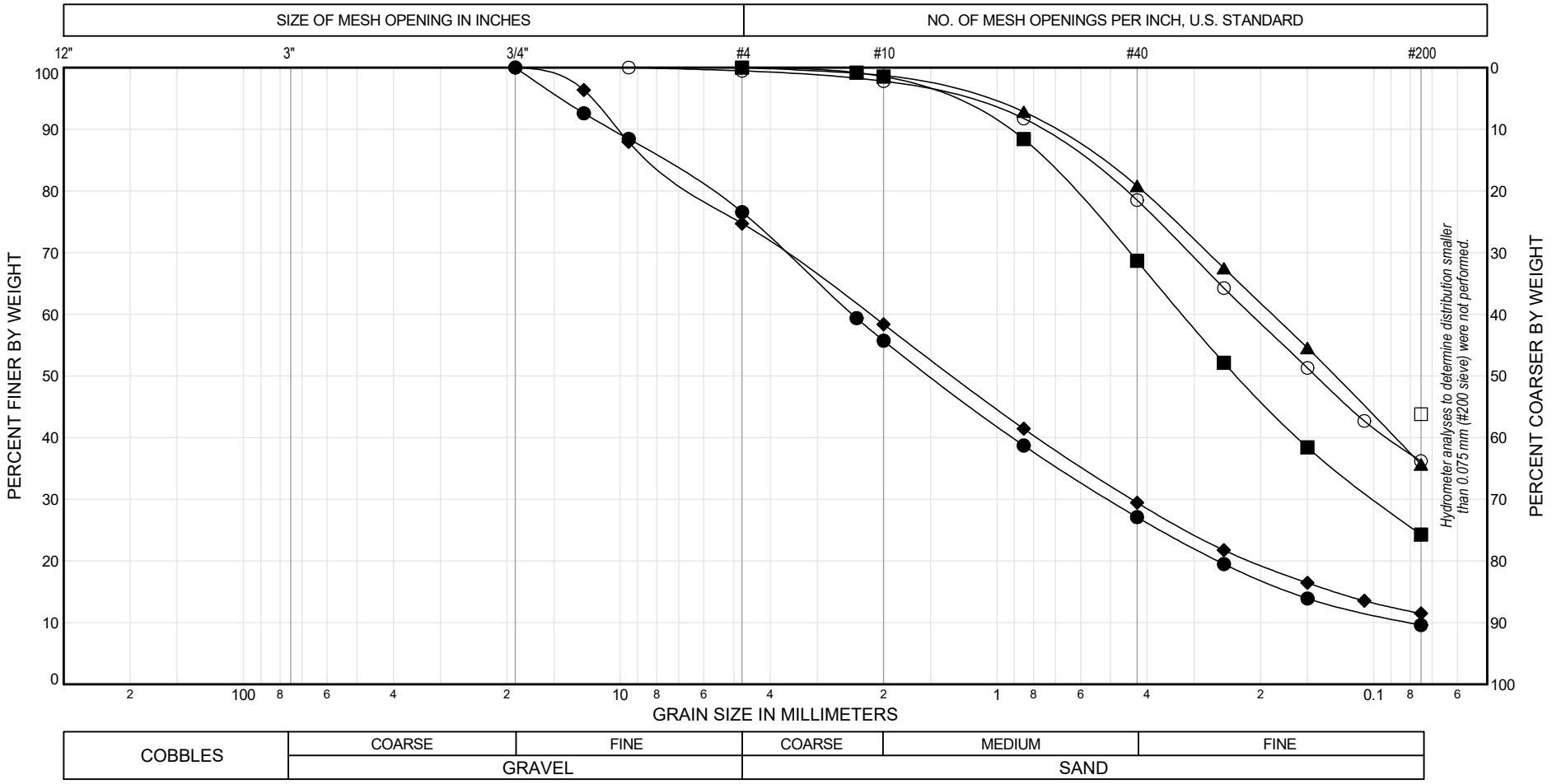


EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	GRAVEL %	SAND %	FINES %	NAT WC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-01, S-1	2.5	SANDY SILT	ML			66	17.3	JYS ASW	D1140	
■ SW-01, S-2	5.0	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		~0	37	63	12.8	GXM ASW	D6913	
▲ SW-02, S-1	1.3	CLAYEY SAND	SC	6	72	22	6.5	GXM ASW	D6913	
◆ SW-03, Bulk 2	3.0	CLAYEY SAND	SC	3	63	34		ASW ASW	D6913	
○ SW-04, S-1	1.2	CLAYEY SAND	SC	11	68	21	9.5	GXM ASW	D6913	
□ SW-05, S-1	0.9	CLAYEY SAND	SC	8	70	21	6.7	GXM JYS	D6913	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the grain size distribution test results.
ABBREVIATIONS: NAT WC = natural moisture content; RVW = reviewed by; STD = Standard; USCS = Unified Soil Classification System code; ~ = approximately (used when measured but not greater than 0.5%)

El Paso County Pedestrian Crossings
El Paso County, Colorado

Gradation Chart

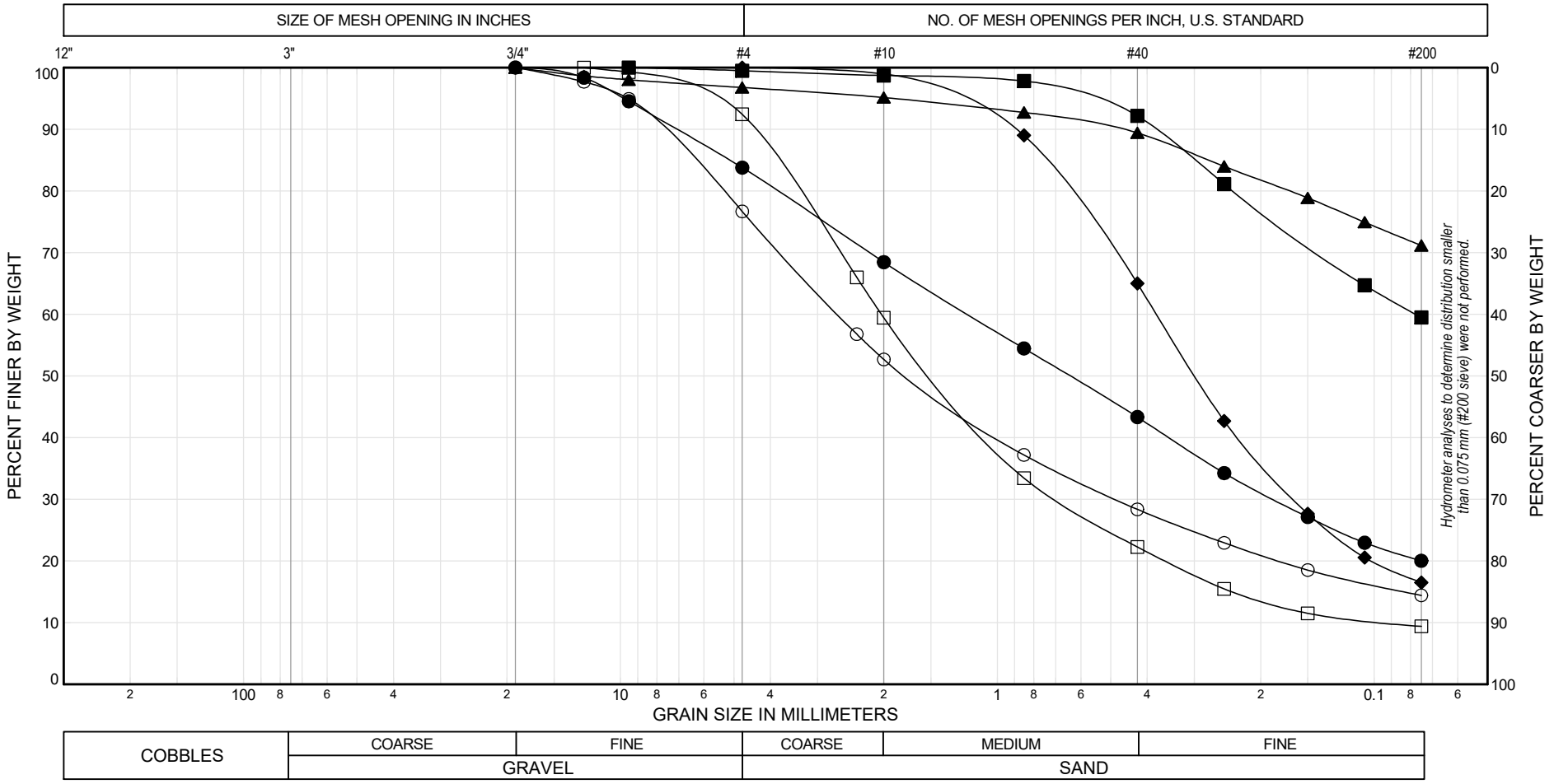


EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	GRAVEL %	SAND %	FINES %	NAT WC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-11, S-1A	0.3	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		23	67	10	2.3	VIVID VIVID	D6913	
■ SW-11, S-1B	0.6	CLAYEY SAND	SC	0	76	24	9.1	VIVID VIVID	D6913	
▲ SW-11, S-2	2.5	CLAYEY SAND	SC	0	64	36	15.2	VIVID VIVID	D6913	
◆ SW-12, S-1A	0.3	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		25	63	11	3.4	ASW ASW	D6913	
○ SW-12, S-1B	1.3	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		1	63	36	13.7	ASW ASW	D6913	
□ SW-12, S-2	1.8	CLAYEY SAND	SC			44	13.6	ASW ASW	D1140	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the grain size distribution test results.
ABBREVIATIONS: NAT WC = natural moisture content; RVW = reviewed by; STD = Standard; USCS = Unified Soil Classification System code; ~ = approximately (used when measured but not greater than 0.5%)

El Paso County Pedestrian Crossings
El Paso County, Colorado

Gradation Chart

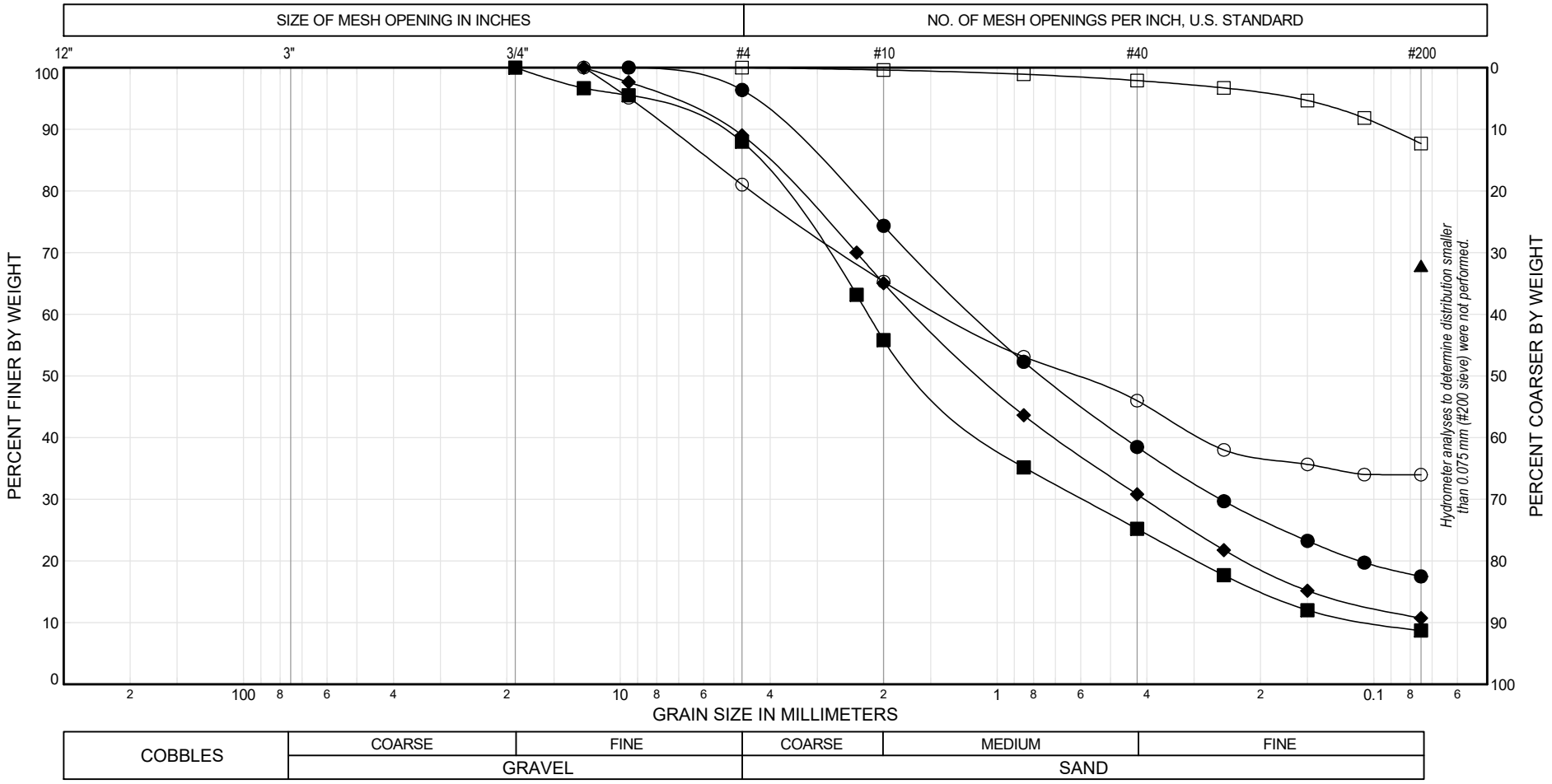


EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	GRAVEL %	SAND %	FINES %	NAT WC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-13, S-1A	0.4	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		16	64	20	6.5	ASW ASW	D6913	
■ SW-13, S-1B	1.3	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		1	40	59	18.5		D6913	
▲ SW-13, Bulk	0.4	LEAN CLAY with SAND	CL	3	26	71		ASW ASW	D6913	
◆ SW-13, S-6	12.5	SILTY SAND	SM	0	83	17	7.3	ASW ASW	D6913	
○ SW-21, S-1A	0.3	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		23	62	14	4.9	VIVID VIVID	D6913	
□ SW-21, S-2	2.5	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		8	83	9	5.8	VIVID VIVID	D6913	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the grain size distribution test results.
ABBREVIATIONS: NAT WC = natural moisture content; RVW = reviewed by; STD = Standard; USCS = Unified Soil Classification System code; ~ = approximately (used when measured but not greater than 0.5%)

El Paso County Pedestrian Crossings
El Paso County, Colorado

Gradation Chart

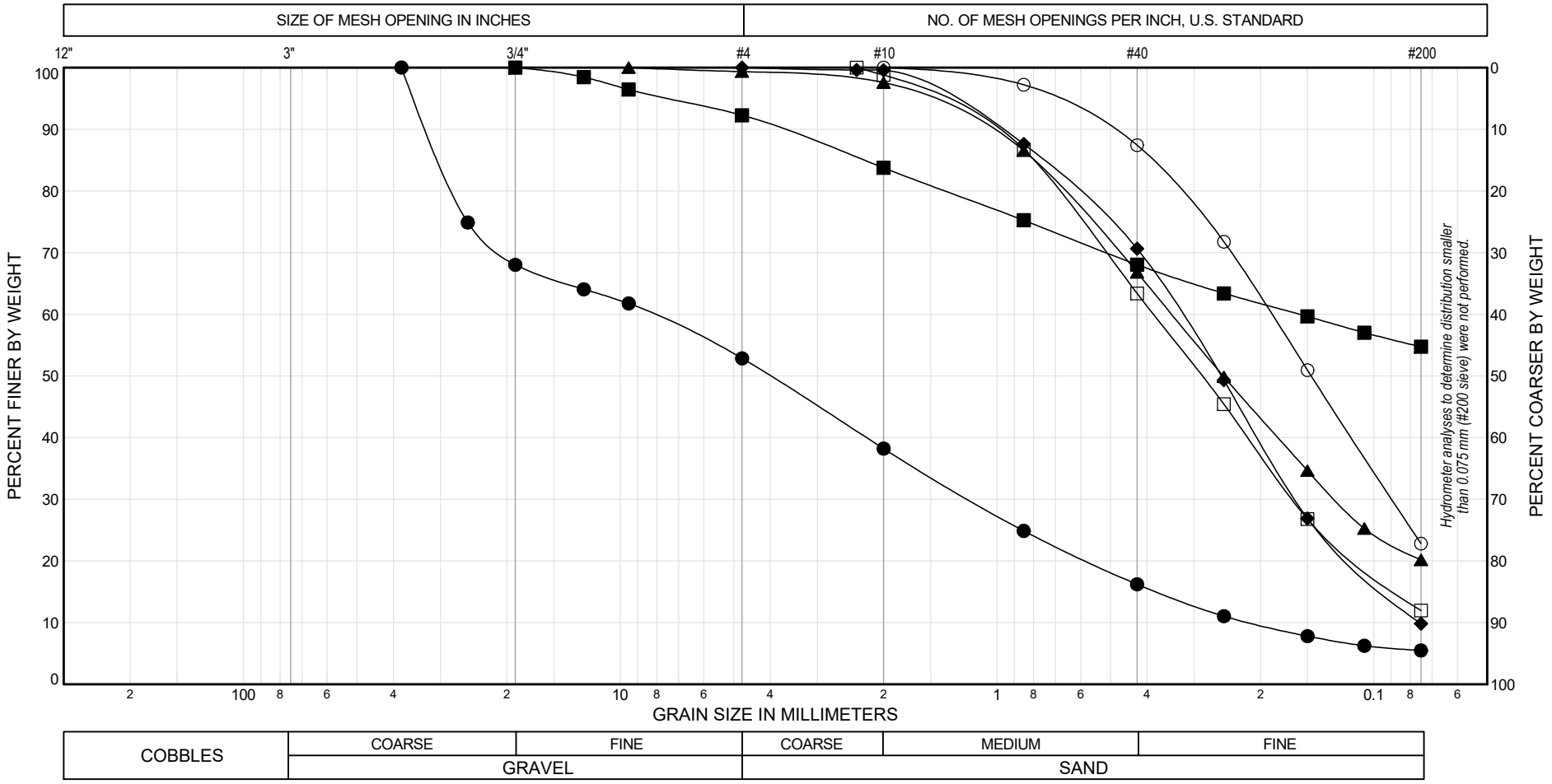


EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	GRAVEL %	SAND %	FINES %	NAT WC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-22, Bulk	0.3	SILTY, CLAYEY SAND	SC-SM	4	79	17		ATY JYS	D6913	
■ SW-22, S-3	5.0	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		12	79	9	6.1	VIVID VIVID	D6913	
▲ SW-22, S-8	20.0	SANDY LEAN CLAY	CL			68	21.1	VIVID VIVID	D1140	
◆ SW-23, S-2	2.5	WELL-GRADED SAND with SILT	SW-SM	11	78	11	4.5	VIVID VIVID	D6913	
○ SW-31, S-1	0.8	CLAYEY SAND with GRAVEL	SC	19	47	34	11.3	GXM ASW	D6913	
□ SW-31, S-4	7.5	LEAN CLAY	CL	0	12	88	23.0	JDT JYS	D6913	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the grain size distribution test results.
ABBREVIATIONS: NAT WC = natural moisture content; RVW = reviewed by; STD = Standard; USCS = Unified Soil Classification System code; ~ = approximately (used when measured but not greater than 0.5%)

El Paso County Pedestrian Crossings
El Paso County, Colorado

Gradation Chart

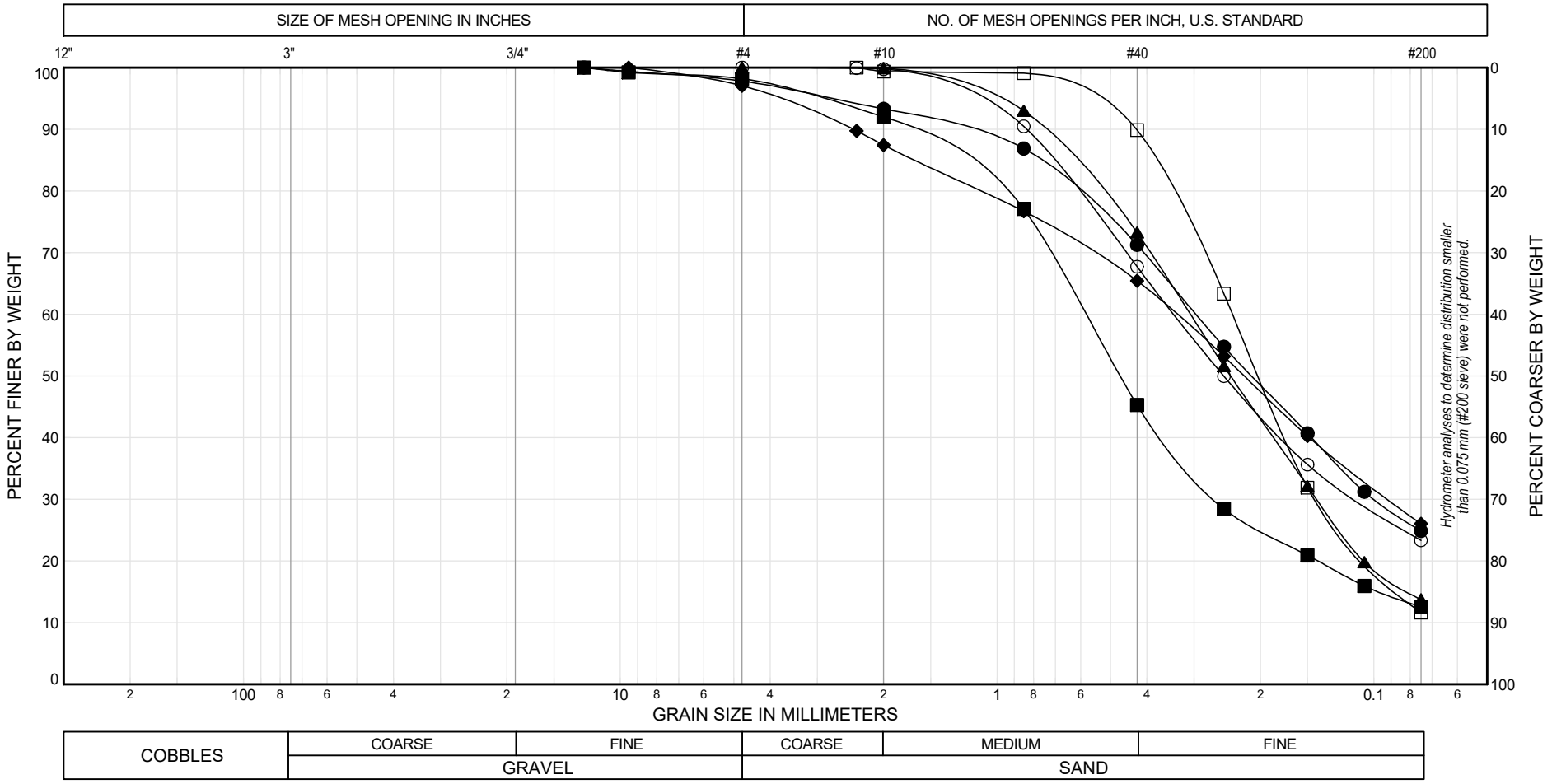


EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	GRAVEL %	SAND %	FINES %	NAT WC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-32, S-1	0.6	POORLY GRADED SAND with SILT and GRAVEL	SP-SM	47	47	5	3.2	GXM ASW	D6913	
■ SW-33, Bulk 2	2.0	SANDY LEAN CLAY	CL	8	38	55		JDT ASW	D6913	
▲ SW-41, Bulk	0.5	SILTY SAND	SM	1	79	20		ATY JYS	D6913	
◆ SW-41, S-5	10.0	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		0	90	10	5.6	VIVID VIVID	D6913	
○ SW-41, S-8	20.0	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		0	77	23	8.2	VIVID VIVID	D6913	
□ SW-42, S-2	2.5	POORLY GRADED SAND with SILT	SP-SM	0	88	12	4.2	VIVID VIVID	D6913	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the grain size distribution test results.
ABBREVIATIONS: NAT WC = natural moisture content; RVW = reviewed by; STD = Standard; USCS = Unified Soil Classification System code; ~ = approximately (used when measured but not greater than 0.5%)

El Paso County Pedestrian Crossings
El Paso County, Colorado

Gradation Chart

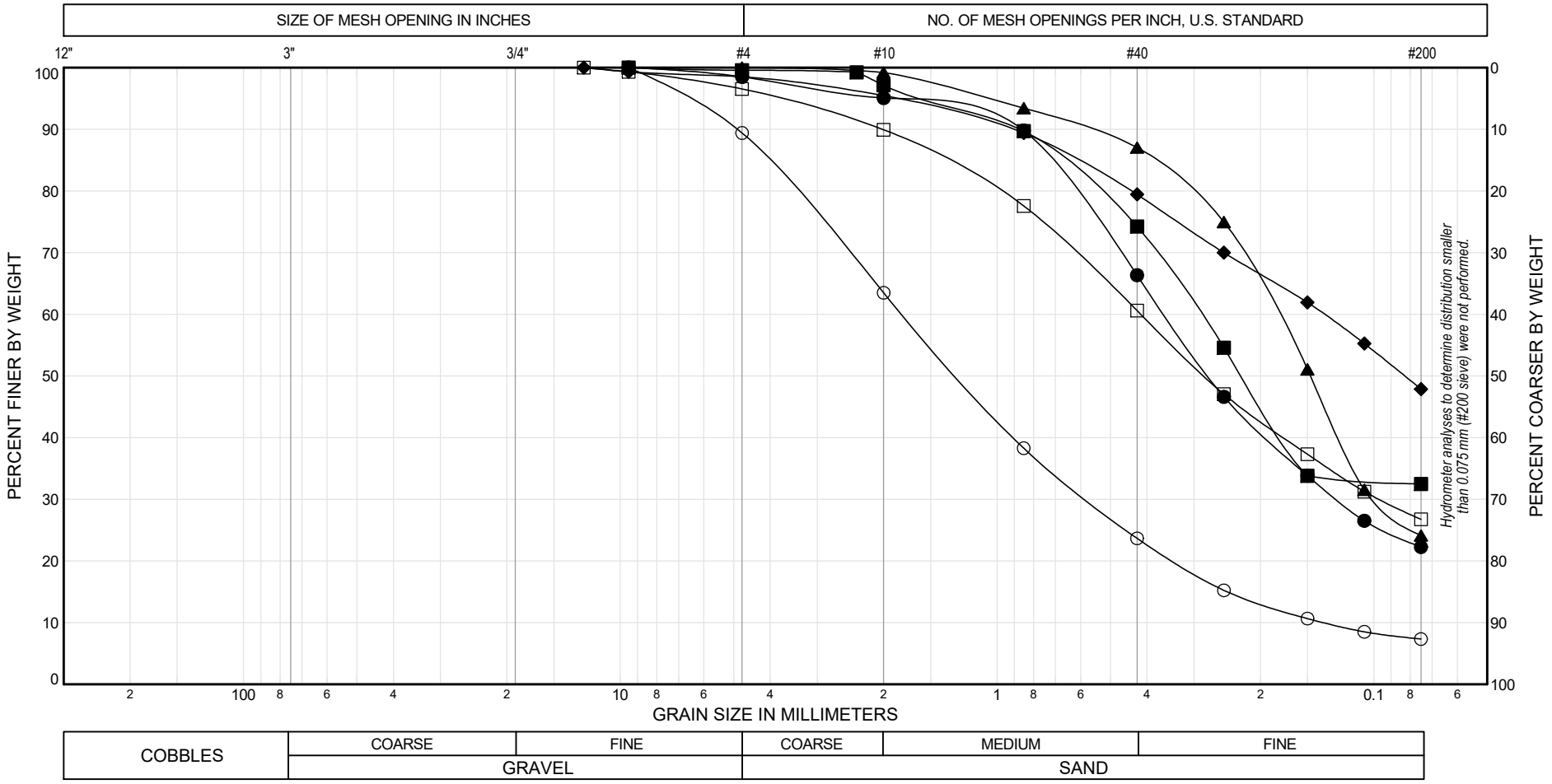


EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	GRAVEL %	SAND %	FINES %	NAT WC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-51A, Bulk	0.5	SILTY SAND	SM	2	73	25		ATY JYS	D6913	
■ SW-51B, S-4	7.5	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		2	86	13	4.7	GXM ASW	D6913	
▲ SW-51B, S-7	15.0	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		0	86	14	6.0	GXM ASW	D6913	
◆ SW-52, S-1	0.8	SILTY, CLAYEY SAND	SC-SM	3	71	26	8.5	VIVID VIVID	D6913	
○ SW-61, S-1	0.7	SILTY SAND	SM	0	77	23	6.5	VIVID VIVID	D6913	
□ SW-61, S-2	2.5	POORLY GRADED SAND with SILT	SP-SM	0	88	12	6.0	VIVID VIVID	D6913	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the grain size distribution test results.
ABBREVIATIONS: NAT WC = natural moisture content; RVW = reviewed by; STD = Standard; USCS = Unified Soil Classification System code; ~ = approximately (used when measured but not greater than 0.5%)

El Paso County Pedestrian Crossings
El Paso County, Colorado

Gradation Chart

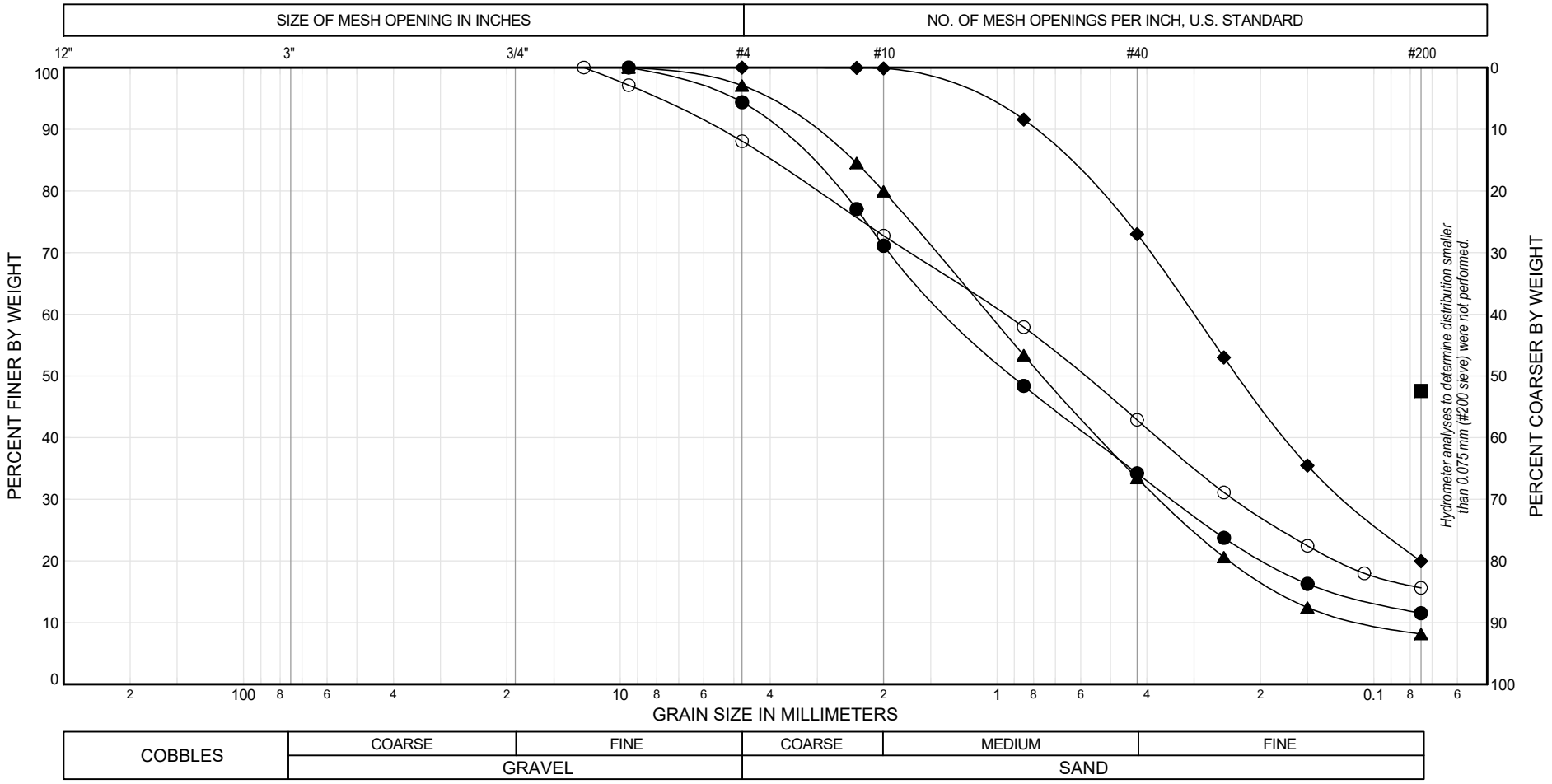


EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	GRAVEL %	SAND %	FINES %	NAT WC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-62, Bulk	0.5	SILTY SAND	SM	2	76	22		ATY JYS	D6913	
■ SW-62, S-5	10.0	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		~0	67	32	5.0	VIVID VIVID	D6913	
▲ SW-63, S-2	2.5	SILTY SAND	SM	0	76	24	8.8	JDT JYS	D6913	
◆ SW-71, Bulk	0.3	CLAYEY SAND	SC	2	51	48		ASW ASW	D6913	
○ SW-71, S-6	12.5	WELL-GRADED SAND with SILT	SW-SM	11	82	7	3.5	ASW ASW	D6913	
□ SW-81, Bulk	0.3	CLAYEY SAND	SC	3	70	27		ATY JYS	D6913	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the grain size distribution test results.
ABBREVIATIONS: NAT WC = natural moisture content; RVW = reviewed by; STD = Standard; USCS = Unified Soil Classification System code; ~ = approximately (used when measured but not greater than 0.5%)

El Paso County Pedestrian Crossings
El Paso County, Colorado

Gradation Chart

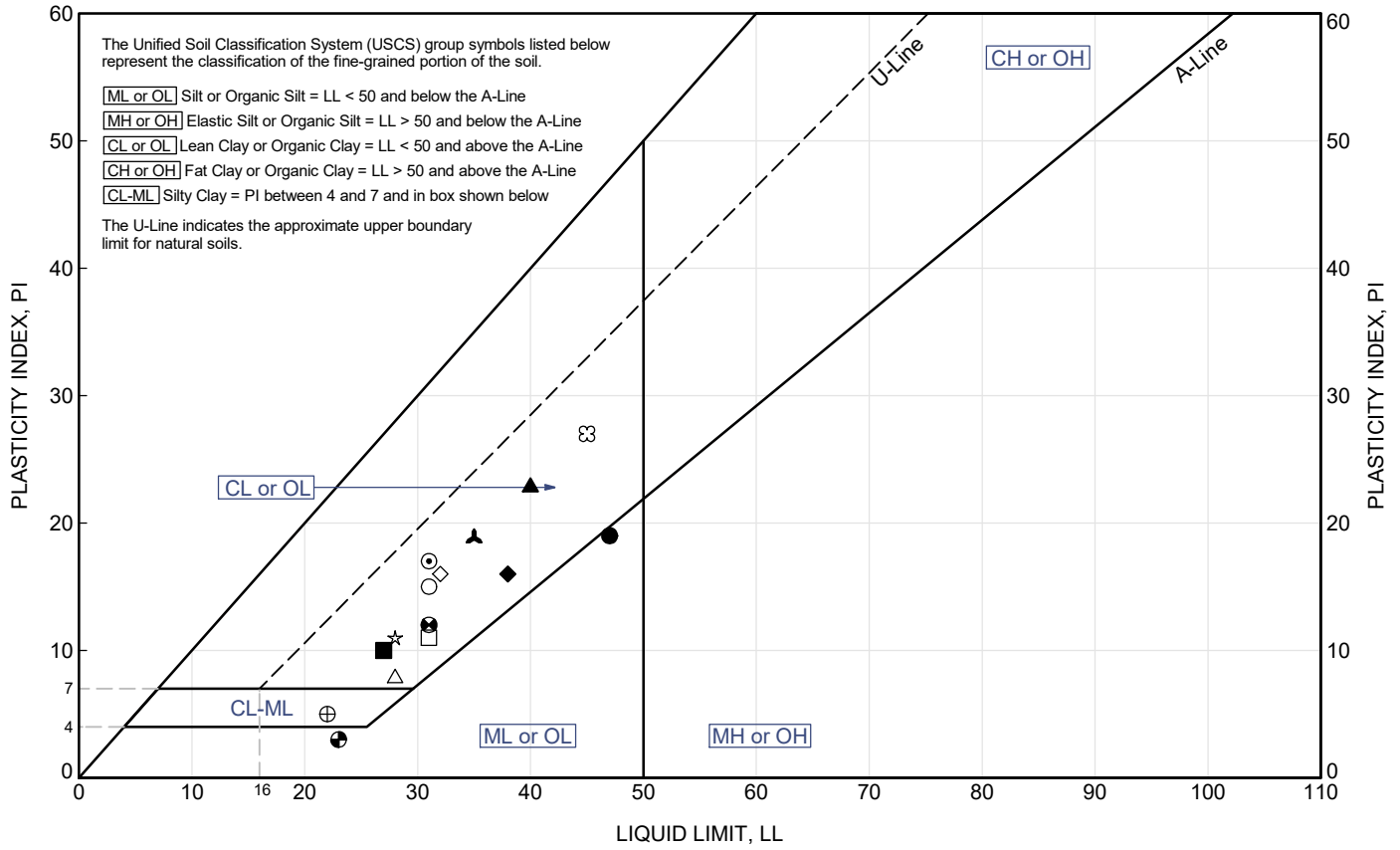


EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	GRAVEL %	SAND %	FINES %	NAT WC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-81, S-5	10.0	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		6	83	12	2.6	VIVID VIVID	D6913	
■ SW-81, S-6B	13.6	CLAYEY SAND	SC			48	7.6	VIVID VIVID	D1140	
▲ SW-81, S-7	15.0	*Sieve analysis only - no Atterberg Limits: Group Name not estimated*		3	89	8	2.1	VIVID VIVID	D6913	
◆ SW-82, S-2	2.5	SILTY SAND	SM	0	80	20	5.5	VIVID VIVID	D6913	
○ SW-91, Bulk	1.0	SILTY SAND	SM	12	72	16		JDT ASW	D6913	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the grain size distribution test results.
ABBREVIATIONS: NAT WC = natural moisture content; RVW = reviewed by; STD = Standard; USCS = Unified Soil Classification System code; ~ = approximately (used when measured but not greater than 0.5%)

El Paso County Pedestrian Crossings
El Paso County, Colorado

Plasticity Chart



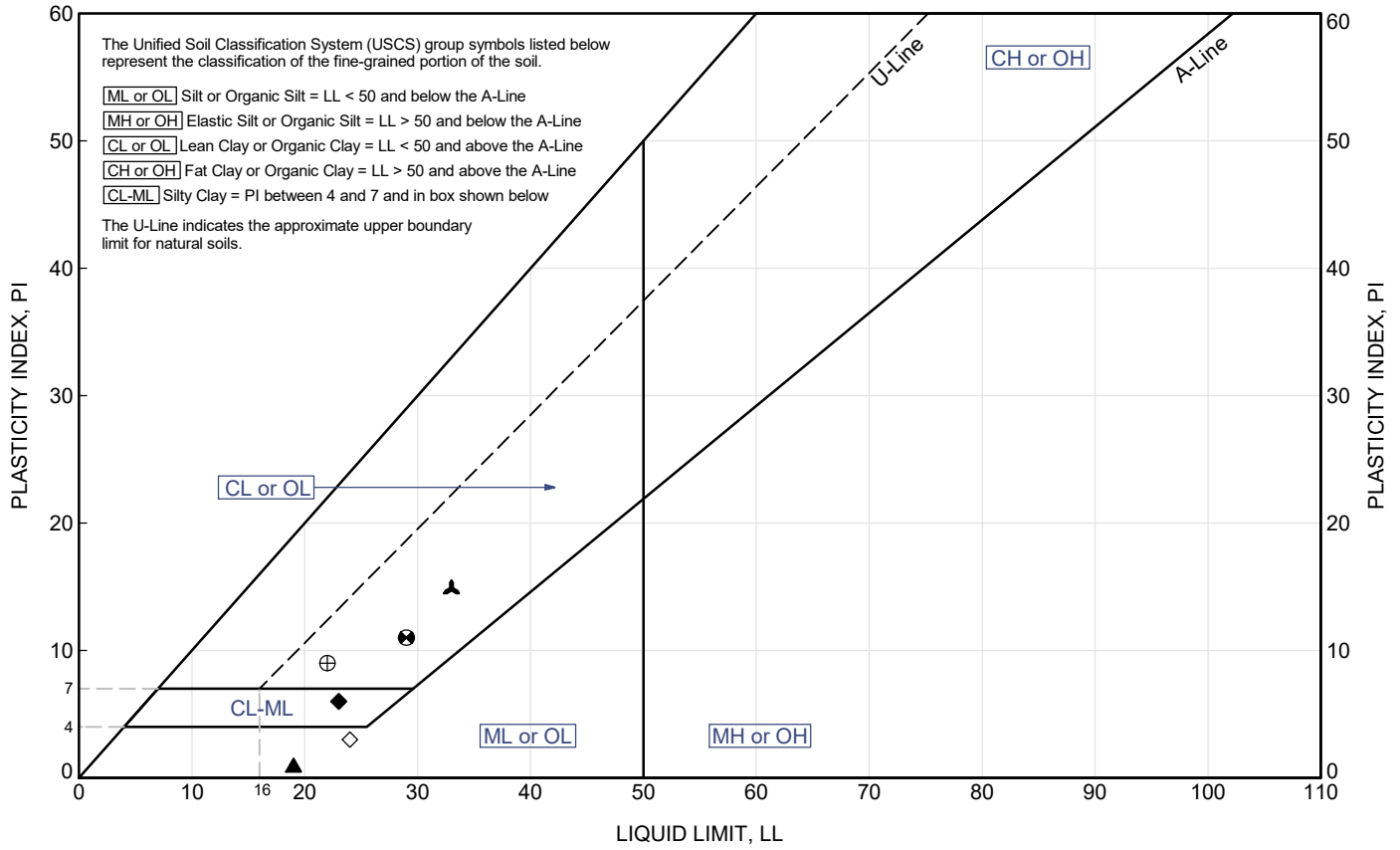
EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	LL	PL	PI	FINES (%)	NAT MC %	TEST BY/RVW	TEST STD	TEST NOTE
● SW-01, S-1	2.5	SANDY SILT	ML	47	28	19	66	17.3	JYS JYS	T89,T90	
■ SW-02, S-1	1.3	CLAYEY SAND	SC	27	17	10	22	6.5	JYS JYS	T89,T90	
▲ SW-03, Bulk 2	3.0	CLAYEY SAND	SC	40	17	23	34		JYS JYS	T89,T90	
◆ SW-04, S-1	1.2	CLAYEY SAND	SC	38	22	16	21	9.5	JYS JYS	T89,T90	
○ SW-05, S-1	0.9	CLAYEY SAND	SC	31	16	15	21	6.7	JYS JYS	T89,T90	
□ SW-11, S-1B	0.6	CLAYEY SAND	SC	31	20	11	24	9.1	VIVID VIVID	T89,T90	
△ SW-11, S-2	2.5	CLAYEY SAND	SC	28	20	8	36	15.2	VIVID VIVID	T89,T90	
◇ SW-12, S-2	1.8	CLAYEY SAND	SC	32	16	16	44	13.6	ATY ASW	T89,T90	
⅄ SW-13, Bulk	0.4	LEAN CLAY with SAND	CL	35	16	19	71		ASW JYS	T89,T90	
SW-13, S-6	12.5	SILTY SAND	SM	*NP*	NP	*NP*	17	7.3	ASW JYS	T89,T90	
⊕ SW-22, Bulk	0.3	SILTY, CLAYEY SAND	SC-SM	22	17	5	17		ASW JYS	T89,T90	
◕ SW-22, S-8	20.0	SANDY LEAN CLAY	CL	31	19	12	68	21.1	VIVID VIVID	T89,T90	
◔ SW-23, S-2	2.5	WELL-GRADED SAND with SILT	SW-SM	23	20	3	11	4.5	VIVID VIVID	T89,T90	
☆ SW-31, S-1	0.8	CLAYEY SAND with GRAVEL	SC	28	17	11	34	11.3	ASW JYS	T89,T90	
⚄ SW-31, S-4	7.5	LEAN CLAY	CL	45	18	27	88	23.0	ASW JYS	T89,T90	
SW-32, S-1	0.6	POORLY GRADED SAND with SILT and GRAVEL	SP-SM	*NP*	NP	*NP*	5	3.2	JYS ASW	T89,T90	
⊙ SW-33, Bulk 2	2.0	SANDY LEAN CLAY	CL	31	14	17	55		JYS JYS	T89,T90	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the Atterberg Limits test results.
ABBREVIATIONS: LL = liquid limit; NAT MC = natural moisture content; n/a = test attempted; NP = nonplastic; PI = plasticity index; PL = plastic limit; STD = standard; RVW = reviewed by; USCS = Unified Soil Classification System symbol

Job#: 113421-001 | Template Ver:1 | File: 113421-001 EPC PED CROSSING.GPJ | Library: SW GINT LIBRARY GLB | Date: 11/1824

El Paso County Pedestrian Crossings
El Paso County, Colorado

Plasticity Chart



EXPLORATION AND SAMPLE NUMBER	DEPTH (feet)	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP NAME	USCS SYMBOL	LL	PL	PI	FINES (%)	NAT MC %	TEST BY/RVW	TEST STD	TEST NOTE
SW-41, Bulk	0.5	SILTY SAND	SM	*NP*	NP	*NP*	20		ASW JYS	T89,T90	
SW-42, S-2	2.5	POORLY GRADED SAND with SILT	SP-SM	*NP*	NP	*NP*	12	4.2	VIVID VIVID	T89,T90	
▲ SW-51A, Bulk	0.5	SILTY SAND	SM	19	18	1	25		JYS JYS	T89,T90	
◆ SW-52, S-1	0.8	SILTY, CLAYEY SAND	SC-SM	23	17	6	26	8.5	VIVID VIVID	T89,T90	
SW-61, S-1	0.7	SILTY SAND	SM	*NP*	NP	*NP*	23	6.5	VIVID VIVID	T89,T90	
SW-61, S-2	2.5	POORLY GRADED SAND with SILT	SP-SM	*NP*	NP	*NP*	12	6.0	VIVID VIVID	T89,T90	
SW-62, Bulk	0.5	SILTY SAND	SM	*NP*	NP	*NP*	22		ASW JYS	T89,T90	
◇ SW-63, S-2	2.5	SILTY SAND	SM	24	21	3	24	8.8	ASW JYS	T89,T90	
SW-71, Bulk	0.3	CLAYEY SAND	SC	33	18	15	48		ASW JYS	T89,T90	
SW-71, S-6	12.5	WELL-GRADED SAND with SILT	SW-SM	*NP*	NP	*NP*	7	3.5	ASW JYS	T89,T90	
⊕ SW-81, Bulk	0.3	CLAYEY SAND	SC	22	13	9	27		JDT JYS	T89,T90	
SW-81, S-6B	13.6	CLAYEY SAND	SC	29	18	11	48	7.6	VIVID VIVID	T89,T90	
SW-82, S-2	2.5	SILTY SAND	SM	*NP*	NP	*NP*	20	5.5	VIVID VIVID	T89,T90	
SW-91, Bulk	1.0	SILTY SAND	SM	*NP*	NP	*NP*	16		JYS JYS	T89,T90	

* Where indicated by *, the USCS Group Name was based on visual-manual examination procedures (ASTM D2488) and the Atterberg Limits test results.
ABBREVIATIONS: LL = liquid limit; NAT MC = natural moisture content; n/a = test attempted; NP = nonplastic; PI = plasticity index; PL = plastic limit; STD = standard; RVW = reviewed by; USCS = Unified Soil Classification System symbol

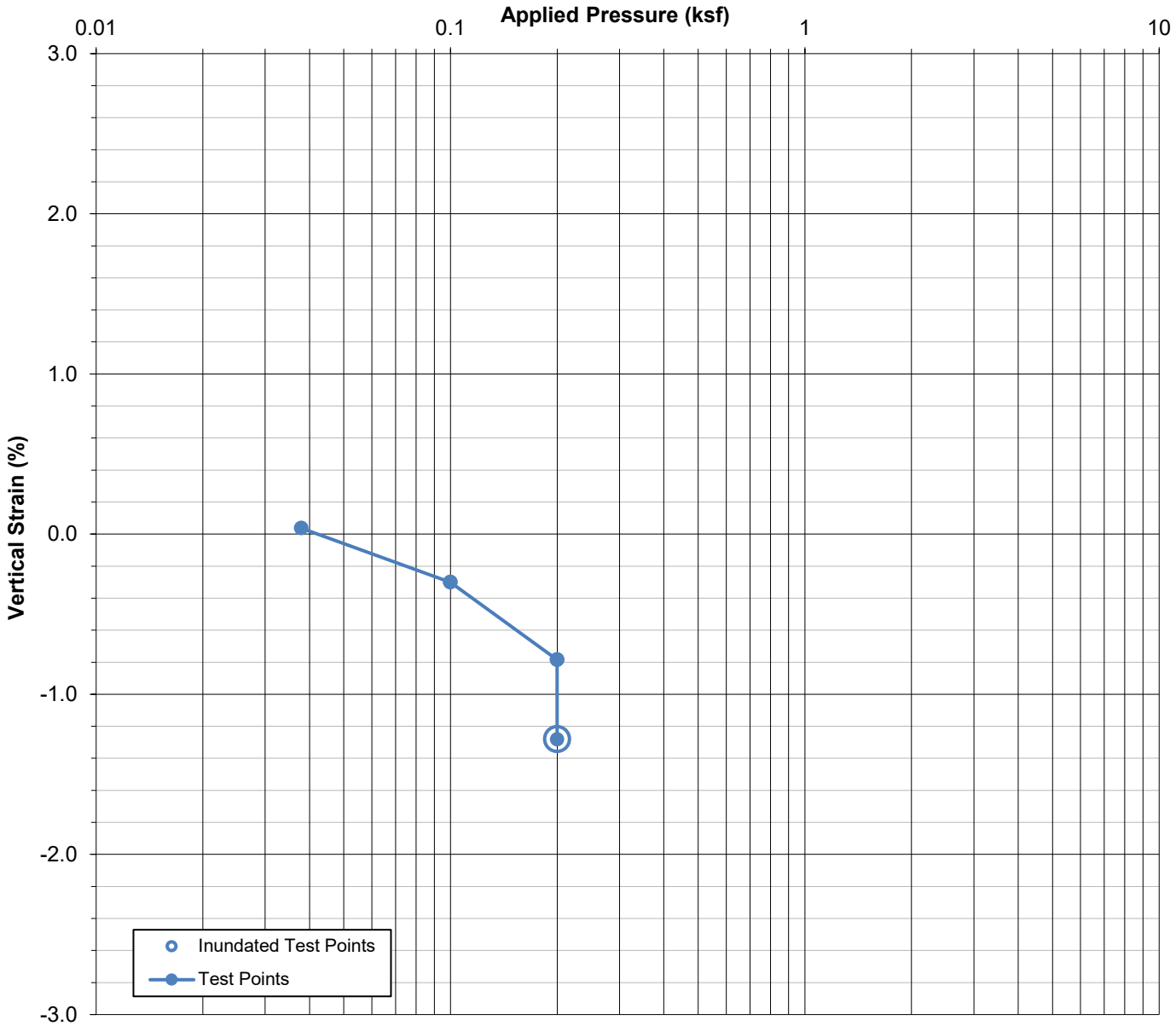
SHANNON & WILSON

ASTM D4546-21

Standard Test Method for One-Dimensional Swell or Collapse of Soils

El Paso County Pedestrian Crossings **El Paso County, Colorado**	**Boring:** SW-11 **Sample:** S-3 **Depth:** 5.0 to 6.0 feet

SWELL/COLLAPSE TEST REPORT



Sample Description: Clayey Sand					
Swell Pressure:	-	psf	Swell (+) or Collapse (-):	-0.5	%
Inundation Pressure:	200	psf	Moist Unit Weight:	123.8	pcf
Initial Moisture Content:	15.9	%	Dry Unit Weight:	106.8	pcf
Final Moisture Content:	19.6	%			

Notes

1. Testing was done in general accordance with Method B (an intact specimen obtained from a natural deposit) of ASTM D 4546, Standard Test Methods for One-Dimensional Swell or Collapse of Soils.

Checked By: JYS

SW-11 S-3_Swell Template_daa.xlsx

113421-001

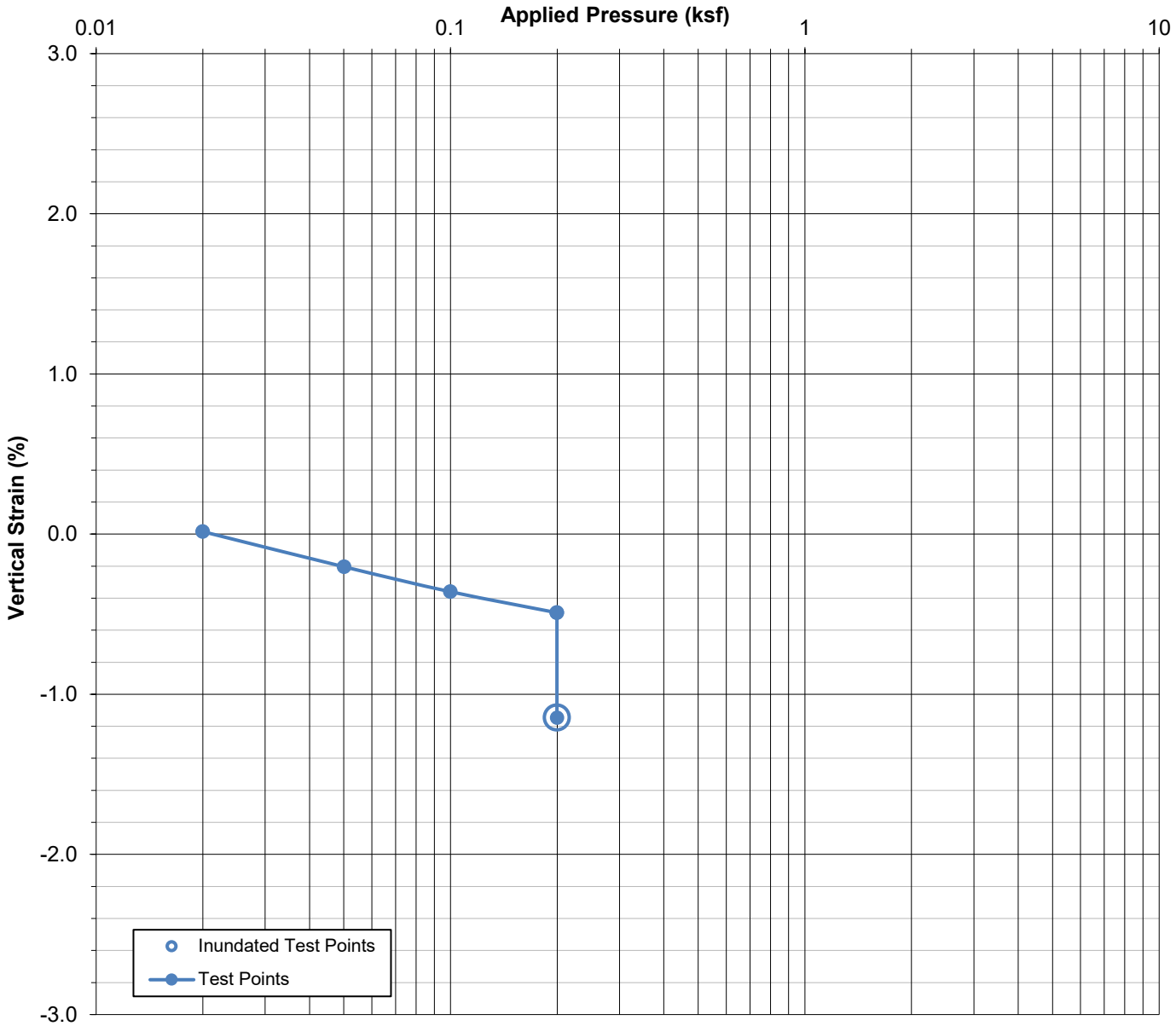
SHANNON & WILSON

ASTM D4546-21

Standard Test Method for One-Dimensional Swell or Collapse of Soils

El Paso County Pedestrian Crossings **El Paso County, Colorado**	**Boring:** SW-12 **Sample:** S-3 **Depth:** 4.0 to 5.0 feet

SWELL/COLLAPSE TEST REPORT



Sample Description:	Clayey Sand				
Swell Pressure:	-	psf	Swell (+) or Collapse (-):	-0.7	%
Inundation Pressure:	200	psf	Moist Unit Weight:	116.9	pcf
Initial Moisture Content:	15.8	%	Dry Unit Weight:	101.0	pcf
Final Moisture Content:	24.0	%			

Notes

1. Testing was done in general accordance with Method B (an intact specimen obtained from a natural deposit) of ASTM D 4546, Standard Test Methods for One-Dimensional Swell or Collapse of Soils.

Checked By: JYS

SW-12 S-3_Swell Template_daa.xlsx

113421-001

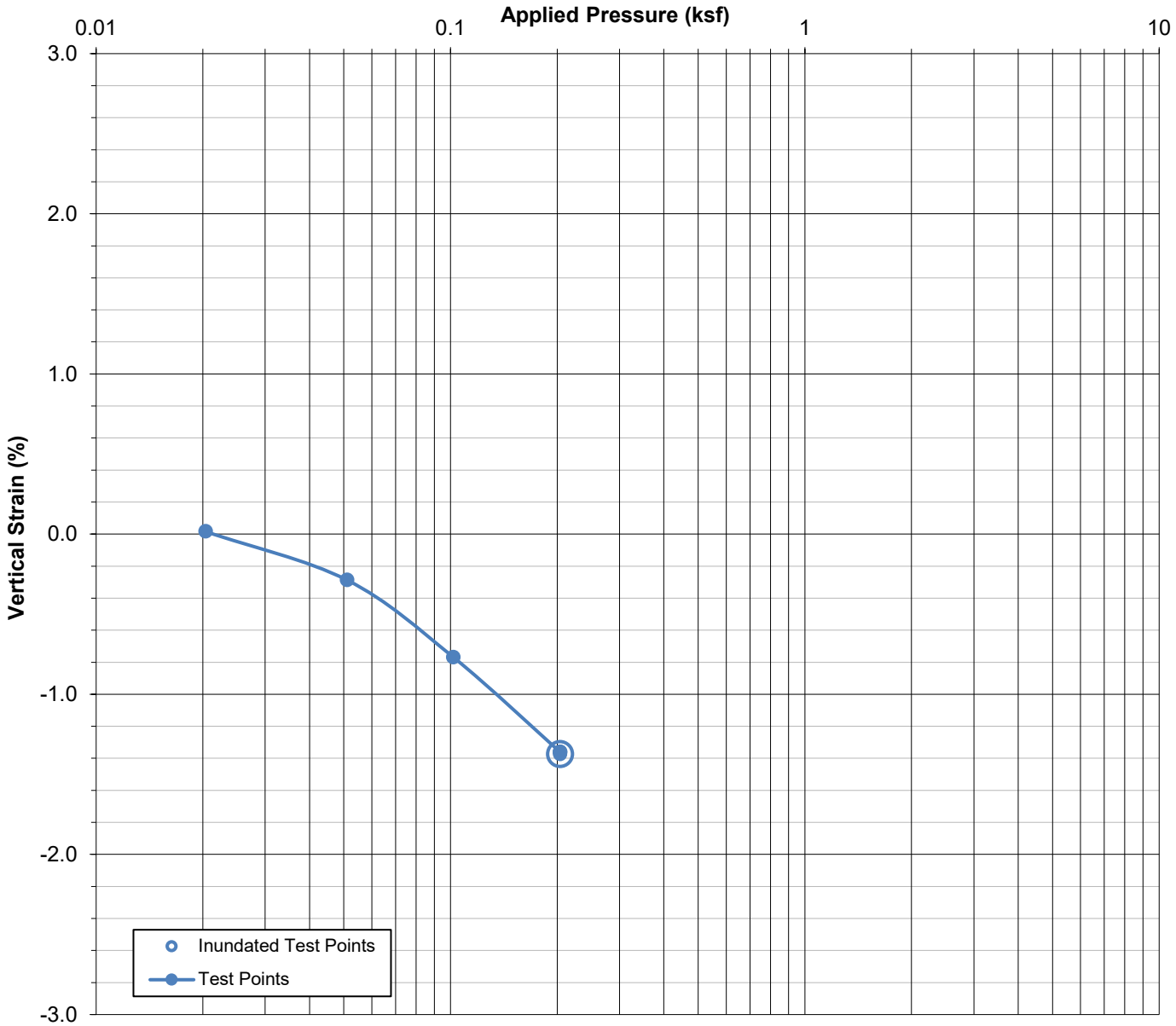
SHANNON & WILSON

ASTM D4546-21

Standard Test Method for One-Dimensional Swell or Collapse of Soils

El Paso County Pedestrian Crossings **El Paso County, Colorado**	**Boring:** SW-13 **Sample:** S-2 **Depth:** 2.0 to 3.0 feet

SWELL/COLLAPSE TEST REPORT



Sample Description: Lean Clay with Sand					
Swell Pressure:	-	psf	Swell (+) or Collapse (-):	0.0	%
Inundation Pressure:	204	psf	Moist Unit Weight:	123.9	pcf
Initial Moisture Content:	18.5	%	Dry Unit Weight:	104.6	pcf
Final Moisture Content:	23.2	%			

Notes

1. Testing was done in general accordance with Method B (an intact specimen obtained from a natural deposit) of ASTM D 4546, Standard Test Methods for One-Dimensional Swell or Collapse of Soils.

Checked By: JYS

SW-13 S-2_Swell Template_daa.xlsx

113421-001

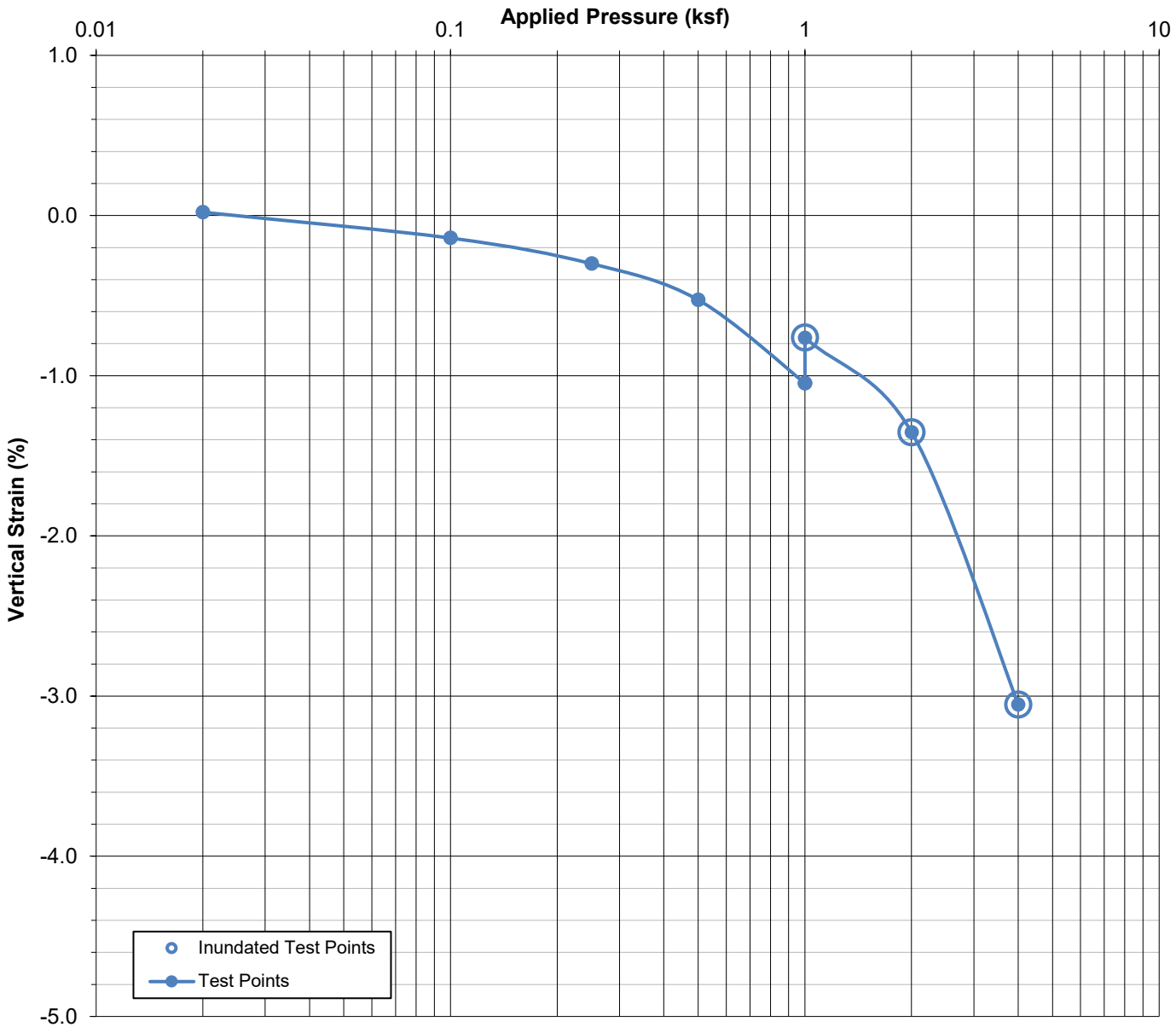
SHANNON & WILSON

ASTM D4546-21

Standard Test Method for One-Dimensional Swell or Collapse of Soils

El Paso County Pedestrian Crossings El Paso County, Colorado	**Boring:** SW-31 **Sample:** S-5 **Depth:** 10.0 to 11.0 feet

SWELL/COLLAPSE TEST REPORT



Sample Description: Lean Clay with Sand					
Swell Pressure:	1,293	psf	Swell (+) or Collapse (-):	0.3	%
Inundation Pressure:	1,001	psf	Moist Unit Weight:	124.6	pcf
Initial Moisture Content:	20.2	%	Dry Unit Weight:	103.7	pcf
Final Moisture Content:	24.4	%			

Notes

1. Testing was done in general accordance with Methods B and C (reloading on intact specimen after undergoing swell deformation) of ASTM D 4546, Standard Test Methods for One-Dimensional Swell or Collapse of Soils.
2. The swell pressure is the applied pressure required to compress the sample to its height immediately prior to inundation.

Checked By: JYS

SW-31 S-5_Swell Template.xlsx

113421-001

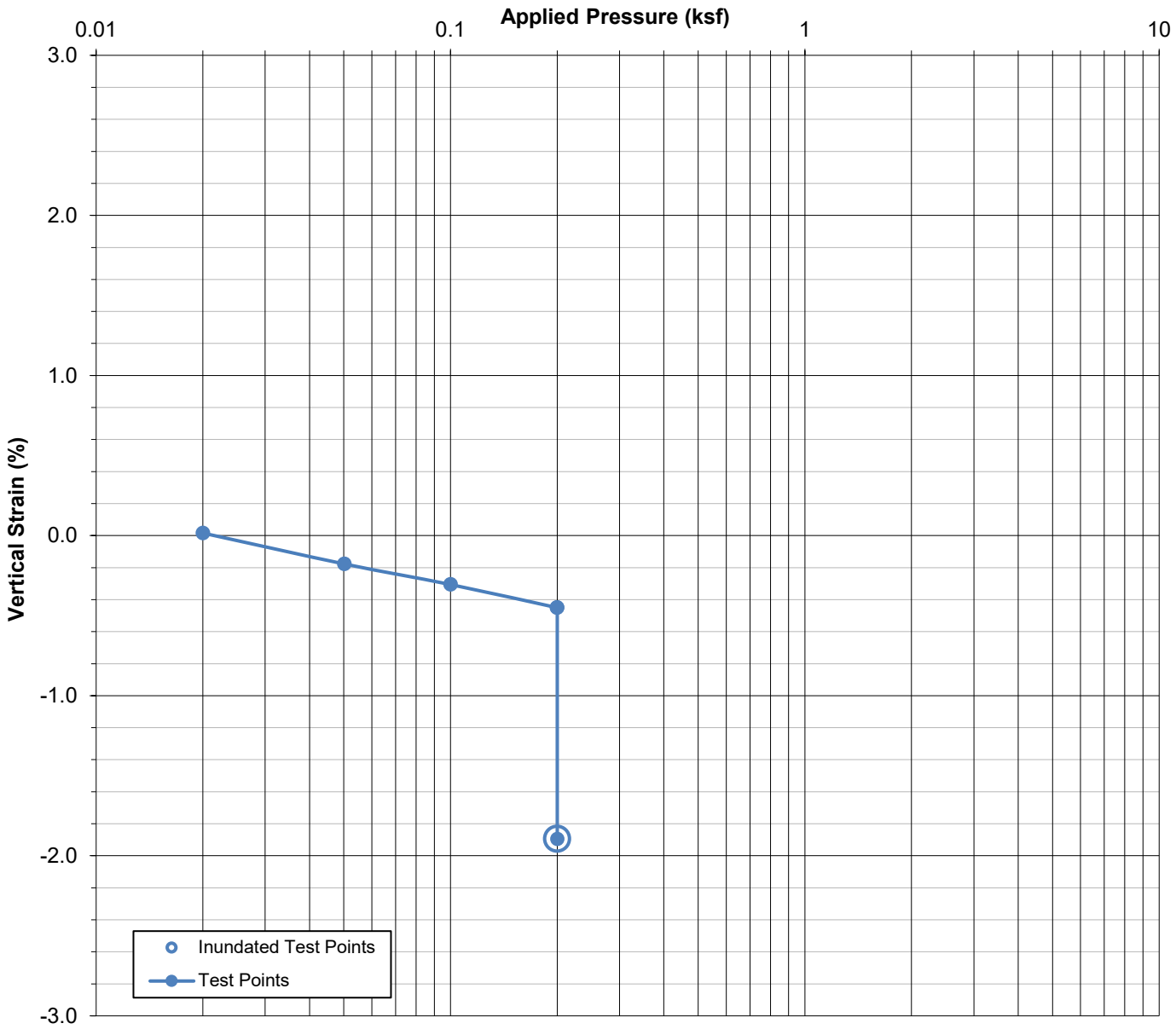
SHANNON & WILSON

ASTM D4546-21

Standard Test Method for One-Dimensional Swell or Collapse of Soils

El Paso County Pedestrian Crossings El Paso County, Colorado	**Boring:** SW-71 **Sample:** S-2 **Depth:** 2.5 to 3.5 feet

SWELL/COLLAPSE TEST REPORT



Sample Description: Clayey Sand					
Swell Pressure:	-	psf	Swell (+) or Collapse (-):	-1.4	%
Inundation Pressure:	200	psf	Moist Unit Weight:	114.9	pcf
Initial Moisture Content:	15.2	%	Dry Unit Weight:	99.7	pcf
Final Moisture Content:	24.2	%			

Notes

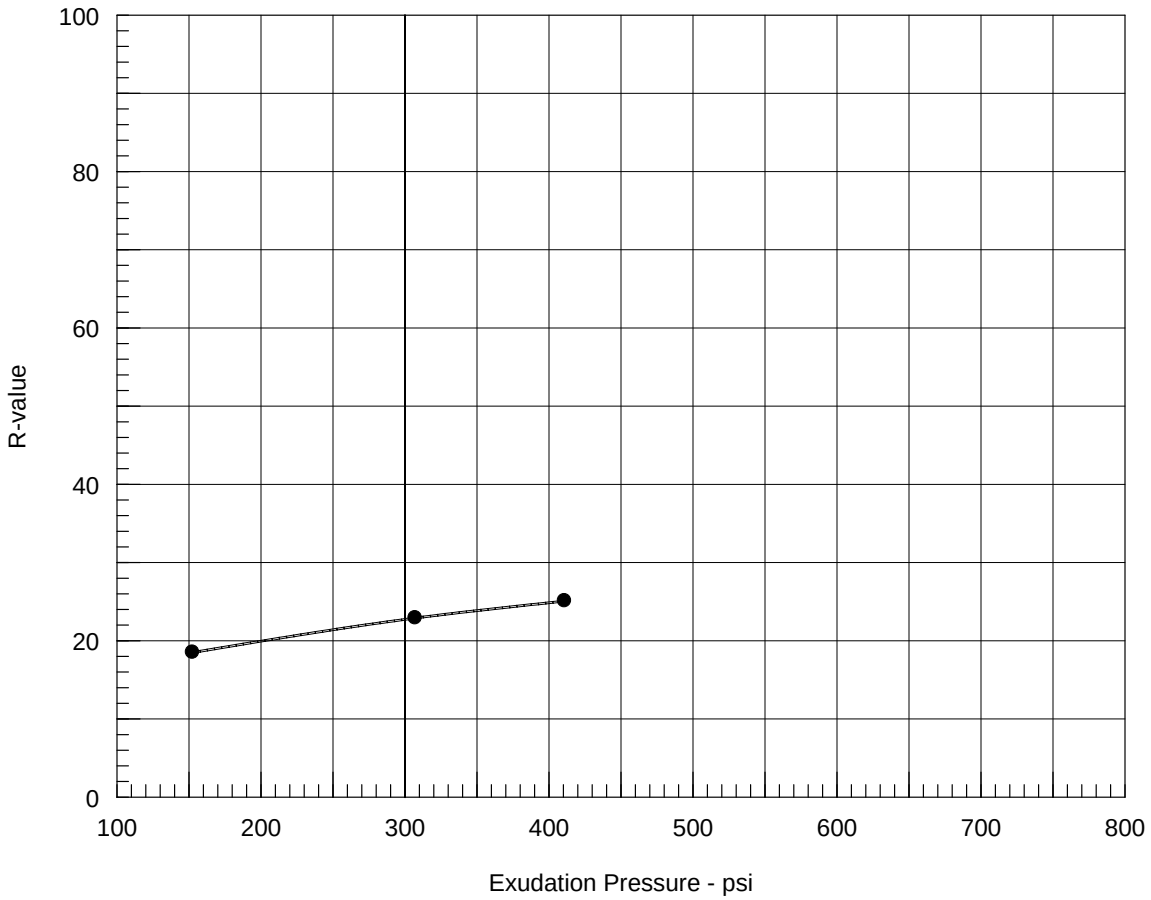
1. Testing was done in general accordance with Method B (an intact specimen obtained from a natural deposit) of ASTM D 4546, Standard Test Methods for One-Dimensional Swell or Collapse of Soils.

Checked By: JYS

SW-71 S-2_Swell Template_daa.xlsx

113421-001

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	60	122.6	13.5	0.00	121	2.60	153	17.3	18.5
2	200	120.7	11.3	0.00	109	2.30	307	26.5	22.9
3	200	120.1	11.4	0.00	108	2.40	411	26.9	25.1

Test Results	Material Description
R-value at 300 psi exudation pressure = 22.7	

Project No.: 24-5007
Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001
Location: Boring SW-03 Sample Bulk 2 Depth 2' - 3'
Sample Number: S7551 **Depth:** 2' - 3'
Date: 10/24/2024

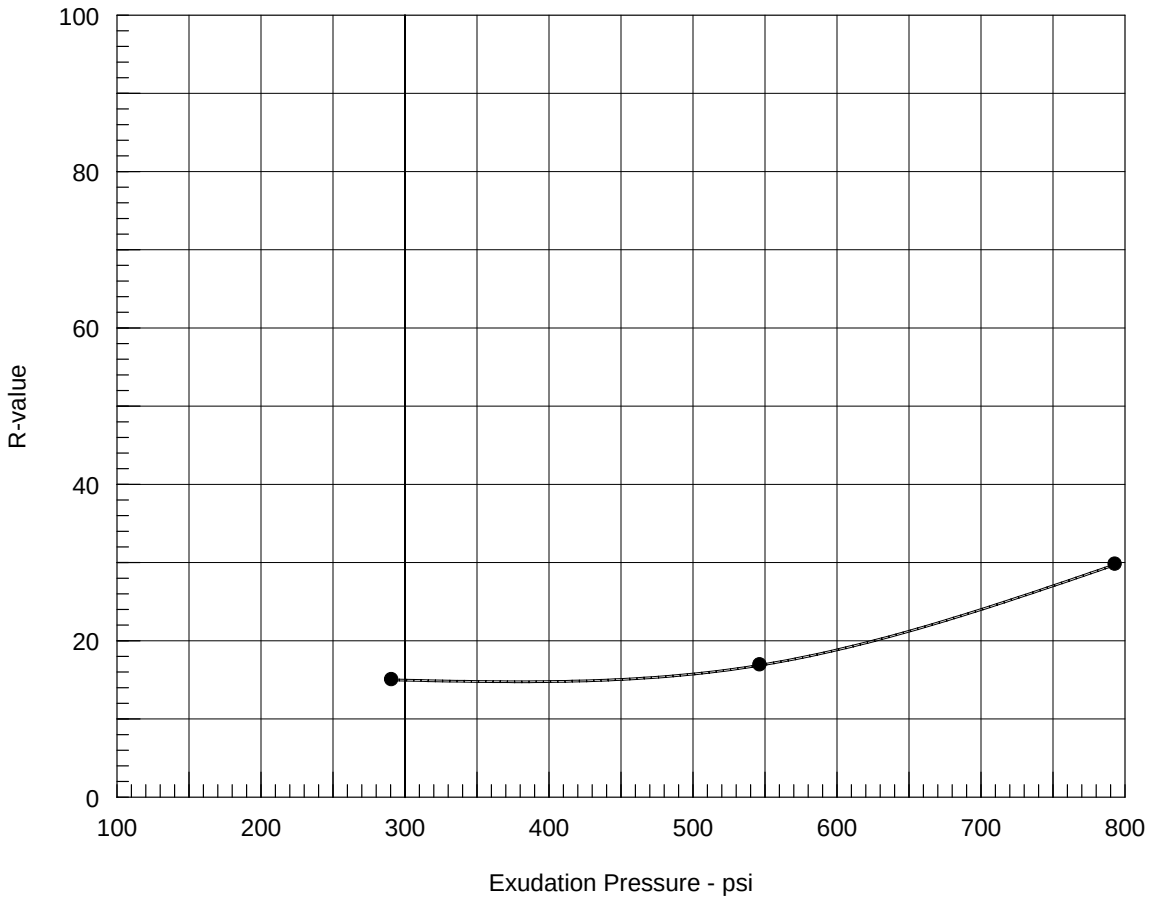
Tested by: Christopher Johnson
Checked by: Stacy Schulz
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7551

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	70	113.6	15.4	0.00	130	2.60	291	14.1	15.0
2	100	121.7	15.6	0.00	122	2.60	547	15.8	16.9
3	130	117.4	13.7	0.00	109	2.60	793	27.9	29.7

Test Results	Material Description
R-value at 300 psi exudation pressure = 15.0	

Project No.: 24-5007

Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001

Location: Boring SW-13 Sample G-1 Depth 0.4' to 5'

Sample Number: S7442 **Depth:** 0.4' to 5'

Date: 9/12/2024

Tested by: Christopher Johnson

Checked by: Stacy Schulz

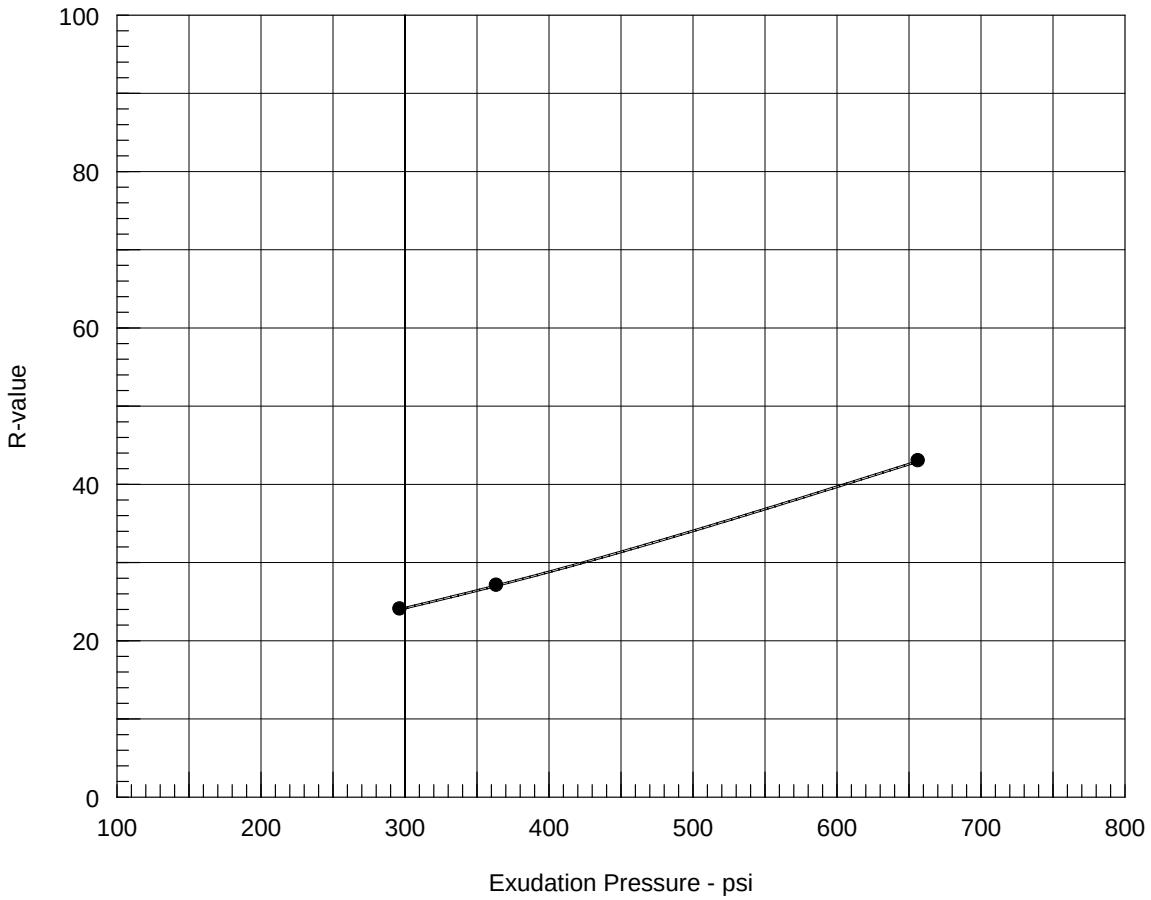
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7442

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	350	131.1	8.5	0.00	75	2.50	657	43.0	43.0
2	130	125.9	9.5	0.00	105	2.60	364	25.3	27.1
3	110	120.9	10.2	0.00	103	2.30	297	27.8	24.0

Test Results	Material Description
R-value at 300 psi exudation pressure = 24.2	

Project No.: 24-5007
Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001
Location: Boring SW-22 Sample B-1 Depth 0.5' - 5'
Sample Number: S7479 **Depth:** 0.5' - 5'
Date: 10/3/2024

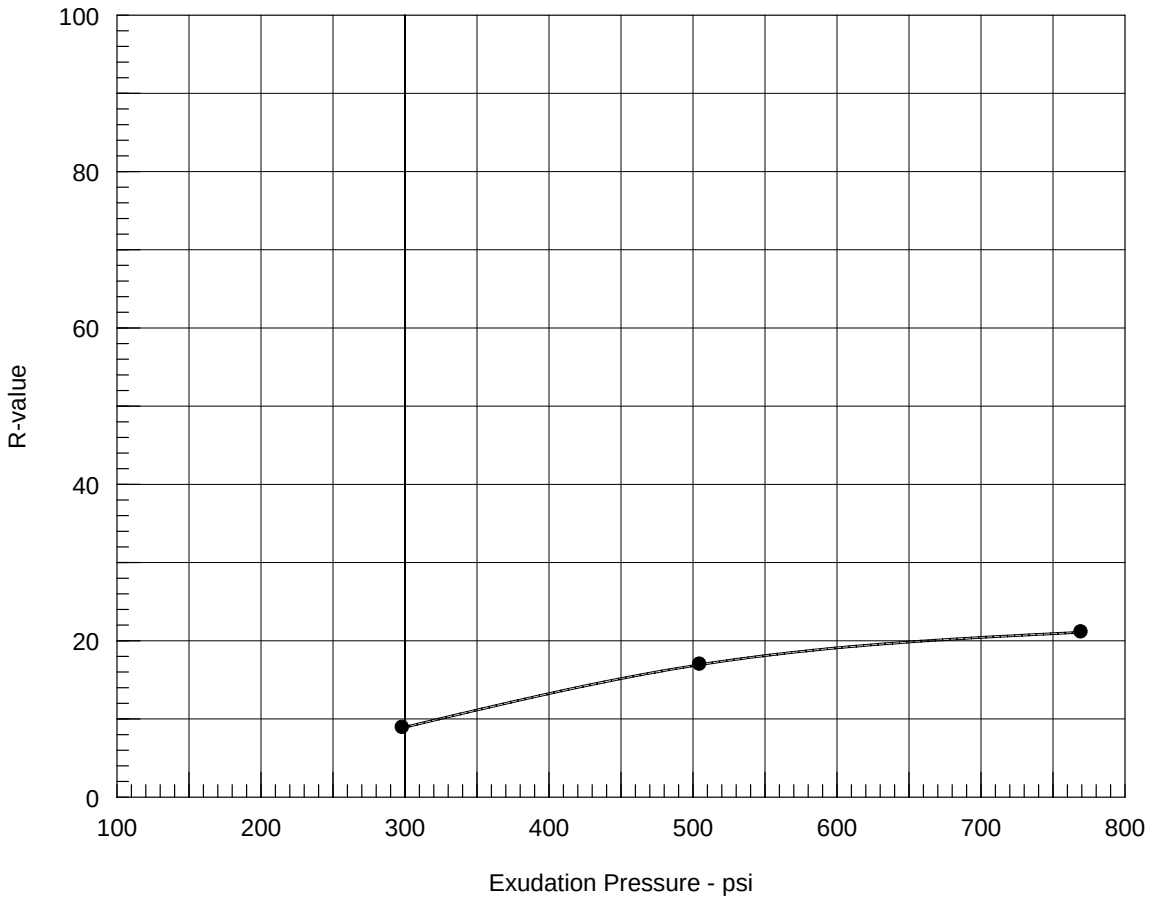
Tested by: Christopher Johnson
Checked by: Stacy Schulz
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7479

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	100	119.6	13.8	0.00	118	2.50	770	21.1	21.1
2	110	132.7	15.3	0.00	124	2.40	505	18.2	16.9
3	150	110.9	17.5	0.00	140	2.70	298	7.9	8.9

Test Results	Material Description
R-value at 300 psi exudation pressure = 9.0	

Project No.: 24-5007

Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001

Location: Boring SW-33 Sample Bulk 2 Depth 3' - 5'

Sample Number: S7552 **Depth:** 3' - 5'

Date: 10/24/2024

Tested by: Christopher Johnson

Checked by: Stacy Schulz

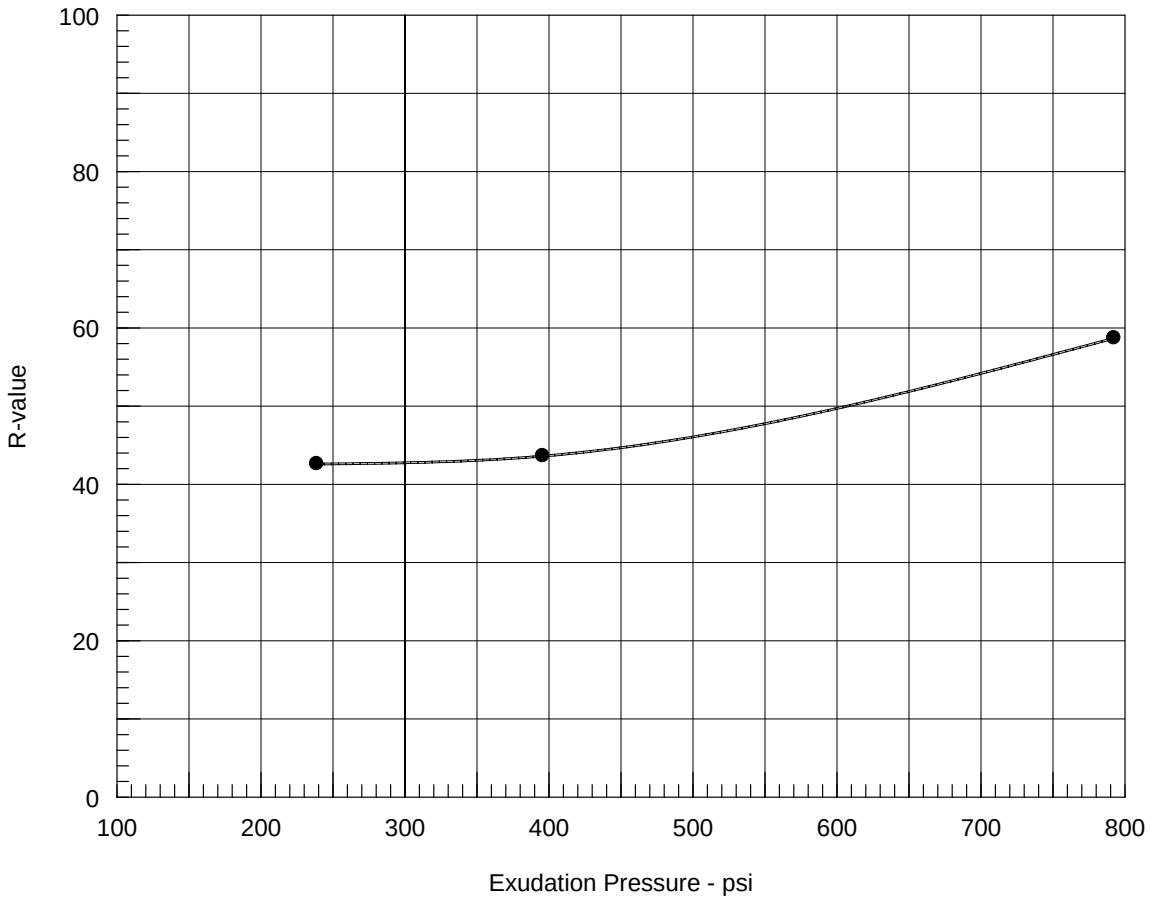
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7552

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	100	119.7	11.9	0.00	72	2.60	396	41.1	43.6
2	350	124.1	9.9	0.00	51	2.60	792	56.1	58.7
3	90	121.9	12.2	0.00	70	2.60	239	40.1	42.6

Test Results	Material Description
R-value at 300 psi exudation pressure = 42.8	

Project No.: 24-5007
Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001
Location: Boring SW-41 Sample B-1 Depth 0.5' - 5'
Sample Number: S7482 **Depth:** 0.5' - 5'
Date: 10/3/2024

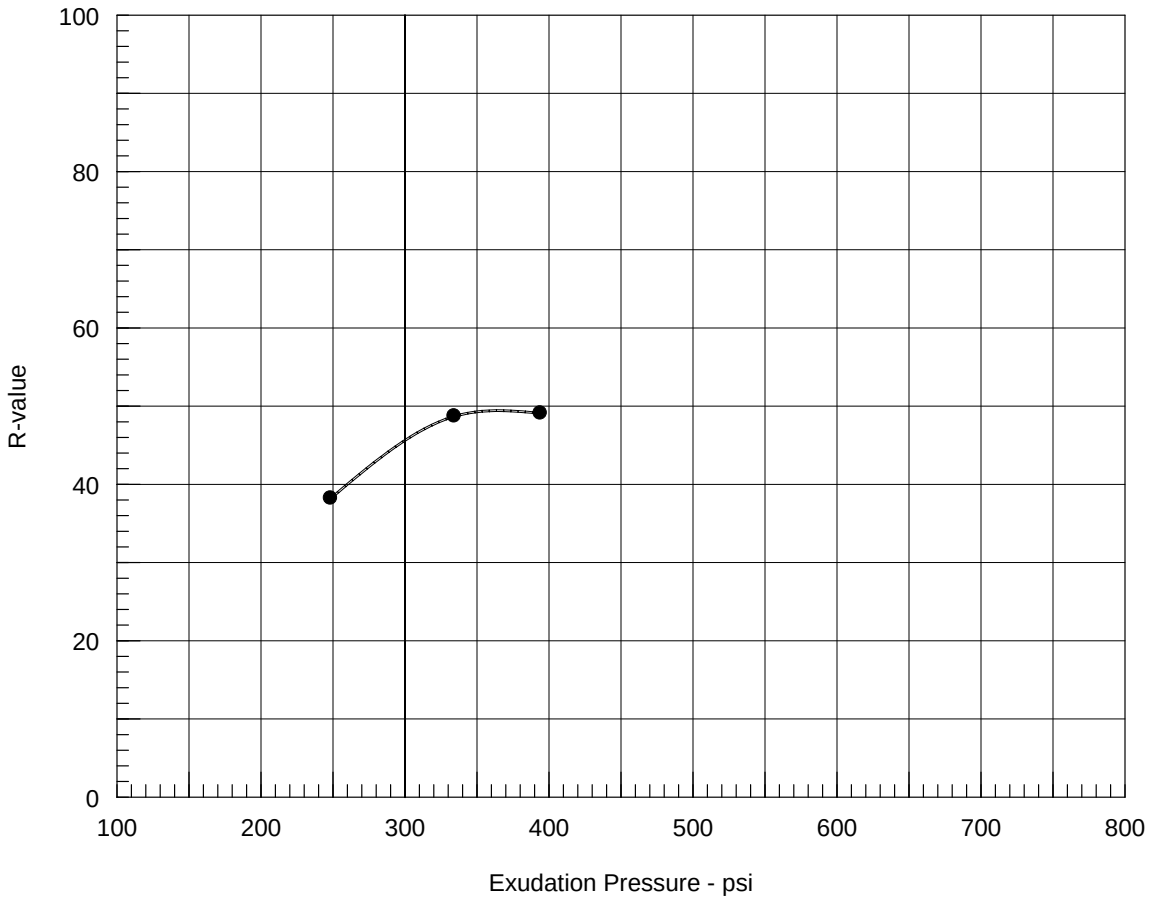
Tested by: Christopher Johnson
Checked by: Stacy Schulz
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7482

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	300	122.7	10.8	0.00	72	2.30	249	43.4	38.2
2	350	125.6	10.6	0.00	65	2.60	394	46.5	49.1
3	350	124.3	10.6	0.00	67	2.70	334	43.5	48.7

Test Results	Material Description
R-value at 300 psi exudation pressure = 45.6	

Project No.: 24-5007

Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001

Location: Boring SW-51 Sample B-1 Depth 0.5' - 5'

Sample Number: S7483 **Depth:** 0.5' - 5'

Date: 10/3/2024

Tested by: Christopher Johnson

Checked by: Stacy Schulz

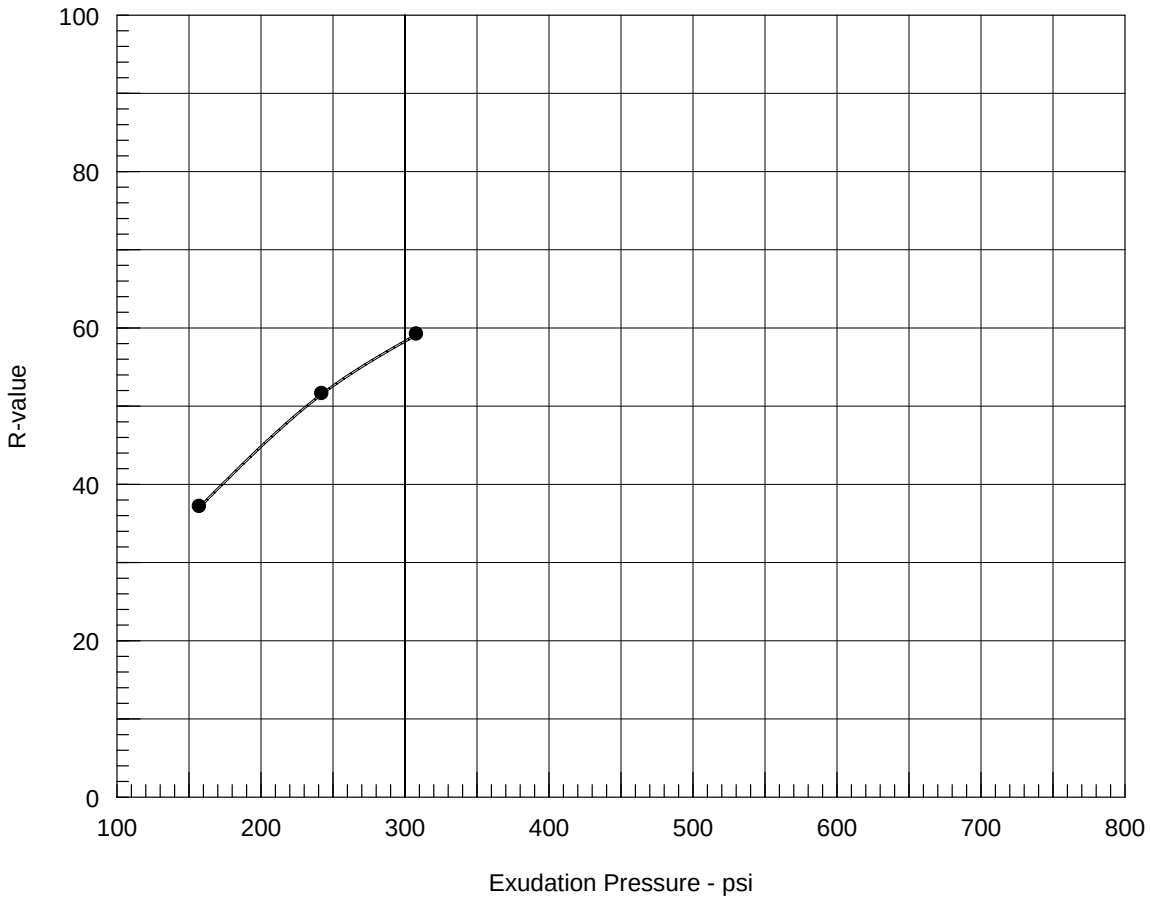
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7483

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	250	122.9	10.1	0.00	78	2.50	158	37.1	37.1
2	350	127.6	9.4	0.00	63	2.70	243	46.3	51.6
3	350	129.5	8.7	0.00	50	2.70	308	53.9	59.2

Test Results	Material Description
R-value at 300 psi exudation pressure = 58.3	

Project No.: 24-5007
Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001
Location: Boring SW-62 Sample B-1 Depth 0.5' - 5'
Sample Number: S7484 **Depth:** 0.5' - 5'
Date: 10/3/2024

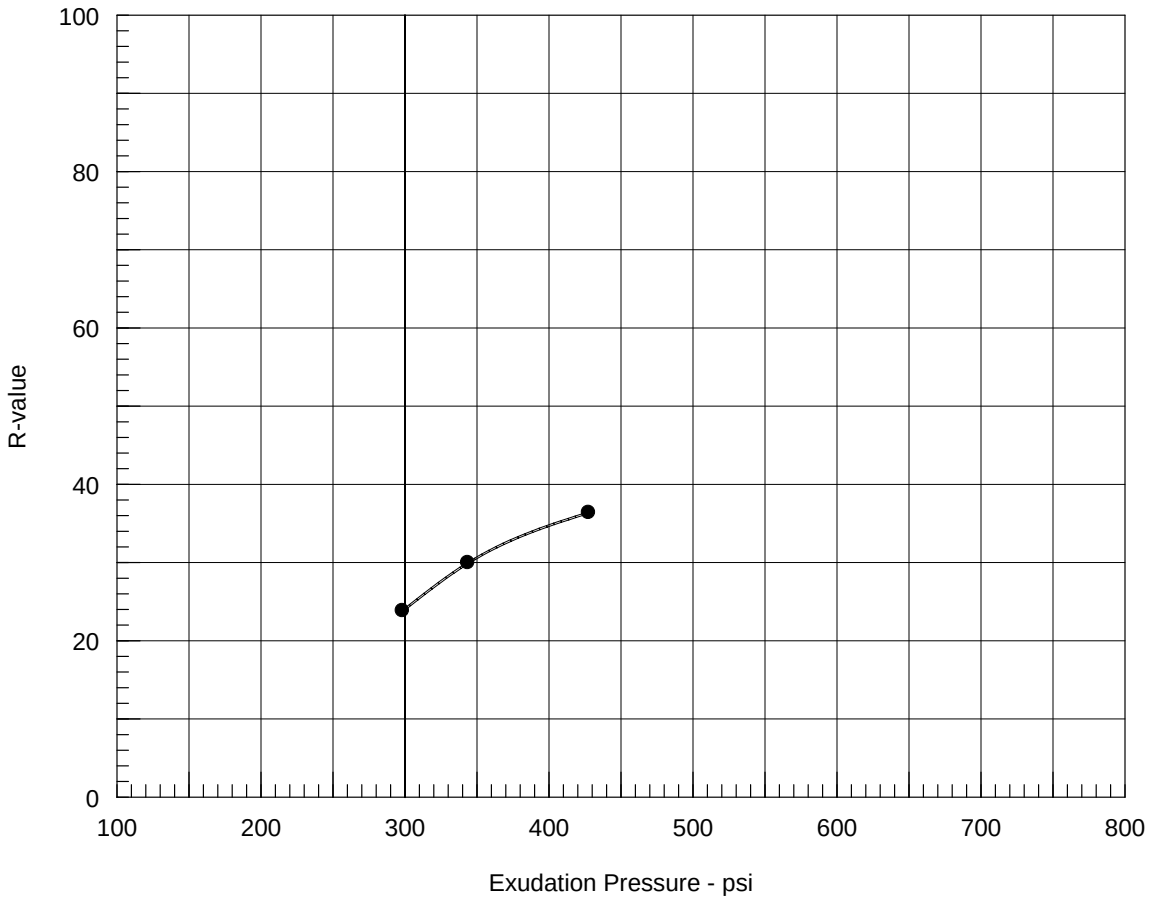
Tested by: Christopher Johnson
Checked by: Stacy Schulz
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7484

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	150	116.8	13.2	0.00	117	2.60	298	22.3	23.8
2	200	106.8	14.0	0.00	104	2.50	344	29.9	29.9
3	220	115.2	13.4	0.00	93	2.50	428	36.4	36.4

Test Results	Material Description
R-value at 300 psi exudation pressure = 24.0	

Project No.: 24-5007

Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001

Location: Boring SW-71 Sample G-1 Depth 0.3' - 5'

Sample Number: S7485 **Depth:** 0.3' - 5'

Date: 10/3/2024

Tested by: Christopher Johnson

Checked by: Stacy Schulz

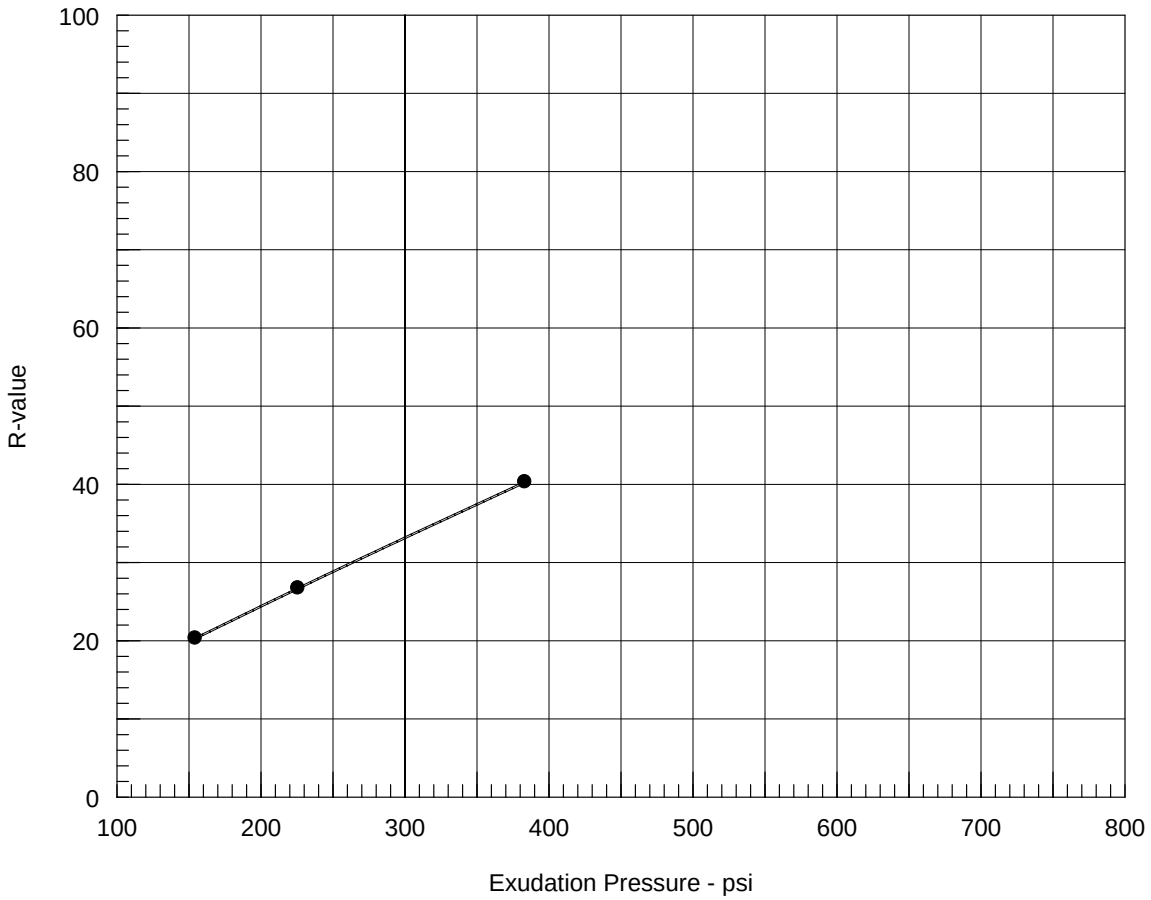
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7485

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	100	124.0	11.2	0.00	117	2.70	155	17.9	20.3
2	125	121.9	10.7	0.00	108	2.70	226	23.5	26.7
3	250	124.0	9.7	0.00	79	2.50	383	40.3	40.3

Test Results	Material Description
R-value at 300 psi exudation pressure = 33.2	

Project No.: 24-5007
Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001
Location: Boring SW-81 Sample G-1 Depth 0.3' - 5'
Sample Number: S7480 **Depth:** 0.3' - 5'
Date: 10/3/2024

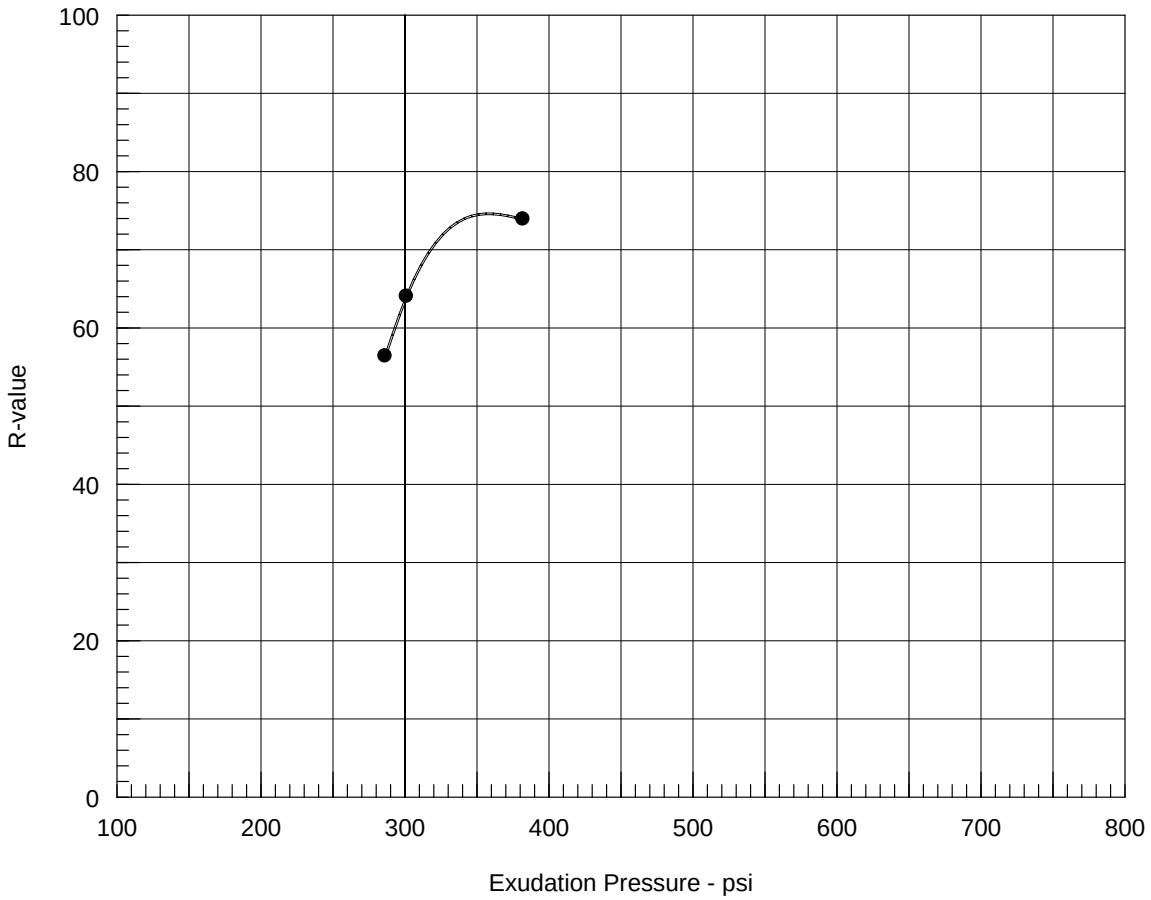
Tested by: Christopher Johnson
Checked by: Stacy Schulz
Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7480

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - AASHTO T 190

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	350	134.7	7.1	0.00	47	2.70	301	59.0	64.0
2	350	133.7	7.3	0.00	35	2.70	382	69.8	73.9
3	350	130.1	7.8	0.00	53	2.60	286	53.8	56.4

Test Results	Material Description
R-value at 300 psi exudation pressure = 63.5	

Project No.: 24-5007

Project: Shannon & Wilson El Paso County Pedestrian Crossing 113421-001

Location: Boring SW-91 Sample Bulk Depth 1' - 5'

Sample Number: S7553 **Depth:** 3' - 5'

Date: 10/24/2024

Tested by: Christopher Johnson

Checked by: Stacy Schulz

Remarks:

R-VALUE TEST REPORT

Vine Laboratories

Figure S7553

APPENDIX C: PAVEMENT ANALYSIS

Appendix C

Pavement Analysis

Table

Site 1: Black Forest Rd. & Shoup Rd.

Site 2: Constitution Ave. & Piros Dr.

Site 3: Galley Rd. & Hathaway Dr.

Site 4: B St. & Crestridge Ave.

Site 5: Main St. & Leta Dr.

Site 6: Fontaine Blvd. & Dartmouth St.

Site 7: Main St. & Normal Dr.

Site 8: Palmer Park Blvd. at Winnebago Rd.

Site 9: Peterson Rd. at Sequoyah Way

Site 10: Main St. at Marquette Dr.

Exhibit C-32 to C-34: Flexible Pavement Design Worksheets and Nomograph

Exhibit C-35 and C-36: Mill & Overlay Analysis Worksheet and Nomograph

APPENDIX C: PAVEMENT ANALYSIS

Table C-1: 18-kip ESAL Calculations

Site	Borings	Street 1	Street 2	a ADT-1	b ADT-2	Class-1	Class-2	No. Through Lanes-1	No. Through Lanes-2	Zoning
1	SW-01 - SW-05	Black Forest Rd.	Shoup Rd.	10,000	10,000	Collector	Collector	1 per direction	1 per direction	Rural
2	SW-11 - SW-13	Constitution Ave.	Piros Dr.	40,000	3,000	Principle Art.	Local	2 per direction	1 per direction	Urban
3	SW-21 - SW-23	Galley Rd.	Hathaway Dr.	20,000	10,000	Minor Art.	Collector	1 per direction	1 per direction	Urban
4	SW-31 - SW-31	B St.	Crestridge Ave.	20,000	10,000	Minor Art.	Collector	2 per direction	1 per direction	Urban
5	SW-41 & SW-42	Main St.	Leta Dr.	10,000	3,000	Collector	Local	1 per direction	1 per direction	Urban
6	SW-51 & SW-52	Fontaine Blvd.	Dartmouth St.	20,000	3,000	Minor Art.	Local	1 per direction	1 per direction	Urban
7	SW-61 - SW-63	Main St.	Normal Dr.	10,000	3,000	Collector	Local	1 per direction	1 per direction	Urban
8	SW-71	Palmer Park	@ Winnebago Rd.	40,000	-	Principle Art.	Local	2 per direction	-	Urban
9	SW-81 & SW-82	Peterson Rd.	@ Sequoyah Way	20,000	-	Minor Art.	Local	2 per direction	-	Urban
10	SW-91	Main St.	@ Marquette Dr.	10,000	-	Collector	Local	2 per direction	-	Urban

												20-Year Design Life		10-Yr DL
	c	d	e	f	g	h	i	j	k	l	m	n1		n2
							Truck Distribution (%)		Design ADT					
Site	Req. EPC Truck Traffic (%)	EPC DD-1	EPC DD-2	EPC DL-1	EPC DL-2	Design ADT	Single Unit Trucks	Comb. Trucks	Passenger Care	Single Unit Trucks	Comb. Trucks	18-kip Design ESAL	EPC Min. Design ESAL	18-kip Design ESAL
1	5.0	0.5	0.5	1.0	1.0	10,000	90	10	9,500	450	50	1,566,399	109,500	744,266
2	8.0	0.5	0.5	0.9	1.0	19,500	90	10	17,940	1,404	156	4,605,068	5,256,000	2,188,074
3	6.0	0.5	0.5	1.0	1.0	15,000	90	10	14,100	810	90	2,747,186	1,971,000	1,305,311
4	6.0	0.5	0.5	0.9	1.0	14,000	90	10	13,160	756	84	2,564,040	1,971,000	1,218,290
5	5.0	0.5	0.5	1.0	1.0	6,500	90	10	6,175	293	33	1,018,159	821,000	483,773
6	6.0	0.5	0.5	1.0	1.0	11,500	90	10	10,810	621	69	2,106,176	1,971,000	1,000,738
7	5.0	0.5	0.5	1.0	1.0	6,500	90	10	6,175	293	33	1,018,159	821,000	483,773
8	8.0	0.5	-	0.9	-	18,000	90	10	16,560	1,296	144	4,250,832	5,256,000	2,019,760
9	6.0	0.5	-	1.0	-	10,000	90	10	9,400	540	60	1,831,457	1,971,000	870,207
10	5.0	0.5	-	1.0	-	5,000	90	10	4,750	225	25	783,199	821,000	372,133

h = a (d) f + b (e) g
k = (1 - c / 100%) h
l = h (c / 100%) (i / 100%)
m = h (c / 100%) (j / 100%)
n1 = 365 days/yr (GF-20yr) { k (o) + l (p) + m (q) }
n2 = 365 days/yr (GF-10tr) { k (o) + l (p) + m (q) }
GF = [(1 + r / 100%)^{DL} - 1] / (r / 100%)
DD = Directional Distribution
DL = Lane Distribution
EPC = El Paso County
ESAL = Equivalent Single-Axle Loading

18 Kip Flex. ESAL Truck Factor	
Passenger Car (o) =	0.003
Single-Unit Truck (p) =	0.249
Combination Truck (q) =	1.087

Annually Comp. Growth Rate (r) =	1.0	%
Design Life (DL) =	20	Years
Growth Factor (GF-20yr) =	22.02	
Design Life (DL) =	10	Years
Growth Factor (GF-10yr) =	10.46	

Design ESALs

Indicates a modification to EPC design criteria due to an increasded number of traffic lanes.

Notes

1. The current ADT is based on discussions with HDR. The percentage of truck traffic is based on El Paso County design criteria.
2. The flexible pavement equivalency factors, directional distribution factor, and traffic lane factor is based on Appendix H of the 2021 CDOT Pavement Design Manual. The analysis assumes a 90:10 ratio of single-unit trucks to combination trucks.

Flexible Pavement Design Worksheet

Location: Site 1: Black Forest Rd. & Shoup Rd. Job No.: 113421-001
Comment: Rural Collector Roadway Classification
Alt. 1: HMA over 6 in. ABC (min)

1. Pavement Design Life: 20.0 years
   Traffic Loading (W_{18}): 18k ESALs: 1,567,000 per lane

3. Serviceability:
   p_0: 4.2 Value assumed based on 1993 AGDPS
   p_t: 2.5 Table D-1 based on roadway classification
   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C
   R-value: 22.7

   Section D.4.1 (C) M_R: 5,395 psi
   S_1 = [(R-value - 5) / 11.29] + 3
   $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,395 psi

5. Reliability:
   R: 80 %
   Table D-1
   Z_R: -0.842

6. Design Standard Deviation (S_o):
   S_o: 0.45
   Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**1.960**
5,395	SN_2:	**3.926**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$
$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$
$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	7.5 inches	3.300	1.960
2	ABC	6.0 inches	3.960	3.926
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-1

Flexible Pavement Design Worksheet

Location: Site 1: Black Forest Rd. & Shoup Rd. Job No.: 113421-001
Comment: Rural Collector Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years
   Traffic Loading (W_{18}): 18k ESALs: 1,567,000 per lane

3. Serviceability:
   p_0: 4.2 Value assumed based on 1993 AGDPS
   p_t: 2.5 Table D-1 based on roadway classification
   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C
   R-value: 22.7

   Section D.4.1 (C) M_R: 5,395 psi
   S_1 = [(R-value - 5) / 11.29] + 3
   $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,395 psi

5. Reliability:
   R: 80 %
   Table D-1 Z_R: -0.842

6. Design Standard Deviation (S_o):
   S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
5,395	SN_1: **3.926**
-NA-	SN_2: **-NA-**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$
$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$
$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	9.5 inches	4.180	3.926
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-2

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

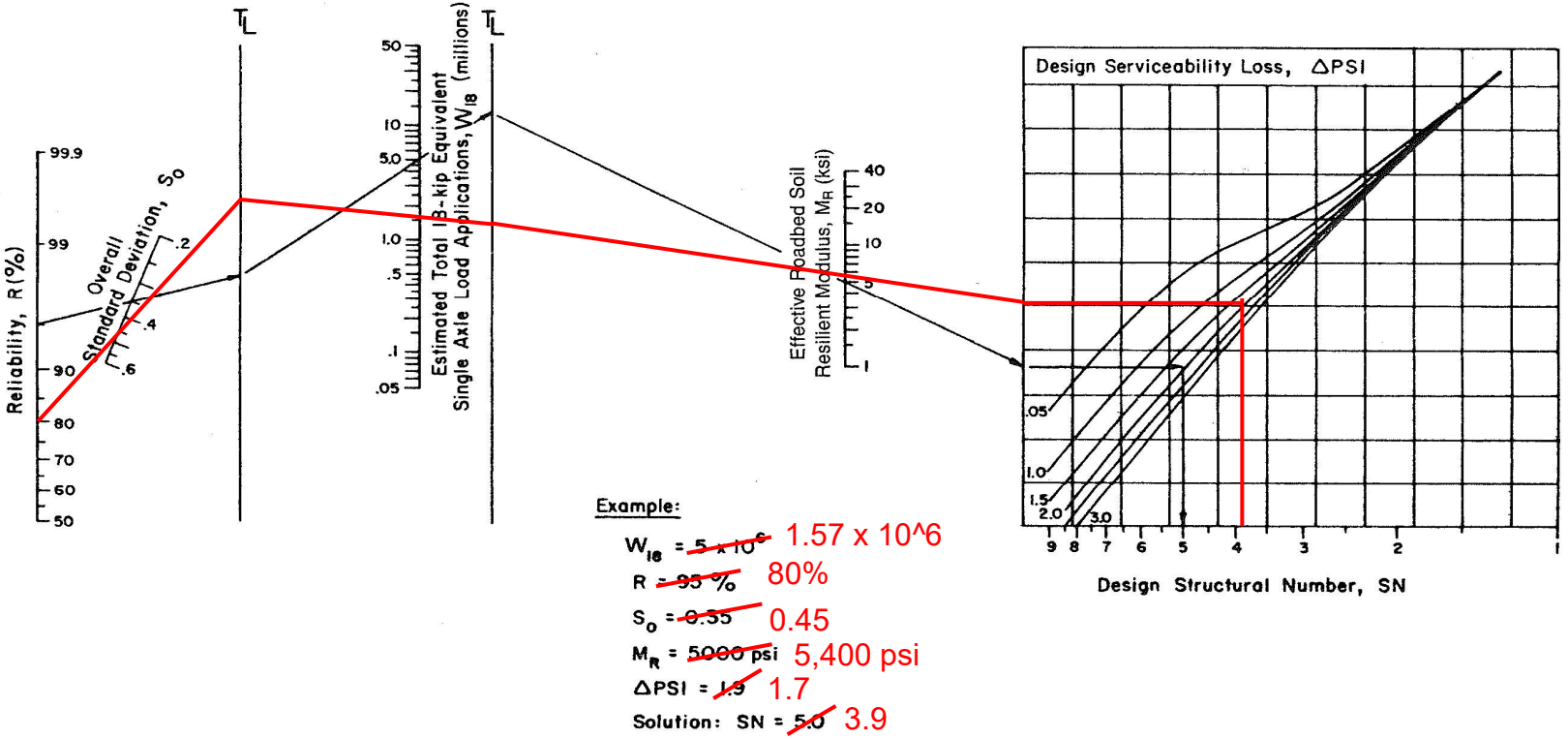


Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 1: Black Forest Rd. & Shoup Rd.

Flexible Pavement Design Worksheet

Location: Site 1: Black Forest Rd. & Shoup Rd. Job No.: 113421-001
Comment: Rural Collector Roadway Classification
2 in. Mill & 2 in. Overlay
Assume 11 in. Full Depth HMA

1. Pavement Design Life: 10.0 years

Traffic Loading (W_{18}): 18k ESALs: 745,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS
p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 22.7

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,395 psi

M_R: 5,395 psi

5. Reliability:

R: 80 % Table D-1

Z_R: -0.842

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
350,000	SN_1:	**0.505**
30,000	SN_2:	**1.789**
5,395	SN_3:	**3.482**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA OL	a_1: 0.44	-	-
2	Ext. HMA	a_2: 0.30	m_2: 1.00	350,000
3		a_3:	m_3: 1.00	30,000

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA OL	2.0 inches	0.880	0.505
2	Ext. HMA	9.0 inches	3.580	1.789
3		inches	3.580	3.482

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-4

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

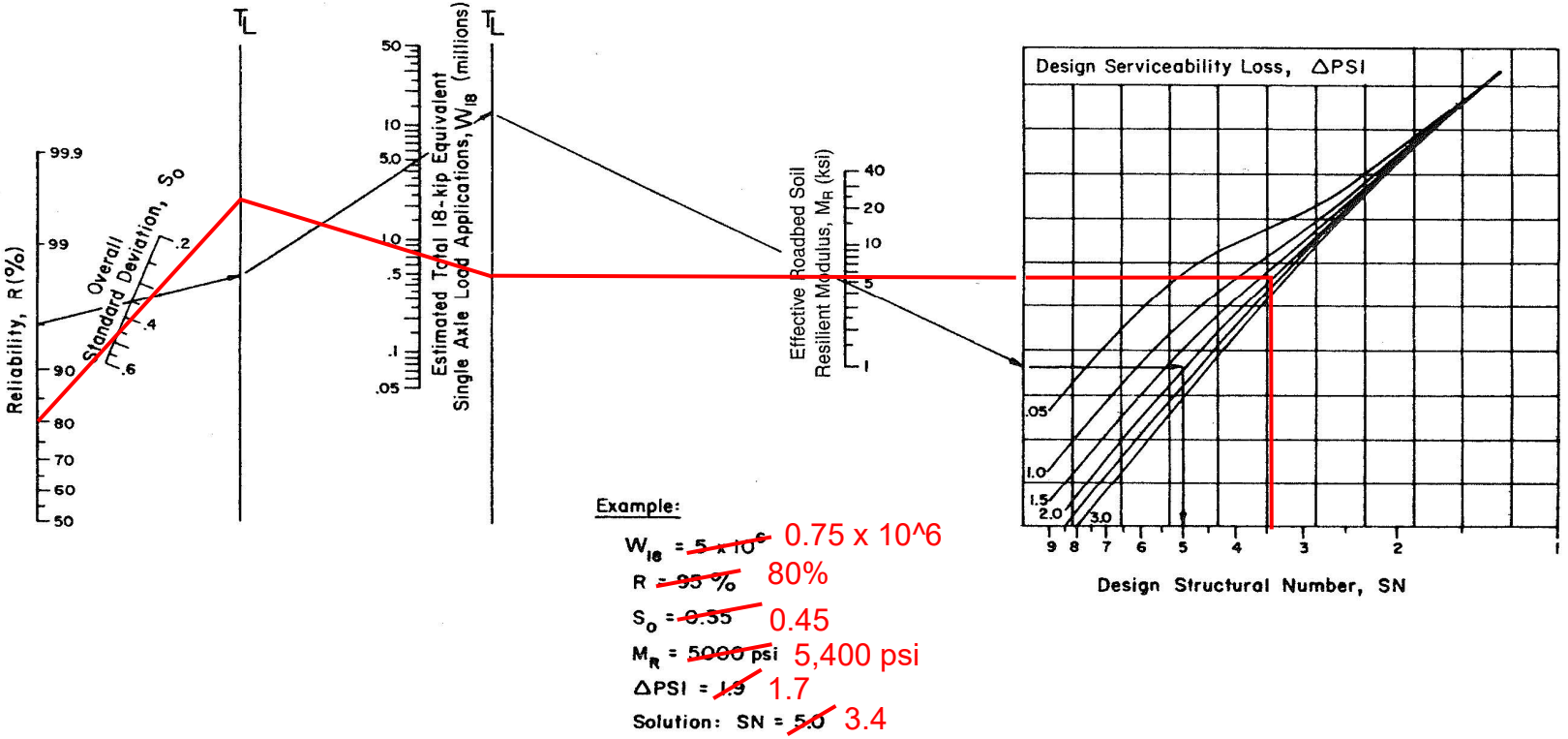


Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 1: Black Forest Rd. & Shoup Rd.

Flexible Pavement Design Worksheet

Location: Site 2: Constitution Ave. & Piros Dr. Job No.: 113421-001
Comment: Urban Principle Arterial (Constitution) Roadway Classification
Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): EPC Min. for Urban Principle Arterial — 18k ESALs: 5,256,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS
p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 15

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 4,195 psi

M_R: 4,195 psi

5. Reliability:

R: 90 % Table D-1

Z_R: -1.282

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**2.591**
4,195	SN_2:	**5.474**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	10.5 inches	4.620	2.591
2	ABC	8.0 inches	5.500	5.474
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-6

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

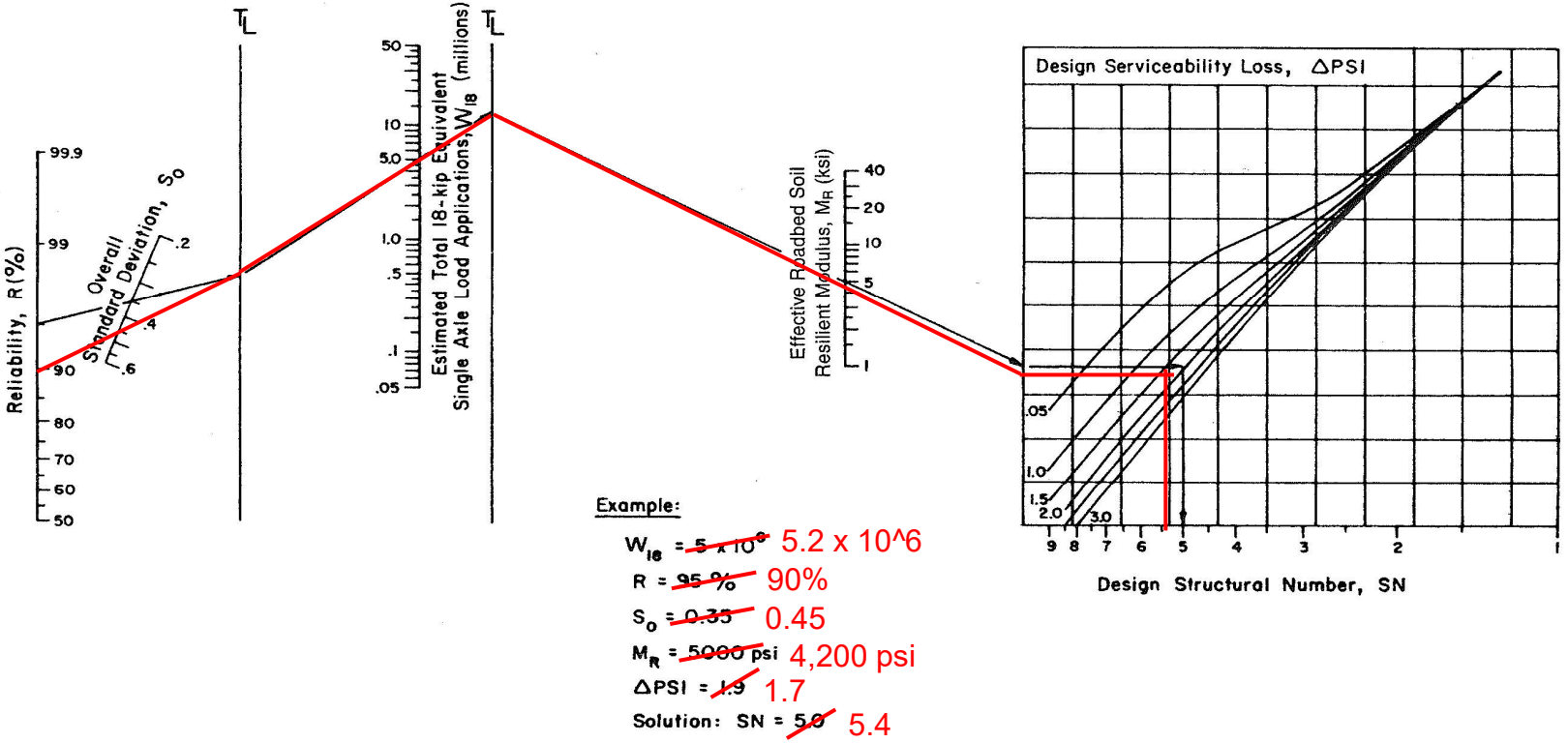


Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 2: Constitution Ave. & Piros Dr.

Flexible Pavement Design Worksheet

Location: Site 3: Galley Rd. & Hathaway Dr. Job No.: 113421-001
Comment: Urban Minor Arterial (Galley) Roadway Classification
Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years
   Traffic Loading (W_{18}): 18k ESALs: 2,748,000 per lane

3. Serviceability:
   p_0: 4.2 Value assumed based on 1993 AGDPS
   p_t: 2.5 Table D-1 based on roadway classification
   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C
   R-value: 24.2

   Section D.4.1 (C) M_R: 5,666 psi
   S_1 = [(R-value - 5) / 11.29] + 3
   $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,666 psi

5. Reliability:
   R: 85 % Table D-1
   Z_R: -1.036

6. Design Standard Deviation (S_o):
   S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**2.229**
5,666	SN_2:	**4.343**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$
$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$
$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	8.0 inches	3.520	2.229
2	ABC	8.0 inches	4.400	4.343
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-8

Flexible Pavement Design Worksheet

Location: Site 3: Galley Rd. & Hathaway Dr. Job No.: 113421-001
Comment: Urban Minor Arterial (Galley) Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years
   Traffic Loading (W_{18}): 18k ESALs: 2,748,000 per lane

3. Serviceability:
   p_0: 4.2 Value assumed based on 1993 AGDPS
   p_t: 2.5 Table D-1 based on roadway classification
   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C
   R-value: 24.2

   Section D.4.1 (C) M_R: 5,666 psi
   S_1 = [(R-value - 5) / 11.29] + 3
   $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,666 psi

5. Reliability:
   R: 85 %
   Table D-1 Z_R: -1.036

6. Design Standard Deviation (S_o):
   S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
5,666	SN_1: **4.344**
-NA-	SN_2: **-NA-**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$
$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$
$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

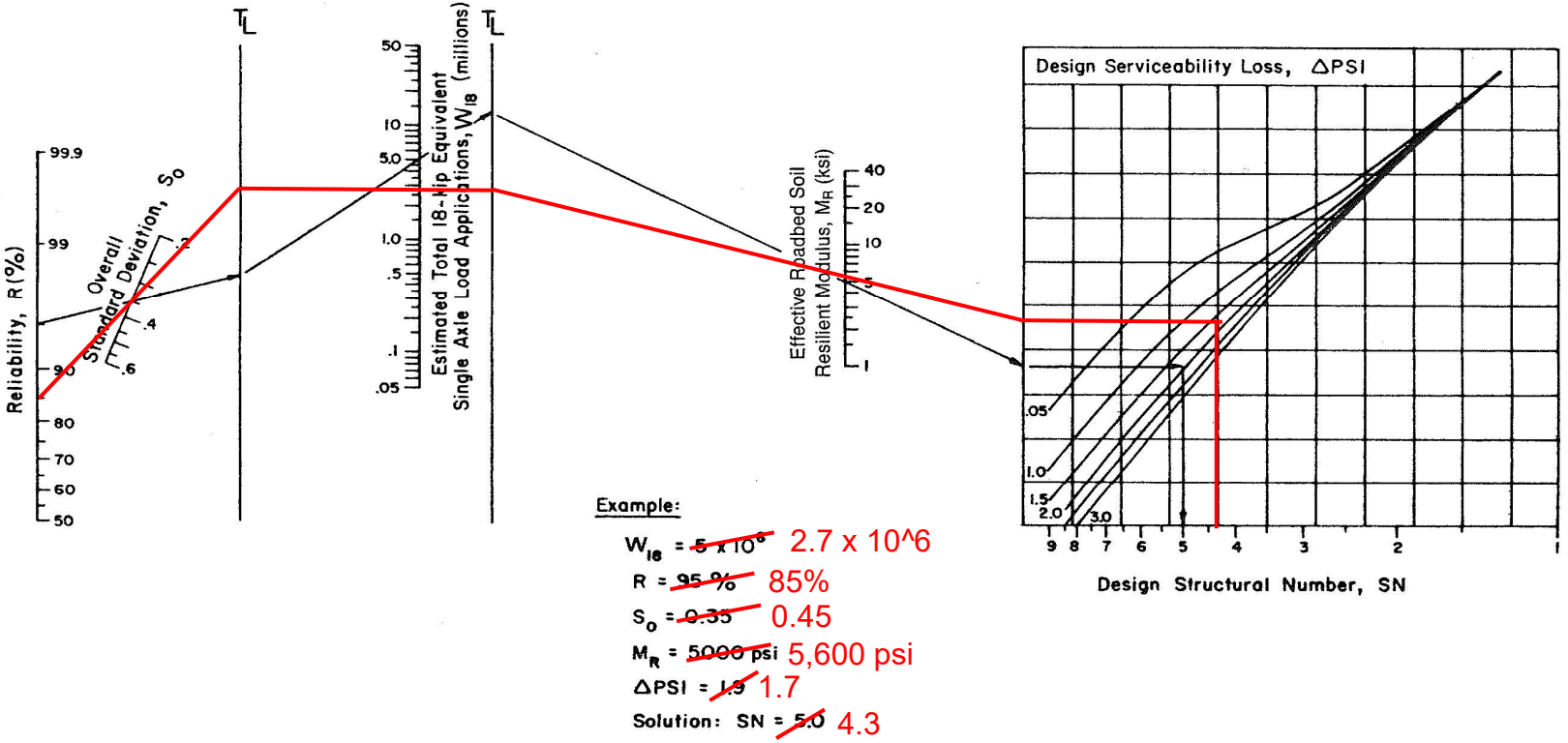
Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	10.0 inches	4.400	4.344
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-9

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example:

W_{18} = ~~5 x 10^6~~ 2.7 x 10^6

R = ~~95 %~~ 85%

S_o = ~~0.35~~ 0.45

M_R = ~~5000 psi~~ 5,600 psi

ΔPSI = ~~1.9~~ 1.7

Solution: SN = ~~5.0~~ 4.3

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 3: Galley Rd. & Hathaway Dr.

Flexible Pavement Design Worksheet

Location: Site 4: B St. & Crestridge Ave. Job No.: 113421-001
Comment: Urban Minor Arterial (B St.) Roadway Classification
Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): 18k ESALs: 2,565,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS
p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 9

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 3,448 psi

M_R: 3,448 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**2.204**
3,448	SN_2:	**5.094**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	10.0 inches	4.400	2.204
2	ABC	8.0 inches	5.280	5.094
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-11

Flexible Pavement Design Worksheet

Location: Site 4: B St. & Crestridge Ave. Job No.: 113421-001
Comment: Urban Minor Arterial (B St.) Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): 18k ESALs: 2,565,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS

p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 9

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 3,448 psi

M_R: 3,448 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
3,448	SN_1: **5.093**
-NA-	SN_2: **-NA-**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	12.0 inches	5.280	5.093
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-12

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

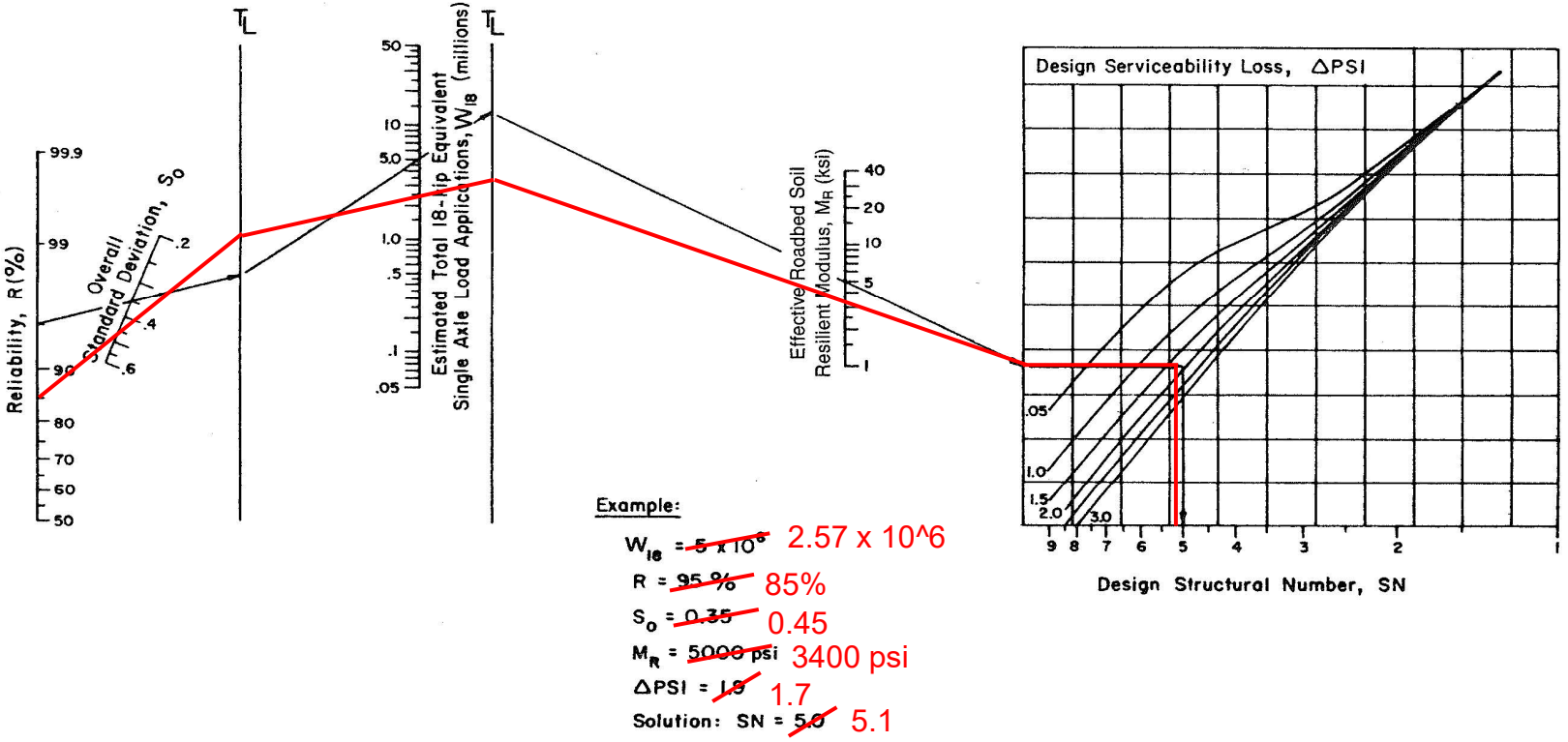


Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 4: B St. & Crestridge Ave.

Flexible Pavement Design Worksheet

Location: Site 5: Main St. & Leta Dr. Job No.: 113421-001

Comment: Urban Collector (Main St.) Roadway Classification

Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years

   Traffic Loading (W_{18}): 18k ESALs: 1,019,000 per lane

3. Serviceability:

   p_0: 4.2 Value assumed based on 1993 AGDPS — ΔPSI: 1.7

   p_t: 2.5 Table D-1 based on roadway classification

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

   R-value: 42.8

   Section D.4.1 (C) — M_R: 10,407 psi

   $S_1 = [(\text{R-value} - 5) / 11.29] + 3$

   $M_R = 10^{[(S_1 + 18.72) / 6.24]} =$ 10,407 psi

5. Reliability:

   R: 85 % Table D-1 — Z_R: -1.036

6. Design Standard Deviation (S_o):

   S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**1.885**
10,407	SN_2:	**2.947**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	5.0 inches	2.200	1.885
2	ABC	8.0 inches	3.080	2.947
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-14

Flexible Pavement Design Worksheet

Location: Site 5: Main St. & Leta Dr. Job No.: 113421-001
Comment: Urban Collector (Main St.) Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): 18k ESALs: 1,019,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS

p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 42.8

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 10,407 psi

M_R: 10,407 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
10,407	SN_1:	**2.947**
-NA-	SN_2:	**-NA-**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

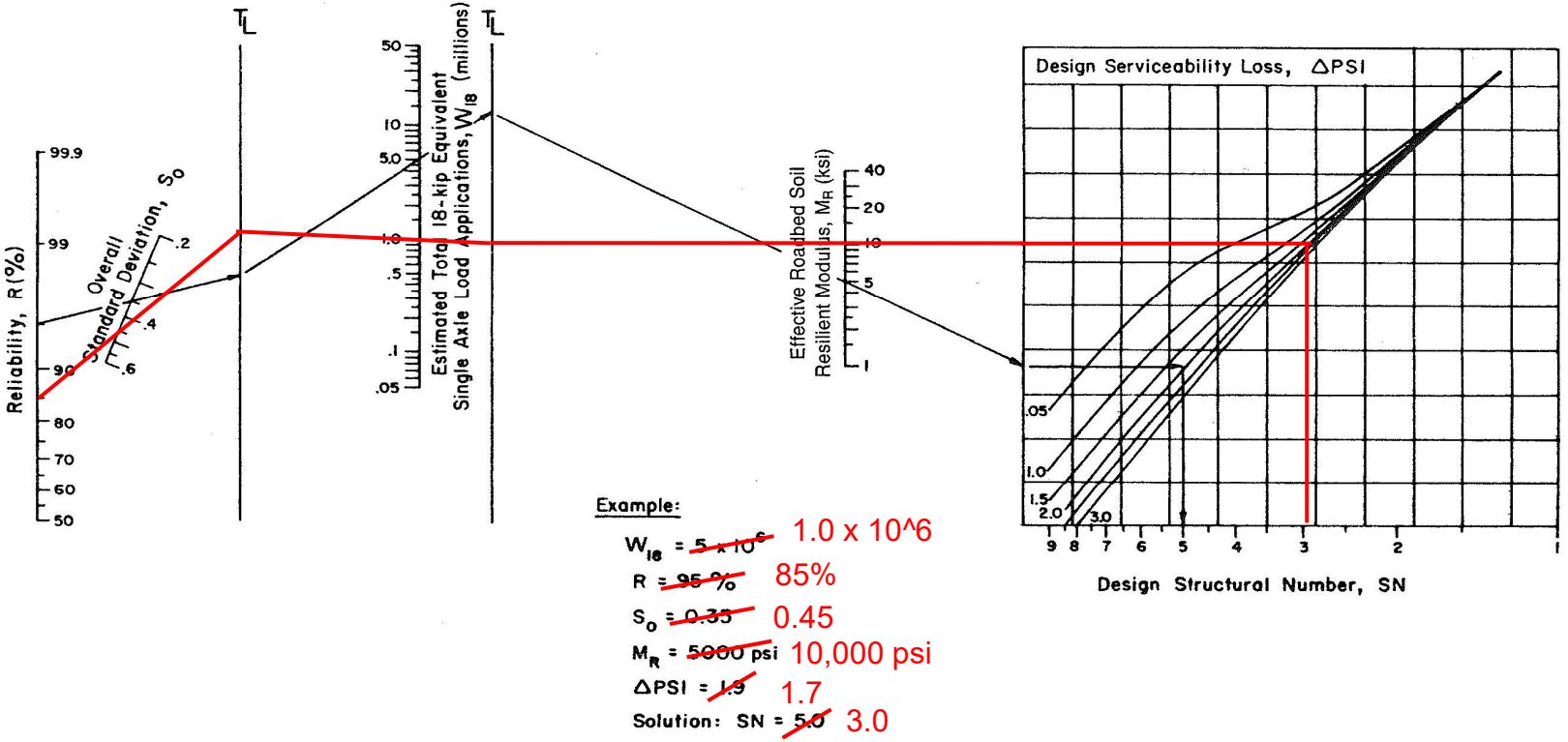
Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	7.0 inches	3.080	2.947
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-15

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example:

W_{18} = ~~5 x 10^6~~ 1.0 x 10^6

R = ~~95 %~~ 85%

S_o = ~~0.35~~ 0.45

M_R = ~~5000 psi~~ 10,000 psi

ΔPSI = ~~1.9~~ 1.7

Solution: SN = ~~5.0~~ 3.0

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 5: Main St. & Leta Dr.

Flexible Pavement Design Worksheet

Location: Site 6: Fontaine Blvd. & Dartmouth St. Job No.: 113421-001
Comment: Urban Minor Arterial (Fontaine Blvd.) Roadway Classification
Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): EPC Min. for Urban Principle Arterial — 18k ESALs: 2,107,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS
p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 45.6

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 11,404 psi

M_R: 11,404 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
32,883	SN_1: **2.132**
11,404	SN_2: **3.209**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	5.5 inches	2.420	2.132
2	ABC	8.0 inches	3.300	3.209
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-17

Flexible Pavement Design Worksheet

Location: Site 6: Fontaine Blvd. & Dartmouth St. Job No.: 113421-001
Comment: Urban Minor Arterial (Fontaine Blvd.) Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): EPC Min. for Urban Principle Arterial — 18k ESALs: 2,107,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS — ΔPSI: 1.7
p_t: 2.5 Table D-1 based on roadway classification

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 45.6

Section D.4.1 (C) — M_R: 11,404 psi

$S_1 = [(\text{R-value} - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]} =$ 11,404 psi

5. Reliability:

R: 85 % Table D-1 — Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
11,404	SN_1: **3.209**
-NA-	SN_2: **-NA-**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	7.5 inches	3.300	3.209
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-18

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

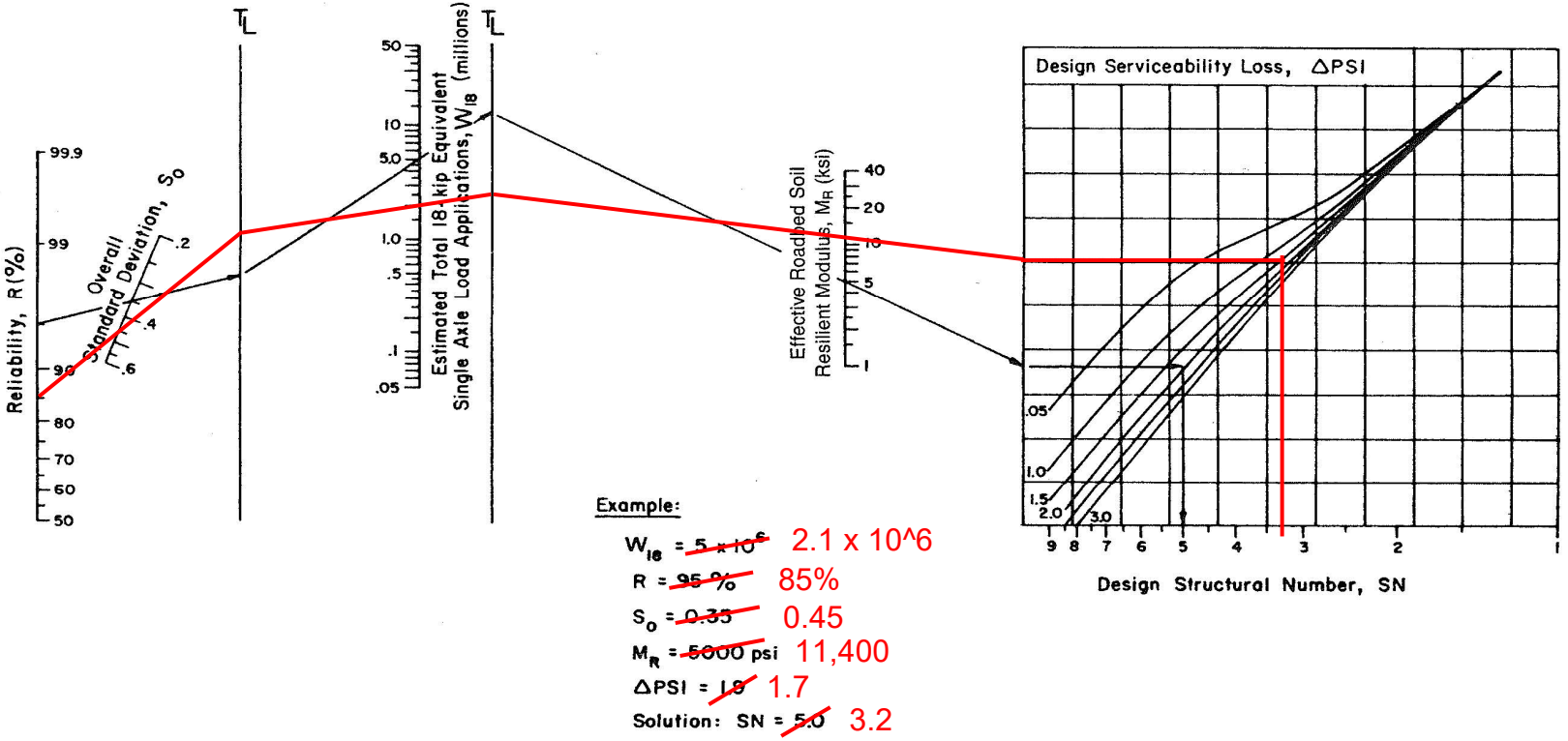


Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 6: Fontaine Blvd. & Dartmouth St.

Flexible Pavement Design Worksheet

Location: Site 7: Main St. & Normal Dr. Job No.: 113421-001
Comment: Urban Collector (Main St.) Roadway Classification
Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years
   Traffic Loading (W_{18}): 18k ESALs: 1,019,000 per lane

3. Serviceability:
   p_0: 4.2 Value assumed based on 1993 AGDPS
   p_t: 2.5 Table D-1 based on roadway classification
   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C
   R-value: 50

   Section D.4.1 (C) M_R: 13,168 psi
   S_1 = [(R-value - 5) / 11.29] + 3
   $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 13,168 psi

5. Reliability:
   R: 85 % Table D-1
   Z_R: -1.036

6. Design Standard Deviation (S_o):
   S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**1.885**
13,168	SN_2:	**2.692**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$
$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$
$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	4.5 inches	1.980	1.885
2	ABC	8.0 inches	2.860	2.692
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-20

Flexible Pavement Design Worksheet

Location: Site 7: Main St. & Normal Dr. Job No.: 113421-001
Comment: Urban Collector (Main St.) Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years
   Traffic Loading (W_{18}): 18k ESALs: 1,019,000 per lane

3. Serviceability:
   p_0: 4.2 Value assumed based on 1993 AGDPS
   p_t: 2.5 Table D-1 based on roadway classification
   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C
   R-value: 50

   Section D.4.1 (C) M_R: 13,168 psi
   S_1 = [(R-value - 5) / 11.29] + 3
   $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 13,168 psi

5. Reliability:
   R: 85 % Table D-1
   Z_R: -1.036

6. Design Standard Deviation (S_o):
   S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
13,168	SN_1: **2.692**
-NA-	SN_2: **-NA-**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$
$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$
$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

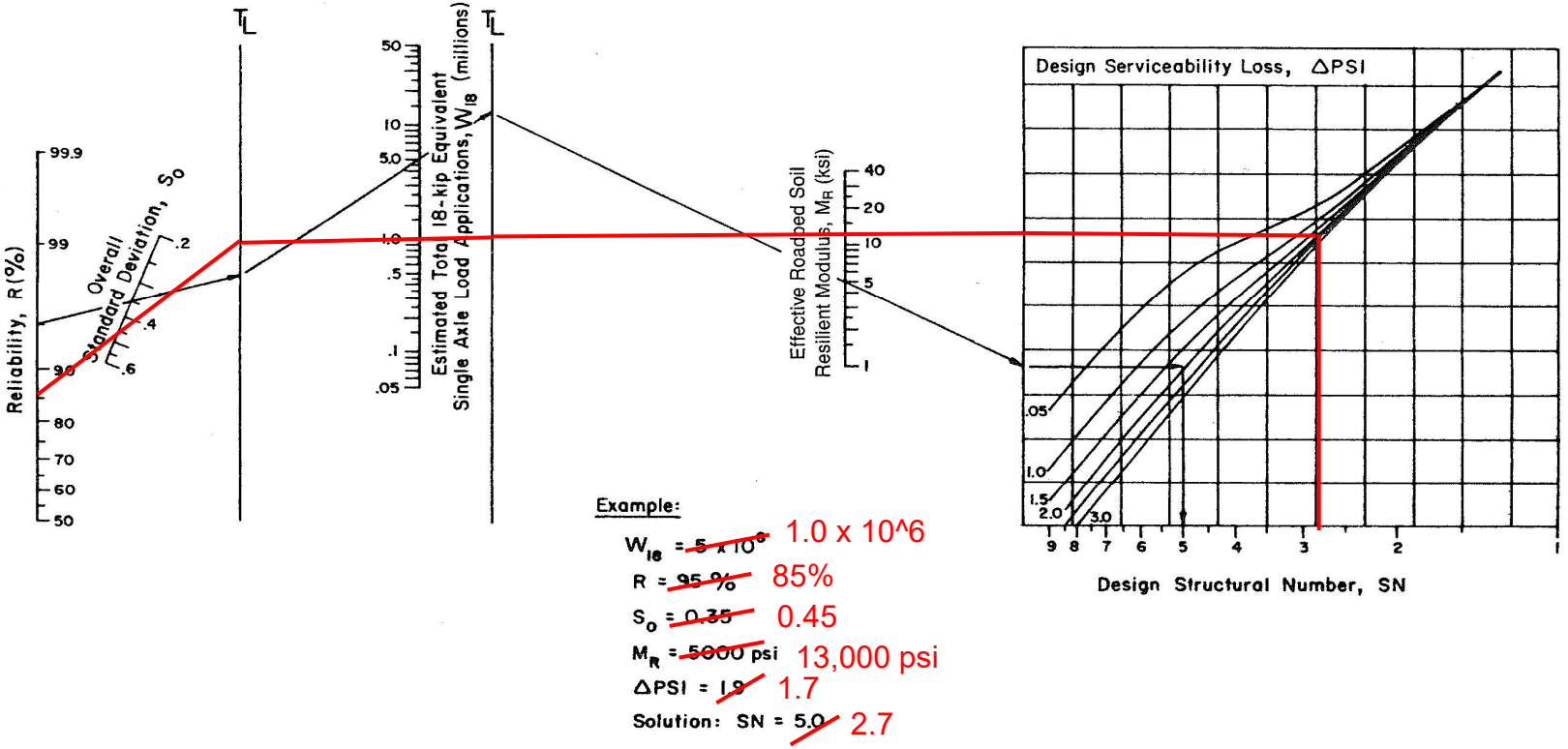
Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	6.5 inches	2.860	2.692
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-21

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example:

W_{18} = ~~5 x 10^6~~ 1.0 x 10^6

R = ~~95 %~~ 85%

S_o = ~~0.35~~ 0.45

M_R = ~~5000 psi~~ 13,000 psi

ΔPSI = ~~1.9~~ 1.7

Solution: SN = ~~5.0~~ 2.7

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 7: Main St. & Normal Dr.

Flexible Pavement Design Worksheet

Location: Site 8: Palmer Park at Winnebago Rd. Job No.: 113421-001
Comment: Urban Principle Arterial (Palmer Park) Roadway Classification
Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): EPC Min. for Urban Principle Arterial — 18k ESALs: 5,256,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS
p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 24

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,629 psi

M_R: 5,629 psi

5. Reliability:

R: 90 % Table D-1

Z_R: -1.282

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**2.591**
5,629	SN_2:	**4.975**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	9.5 inches	4.180	2.591
2	ABC	8.0 inches	5.060	4.975
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-23

Flexible Pavement Design Worksheet

Location: Site 8: Palmer Park at Winnebago Rd. Job No.: 113421-001
Comment: Urban Principle Arterial (Palmer Park) Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): EPC Min. for Urban Principle Arterial — 18k ESALs: 5,256,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS — ΔPSI: 1.7
p_t: 2.5 Table D-1 based on roadway classification

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 24

Section D.4.1 (C) — M_R: 5,629 psi

$S_1 = [(\text{R-value} - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]} =$ 5,629 psi

5. Reliability:

R: 90 % Table D-1 — Z_R: -1.282

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
5,629	SN_1: **4.975**
-NA-	SN_2: **-NA-**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

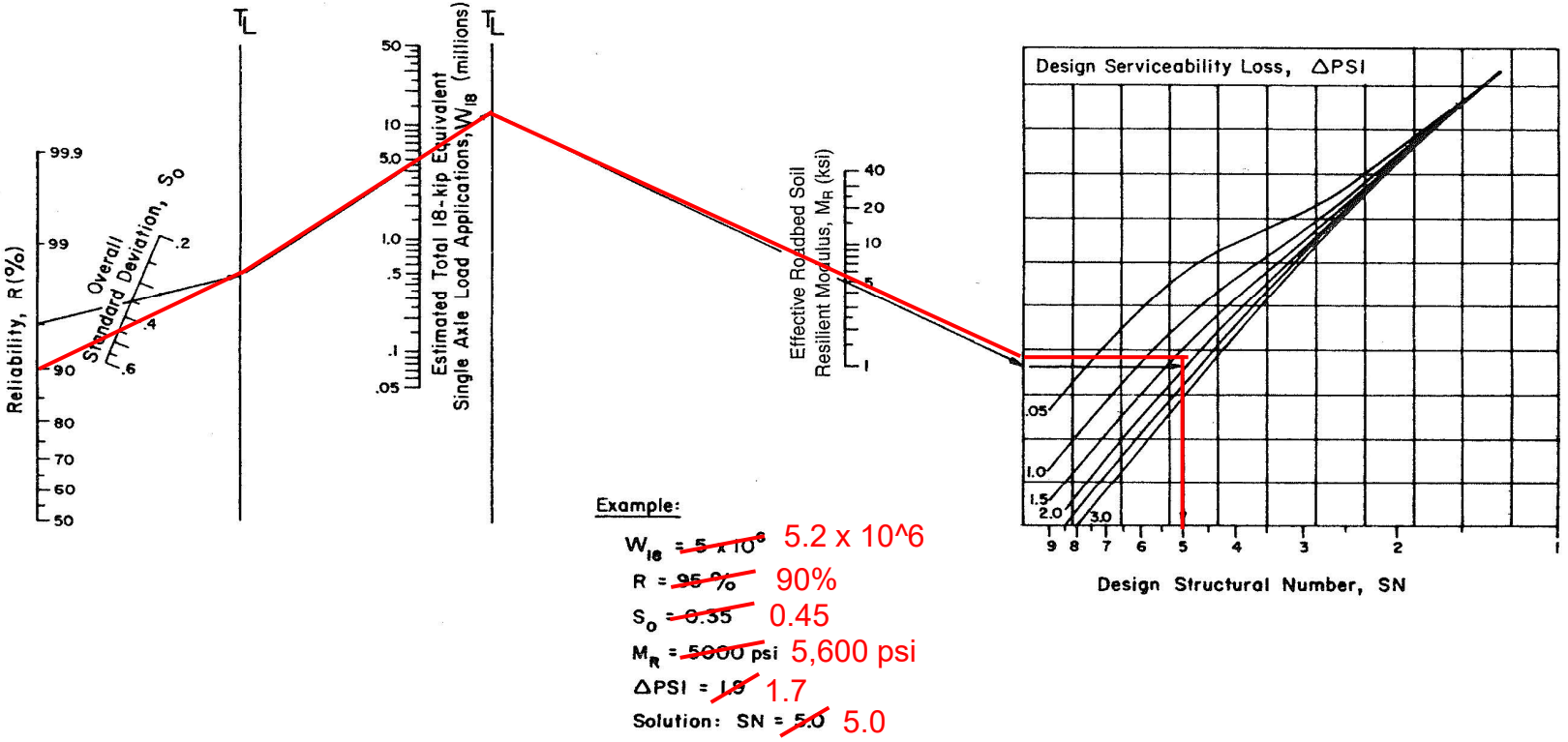
Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	11.5 inches	5.060	4.975
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-24

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example:

W_{18} = ~~5 x 10^6~~ 5.2 x 10^6

R = ~~95 %~~ 90%

S_o = ~~0.35~~ 0.45

M_R = ~~5000 psi~~ 5,600 psi

ΔPSI = ~~1.9~~ 1.7

Solution: SN = ~~5.0~~ 5.0

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 8: Palmer Park at Winnebago Rd.

Flexible Pavement Design Worksheet

Location: Site 9: Peterson Rd. at Sequoyah Way Job No.: 113421-001
Comment: Urban Minor Arterial (Peterson Rd.) Roadway Classification
Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years
   Traffic Loading (W_{18}): 18k ESALs: 1,832,000 per lane

3. Serviceability:
   p_0: 4.2 Value assumed based on 1993 AGDPS
   p_t: 2.5 Table D-1 based on roadway classification
   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C
   R-value: 33.2

   Section D.4.1 (C)
   S_1 = [(R-value - 5) / 11.29] + 3
   $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 7,604 psi
   M_R: 7,604 psi

5. Reliability:
   R: 85 % Table D-1
   Z_R: -1.036

6. Design Standard Deviation (S_o):
   S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**2.082**
7,604	SN_2:	**3.659**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$
$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$
$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	6.5 inches	2.860	2.082
2	ABC	8.0 inches	3.740	3.659
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-26

Flexible Pavement Design Worksheet

Location: Site 9: Peterson Rd. at Sequoyah Way Job No.: 113421-001
Comment: Urban Minor Arterial (Peterson Rd.) Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): 18k ESALs: 1,832,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS

p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 33.2

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 7,604 psi

M_R: 7,604 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
7,604	SN_1: **3.659**
-NA-	SN_2: **-NA-**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

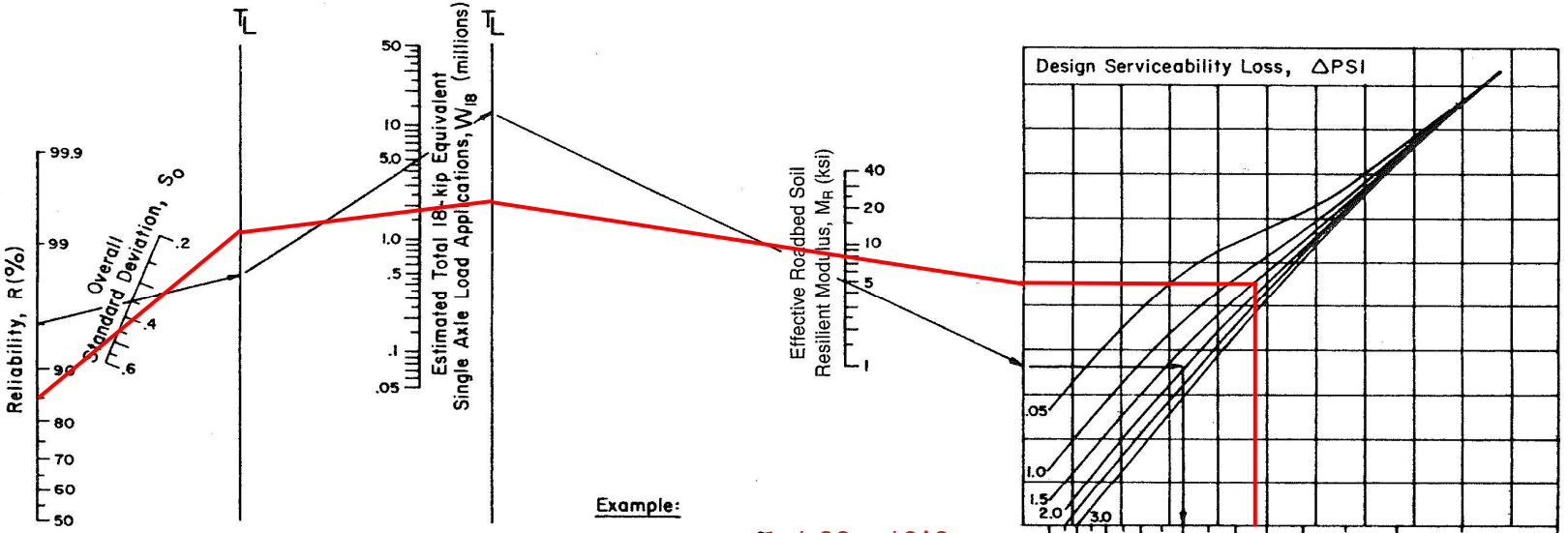
Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	8.5 inches	3.740	3.659
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-27

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example:

W_{18} = ~~5 x 10^6~~ 1.83 x 10^6

R = ~~95 %~~ 85%

S_o = ~~0.35~~ 0.45

M_R = ~~5000 psi~~ 7,600 psi

ΔPSI = ~~1.9~~ 1.7

Solution: SN = ~~5.0~~ 3.6

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 9: Peterson Rd. at Sequoyah Way

Flexible Pavement Design Worksheet

Location: Site 9: Peterson Rd. at Sequoyah Way Job No.: 113421-001
Comment: Urban Minor Arterial (Peterson Rd.) Roadway Classification
3 in. Mill & 3 in. Overlay, 10 yr DL
8 in Full Depth HMA

1. Pavement Design Life: 10.0 years

Traffic Loading (W_{18}): 18k ESALs: 871,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS

p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 33.2

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 7,604 psi

M_R: 7,604 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
350,000	SN_1:	**0.563**
7,604	SN_2:	**3.240**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA OL	a_1: 0.44	-	-
2	Ext. HMA	a_2: 0.30	m_2: 1.00	350,000
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	3.0 inches	1.320	0.563
2	ABC	5.0 inches	2.820	3.240
3		inches		

Note: Required SN > Pavement SN, Design is Unacceptable

Exhibit C-29

Flexible Pavement Design Worksheet

Location: Site 9: Peterson Rd. at Sequoyah Way Job No.: 113421-001
Comment: Urban Minor Arterial (Peterson Rd.) Roadway Classification
3 in. Mill & 3 in. Overlay, Reduced DL
8 in Full Depth HMA

1. Pavement Design Life: 4.3 years

Traffic Loading (W_{18}): 18k ESALs: 365,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS

p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 33.2

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 7,604 psi

M_R: 7,604 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
350,000	SN_1:	**0.424**
7,604	SN_2:	**2.805**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA OL	a_1: 0.44	-	-
2	Ext. HMA	a_2: 0.30	m_2: 1.00	350,000
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

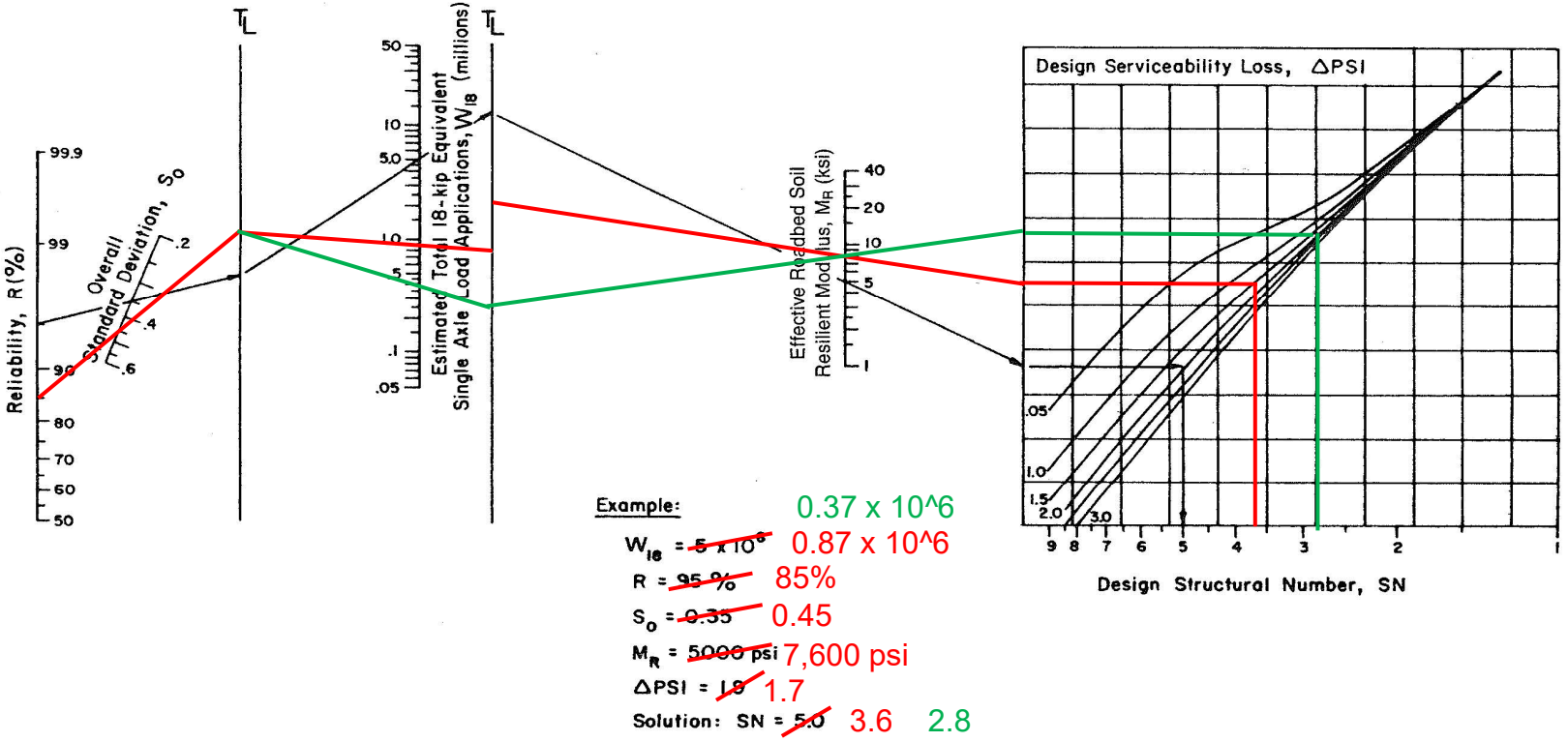
Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	3.0 inches	1.320	0.424
2	ABC	5.0 inches	2.820	2.805
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-30

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example:

W_{18} = ~~5 x 10^6~~ 0.87 x 10^6 (0.37 x 10^6)

R = ~~95 %~~ 85%

S_o = ~~0.35~~ 0.45

M_R = ~~5000 psi~~ 7,600 psi

ΔPSI = ~~1.9~~ 1.7

Solution: SN = ~~5.0~~ 3.6 2.8

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 9: Peterson Rd. at Sequoyah Way

Flexible Pavement Design Worksheet

Location: Site 10: Main St. at Marquette Dr. Job No.: 113421-001
Comment: Urban Collector (Main St.) Roadway Classification
Alt. 1: HMA over 8 in. ABC (min)

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): EPC Min. for Urban Collector — 18k ESALs: 821,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS
p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 50

Section D.4.1 (C)

$S_1 = [(\text{R-value} - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]} =$ 13,168 psi

M_R: 13,168 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**1.816**
13,168	SN_2:	**2.597**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	4.5 inches	1.980	1.816
2	ABC	8.0 inches	2.860	2.597
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-32

Flexible Pavement Design Worksheet

Location: Site 10: Main St. at Marquette Dr. Job No.: 113421-001
Comment: Urban Collector (Main St.) Roadway Classification
Alt. 2: Full Depth HMA

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): EPC Min. for Urban Collector — 18k ESALs: 821,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS — ΔPSI: 1.7
p_t: 2.5 Table D-1 based on roadway classification

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 50

Section D.4.1 (C) — M_R: 13,168 psi

$S_1 = [(\text{R-value} - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]} =$ 13,168 psi

5. Reliability:

R: 85 % Table D-1 — Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
13,168	SN_1:	**2.597**
-NA-	SN_2:	**-NA-**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2		a_2:	m_2:	
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

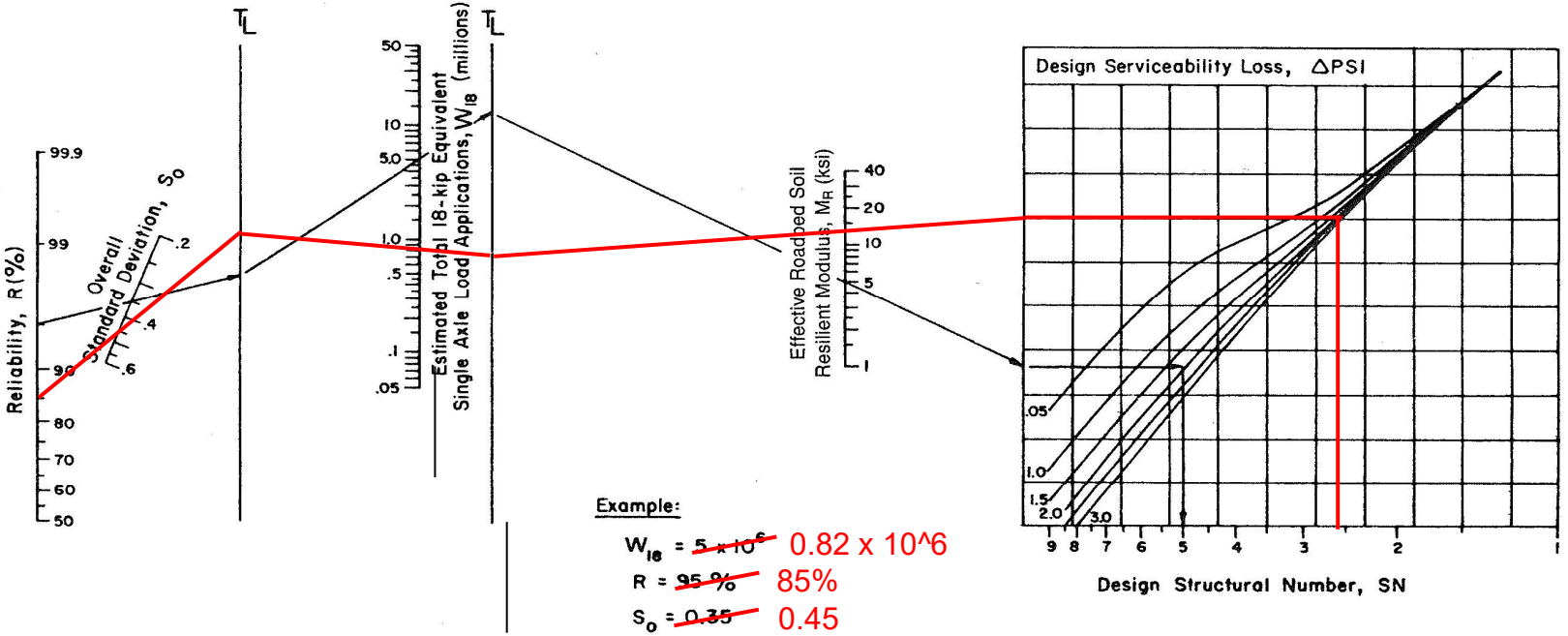
Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	6.5 inches	2.860	2.597
2		inches		
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-33

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example:

W_{18} = ~~5 x 10^6~~ 0.82 x 10^6

R = ~~95 %~~ 85%

S_o = ~~0.35~~ 0.45

M_R = ~~5000 psi~~ 13,200 psi

ΔPSI = ~~1.9~~ 1.7

Solution: SN = ~~5.0~~ 2.6

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 10: Main St. at Marquette Dr.

Flexible Pavement Design Worksheet

Location: Site 10: Main St. at Marquette Dr. Job No.: 113421-001

Comment: Urban Collector (Main St.) Roadway Classification

2 in. Mill & 2 in. Overlay

Assume 12 in. Full Depth HMA

1. Pavement Design Life: 10.0 years

Traffic Loading (W_{18}): EPC Min. for Urban Collector — 18k ESALs: 373,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS

p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R): Section D.4.1 C

R-value: 50

Section D.4.1 (C)

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72)/6.24]}$ = 13,168 psi

M_R: 13,168 psi

5. Reliability:

R: 85 % Table D-1

Z_R: -1.036

6. Design Standard Deviation (S_o):

S_o: 0.45 Section D.4.1 C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
350,000	SN_1:	**0.428**
13,168	SN_2:	**2.277**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA OL	a_1: 0.44	-	-
2	Ext. HMA	a_2: 0.30	m_2: 1.00	350,000
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

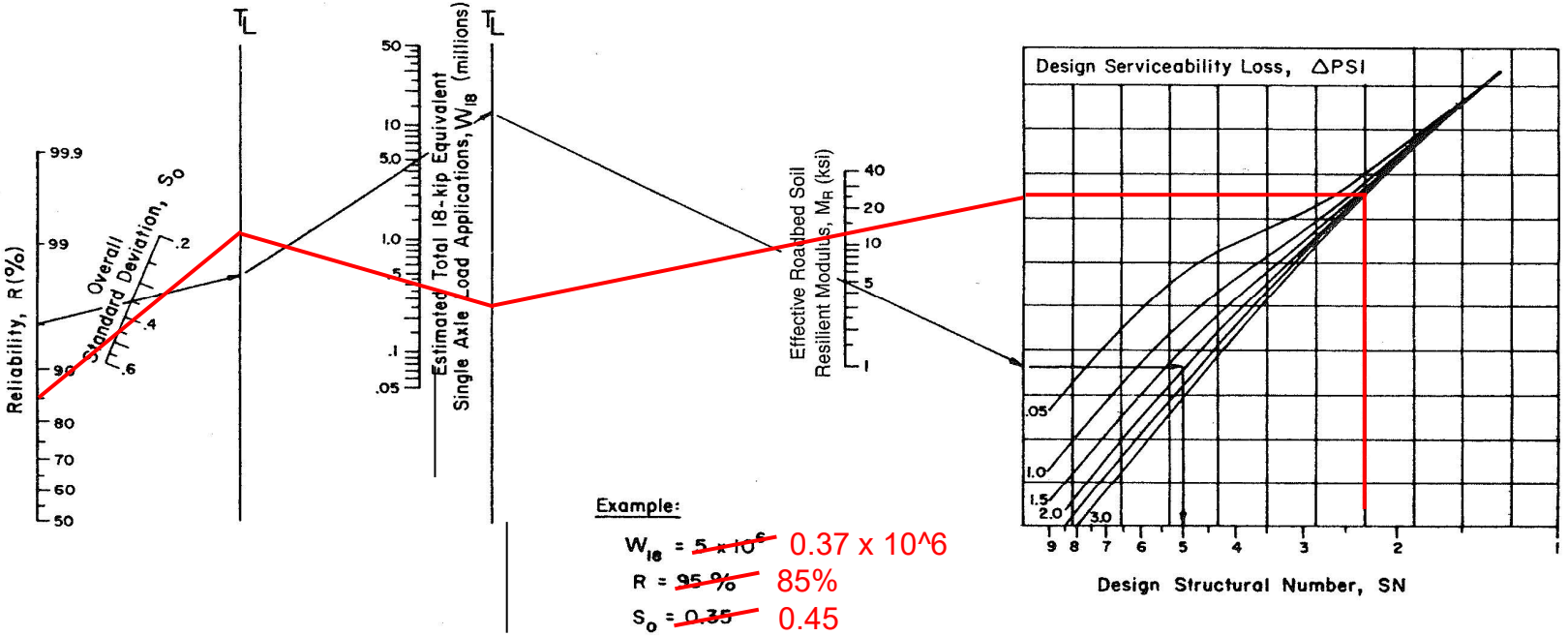
Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA OL	2.0 inches	0.880	0.428
2	Ext. HMA	10.0 inches	3.880	2.277
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Exhibit C-35

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example:

W_{18} = ~~5 x 10^6~~ 0.37 x 10^6

R = ~~95 %~~ 85%

S_o = ~~0.35~~ 0.45

M_R = ~~5000 psi~~ 13,200 psi

ΔPSI = ~~1.9~~ 1.7

Solution: SN = ~~5.0~~ 2.2

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

Site 10: Main St. at Marquette Dr.

IMPORTANT INFORMATION

Important Information

About Your Geotechnical Report

IMPORTANT INFORMATION

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining

IMPORTANT INFORMATION

your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims

being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland.