REPORT OF PAVEMENT INVESTIGATION

Guthrie County Road Investigations
Guthrie County, Iowa

AET Report No. P-0020125

Date:
August 6, 2023

Prepared for:

Veenstra & Kimm Inc.
3000 Westown Pkwy
West Des Moines, IA 50266

Geotechnical • Materials
Forensic • Environmental
Building Technology
Petrography/Chemistry

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August 6, 2023

Veenstra & Kimm Inc.
3000 Westown Pkwy
West Des Moines, IA 50266

Attn: Mr. Greg Roth

RE: Report of Pavement Investigation
Guthrie County Road Investigations
West Des Moines, IA 50266
AET Project No. P-0020125

Dear Mr. Roth:

American Engineering Testing, Inc. (AET) is pleased to present the results of our pavement investigation services for the above-referenced project.

We are submitting an electronic (PDF) version of this report to you. Unless you request otherwise, we will not submit any hard copies of the report.

We appreciate the opportunity to work with you on this phase of the project. Please contact us if you have questions about this report or require further assistance.

Sincerely,
American Engineering Testing, Inc.

Jacob O. Michalowski
Senior Engineer, Pavement Division
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SIGNATURE PAGE

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Veenstra & Kimm Inc.
3000 Westown Pkwy
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1.0 INTRODUCTION

Veenstra & Kimm Inc. ("V&K") is assisting Guthrie County Engineering Department to evaluate possible options for the rehabilitation of several roads ("Project") in Guthrie County, Iowa. To assist planning and engineering, V&K has retained American Engineering Testing, Inc. (AET) to perform geotechnical exploration and nondestructive pavement testing at the Project to evaluate the roads. This report (AET P-0020125) presents the results of our services for the Project.

2.0 SCOPE OF SERVICES

The authorized scope consists of the following services.

- Falling weight deflectometer (FWD) testing of the Project roads
- Ground penetrating radar (GPR) testing on the Project roads
- Engineering evaluation of the Project roads using GPR, FWD, pavement core, and soil boring data to evaluate the existing conditions of the Project roads
- Production of this report summarizing our evaluation of Project roads

In addition to the scope of services AET provided, Allender Butzke Engineers, Inc. (ABE) was contracted by V&K to obtain 46 pavement cores with soil probing and dynamic cone penetrometer (DCP) tests to depths of approximately 4 feet below existing grades. These results were used in our review and analysis of the GPR data, FWD data, and preparation of this report.

These services are exclusively intended to evaluate the Project roads. The scope is not intended to explore for the presence or extent of environmental contamination in the soil or groundwater. Specific details on the analysis performed are described in the sections below and in appendices to this report.

3.0 PROJECT INFORMATION

3.1 Project location and road

The Project is in Guthrie County, Iowa (Figure 1) and it consists of the following selected roads:

- White Pole Rd, from Frontier Rd to Kelsey Rd (6.40 miles)
- White Pole Rd, from E Grant St to 340th St (1.87 miles)
- White Pole Rd, from Pecan Ave to Sheridan St (2.34 miles)
- White Pole Rd, from Adair St (Menlo) to N Adair St (Stuart) (4.17 miles)
- Wagon Rd, from N 10th St to 248th Trail (9.55 miles)

3.2 Traffic data

We consulted the recent traffic information through the Iowa DOT Interactive Traffic Counts Map

Application (TCMap)[1]. These were used for our preliminary FWD analyses that were discussed during the meeting with the V&K, the County and ABE that occurred on August 1, 2023. After the meeting, V&K provided additional and updated traffic information, including trucks count percentages. This new data was used to finalize our analyses and the final report. The available average daily traffic (ADT) for the Project roads ranged from 770 to 3,200 vehicles with a truck traffic (ADTT) ranging from 15 to 20 percent

4.0 SUBSURFACE EXPLORATION, ROAD TESTING, AND RESULTS

AET allocated the Project roads (totaling approximately 24.3 centerline miles) into 14 sections according to pavement structure and traffic conditions. Tests and test results on the Project roads are described in the subsections below and summarized in the appended Table 1 and Table 2. We encountered two different pavement structures:

- White Pole Road is surfaced with bituminous pavement (BP) over a Portland cement concrete layer (PCC), considered as bituminous over concrete (BOC).
- Wagon Road is surfaced with PCC

Our classification of the road section follows basic pavement engineering principles to help us organize field/lab activities, analysis, and evaluation. These general classifications are not intended to conflict with or replace state agency road classifications, which rely on as-built information, road histories, agency material classifications, and other matters whose review are beyond the scope described in Section 2.

4.1 Subsurface conditions

ABE performed forty-six (46) pavement cores with soil probing and dynamic penetrometer (DCP) to depths of approximately 4 feet below existing grade along the Project road during the timeframe 6/12/23-6/26/23. Collected samples were analyzed to evaluate surfacing material and soil layering and classification. Detailed results of subsurface testing are provided in Appendix A which includes pavement core photographs together with boring logs, and water level measurements. These results are summarized below by road type and structural layer.

Bituminous pavement. From the pavement cores obtained, the pavement had a recovered bituminous pavement thickness ranging from 0.75 to 8.75 inches.
Portland cement concrete pavement. From the pavement cores obtained, the pavement had a recovered Portland cement concrete pavement thickness ranging from 6.5 to 8.25 inches.

- The bituminous layer generally shows low to high severity weathering.
- In seven of the cores, we observed high severity stripping and separation of lifts.

[1] Iowa Department of Transportation (2023). Traffic Counts Map Application (TCMap). Available from https://iowadot.maps.arcgis.com/apps/MapSeries/index.html?appid=0cce99afb78e4d3b9b24f8263717f910

- The PCC layer that is underneath the bituminous layer shows presence of medium to high severity cracks propagating mainly horizontally. The concrete layer is delaminated from the bituminous layer above except for core C-3, C-4, C-12, C-13, C-28, and C-33.
- Core C-29 to C-46 are generally solid except for C-32 that shows signs of possible incomplete recovery.
- Core C-24 shows a thin bituminous overlay of 0.75" over a layer of concrete, indicating a localized area with a pavement structure thickness different from the surrounding areas.

Layers directly supporting paved surfaces. Below the pavement materials (BP over PCC and PCC), we observed mostly cohesive soil with high clay content.

4.2 Surface course thickness (ground penetrating radar)

The road layer thickness testing program involves the use of a high-speed (air coupled) GPR antenna to collect pavement data that is later analyzed to evaluate layer thicknesses. AET performed GPR testing on approximately 24.3 centerline miles of Project roads on 5/1/23 using a 2 GHz antenna, which allows material layer measurements at depths of 18 inches with a resolution of approximately one-half inch. The GPR data was collected in the driving lanes.

Our analysis of collected GPR data (summarized by road section in Table 1 and Table 2) included statistical analysis to determine 15th-percentile values for each section. Engineers often use the 15th percentile value – instead of an average or mean (the 50th percentile value) – as a structural "safety factor" to represent layer thickness for pavement design purposes.

- The average thickness of bituminous surfacing ranged from 1.5 to 7.4 inches and the thickness of Portland cement concrete layer beneath ranged from 5.5 to 11.3 inches.
- The average thickness of Portland cement concrete surfacing ranged from 6.8 to 7.0 inches.

Assessing layer thicknesses is a matter of engineering judgement. The distinction between layers in the road is not always explicit. Factors influencing definition of radar scans include ambient electromagnetic interference, the presence of moisture, the presence of voids, and the similarity of material layer type between layers. More specific detail, including statistical analysis of GPR data describing average thickness and variability by section, is provided in Appendix B. Figure 2 shows a visual representation of the GPR thicknesses of the bituminous pavement.

4.3 Pavement strength (falling weight deflectometer)

Deflection testing was performed on 24.3 centerline miles of the Project roads on 5/1/23, using a Dynatest 8002 falling weight deflectometer (FWD). Locations of FWD tests are indicated in Figure 3. Collected FWD data – along with information described in the sections above – are used to estimate the elastic stiffness of pavement layers using backcalculation analysis according to the method in the AASHTO *Guide for Design of Pavement Structures* (1993) and Texas Department of Transportation (TxDOT) Modulus 7.0 Program for backcalculation.

Our backcalculation results were used to estimate the effective subgrade resilient modulus (Mr), the effective structural number (ESN), k-value and elastic modulus of concrete slab of all Project road sections. As with GPR-based thickness analysis results, the results of backcalculation analysis of collected Project FWD data are summarized below (and in Table 1 and Table 2) using 15th-percentile values.

- The subgrade Mr for all sections ranged from 2.1 to 3.5 ksi.
- The SN value for all sections ranged from 3.5 to 6.7 inches.
- The k-value for all the sections ranged from 68.1 to 89.8 pci.
- The elastic modulus of concrete slab ranged from 2,395 to 3,334 ksi

Additional details of the FWD testing and analysis procedures, including field test data, are provided in Appendix C.

4.5 Summary results of testing and road condition rating

As noted above, all road test and survey results, including summary analysis of test data, are reported in Table 1 and Table 2 for 14 paved sections.

5.0 EVALUATION OF ROAD CONDITION

5.1 Discussion

We understand the County is evaluating different pavement improvement methods for White Pole Road and Wagon Road. AET met with V&K, the County and ABE on 8/1/2023 to discuss the preliminary results of the FWD backcalculation together with the cores, borings, and GPR data.

We observed the following in review of the data:

- The pavement structure along White Pole Road was classified as BOC (composite layer of bituminous over Portland cement concrete or semi rigid). This classification should be intended for pavement type classification only. Based on the FWD analyses, PASER and core pictures, it appears that a crack and seat rehabilitation method may have been performed in this section of roadway prior to bituminous surfacing, resulting in a behavior of flexible pavement instead of semi rigid pavement.
- Reflective cracks on the bituminous layer propagating from the Portland cement concrete layer are visible along White Pole Road. This is another factor that supports that a crack & seat may have been performed in the past. However, the presence of reflective cracks at regular intervals indicates that the crack and seat did not stop or mitigate the propagation of reflective cracks through the bituminous layer.
- Section S03B shows an average bituminous surface thickness of 4.5 in over a layer of concrete (PCC) with thickness 11.2 inches which describes a different pavement structure if compared to

the other sections along White Pole Road. This section behaves like a semi rigid pavement.

- Section S08B on Wagon Rd, 0.42 mi N of Wagn Ln has an average bituminous thickness of 1.5 inches over a layer of concrete of thickness (PCC) of approximately 7.1. The high deflections, recorded from the FWD on this section, resulted in a low modulus of PCC, which is inconsistent with the results of coring and our GPR analyses Consideration should be given to further investigation along this section, such as targeted FWD test locations and additional cores and borings to understand the condition and strength of the pavement layers and supporting materials
- The surface condition of the pavement was judged through the Pavement Surface and Evaluation Manual for Asphalt, 2013 (PASER) rating ranging from 4 to 5. This rating system result in a PASER rating that describes road condition on a scale of 1 to 10 for bituminous surfaced roads. This rating was limited to a desktop review of the video collected during the GPR testing and should not be taken as a formal pavement condition rating.
    - "Failed" (1), "Very Poor" (2), "Poor" (3), "Fair" (4-5), "Good" (6-7), "Very Good" (8), and "Excellent" (9-10)

Based on the results of the investigation and our conversations with V&K, the County, and ABE, we understand the projects are being considered for different rehabilitation methods. We are providing the following for discussion purposes and your consideration.

Wagon Road (existing PCC)

- Dowel bar retrofit
    - Pros – correct faulting, provide load transfer back to joints, does not raise road profile.
    - Cons – does not address other distresses in PCC or soft subgrade areas.
- Crack and seat with bituminous overlay
    - Pros – Less expensive than reconstruction, removes surface distresses and allows existing PCC to act as base for new bituminous pavement
    - Cons – Requires a strong subgrade that doesn't require subgrade repairs, significant rise in road profile, edge drains need to be installed prior to crack and seat.

White Pole Road (existing BOC)

- Bituminous mill and overlay
    - Pros – controls grade, provides new surfacing for smooth ride quality.
    - Cons – does not address PCC concerns and reflective cracking will return.
- Unbonded concrete overlay (Whitetopping)
    - Pros – will provide a long-lasting pavement, corrects ride quality.
    - Cons – does not address subgrade concerns, requires some pre-overlay repairs if asphalt surface is in poor condition.

5.2 Structural properties of road subgrade

The subgrade type for the project corridor consists of mostly cohesive soil with high clay content. Our FWD backcalculation analysis of the structural properties of the subgrade determined that subgrade soils under White Pole Road had an average 15th-percentile Mr value of 2.9 ksi and under Wagon Road a modulus of subgrade reaction (k-value) of 81.8 pci.

The modulus of subgrade reaction (k-value) along the road surfaced with Portland cement concrete results to be less than 100 pci, with an average 15th percentile of 82 pci. This number is in agreement with the information provided by boring logs that report presence of fat clays in many locations. Figure 3A and Figure 3C, respectively, show values of Mr and k-value calculated at each of the tested locations.

5.3 Structural properties of road surface layers

We anticipate that the structural capacity of the road surfacing will vary with changes in subgrade support and surfacing thickness. Additional variation may occur due to pavement condition.

- The sections with Portland cement concrete overlaid by bituminous layer have an average 15th-percentile SN of 4.3 inches, with minimum and maximum SN of 3.5 and 6.7 inches, respectively.
- The sections paved with a single layer of Portland cement concrete have an average 15th-percentile elastic modulus of concrete slab 2,888 ksi, with minimum and maximum elastic modulus of concrete of 2,395 and 3,334 ksi, respectively.

Figure 3B and Figure 3D show respectively values of SN and E concrete modulus calculated at each of the tested locations.

5.4 Project Considerations

6.0 TEST STANDARDS

When we refer to a test standard (e.g., ASTM, AASHTO) in this report, we mean that our services were performed in general accordance with that standard. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

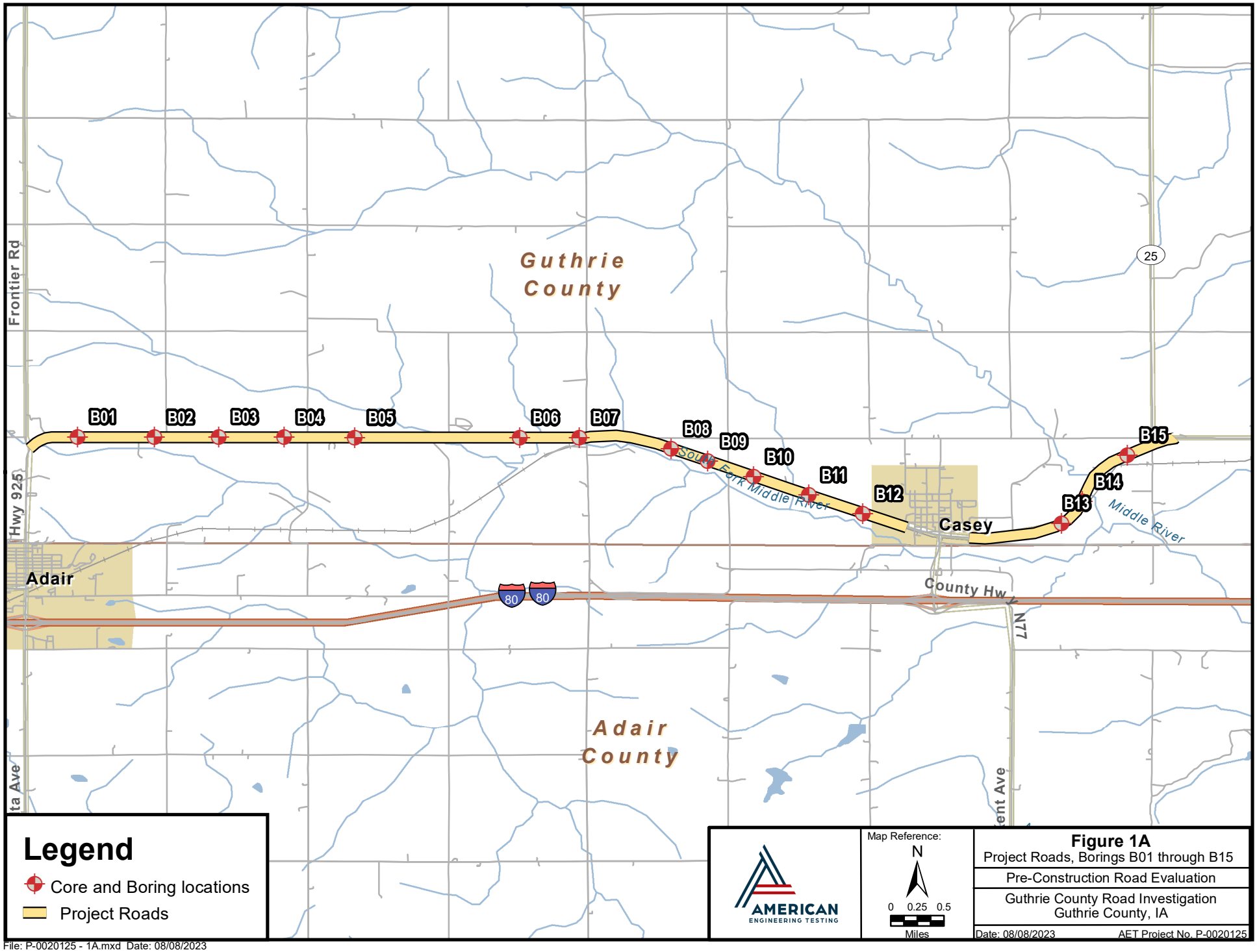
7.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, we have endeavored to provide our services according to generally accepted geotechnical engineering practices at present time and this location. Other than this, no warranty, express or implied, is intended. Important information regarding risk management and proper use of this report is given in Appendix D, “Geotechnical Report Limitations and Guidelines for Use.”

Figures and Tables

Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
AASHTO Soil Classification System
Unified Soil Classification System
Subsurface Boring Logs and Pavement Core Pictures



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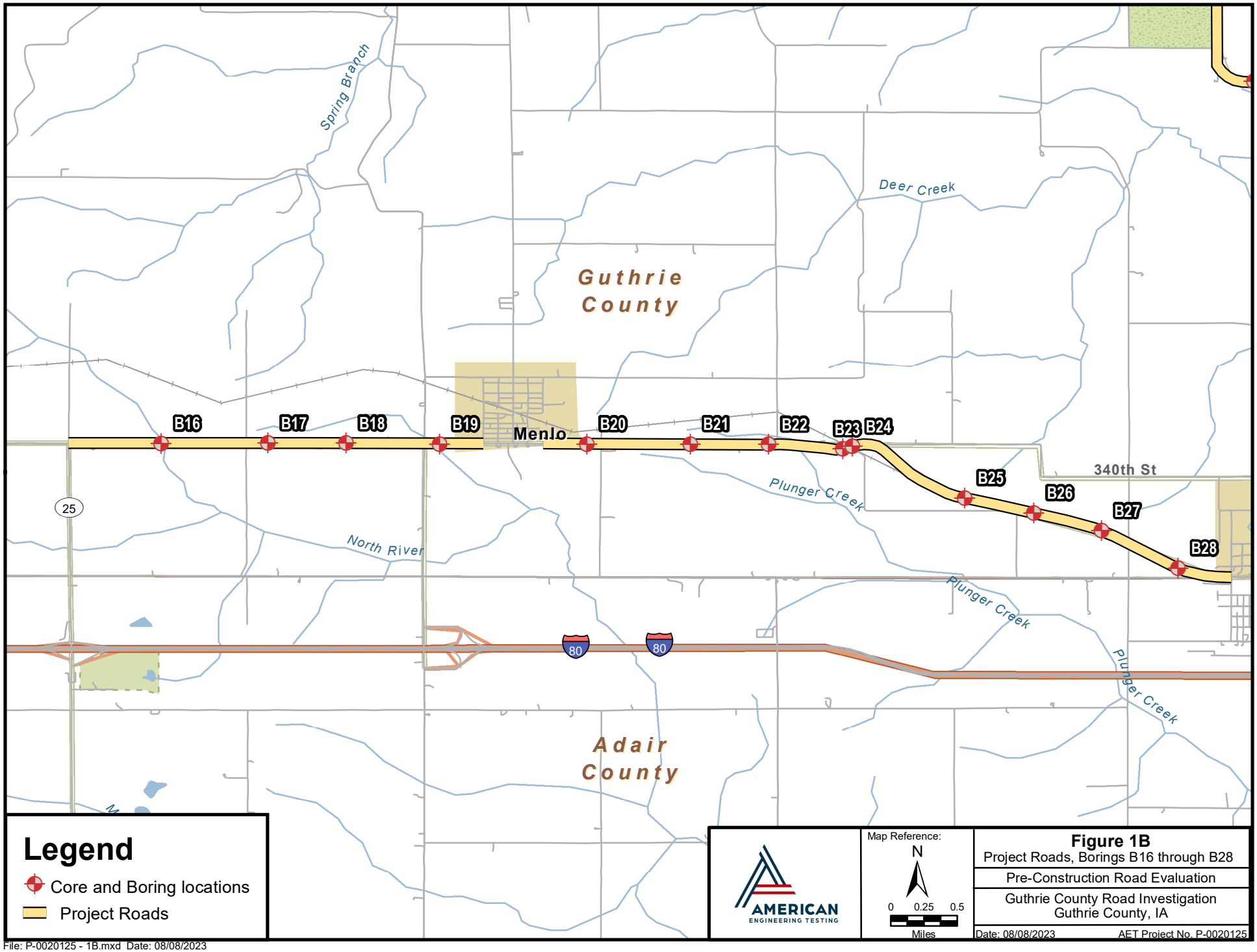

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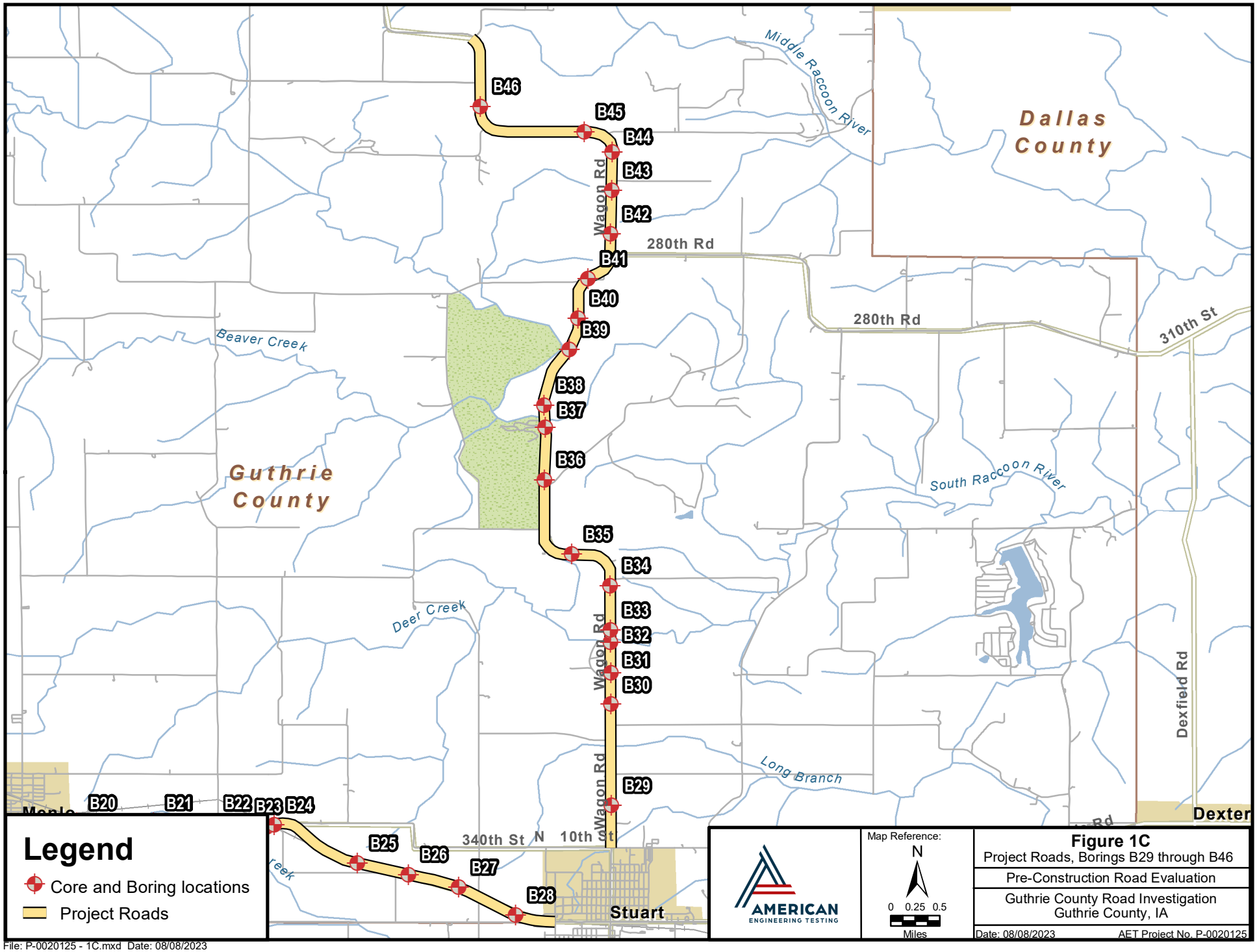

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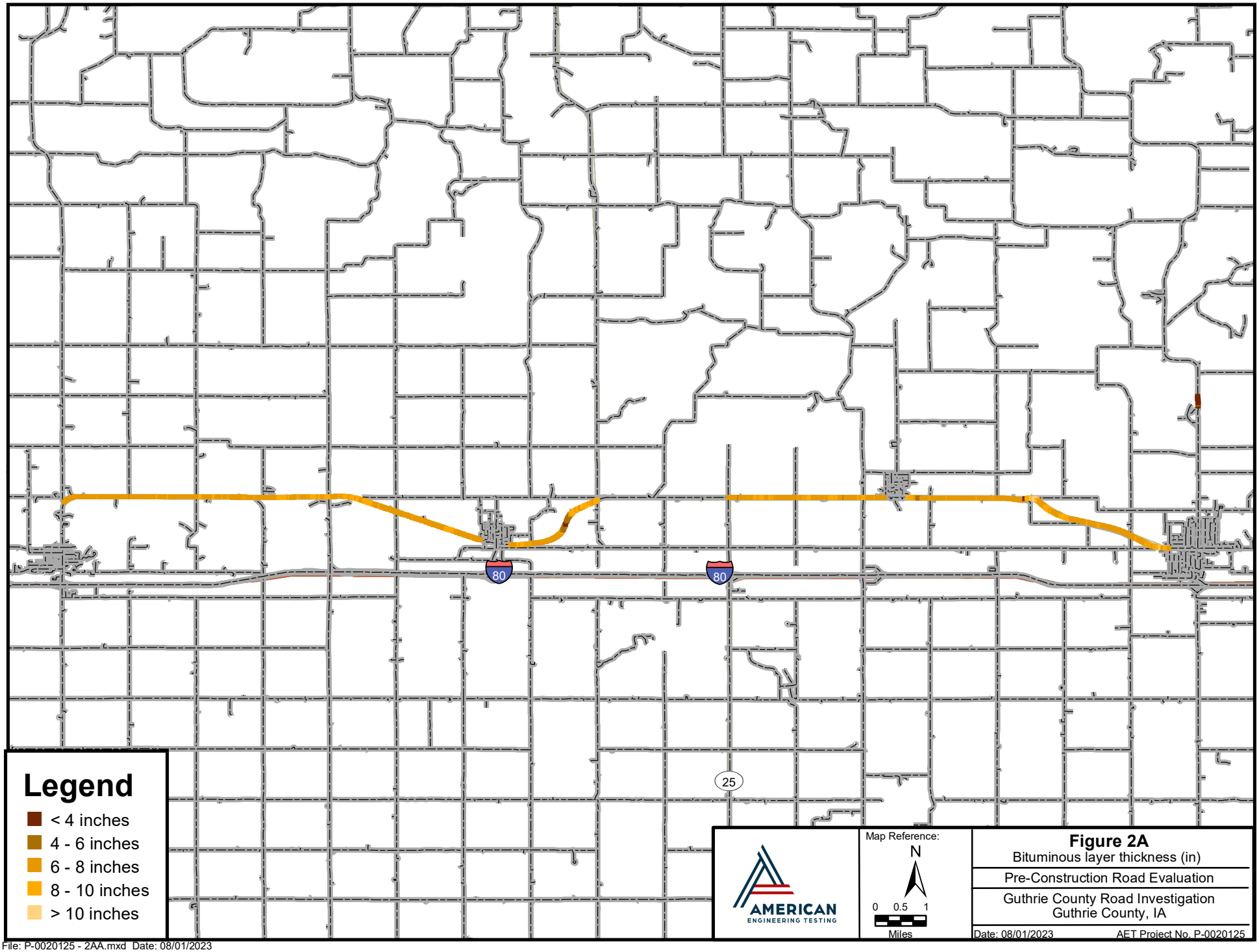

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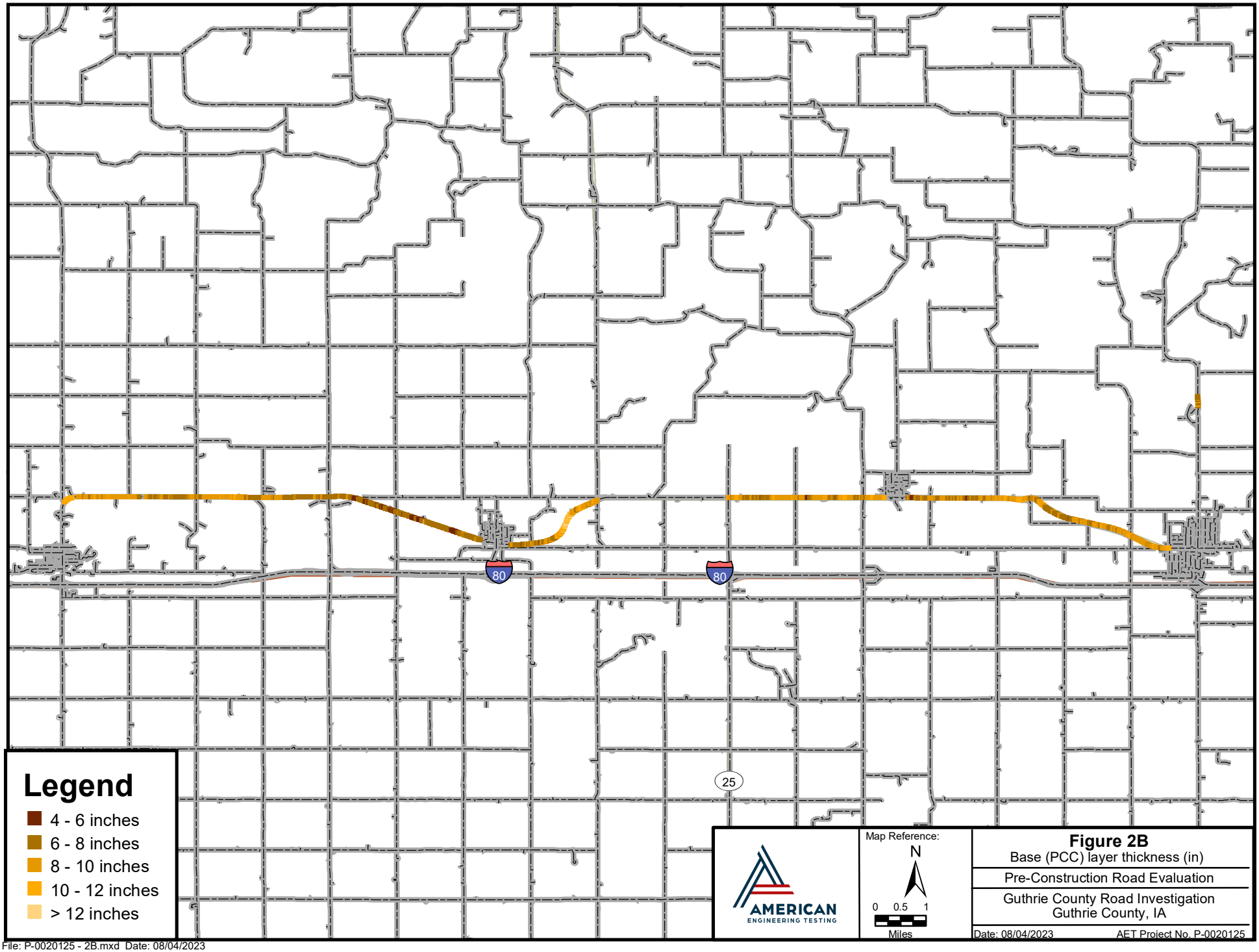

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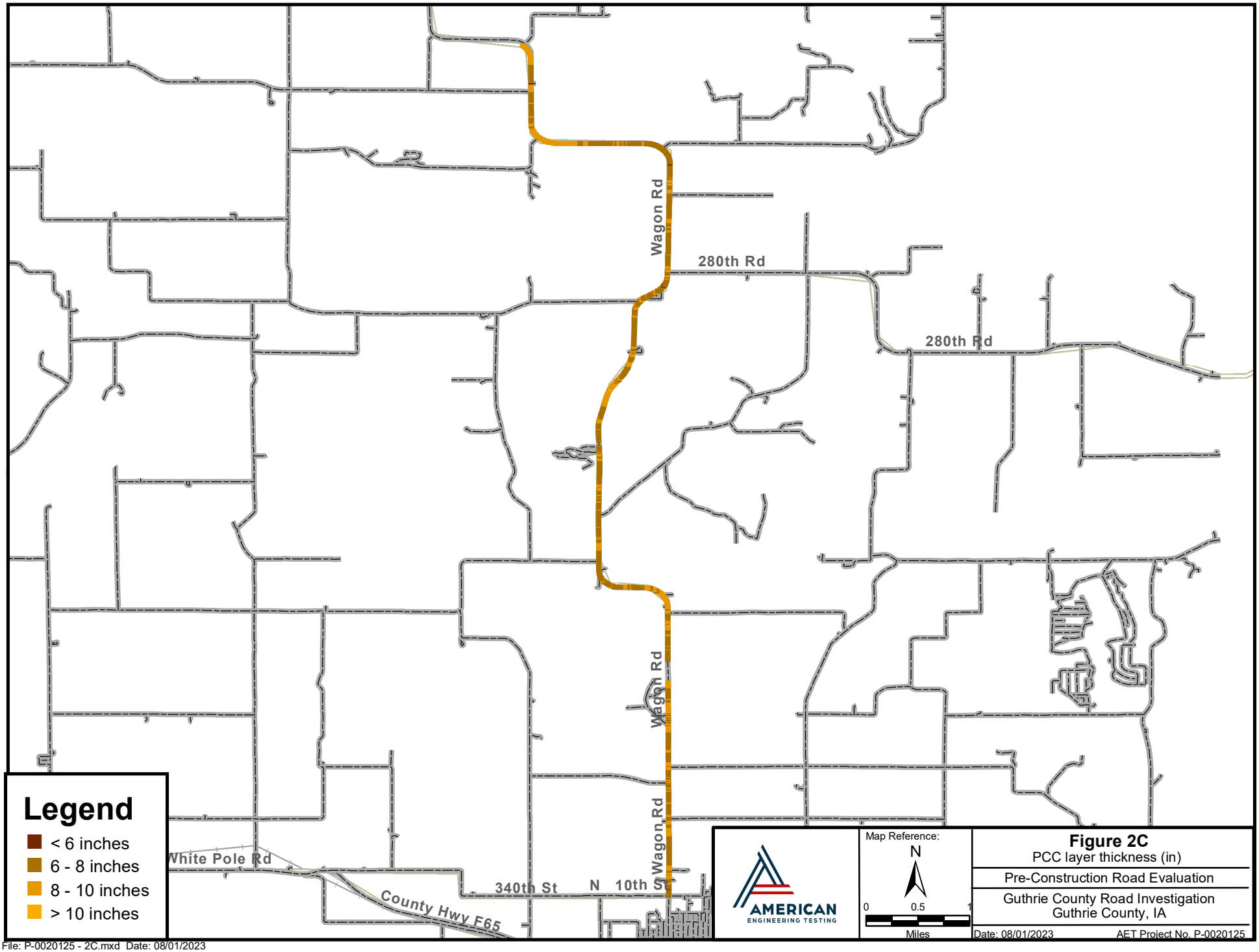

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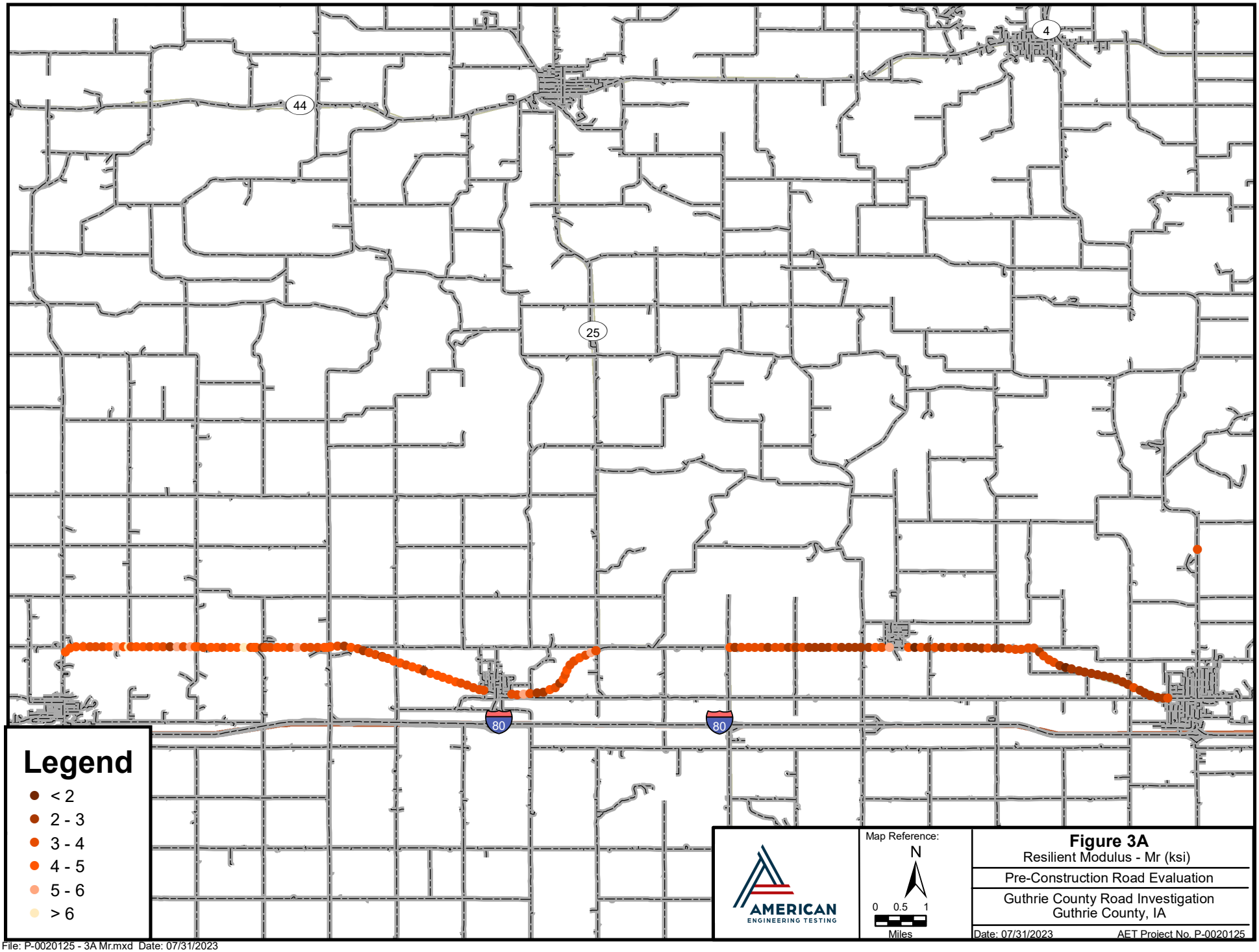

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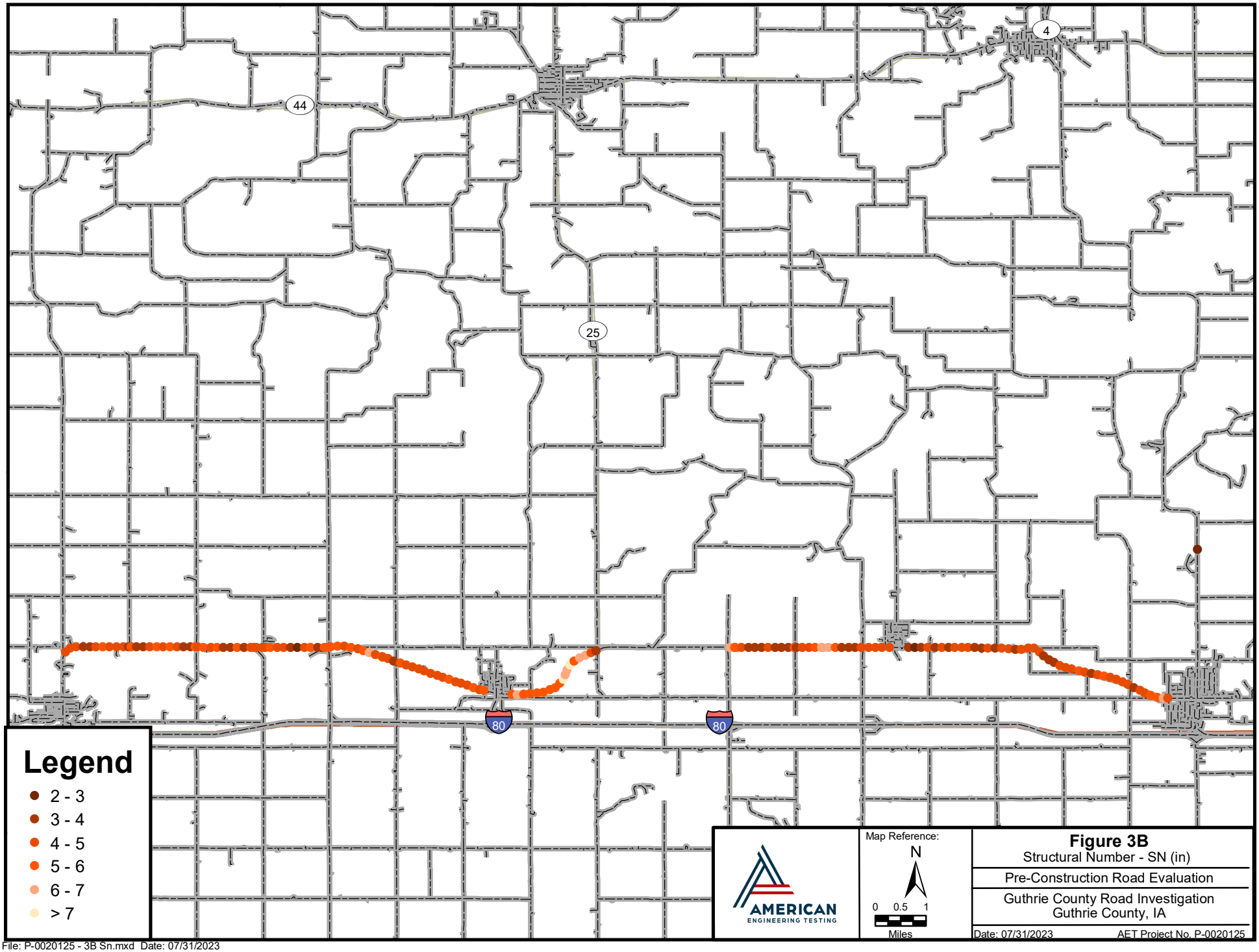

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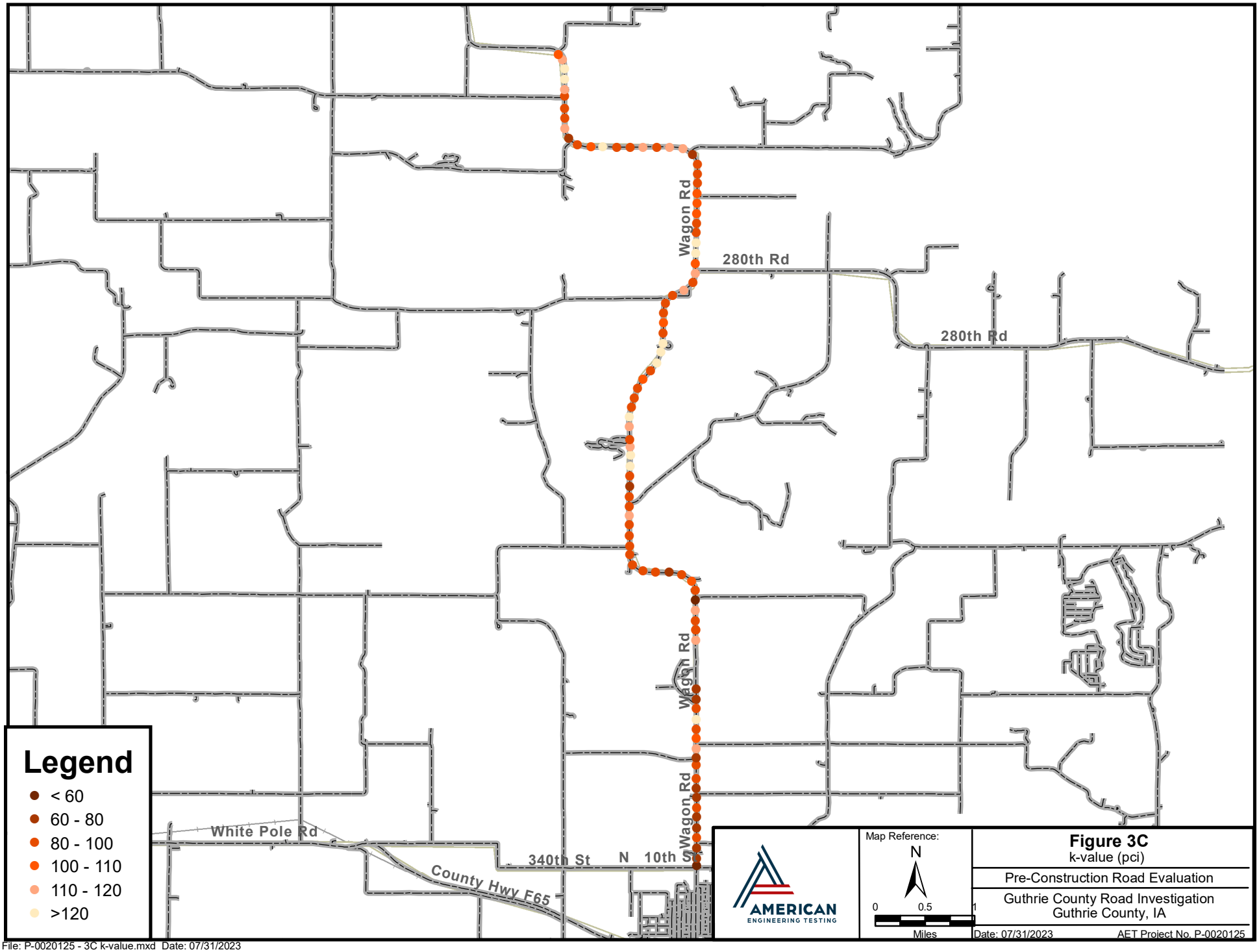

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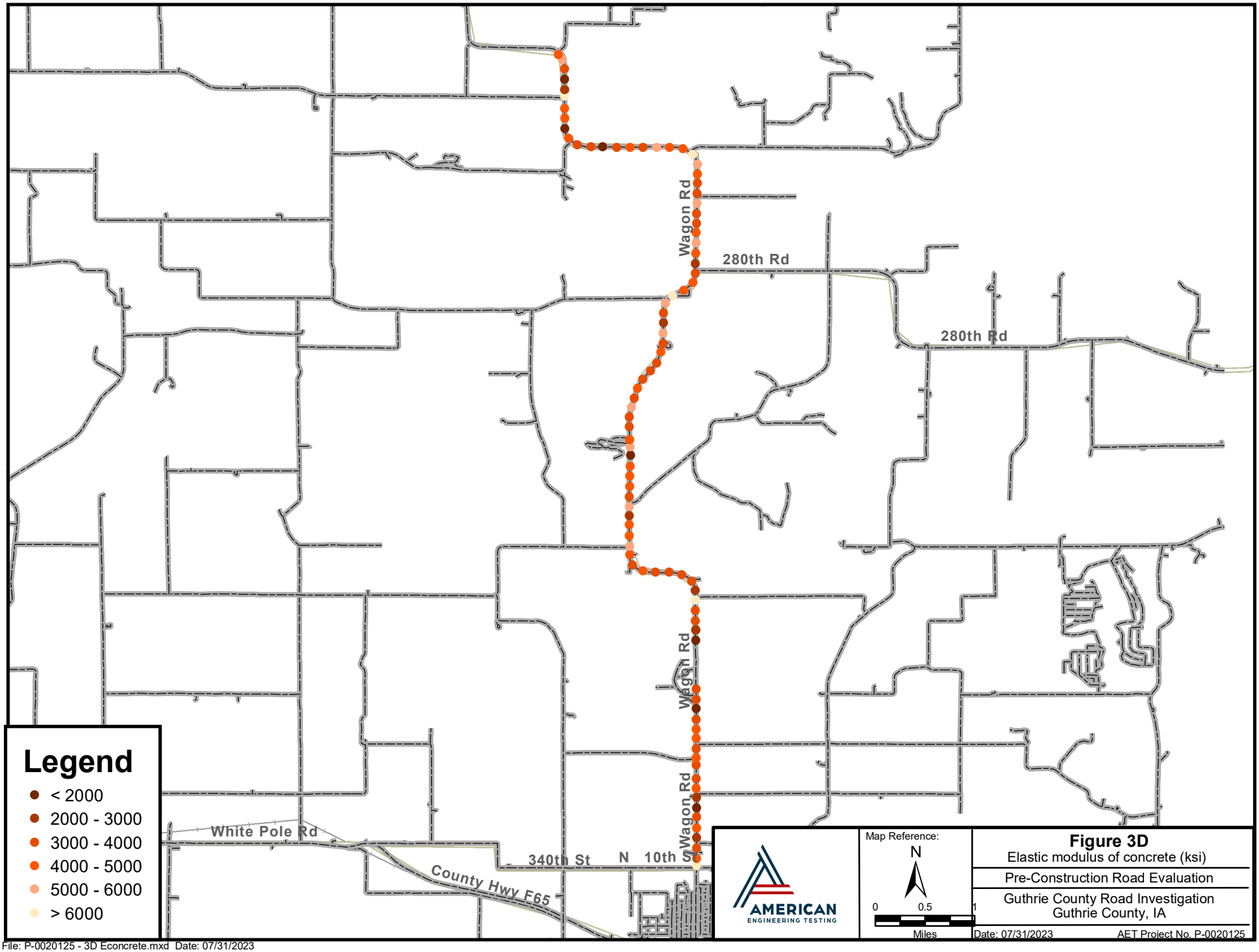


File: P-0020125 - 3D Econcrete.mxd Date: 07/31/2023

Section ID	Road	From	To	Length (mi)	Type	PASER	Surface Thickness (in)*	Base Thickness (in)*	Mr Subgrade (ksi)*	Structural Number (in)*
S01	White Pole Rd/CTH 925	Frontier Rd	CTH N72	4.0	BOC	5	6.5	7.3	3.5	3.8
S02	White Pole Rd/CTH 925	CTH N72	Kelsey Rd	2.4	BOC	5	7.3	5.8	3.0	4.2
S03A	White Pole Rd/CTH 925	E Grant Rd	0.87 mi E	0.9	BOC	4	7.0	7.0	2.8	5.1
S03B	White Pole Rd/CTH 925	0.87 mi E of E Grant Rd	0.37 mi E	0.4	BOC	4	4.5	11.2	3.4	6.7
S03C	White Pole Rd/CTH 925	0.45 mi W	STH 25	0.5	BOC	4	7.9	8.3	3.1	3.7
S04	White Pole Rd/CTH 925	STH 25	CTH P20	2.0	BOC	4	6.6	7.2	2.2	3.5
S05	White Pole Rd/CTH 925	CTH P20	Seridan St	0.3	BOC	4	6.7	8.2	2.8	4.5
S06	White Pole Rd/CTH 925	Adair St (Menlo)	340th St	1.9	BOC	4	6.7	7.2	2.4	3.5
S07	White Pole Rd/CTH 925	340th St	N Adair St (Stuart)	1.9	BOC	4	6.8	7.4	2.1	3.7
S08B	White Pole Rd/CTH 925	0.42 mi N of Wagon Ln	0.2 mi N	0.2	BOC	5	1.5	7.1	3.5	**

** - 15th Percentile Values*

***- Inconclusive*

AMERICAN ENGINEERING TESTING

Table 1

Summary of evaluation results for BOC Project roads

Pre-construction Road Evaluation

Guthrie County Road Investigations

Guthrie County, IA

Date: 3/15/23 AET Project P-0020125

Section ID	Road	From	To	Length (ft)	Type	PASER	Surface Thickness (in)*	Base Thickness (in)*	Modulus of Subgrade Reaction k-value (pci)*	Elastic Modulus of Concrete Slab (ksi)*
S08A	Wagon Rd/CTH P28	N 10th St	2.06 mi N	2.1	PCC	5	7.2	--	68.1	2394.5
S08C	Wagon Rd/CTH P28	2.44 mi S	Bridge	2.4	PCC	5	7.1	--	80.3	2822.0
S09	Wagon Rd/CTH P28	Bridge	280th Rd	1.8	PCC	5	6.9	--	89.0	3334.0
S10	Wagon Rd/CTH P28	280th Rd	CTH F51 N Jct	3.1	PCC	5	6.9	--	89.8	3002.0

^

** 15th Percentile Values*

AMERICAN ENGINEERING TESTING

Table 2

Summary of evaluation results for PCC Project roads

Pre-construction Road Evaluation

Guthrie County Road Investigations

Guthrie County, IA

Date: 3/15/23 AET Project P-0020125

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
AR:	Sample of material obtained from cuttings blown out the top of the borehole during air rotary procedure.
B, H, N:	Size of flush-joint casing
CAS:	Pipe casing, number indicates nominal diameter in inches
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
DP:	Direct push drilling; a 2.125 inch OD outer casing with an inner 1½ inch ID plastic tube is driven continuously into the ground.
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RDA:	Rotary drilling with compressed air and roller or drag bit.
RDF:	Rotary drilling with drilling fluid and roller or drag bit
REC:	In split-spoon (see notes), direct push and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
SS:	Standard split-spoon sampler (steel; 1.5" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q_p:	Pocket Penetrometer strength, tsf (approximate)
q_c:	Static cone bearing pressure, tsf
q_u:	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designation of Rock Core, in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remolded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES
(Calibrated Hammer Weight)

The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N_{60} values) and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM: D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM: D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").

AASHTO SOIL CLASSIFICATION SYSTEM

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

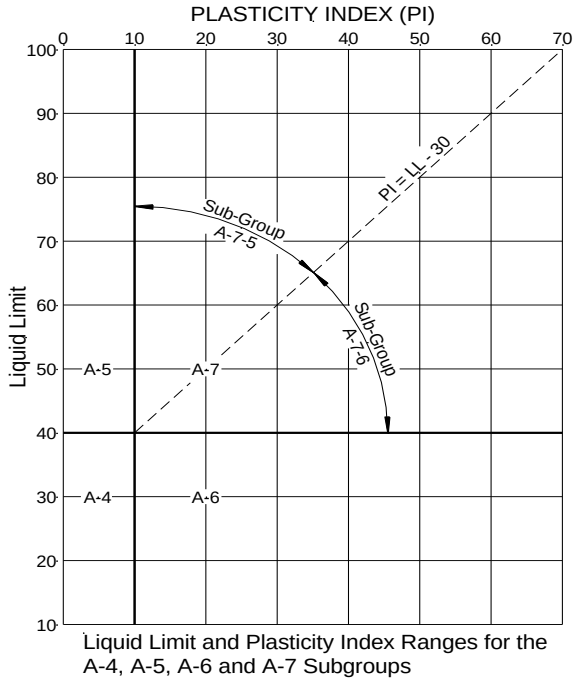
Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35% or less passing No. 200 sieve)							Silt-Clay Materials (More than 35% passing No. 200 sieve)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis, Percent passing:											
No. 10 (2.00 mm)	50 max.	....	....	....	....	....	....	....	....	....	....
No. 40 (0.425 mm)	30 max.	50 max.	51 min.	....	....	....	....	....	....	....	....
No. 200 (0.075 mm)	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of Fraction Passing No. 40 (0.425 mm)											
Liquid limit	....		....	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		N.P.	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.
Usual Types of Significant Constituent Materials	Stone Fragments, Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	
General Ratings as Subgrade	Excellent to Good							Fair to Poor			

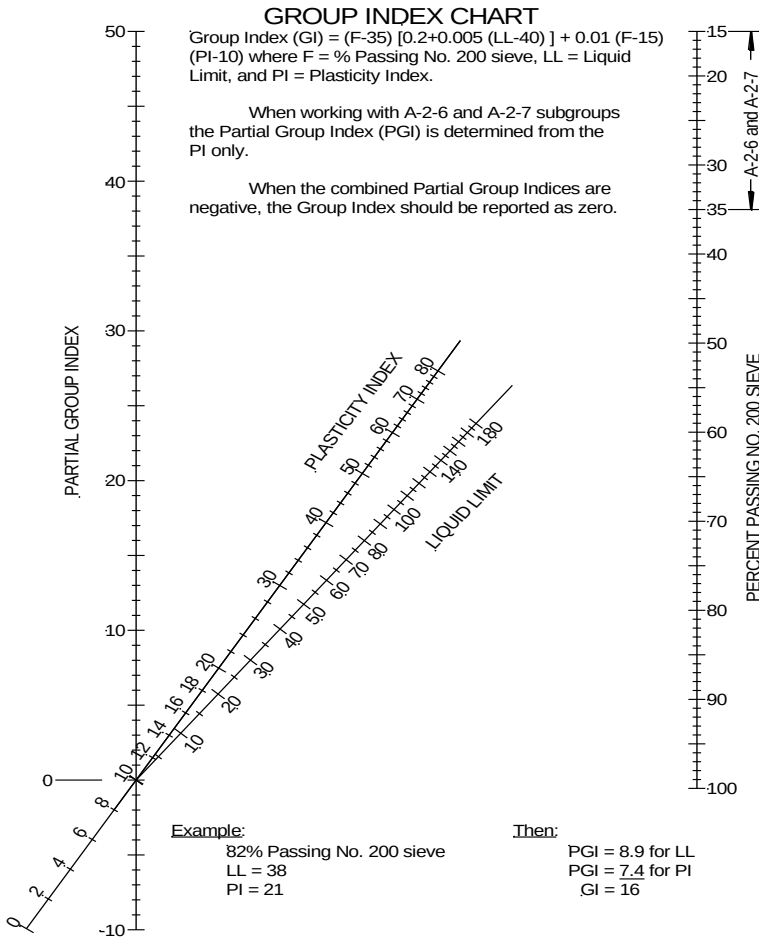
The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30.

Group A-8 soils are organic clays or peat with organic content >5%.



Liquid Limit and Plasticity Index Ranges for the A-4, A-5, A-6 and A-7 Subgroups



Definitions of Gravel, Sand and Silt-Clay

The terms "gravel", "coarse sand", "fine sand" and "silt-clay", as determinable from the minimum test data required in this classification arrangement and as used in subsequent word descriptions are defined as follows:

GRAVEL - Material passing sieve with 3-in. square openings and retained on the No. 10 sieve.

COARSE SAND - Material passing the No. 10 sieve and retained on the No. 40 sieve.

FINE SAND - Material passing the No. 40 sieve and retained on the No. 200 sieve.

COMBINED SILT AND CLAY - Material passing the No. 200 sieve

BOULDERS (retained on 3-in. sieve) should be excluded from the portion of the sample to which the classificaiton is applied, but the percentage of such material, if any, in the sample should be recorded.

The term "silty" is applied to fine material having plasticity index of 10 or less and the term "clayey" is applied to fine material having plasticity index of 11 or greater.

UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

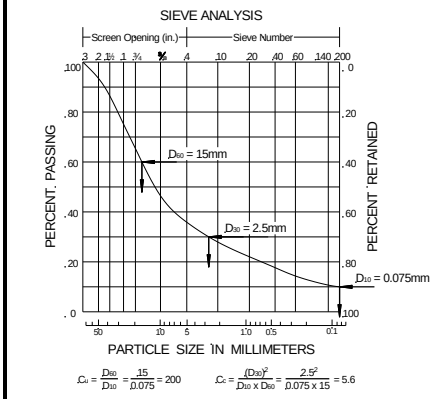
Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	Cu≥4 and 1≤Cc≤3[E]	GW	Well graded gravel[F]
			Cu<4 and/or 1>Cc>3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines more than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	Cu≥6 and 1≤Cc≤3[E]	SW	Well-graded sand[I]
			Cu<6 and/or 1>Cc>3[E]	SP	Poorly-graded sand[I]
		Sands with Fines more than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit–oven dried / Liquid limit – not dried <0.75	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	Liquid limit–oven dried / Liquid limit – not dried <0.75	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
Highly organic soil			Primarily organic matter, dark in color, and organic in odor	PT	Peat[R]

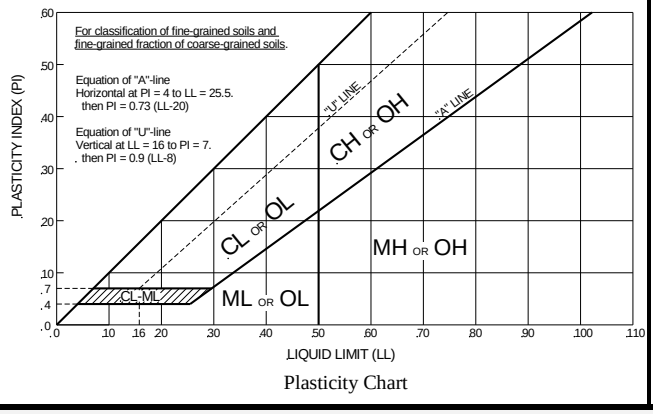
Notes

[A]Based on the material passing the 3-in (75-mm) sieve.
[B]If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C]Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D]Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E]$Cu = D_{60} / D_{10}$, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F]If soil contains ≥15% sand, add "with sand" to group name.
[G]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H]If fines are organic, add "with organic fines" to group name.
[I]If soil contains ≥15% gravel, add "with gravel" to group name.
[J]If Atterberg limits plot is hatched area, soil is a CL-ML silty clay.
[K]If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.
[L]If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
[M]If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N]PI≥4 and plots on or above "A" line.
[O]PI<4 or plots below "A" line.
[P]PI plots on or above "A" line.
[Q]PI plots below "A" line.
[R]Fiber Content description shown below.





Plasticity Chart

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

Term	Particle Size
Boulders	Over 12"
Cobbles	3" to 12"
Gravel	#4 sieve to 3"
Sand	#200 to #4 sieve
Fines (silt & clay)	Pass #200 sieve

Gravel Percentages

Term	Percent
A Little Gravel	3% - 14%
With Gravel	15% - 29%
Gravelly	30% - 50%

Consistency of Plastic Soils

Term	N-Value, BPF
Very Soft	less than 2
Soft	2 - 4
Firm	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	Greater than 30

Relative Density of Non-Plastic Soils

Term	N-Value, BPF
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Greater than 50

Moisture/Frost Condition

(MC Column)

D (Dry): Absence of moisture, dusty, dry to touch.
M (Moist): Damp, although free water not visible. Soil may still have a high water content (over "optimum").
W (Wet/ Waterbearing): Free water visible, intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.
F (Frozen): Soil frozen

Layering Notes

Laminations: Layers less than ½" thick of differing material or color.
Lenses: Pockets or layers greater than ½" thick of differing material or color.

Peat Description

Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

Organic Description (if no lab tests)

Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the Liquid Limit properties. *Slightly organic* used for borderline cases.

Root Inclusions

With roots: Judged to have sufficient quantity of roots to influence the soil properties.
Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.

ALLENDER BUTZKE ENGINEERS INC.
GEOTECHNICAL • ENVIRONMENTAL • CONSTRUCTION Q. C.

July 6, 2023

Guthrie County
c/o Veenstra & Kimm, Inc.
3000 Westown Parkway
West Des Moines, IA 50266
Attn: Greg Roth, P.E.

RE: Geotechnical Exploration
Guthrie County Pavement Cores
White Pole Road | Co. Hwy P28
Guthrie County, Iowa
PN 221438

Dear Mr. Roth:

Enclosed you will find the Laboratory/Field Test Results and Core Logs for the above referenced project. Forty-six pavement cores with soil probing and dynamic cone penetrometer (DCP) tests to depths of 4 feet below existing grades were conducted at each location on June 12 through 14, 21 through 23, and 26, 2023. Moisture content tests were performed on the subgrade soil samples at about each foot encountered below the pavement in the cores. Approximate locations of the borings are shown on the enclosed Site Plans. Boring locations and ground surface elevations were provided by Veenstra & Kimm, Inc. Geotechnical subgrade and pavement thickness analyses were not in ABE's scope of services.

The pavement cores in Core Nos. 1 through 28 on White Pole Road from Adair to Stuart generally consisted of 5.75 to 8.75 inches of hot mix asphalt (HMA) overlying 6.75 to 11.75 inches of Portland cement concrete (PCC). Pavement in Core Nos. 29 through 46, conducted on Co. Hwy P28, north of Stuart, generally consisted of 6.5 to 9.25 inches of PCC. Pavements at the core locations were supported directly on mostly high clay content cohesive soil subgrades.

We appreciate the opportunity to provide our services for this project. If you have any questions or need further assistance, please contact us at your convenience.

Respectfully submitted,
ALLENDER BUTZKE ENGINEERS INC.

Anton J. Schneider Jr., P.E.
Project Engineer

David Logemann, P.E.
Senior Principal Engineer

1 PC and Email Above
Email AET; Attn: Jacob Micalowski, and Guthrie County; Attn: Joshua Sebern & Evan Subbert

CORE NO. 1 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/22/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1383.0'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7.0")**				0.6
1382.4				**PCC (9.75")**				1382.4 1.4
	1.8	24.1		Brown lean to fat clay, moist **B-HORIZON LOESS**		CL-CH		1381.6 2.3
1380.6		26.5		Brown-gray lean clay, very moist **LOESS**		CL		1380.7
	3.6	28.2						
1378.8								4.3
	5.4			End of Boring				1378.7

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 2 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/22/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1345.3'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7.5")**				0.6
1344.6				**PCC (7.5")**				1344.7 1.3
	1.8	16.9		Brown to brown-gray sandy lean to fat clay, trace gravel, moist		CL-CH		1344.1
1342.8		21.1	13→	**FILL** Mixed with dark gray after 2.8'				
	3.6	19.1						4.0
1341				End of Boring				1341.3
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

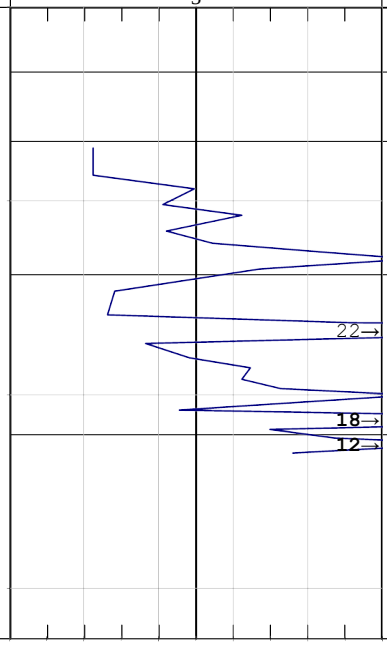
CORE NO. 3 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/23/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1391.0'**
Datum: **Site Survey**

Remarks:



Elevation ft.	Depth ft.	Moisture Content, %	Material Description*	USCS	Depth / Elevation ft.
	0		**HMA (7.25")**		0.6
			REINFORCED PCC (7.75")		1390.4 1.3
1389.6	1.8	20.3	Brown lean to fat clay, moist **B-HORIZON LOESS**	CL-CH	1389.8 2.5
		19.9	Brown-gray lean clay, very moist **LOESS**	CL	1388.5
1387.8	3.6	18.9	Sandy after 3'		4.0
			End of Boring		1387.0
1386	5.4				

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 4 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/23/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1361.6'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7.25")**				0.6
1360.8				**PCC (7.75")**				1361.0 1.3
	1.8	16.3	15→	Dark brown mixed with brown and dark gray lean to fat clay, damp **FILL**		CL-CH		1360.4 2.5
1359		16.7	28→ 33→ 25→ 39→ 25→ 16→	Brown sandy lean to fat clay, trace gravel, moist **PRE-ILLINOIAN GLACIAL TILL**		CL-CH		1359.1
	3.6	16.9	33→ 18→ 39→ 11→					4.0
1357.2				End of Boring				1357.6
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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ABE_DCP

CORE NO. 5 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/23/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1349.3'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7.25")**				0.6
1348.2				**PCC (8.5")**				1348.7 1.3
	1.8	17.2		Brown to red-brown sandy lean to fat clay, trace gravel, moist		CL-CH		1348.0
1346.4		19.0		**PRE-ILLINOIAN GLACIAL TILL**				
	3.6	18.9						4.0
1344.6				End of Boring				1345.3
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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ABE_DCP

CORE NO. 6 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/23/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1287.4'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1287	0		5	**HMA (7.25")**				0.6
				PCC (8.25")				1286.8 1.3
	1.8	19.3		Red to red-brown with gray-brown sandy at clay, trace gravel, moist		CH		1286.1
1285.2				**PRE-ILLINOIAN GLACIAL TILL**				
	3.6	17.0						4.0
1283.4			15	End of Boring				1283.4
1281.6	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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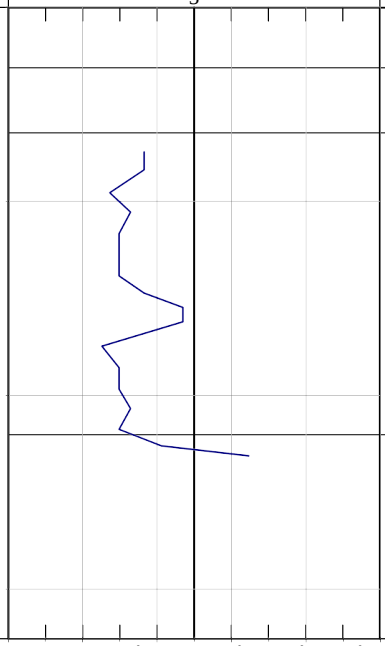
CORE NO. 7 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/23/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1251.5'**
Datum: **Site Survey**

Remarks:



Elevation ft.	Depth ft.	Moisture Content, %	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1251	0		**HMA (6.75")**				0.6
			PCC (7.25")				1250.9 1.2
	1.8	18.3	Dark brown with brown-gray sandy lean to fat clay, trace gravel, moist		CL-CH		1250.3
1249.2		15.5	**FILL** Less sand after 3'				
	3.6	18.1					4.0
1247.4			End of Boring				1247.5
	5.4						
1245.6							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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ABE_DCP

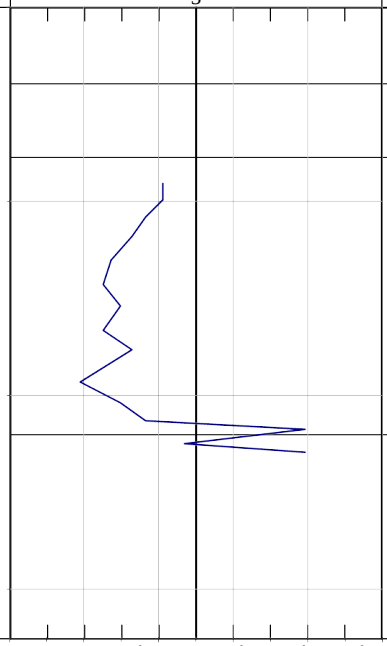
CORE NO. 8 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/23/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1245.1'**
Datum: **Site Survey**

Remarks:



Elevation ft.	Depth ft.	Moisture Content, %	Material Description*	USCS	Depth / Elevation ft.
	0		**HMA (8.5")**		0.7
			PCC (8.25")		1244.4 / 1.4
1243.8	1.8	24.8	Very dark gray lean to fat clay, moist	CL-CH	1243.7
1242	3.6	27.8 / 31.0	**FILL**		4.0
			End of Boring		1241.1
1240.2	5.4				

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

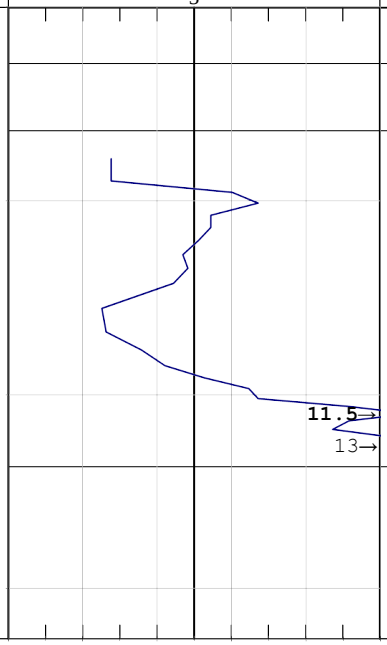
CORE NO. 9 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/26/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1253.3'**
Datum: **Site Survey**

Remarks:



Elevation ft.	Depth ft.	Moisture Content, %	Material Description*	USCS	Depth / Elevation ft.
1252.8	0		**HMA (6.25")**		0.5
			PCC (7.5")		1252.8 1.2
	1.8	21.1	Brown to brown-gray lean to fat clay, moist	CL-CH	1252.2
1251		21.6	**B-HORIZON LOESS** Very moist after 3'		
	3.6	25.5	With sand seams after 3.5'		
1249.2					4.3
			End of Boring		1249.0
	5.4				
1247.4					

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 10 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/26/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1239.2'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7.0")**				0.6
1238.4				**PCC (6.75")**				1238.6 1.2
	1.8	31.0		Very dark gray lean to fat clay, moist		CL-CH		1238.1
1236.6		30.4		**COHESIVE ALLUVIUM**				
	3.6	33.7	20→ 28→	Silty with dark gray after 3.5'				4.3
1234.8			39→	End of Boring				1234.9
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 11 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/26/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1238.5'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1238.4	0		5	**HMA (7.5")**				0.6
				PCC (7.0")				1237.9 1.2
1236.6	1.8	21.2		Very dark brown with dark gray lean to fat clay, moist **FILL**		CL-CH		1237.3 2.3
1234.8	3.6	23.6 24.3		Dark gray lean to fat clay, moist **COHESIVE ALLUVIUM** Very dark gray silty, very moist after 3.5'		CL-CH		1236.2 4.3
1233	5.4			End of Boring				1234.2

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 12 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/26/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1233.2'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1233	0		5	**HMA (7.0")**				0.6
				PCC (7.75")				1232.6 1.2
	1.8	27.2		Very dark gray lean to fat clay, moist		CL-CH		1232.0
1231.2		31.5		**COHESIVE ALLUVIUM** With dark gray, silty after 3.5'				
	3.6	32.6	13→ 12→					4.3
1229.4				End of Boring				1228.9
1227.6	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

CORE NO. 13 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/26/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1249.2'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1249.2	0		5	**HMA (6.5")**				0.5
				PCC (7.5")				1248.7 1.2
1247.4	1.8	21.1		Brown with dark brown lean to fat clay, moist **FILL**		CL-CH		1248.0 2.5
1245.6	3.6	27.6 26.2		Brown lean to fat clay, damp **B-HORIZON LOESS**		CL-CH		1246.7 4.3
1243.8	5.4			End of Boring				1244.9

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

CORE NO. 14 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/26/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1240.6'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1240.2	0		5	**HMA (5.5")**				0.5
				PCC (9.25")				1240.1 1.2
	1.8	20.3		Brown-gray sandy lean to fat clay, moist		CL-CH		1239.4
1238.4				Less sand after 2.3'				
		17.8		**FILL**				
	3.6		11→	More gray after 3.5'				
1236.6		19.5	14→ 11→					4.3
				End of Boring				1236.3
1234.8	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

CORE NO. 15 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/26/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1238.0'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (8.75")**				0.7
				PCC (7.5")				1237.3 1.4
1236.6	1.8	22.1		Brown to brown-gray lean to fat clay, moist **FILL**		CL-CH		1236.7
1234.8	3.6	25.8 26.1						4.3
1233	5.4			End of Boring				1233.7

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 16 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/22/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1233.9'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (8.0")**				0.7
1233				**PCC (7.75")**				1233.2 1.3
	1.8	22.6		Very dark gray with brown-gray lean to fat clay, moist **FILL**		CL-CH		1232.6
1231.2		28.6						3.3
	3.6	26.2		Dark gray-brown lean to fat clay, very moist **COHESIVE ALLUVIUM**		CL-CH		1230.6 4.3
1229.4				End of Boring				1229.6
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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CORE NO. 17 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/22/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1282.2'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7.5")**				0.6
1281.6				**PCC (7.75")**				1281.6 1.3
	1.8	21.8		Very dark brown with brown lean to fat clay, moist **FILL**		CL-CH		1280.9 2.0
1279.8				Brown to brown-gray lean to fat clay, moist **B-HORIZON LOESS**		CL-CH		1280.2 3.3
	3.6	26.3 30.7		Brown-gray lean clay, very moist **LOESS**		CL		1278.9 4.3
1278				End of Boring				1277.9
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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CORE NO. 18 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/22/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1256.4'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1256.4	0		5	**HMA (8.25")**				0.7
				PCC (8.5")				1255.7 1.4
1254.6	1.8	31.7		Very dark gray lean to fat clay, moist **FILL**		CL-CH		1255.0
		36.9						
1252.8	3.6	36.3	18→					4.0
				End of Boring				1252.4
1251	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

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CORE NO. 19 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/22/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1224.3'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1224	0		5	**HMA (6.75")**				0.6
				PCC (8.5")				1223.7 1.3
	1.8	26.9		Brown-gray lean to fat clay, moist		CL-CH		1223.0
1222.2		29.4		**FILL** Dark brown after 2.8'				
	3.6							
1220.4		32.3						4.0
				End of Boring				1220.3
	5.4							
1218.6								

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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CORE NO. 20 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/21/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1262.0'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1261.8	0		5	**HMA (7.0")**				0.6
				PCC (8.5")				1261.4 1.3
1260	1.8	24.1		Very dark brown-gray lean to fat clay, moist **LOCAL ALLUVIUM**		CL-CH		1260.7
		27.5						3.0
1258.2	3.6	26.5		Brown to brown-gray lean to fat clay, moist **B-HORIZON LOESS**		CL-CH		1259.0 4.3
1256.4	5.4			End of Boring				1257.7

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

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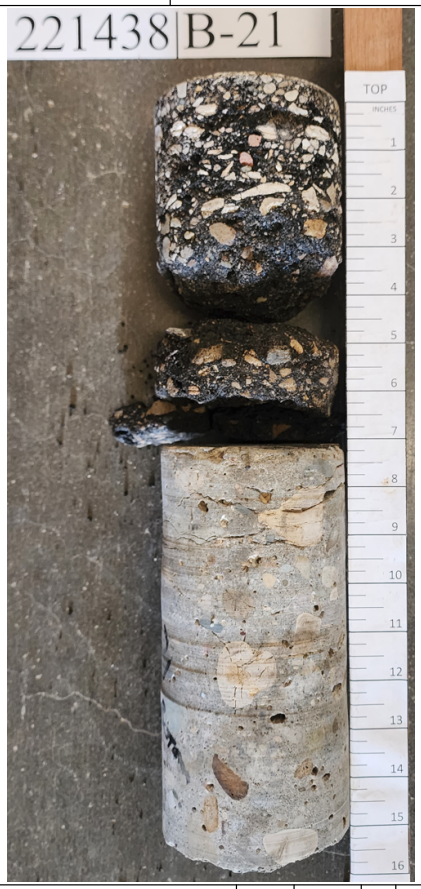
CORE NO. 21 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/21/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1236.0'**
Datum: **Site Survey**

Remarks:



Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7.0")**				0.6
				PCC (8.0")				1235.4 / 1.3
1234.8	1.8	28.1	16→	Very dark gray lean to fat clay, moist		CL-CH		1234.8
1233	3.6	34.7	14→ 11→	**LOCAL ALLUVIUM**				4.3
1231.2	5.4	28.7	16→ 20→ 15→	End of Boring				1231.7

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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CORE NO. 22 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/21/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1217.3'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1216.8	0		5	**HMA (7.0")**				0.6
				PCC (8.5")				1216.7 1.3
	1.8	30.6	11→	Very dark gray lean to fat clay, moist		CL-CH		1216.0
1215		34.7		**LOCAL ALLUVIUM**				
	3.6	36.3	12→ 14→ 16→ 18→					
1213.2								4.3
				End of Boring				1213.0
	5.4							
1211.4								

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

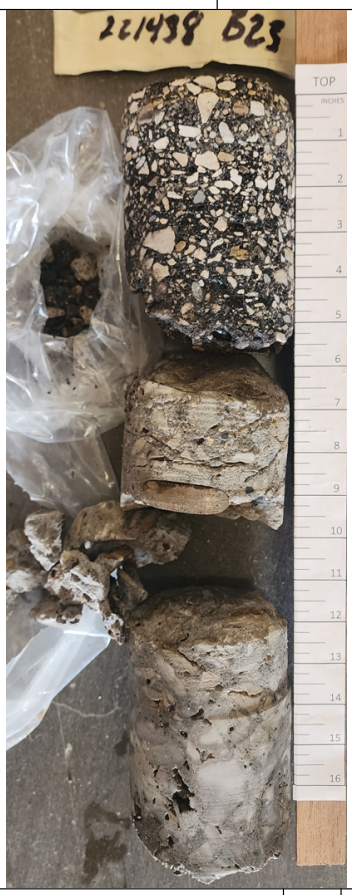
CORE NO. 23 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1223.1'**
Datum: **Site Survey**

Remarks:



Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (5.75")**				0.5
1222.2				**REINFORCED PCC (11.75")**				1222.6 1.5
	1.8	25.4		Brown-gray lean clay, moist to very moist		CL		1221.6
		25.3						
1220.4		28.7		**LOESS**				
	3.6	28.3						
		29.5						
1218.6				Gray after 4.5'				
		27.9						5.3
	5.4			End of Boring				1217.8

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

CORE NO. 24 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1215.8'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (0.75")**				0.1
				PCC (9.75")				1215.7
1215								0.9
			14→	**CRUSHED ROCK SUBBASE (9.5"±)**				1214.9
			11→					1.8
	1.8	23.1		Dark gray to gray-brown fat clay, moist		CH		1214.1
1213.2								
		26.6		**PALEOSOL**				
	3.6	26.6		With sand after 4'				
1211.4		26.9						
		26.8						5.0
	5.4			End of Boring				1210.8

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

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ABE_DCP

CORE NO. 25 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/12/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1230.8'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7.5")**				0.6
				PCC (9.5")				1230.2 1.4
1229.4	1.8	39.8		Very dark brown lean to fat clay with organics, moist **FILL/OLD TOPSOIL**		CL-CH		1229.4 3.0
1227.6	3.6	33.9 36.6 32.9		Brown lean to fat clay, moist **B-HORIZON LOESS**		CL-CH		1227.8 4.5
1225.8	5.4			End of Boring				1226.3

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

CORE NO. 26 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/12/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1230.2'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7")**				0.6
1229.4				**PCC (11")**				1229.6 1.5
	1.8	33.1 31.8		Very dark brown lean to fat clay with organics, moist to very moist **FILL/OLD TOPSOIL**		CL-CH		1228.7
1227.6		36.6						3.0
	3.6	37.5 32.1		Brown to brown-gray lean clay, very moist **LOESS**		CL		1227.2
1225.8								4.5
	5.4			End of Boring				1225.7

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

CORE NO. 27 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/12/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1226.8'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7")**				0.6
1225.8				**PCC (9")**				1226.2 1.3
	1.8	40.0		Very dark brown lean to fat clay with organics, moist to very moist **FILL/OLD TOPSOIL**		CL-CH		1225.5 2.5
1224		47.4		Brown-gray lean to fat clay, very moist **LOESS**		CL-CH		1224.3
1222.2	3.6	34.0						5.3
	5.4			End of Boring				1221.5

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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ABE_DCP

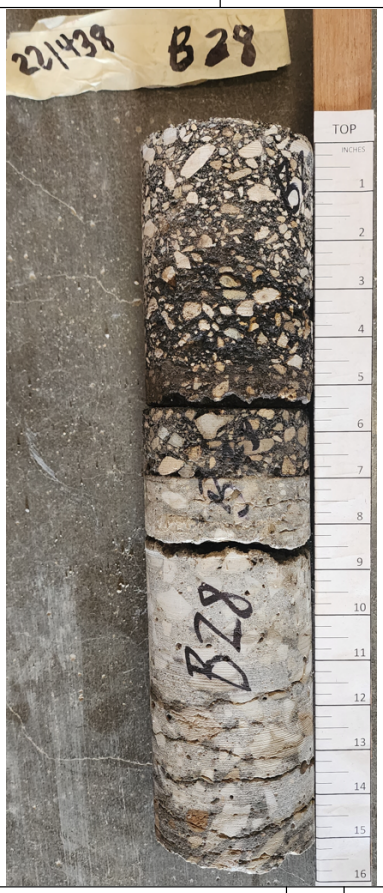
CORE NO. 28 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/12/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1222.9'**
Datum: **Site Survey**

Remarks:



Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (7")**				0.6
1222.2				**PCC (8.25")**				1222.3 1.3
	1.8	30.5		Very dark brown lean to fat clay, trace organics, moist **FILL/OLD TOPSOIL**		CL-CH		1221.6 2.3
1220.4		26.1		Brown-gray lean to fat clay, moist		CL-CH		1220.6
	3.6	27.1		**B-HORIZON LOESS**				
1218.6		27.8						
	5.4			End of Boring				5.5 1217.4

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 29 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1181.7'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (7.5")**				0.6
1180.8		19.7		Brown with gray lean clay with sand, moist **FILL**		CL		1181.1
	1.8	21.0		Brown-gray lean to fat clay, moist **LOESS**		CL-CH		1179.7
1179		24.3						3.0
	3.6	32.6		Gray with brown fat clay, moist **PALEOSOL**		CH		1178.7
		29.6						4.5
1177.2				End of Boring				1177.2
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 30 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1148.1'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (7.0")**				0.6
		15.7		Brown sandy lean to fat clay, trace gravel, moist		CL-CH		1147.5
1146.6	1.8	14.2	33→	Clayey sand with gravel from 1.5' to 2.3'		SC		
		7.1	22→	**PRE-ILLINOIAN GLACIAL TILL**				
			33→	Brown-gray sandy lean to fat clay, trace gravel after 2.3'		CL-CH		
		15.8	17→ 14→					3.0
1144.8	3.6			End of Boring				1145.1
1143	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 31 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1131.4'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (7.5")**				0.6
1130.4	1.8	18.9 19.7 23.9		Brown lean to fat clay, moist **B-HORIZON LOESS**		CL-CH		1130.8 2.8
1128.6	3.6	25.9 26.5 28.2	12→ 14→ 22→	Brown-gray lean clay, moist to very moist **LOESS**		CL		1128.6 4.5
1126.8	5.4			End of Boring				1126.9

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

CORE NO. 32 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1034.1'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (1.25")**				0.1
				PCC (9.25")				1034.0
1033.2								0.9
		17.7		Brown-gray with maroon shaley fat clay, moist		CH		1033.2
	1.8	17.5						
1031.4								
		19.0		Less maroon after 3'				
	3.6	23.4		**FILL**				
1029.6								
		19.5						
		20.6						5.3
	5.4			End of Boring				1028.8

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 33 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1029.3'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**HMA (1.5")**				0.1
				PCC (6.75")				1029.2
				CRUSHED ROCK SUBBASE (1.75"±)				0.7
		17.7		Gray-brown sandy lean to fat clay, moist		CL-CH		1028.6
1027.8	1.8							0.8
		18.0		**FILL**				1028.5
		19.5		With maroon shaley fat clay after 3'		CH		
1026	3.6	17.5	14→	Brown-gray silty sand after 3.5'		SM		
		17.1	11→ 11→ 22→	End of Boring				4.0
								1025.3
1024.2	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

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CORE NO. 34 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1121.8'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1121.4	0		5	**PCC (7.75")**				0.6
				CRUSHED ROCK SUBBASE (2.25"±)				1121.2
		20.8		Brown lean to fat clay, moist		CL-CH		0.8
	1.8	20.0		Dark gray after 1.5'				1121.0
1119.6		25.6		**FILL**				
		19.9	13→	Brown-gray sandy after 3.3'				
	3.6							
1117.8		25.9	11→	Dark gray-brown after 3.8'				4.3
				End of Boring				1117.5
	5.4							
1116								

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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ABE_DCP

CORE NO. 35 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/13/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1132.1'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (7.5")**				0.6
		16.8		Dark gray lean to fat clay, moist **FILL**		CL-CH		1131.5 1.6
1130.4	1.8	16.2 18.8	18→ 16→	Brown-gray sandy lean to fat clay, trace gravel, moist Dark gray after 2.5' **PRE-ILLINOIAN GLACIAL TILL**		CL-CH		1130.5
		13.5	11→					
1128.6	3.6							3.8
				End of Boring Dark gray-brown after 3.8'				1128.3
1126.8	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
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CORE NO. 36 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/14/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1126.0'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (6.5")**				0.5
				SAND SUBBASE (1/2"±)				1125.5
1125		24.2		Gray with brown fat clay, moist **PALEOSOL**		CH		0.6 1125.4
	1.8	20.2						1.8
		14.9		Brown-gray sandy lean to fat clay, trace gravel, moist		CL-CH		1124.2
1123.2				**PRE-ILLINOIAN GLACIAL TILL**				
		15.4						
	3.6	13.4	15→25→11	Dark gray-brown after 3.8'				4.0
				End of Boring				1122.0
1121.4								
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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CORE NO. 37 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/14/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **991.3'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (7.75")**				0.7
990	1.8	21.2		Gray with brown fat clay, moist **FILL**		CH		990.7 2.0
988.2	3.6	25.5 25.5	16→ 20→ 11→ 18→ 33→ 20→	Gray weathered clay shale,moist **WEATHERED BEDROCK**		CH		989.3 3.3
986.4	5.4		48→ 40→ 48→	End of Boring				988.0

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 38 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/14/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **987.3'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0			**REINFORCED PCC (7.0")**				0.6
986.4		15.9	18→ 20→	Very dark brown clayey sand, moist		SC		986.7
		16.5		Very dark gray lean to fat clay, moist after 1'		CL-CH		
	1.8			**FILL**				
		16.5	22→ 33→	Possible sand layer near or after 2.3'				2.3
984.6			14→ 26→ 48→	End of Boring				985.0
	3.6		33→ 48→ 29→ 22→					
982.8			16→ 12→					
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 39 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/14/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1038.7'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1038.6	0		5	**PCC (7.25")**				0.6
		13.4	11→	Brown to dark gray lean to fat clay with sand, moist		CL-CH		1038.1
			11→					
		11.4	13→	**FILL**				
1036.8	1.8		14→					
		10.5	11→					
			22→					
			14→					2.5
			33→	Brown sandy lean clay, damp		CL		1036.2
			16→	**GLACIAL TILL**				
		12.4						3.3
1035	3.6			End of Boring				1035.4
			18→					
1033.2	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 40 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/14/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1133.8'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (7.0")**				0.6
		11.8	22	Brown-gray mixed with dark gray sandy lean clay, trace gravel, moist		CL		1133.2
1132.2	1.8	14.3	33, 11, 20	Dark gray very sandy after 1.3'				
			14	Dark gray lean to fat clay after 2'		CL-CH		
		22.1	33, 12	**FILL**				
1130.4	3.6		33					4.0
			25, 33	End of Boring				1129.8
1128.6	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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CORE NO. 41 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/14/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1156.3'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (8.25")**				0.7
1155.6		24.6		Very dark gray lean to fat clay, moist		CL-CH		1155.6
	1.8	21.2		Dark gray after 1.3'				
		21.6		**FILL**				
1153.8		22.9						
		23.2						
	3.6	24.0	13→ 22→ 35→ 50→					4.0
1152				End of Boring				1152.3
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. ▽ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
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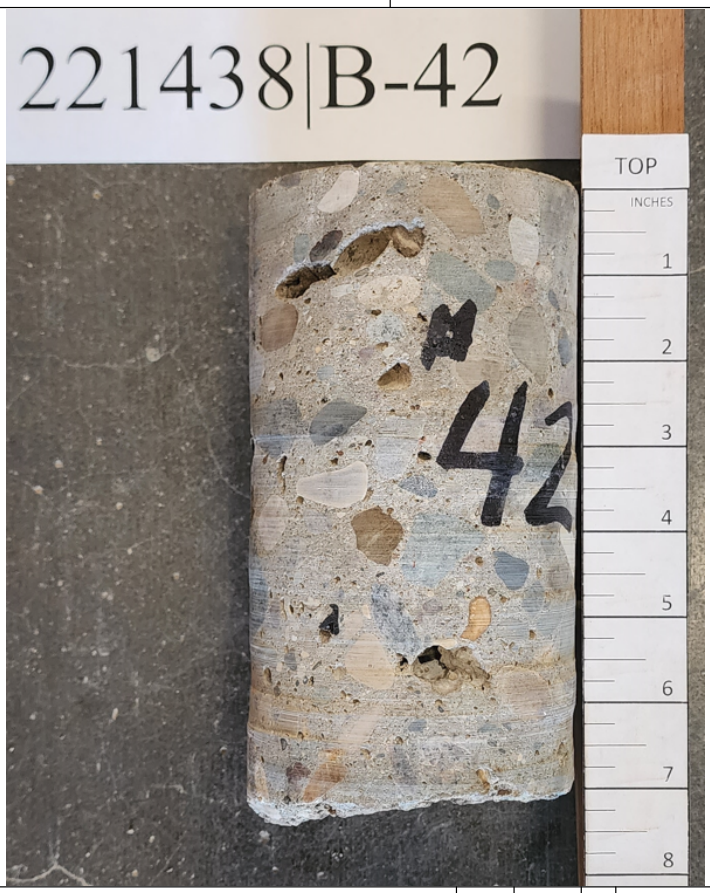
CORE NO. 42 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/21/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1162.2'**
Datum: **Site Survey**

Remarks:



Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (7.0")**				0.6
1161		20.2	48→ 100+→	Very dark gray and gray lean to fat clay, moist		CL-CH		1161.6
	1.8	13.8		**FILL** Very dark brown clayey sand with gravel after 1.3'		SC		2.0
			60→ 48→	End of Boring				1160.2
1159.2	3.6		39→ 12→					
1157.4	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
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ABE_DCP

CORE NO. 43 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/21/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1163.0'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
1162.8	0		5	**PCC (6.75")**				0.6
		24.7	20→	Very dark gray fat clay, moist		CH		1162.4
		17.3	15→	**FILL**				
1161	1.8		15→	With sand after 1.8'				
		18.8						2.8
		24.1		Very dark gray lean to fat clay, moist **LOCAL ALLUVIUM**		CL-CH		1160.2 3.3
1159.2	3.6		**14**→ 20→	End of Boring				1159.7
1157.4	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 44 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/21/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1151.0'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (6.5")**				0.5
1150.2		21.9		Dark gray to very dark gray lean to fat clay, moist		CL-CH		1150.5
	1.8	17.0		Clayey sand seam near 1'				
		17.5		Sandy lean to fat clay after 1.5'				
1148.4		14.8	14 →	**FILL**				2.8
			12 →	End of Boring				1148.2
1146.6	3.6							
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

ABE_DCP

CORE NO. 45 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/21/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1147.5'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (8.25")**				0.7
1146.6		16.2	13→	Dark gray with very dark gray sandy lean to fat clay, trace gravel, moist		CL-CH		1146.8
	1.8	18.8		**FILL**				
1144.8		25.3		Less sand after 2.5'				3.3
	3.6		12→ 14→	End of Boring				1144.2
1143								
	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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ABE_DCP

CORE NO. 46 | Project No.: **221438**

Project: **White Pole Road and P28 Pavement Cores**
Guthrie County, Iowa

Client: **Veenstra & Kimm, Inc.**
3000 Westown Pkwy
West Des Moines, IA 50266

Date Drilled: **6/21/2023**
Drilling Method: **Core, DCP, and Hand Probe**
Surface Elevation: **1141.1'**
Datum: **Site Survey**

Remarks:

Elevation ft.	Depth ft.	Moisture Content, %	California Bearing Ratio (Correlated from Dynamic Cone Penetrometer (ASTM D6951))	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0		5	**PCC (7.0")**				0.6
		22.1		Dark gray with very dark gray lean to fat clay, moist		CL-CH		1140.5
1139.4	1.8	22.7		**FILL**				2.3
		24.2		Dark gray fat clay, moist **PALEOSOL**		CH		1138.8 / 3.3
1137.6	3.6			End of Boring				1137.8
1135.8	5.4							

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs.
Depth to water: **Dry** ft. _____ ft.

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ABE_DCP

PN 221438

Site Plan 1

PN 221438

MONTIETH RD
B-46
WINDING TRL
WAGON RD
B-45
268TH ST
B-44
270TH ST
TANK AVE
272ND LN
B-43
ABILENE WAY
298TH PL
B-42
B-41
285TH ST
280TH RD
ABILENE AVE
290TH LN
B-40
290TH LN
B-39
WALNUT TRL
B-38
298TH LN
VICTORY TRL
B-37
YORK AVE
ZACK LN
B-36
310TH ST
310TH ST
310TH ST
B-35
315TH ST
B-34
315TH ST
B-33
B-32
TULIP TRL
B-31
325TH ST
325TH ST
VICTORY TRL
B-30
WAX TRL
ZEPHER TRL
330TH ST
331ST ST
330TH ST
330TH TRL
335TH ST
UTE AVE
335TH ST
B-29
B-23
B-24
340TH ST
340TH ST
343RD ST
B-25
345TH TRL
B-26
B-27
N HARLAN ST
N 7TH ST
N ADAIR ST
N MAIN ST
N 4TH ST
N 3RD ST
N 2ND ST
B-28
WHITE POLE RD

Site Plan 2

Appendix B

Ground Penetrating Radar Field Exploration and Testing
GPR Plots

B.1 FIELD EXPLORATION

The pavement structural conditions at the site were evaluated nondestructively using Ground Penetrating Radar (GPR). The description of the equipment precedes the GPR Data and Analysis Results in this appendix.

B.2 EQUIPMENT DESCRIPTION

B.2.1 GSSI GPR Test System

The GPR test system owned by AET is a bumper-mounted, 2 GHz air-coupled antenna; dual-channel controller/data acquisition system; wheel-mounted DMI (Distance Measuring Instrument); and laptop with the GSSI controller software. AET uses GPR systems for testing and analysis that meets the ASTM D4748-10 Determining the Thickness of Bound Pavement Layers Using Short-Pulse Radar and D6087 Evaluating Asphalt-Covered Concrete Bridge Decks Using Ground Penetrating Radar test standards. Figure B1 provides an example of a vehicle outfitted with the air-coupled antenna and the raw GPR data prior to processing.

(a) **(b)**

Figure B1. (a) GSSI 2 GHz Air-coupled GPR Test System mounted to the rear of an AET survey vehicle and (b) example of raw data collected using the GPR test system

The GPR antenna emits a high-frequency electromagnetic wave into the material under investigation. The reflected energy caused by changes in the electromagnetic properties within the material is detected by a receiver antenna and recorded for subsequent analysis. The 2 GHz air-coupled GPR can collect radar waveforms at more than 100 signals per second, which allows for data to be collected at driving speeds along the longitudinal dimension of a road with the antennas fixed at the rear or in front of the vehicle.

AET prefers the 2 GHz antenna for road surveys as it combines excellent resolution with reasonable depth penetration (18-24 inches in pavement materials). As data collection is performed at normal driving speeds (45-55 mph), no lane closures are required. At this speed the 2 GHz antenna can collect data at 6-inch interval (2 scans/foot), however data collection varies by project. Specific data collection rates (in scans per foot) will be described in project reports. Vertical scans consist of 512 samples and the recorded length in time of each scan is 12 nanoseconds. Data acquisition uses 300 MHz high pass and 5,000 MHz low pass filters.

In a GPR test, the antenna is moved continuously across the test surface and the control unit collects data at a specified distance increment. In this way, the data collection rate is independent of the scan rate. Alternatively, scanning can be performed at a constant rate of time, regardless of the scan distance. Single point scans can be performed as well. Data is reviewed in the controller software in real-time during field testing to identify reflections and ensure proper data collection parameters.

B.2.2 System Calibrations

Prior to each use, the GPR test system is calibrated using metal plate and air calibration methods suggested by the GPR manufacturer. In addition, the DMI is calibrated to within +/- 1 foot/mile.

- Metal plate calibration is obtained with the antenna placed over a metal plate at the same

elevation as a scan obtained over pavement. Time-based collection (as opposed to distance) is performed to provide the velocity of the radar energy in terms of reflection strengths (amplitudes) from a pavement layer interface relative to a perfect reflector (a metal plate).

- Air calibrations are also performed in time-based collection mode to account for the vertical travel of the antenna during vehicle-mounted testing. To approximate the range of travel encountered during testing, data is collected for fifteen seconds while an operator moves the vehicle vertically (by jumping up and down on the mounting point at the bumper) to record data. This information is used in later GPR analysis.
- The DMI is calibrated by laying out a long distance (typically 100 feet) with a tape measure, marking the termini, and traversing the known distance. Recorded distance in the controller software is confirmed against actual distance, and adjustments in the controller software are made to ensure that DMI information that is paired with GPR data is accurate.

B.2.3 Linear Distance and Spatial Reference System
The distance measuring instrument (DMI) is a trailer mounted two phase encoder system. When DMI is connected to the GPR controller it provides for automatic display and recording distance information in both English and metric units within a 1-foot (0.3 meters) resolution when calibrated using provided procedure in the controller software.

The spatial reference system is provided using either Trimble or EOS Arrow Global Positioning System (GPS) systems that consist of a fully integrated receiver, antenna, and battery unit to provide subfoot (30 cm) post processed accuracy. All GPS information is coupled with raw GPR data within the GPR controller software.

B.2.4 Camera Monitoring System
A truck-mounted, battery-operated independent 4K waterproof multi-functional digital camera with an SD card is used to capture digital video of the pavement surface during GPR data collection.

B.3 SAMPLING METHODS

Sampling methods using the GPR test system comply with the test standard (ASTM D4748-10). Sampling rates (i.e. scans per foot), sampling location (e.g. right wheel path, middle lane, both wheel paths), and the use of alternative equipment for GPR collection, if applicable (e.g. ground-coupled antennas), are described in the body of the project report.

B.4 QUALITY CONTROL (QC) AND QUALITY ASSURANCE (QA)

Beside the daily metal plate calibration, the DMI is also calibrated at regular intervals by driving the vehicle over a known distance to calculate the distance scale factor. The GPR will be monitored in real time in the data collection vehicle to minimize data errors. The GPR units will be identified with a unique number and that number will accompany all data reported from that unit as required in the QC/QA plan.

Scheduled preventive maintenance ensures proper equipment operation and helps identify potential problems that can be corrected to avoid poor quality or missing data that results if the equipment malfunctions while on site. The routine and major maintenance procedures established by the Federal Highway Administration's Long-Term Pavement Performance research program are adopted and any maintenance has been done at the end of the day after the testing is complete and become part of the routine performed at the end of each test/travel day and on days when no other work is scheduled.

As noted in the applicable test standard (ASTM D4748-10), quality assurance of GPR data is compromised when suboptimal test conditions exist. Such conditions may include wet surfaces (including standing water), ambient electromagnetic interference, or pavement distresses that can significantly scatter the GPR signal.

B.5 DATA ANALYSIS METHODS

B.5.1 Data Editing
Field acquisition is seldom so routine that no errors, omissions, or data redundancy occur. Data editing encompasses issues such as data re-organization, data file merging, data header or background information updates, repositioning, and inclusion of elevation information with the data.

B.5.2 Basic Processing
Basic data processing addresses some of the fundamental manipulations applied to data to make a more acceptable product for initial interpretation and data evaluation. In most instances this type of processing is already applied in real-time to generate the real-time display. The advantage of post survey processing is that the basic processing can be done more systematically and non-causal operators to remove or enhance certain features can be applied.

The Reflection Picking procedure is used to eliminate unwanted noise, detects significant reflections, and records the corresponding time and depth. It uses antenna calibration file data to calculate the radar signal velocity within the pavement.

B.5.3 Advanced Processing
Advanced data processing addresses the types of processing which require a certain amount of operator bias to be applied and which will result in data which are significantly different from the raw information which were input to the processing. This stage of analysis relies on supplementary resources (e.g. boring/coring logs, design plans, as-built records, historical records, conversations with road engineers/supervisors).

B.5.4 Data Interpretation
In some cases, automated layer interpretation modules within the analysis software can be used from preliminary analysis to map structural layers and calculate the corresponding velocities and depths. When used, the results from these modules require engineering review and approval.

B.6 TEST LIMITATIONS

B.6.1 Test Methods
The testing we performed identified pavement conditions only at those points where we measured pavement thicknesses and observed pavement surface conditions. Depending on the sampling methods and sampling frequency, every location may not be tested. Test conditions may limit the quality of the data collected, and some anomalies may be present in the pavement that compromise data and/or data collection at a given location.

Furthermore, because analysis procedures involve matters of engineering judgement, the final analysis developed represents our professional opinions about the subsurface conditions. More specifically, as relates to pavement systems, assessing layer thicknesses using GPR is a matter of engineering judgement. To enrich the analysis, we rely on supporting test methods and project information. However, even with supporting information, the distinction between layers in the road is not always explicit. Factors influencing definition of radar scans include ambient electromagnetic interference, the presence of moisture, the presence of voids, and the similarity of material layer type between layers.

Other factors external to related to methods and analysis data may require that we alter our conclusions and recommendations accordingly.

B.6.2 Test Standards
Pavement testing is performed in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

B.7 SUPPORTING TEST METHODS

B.7.1 Soil Boring/Coring Field Exploration

If both pavement thicknesses and subgrade soil types and conditions are desired, pavement cores and soil borings are obtained. The limited number of cores and borings are necessary to verify the GPR layer thickness data.

B.7.2 Pavement Surface Condition

Certain pavement distresses may affect the electromagnetic signal to an extent that complicates the analysis of GPR data. The results of a pavement condition survey are useful to identify near-surface features (e.g. stripped asphalt) or sub-surface features (e.g. local saturated layers due to ingress of water at the surface) when reviewing GPR data.

When we do not perform a standard pavement condition survey alongside GPR data, we rely on GPR operators to note possible distresses as they traverse the pavement from about 1 ft (0.3 m) in front of vehicle to about 30 ft (9 m) ahead. These test notes are consulted during GPR analysis, however they are not a substitute for a conventional rigorous pavement condition survey.

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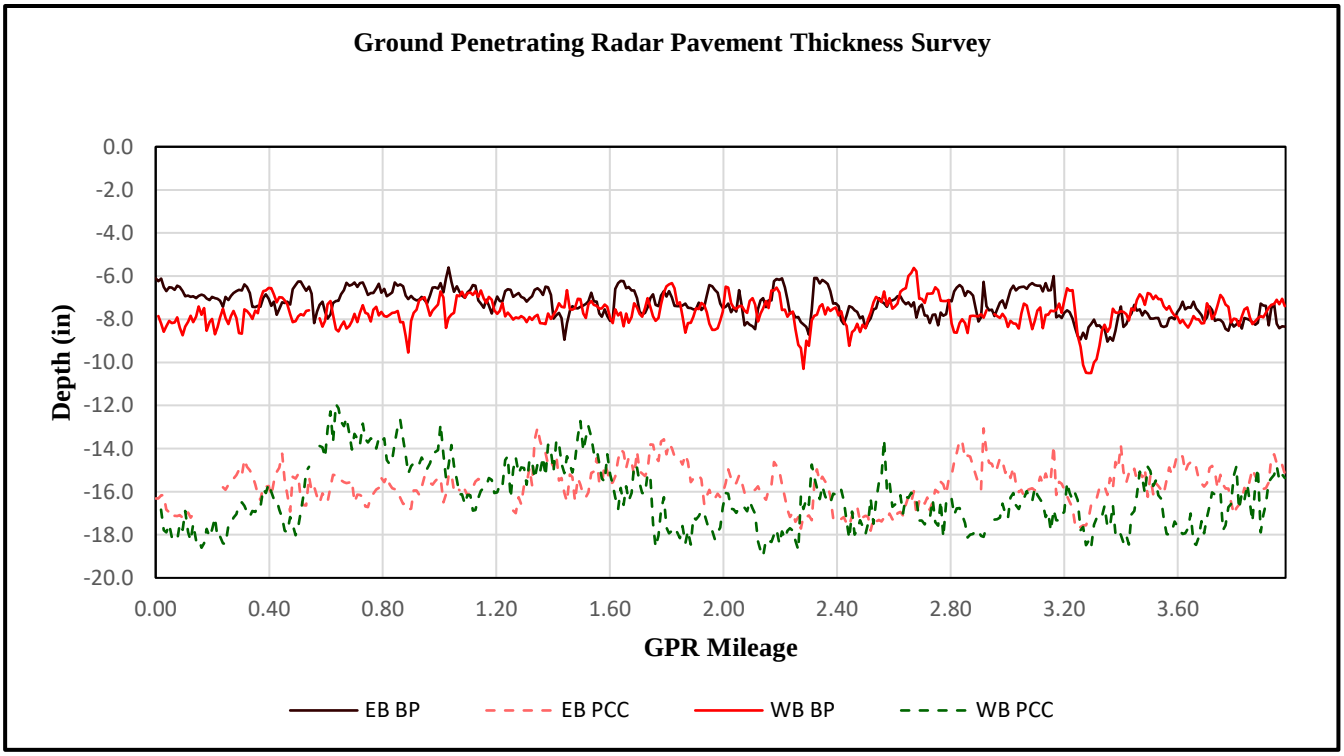
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S01
From:	Frontier Rd	**To:**	CTH N72

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	7.3	9%	6.5	5.6	7.7	9%	7.1	5.6
PCC	8.5	12%	7.3	6.1	8.6	18%	6.9	3.5



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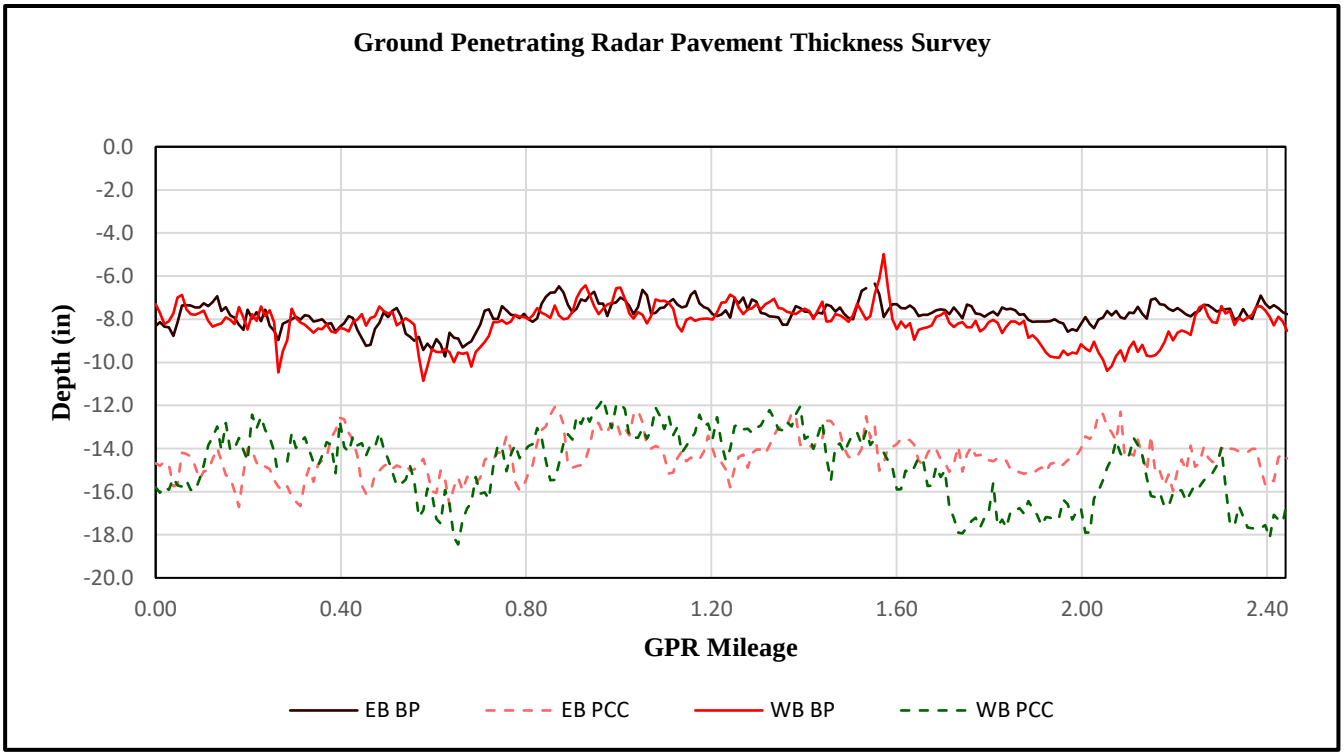
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S02
From:	CTH N72	**To:**	Kelsey Rd

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	7.8	7%	7.3	6.4	8.2	10%	7.5	5.0
PCC	6.6	14%	5.8	4.2	6.7	22%	5.3	3.9



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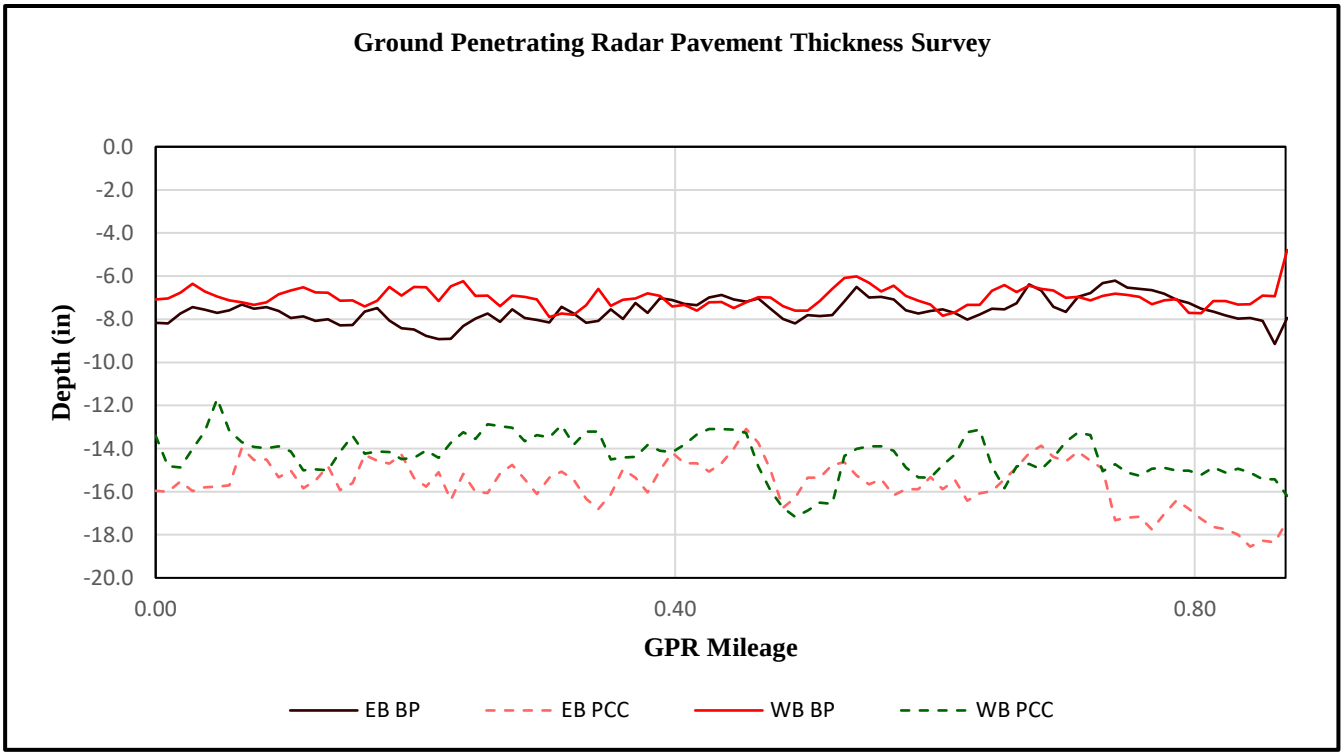
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S03A
From:	E Grant Rd	**To:**	0.87 mi E

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	7.6	8%	7.0	6.2	7.0	7%	6.6	4.8
PCC	8.0	14%	7.0	5.9	7.3	16%	6.1	4.7



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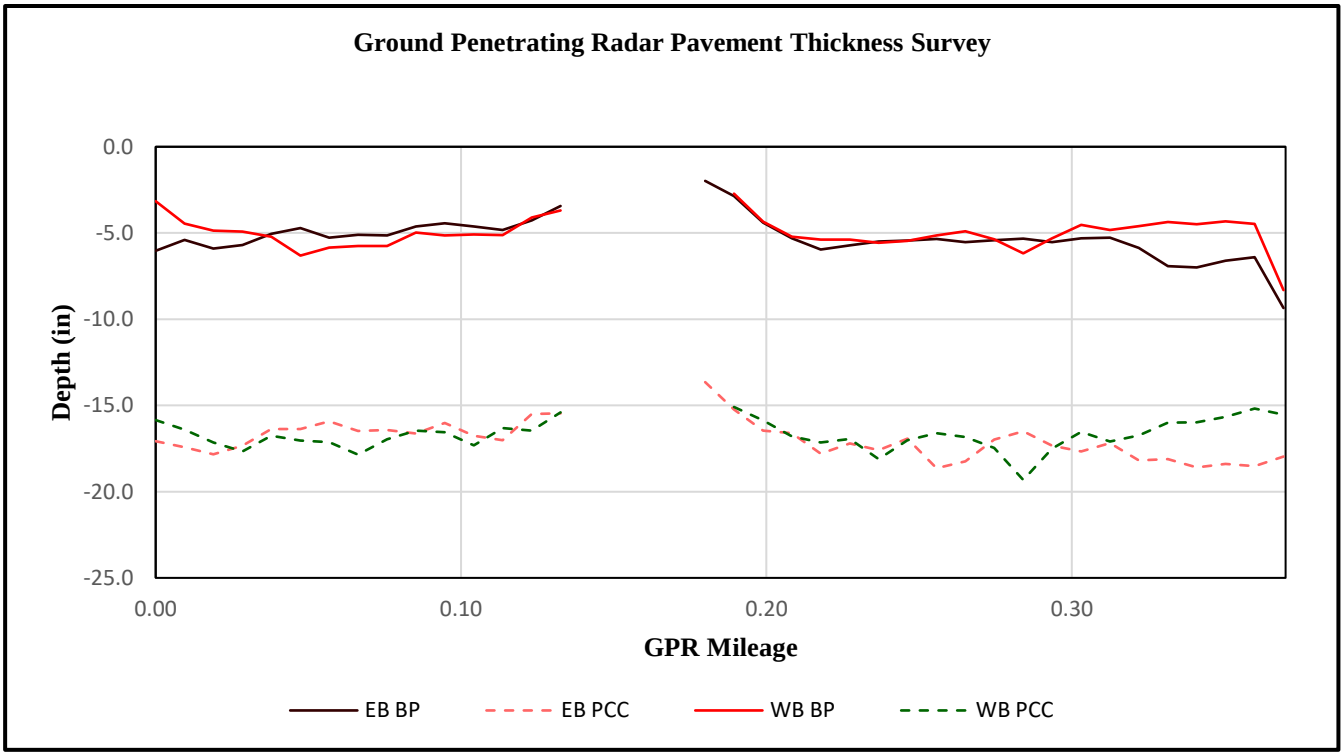
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S03B
From:	0.87 mi E of E Grant Rd	**To:**	0.37 mi E

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	5.3	23%	4.5	2.0	5.0	19%	4.3	2.7
PCC	11.7	6%	11.2	8.6	11.7	8%	11.3	7.2



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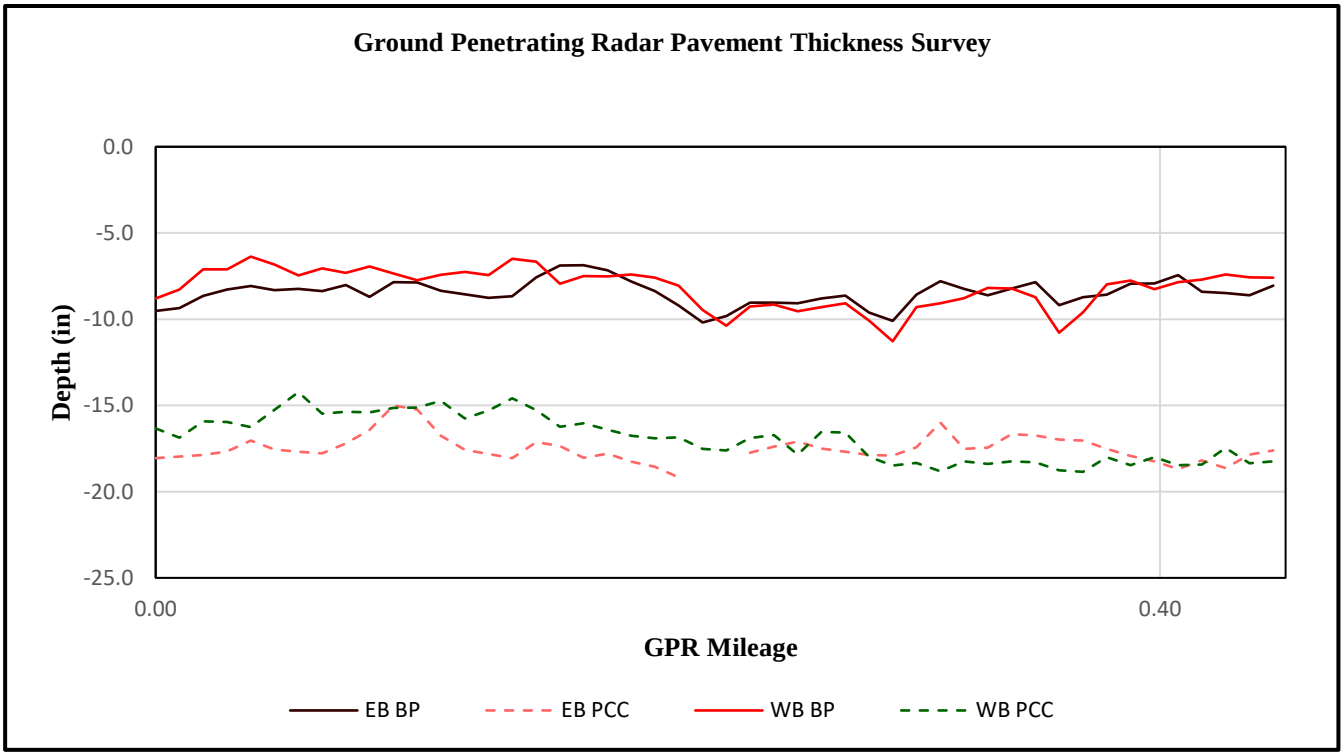
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S03C
From:	0.45 mi W	**To:**	STH 25

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	8.5	9%	7.9	6.9	8.2	14%	7.1	6.4
PCC	9.1	10%	8.3	7.1	8.7	13%	7.5	6.8



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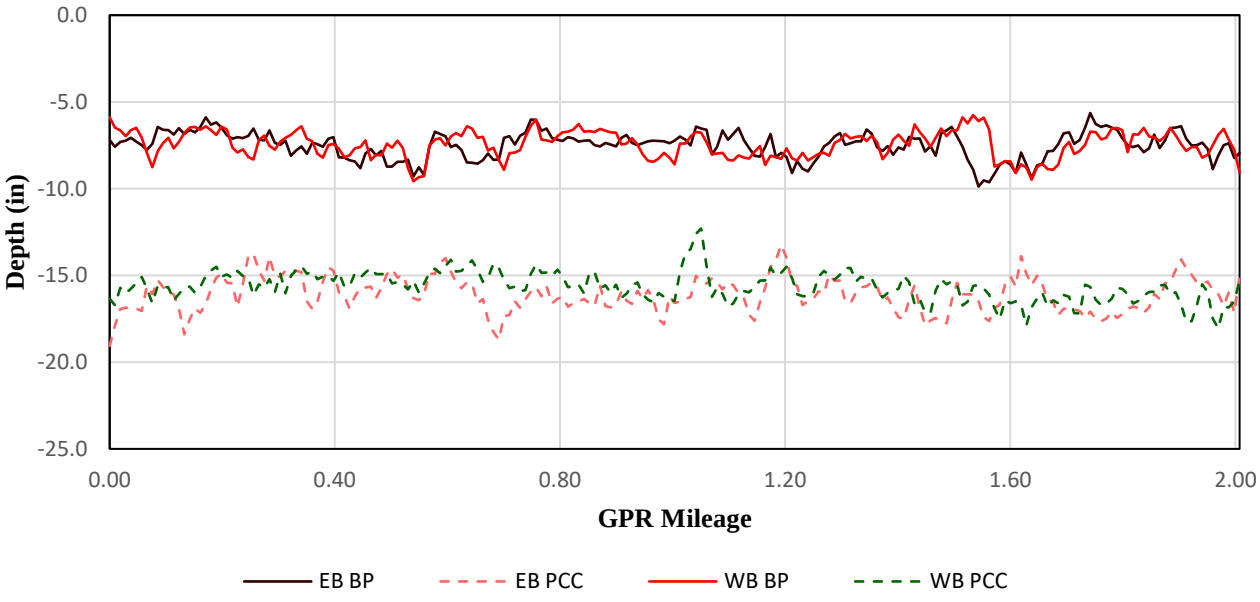
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S04
From:	STH 25	**To:**	CTH P20

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	7.5	10%	6.6	5.6	7.4	10%	6.6	5.8
PCC	8.6	15%	7.2	5.3	8.2	12%	7.2	5.5



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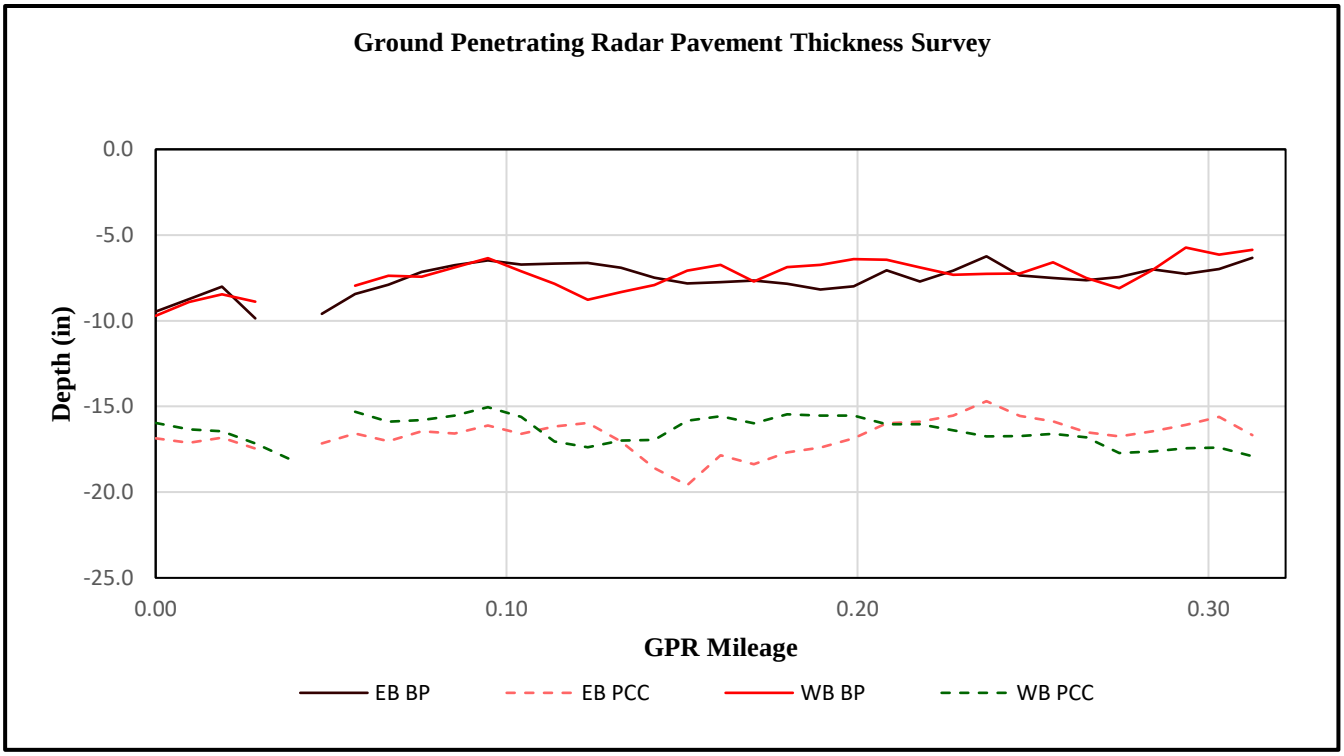
Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S05
From:	CTH P20	**To:**	Seridan St

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	7.6	12%	6.7	6.2	7.4	13%	6.4	5.7
PCC	9.2	11%	8.2	7.4	9.3	21%	8.3	6.3



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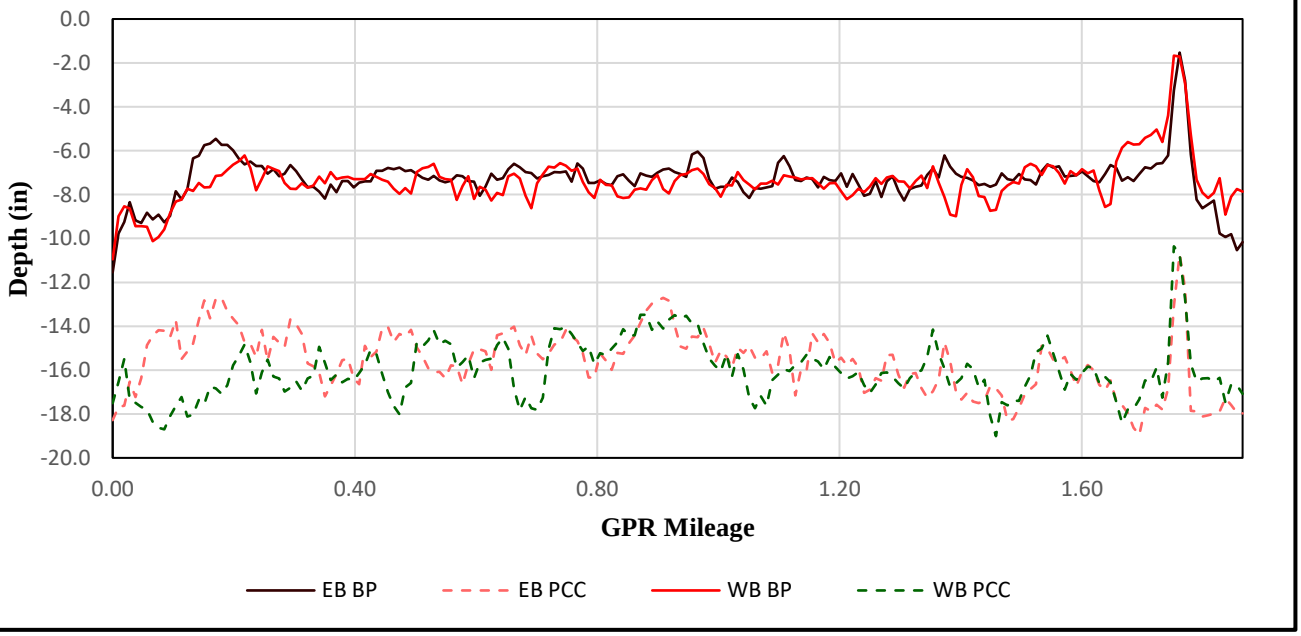
Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S06
From:	Adair St (Menlo)	**To:**	340th St

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	7.3	14%	6.7	1.5	7.4	15%	6.8	1.7
PCC	8.3	15%	7.2	4.9	8.6	14%	7.6	5.7



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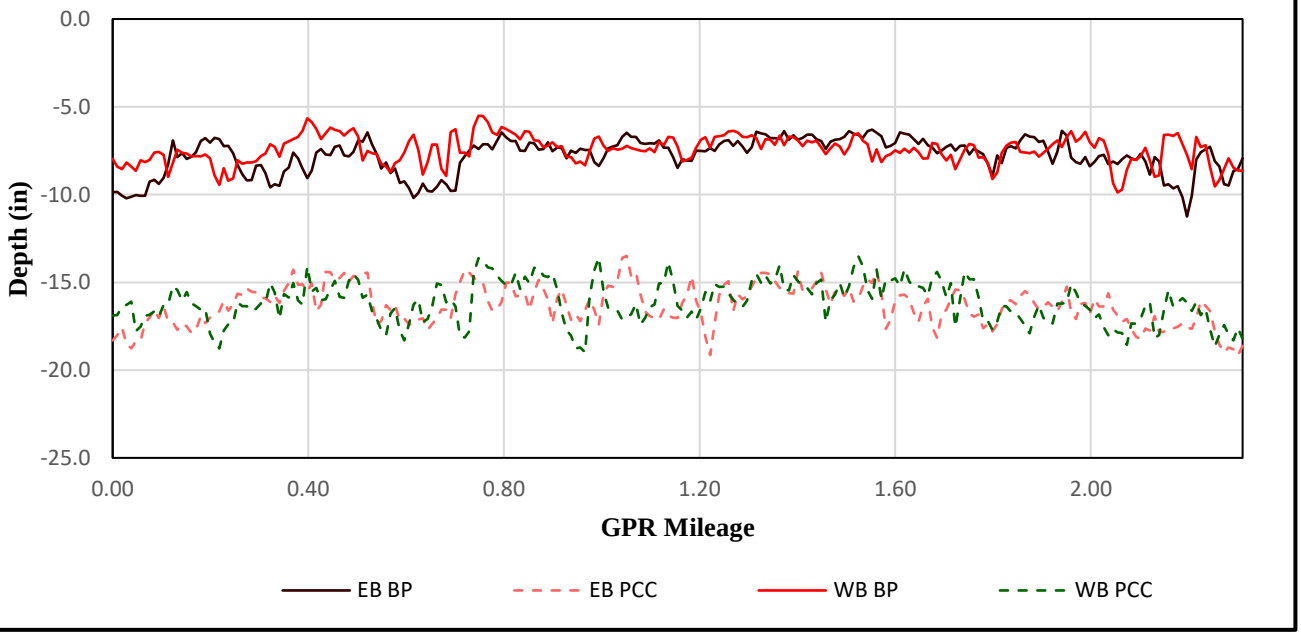
Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH 925	**Section/Grid:**	S07
From:	340th St	**To:**	N Adair St (Stuart)

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	7.8	13%	6.8	6.3	7.5	11%	6.6	5.5
PCC	8.5	13%	7.4	5.9	8.7	10%	7.7	6.6



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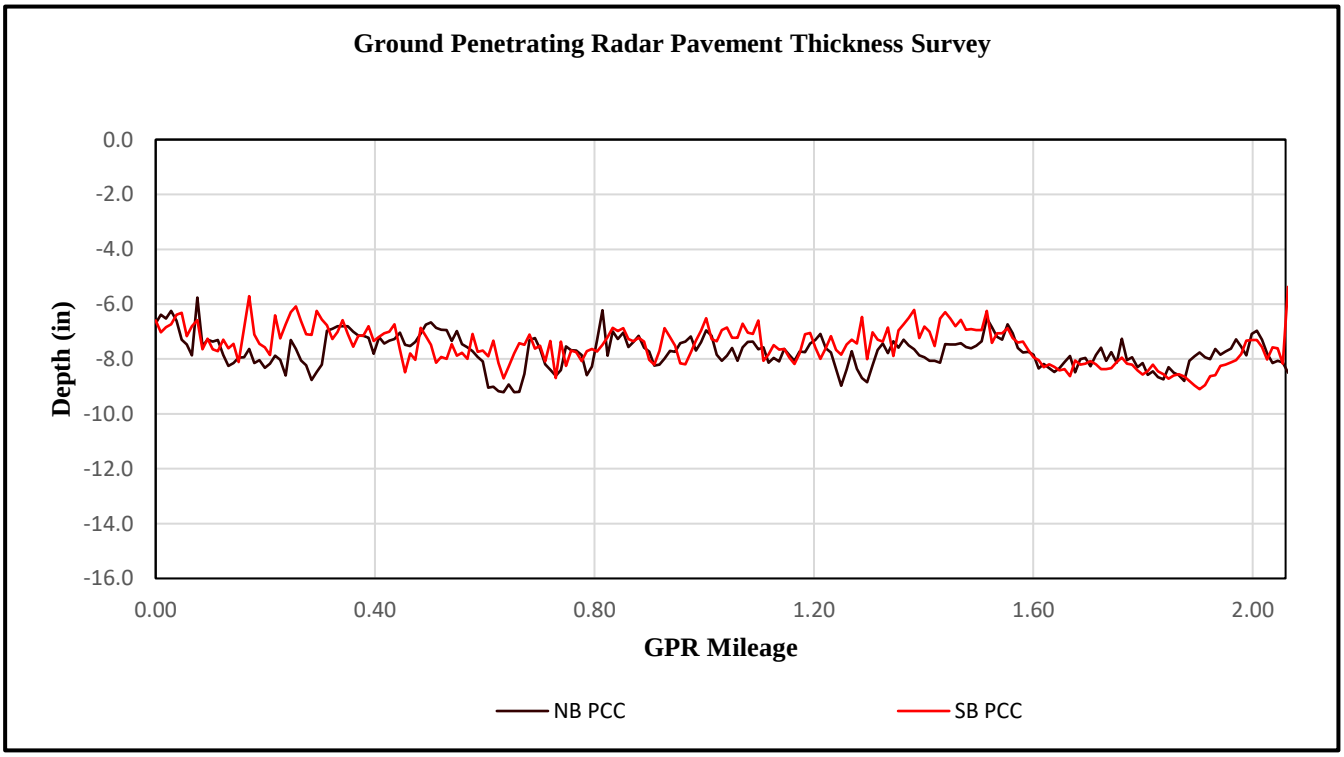
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH P28 (Wagon Rd)	**Section/Grid:**	S08A
From:	N 10th St	**To:**	2.06 mi N

SUMMARY STATISTICS

Units: inches

	NB				SB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
PCC	7.7	8%	7.2	5.8	7.5	9%	6.8	5.4



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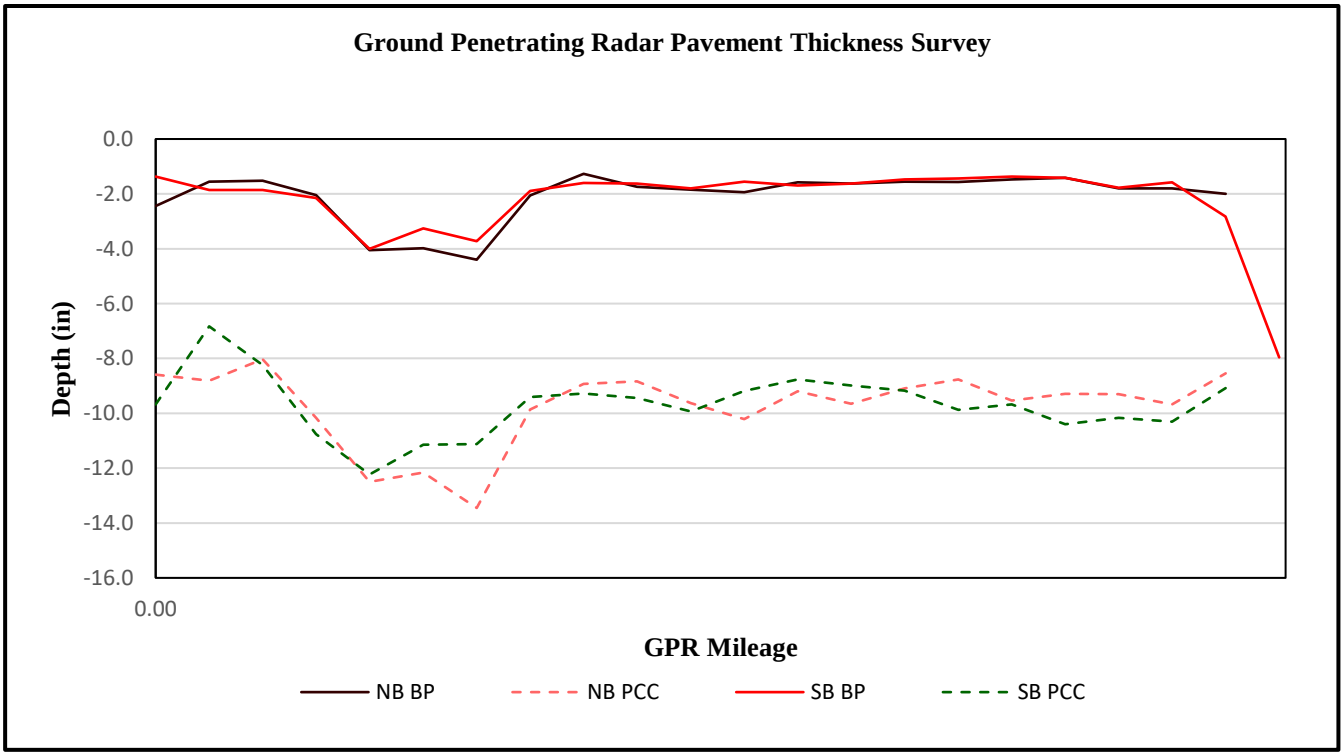
Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH P28 (Wagon Rd)	**Section/Grid:**	S08B
From:	0.42 mi N of Wagon Ln	**To:**	0.2 mi N

SUMMARY STATISTICS

Units: inches

	NB				SB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
BP	2.1	44%	1.5	1.3	2.3	65%	1.4	1.4
PCC	7.6	9%	7.1	6.2	7.7	12%	7.1	5.0



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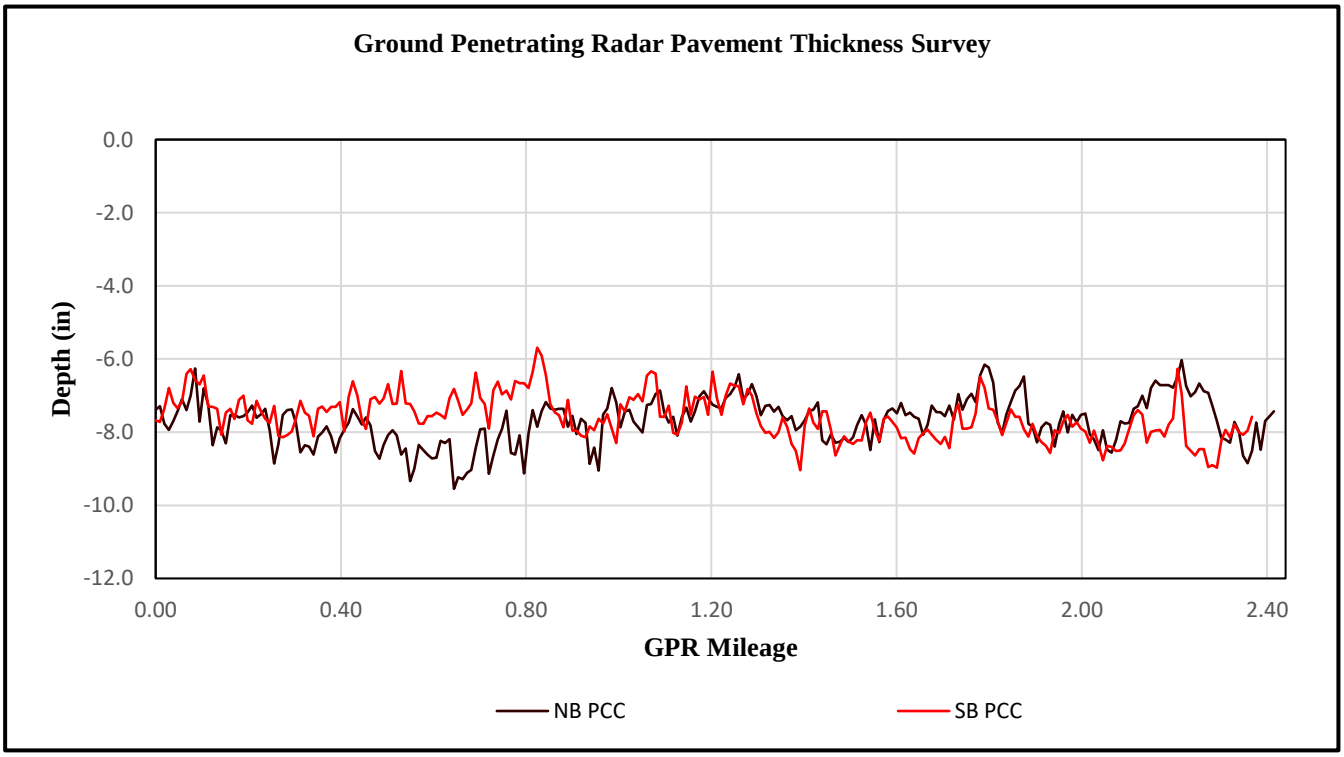
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH P28 (Wagon Rd)	**Section/Grid:**	S08C
From:	2.44 mi S	**To:**	Bridge

SUMMARY STATISTICS

Units: inches

	NB				SB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
PCC	7.7	8%	7.1	6.0	7.6	8%	7.0	5.7



American Engineering Testing, Inc.
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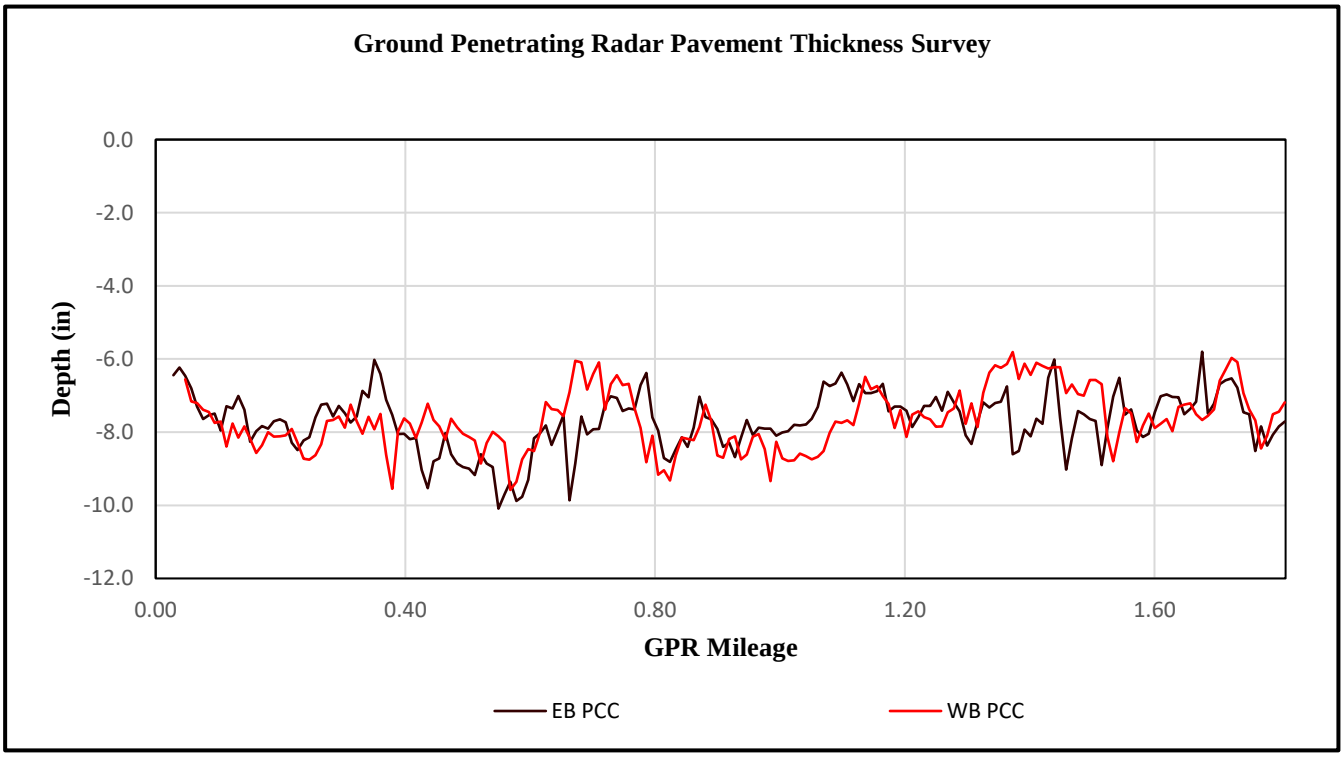
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH P28 (Wagon Rd)	**Section/Grid:**	S09
From:	Bridge	**To:**	280th Rd

SUMMARY STATISTICS

Units: inches

	EB				WB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
PCC	7.7	10%	6.9	5.8	7.7	11%	6.7	5.8



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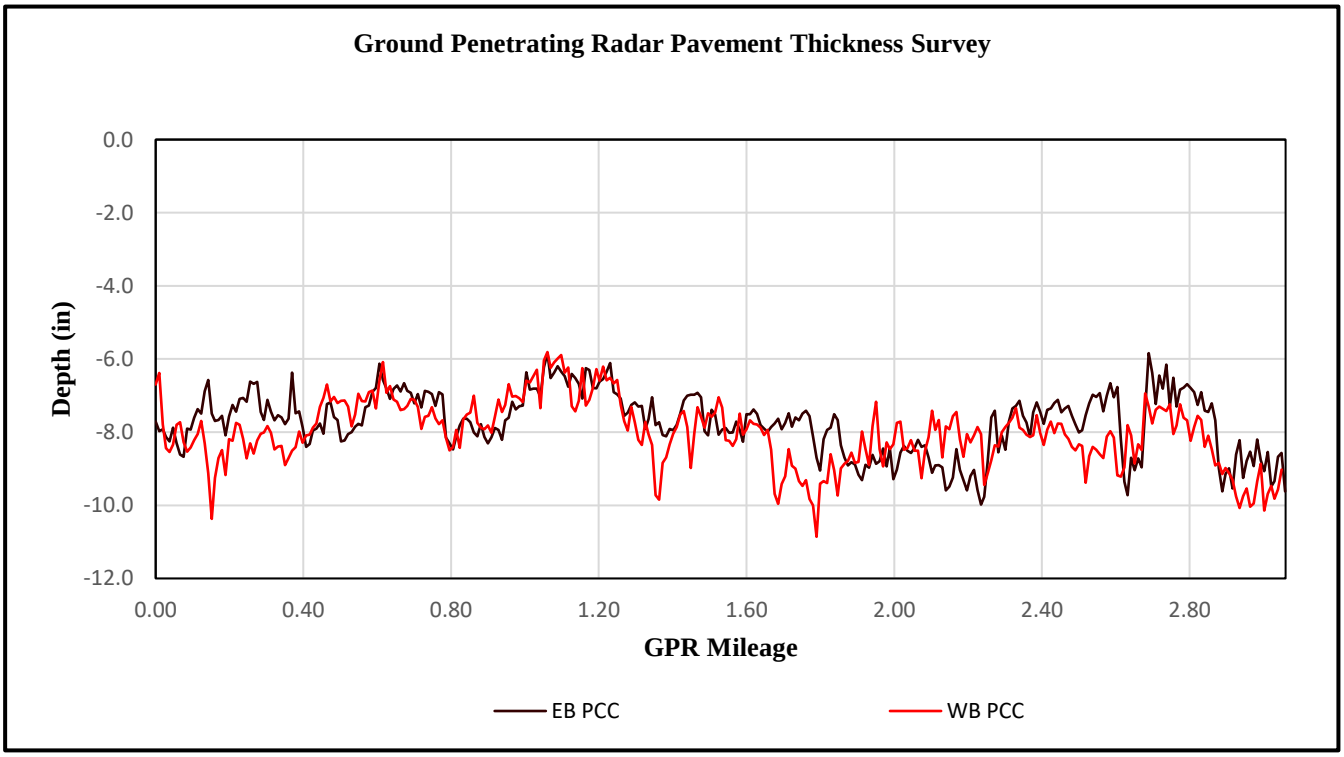
GENERAL INFORMATION: GROUND PENETRATING RADAR

Project:	Guthrie County Roads Investigation	**Date:**	7/13/23
AET Job No.:	P-0020125	**Test Date:**	5/1/23
Road:	CTH P28 (Wagon Rd)	**Section/Grid:**	S10
From:	280th Rd	**To:**	CTH F51 N Jct

SUMMARY STATISTICS

Units: inches

	NB				SB			
Layer	**Average**	**CV**	**15th**	**Min.**	**Average**	**CV**	**15th**	**Min.**
PCC	7.7	11%	6.9	5.8	8.0	11%	7.2	5.8



Appendix C

Falling Weight Deflectometer Field Exploration and Testing

Appendix C
Falling Weight Deflectometer Field Exploration and Testing
AET Project No. P-0020125

C.1 PAVEMENT TESTING

The pavement structural conditions at the site were evaluated nondestructively using Falling Weight Deflectometer (FWD). The description of the equipment precedes the Deflection Data and Analysis Results in this appendix.

C.2 EQUIPMENT DESCRIPTION

C.2.1 Dynatest 8000 FWD Test System

The FWD owned by AET is a Dynatest 8000 FWD Test System that consists of a Dynatest 8002 trailer and a third generation control and data acquisition unit developed in 2003, called the Dynatest Compact15, featuring fifteen (15) deflection channels. The new generation FWD, including a Compact15 System and a standard PC with the FwdWin Field Program constitutes the newest, most sophisticated Dynatest FWD Test System, which fulfills or exceeds all requirements to meet ASTM-4694 Standards. Figure C1 provides a view of this equipment.

Figure C1 Dynatest 8002 FWD Test System

The FWD imposes a dynamic impulse load onto the pavement surface through a load plate. Total pulse is an approximately half sine shape with a total duration typically between 25 to 30 ms. The FWD is capable of applying a variety of loads to the pavement ranging from 1,500 lbf (7 kN) to 27,000 ibf (120 kN) by dropping a variable weight mass from different heights to a standard, 11.8-inch (300-mm) diameter rigid plate.

The drop weights and the buffers are constructed so that the falling weight buffer subassembly may be quickly and conveniently changed between falling masses of 440 lbm (200 kg) for highways and 770 lbm (350 kg) for airports. With the 440 lbm (200 kg) package for highways three drop heights are used with the target load of 6,000 lbf (27 kN) at drop height 1, 9,000 lbf (40 kN) at drop height 2, and 12,000 lbf at drop height 3 (53 kN). The drop sequence consists of two seating drops from drop height 3 and 2 repeat measurements at drop height 1 and 1 measurement at drop height 2 for flexible pavements and 2 repeat measurements at drop height 2 and 1 measurement at drop height 3 for rigid pavements. The data from the seating drops is not stored.

The FWD is equipped with a load cell to measure the applied forces and nine geophones or deflectors to measure deflections up to 100 mils (2.5 mm). The load cell is capable of accurately measuring the force that is applied perpendicular to the loading plate with a resolution of 0.15 psi (1 kPa) or better. The force is expressed in terms of pressure, as a function of loading plate size.

Nine deflectors at the offsets listed in the following table in the Long Term Performance Program (LTPP) configuration are capable of measuring electronically discrete deflections per test, together with nine (9) separate deflection measuring channels for recording of the data. One (1) of the deflectors measures the deflection of the pavement surface through the center of the loading plate, while seven (7) deflectors are capable of being positioned behind the loading plate along the housing bar, up to a distance of 5 ft (2.5 m) from the center of the loading plate and one (1) being positioned in front of the loading plate along the bar.

Deflector	D9	D1	D2	D3	D4	D5	D6	D7	D8
Offset (in.)	-12	0	8	12	18	24	36	48	60

Field testing is performed in accordance with the standard ASTM procedures as described in ASTM D 4695-96, "Standard Guide for General Pavement Deflection Measurements" and the calibration of our equipment is verified each year at the Long Term Pavement Performance Calibration Center in Maplewood, MN.

C.2.2 Linear Distance and Spatial Reference System
Distance measuring instrument (DMI) is a trailer mounted two phase encoder system. When DMI is connected to the Compact15 it provides for automatic display and recording distance information in both English and metric units with a 1 foot (0.3 meters) resolution and four percent accuracy when calibrated using the provided procedure in the Field Program.

Spatial reference system is a Trimble ProXH Global Positioning System (GPS) that consists of fully integrated receiver, antenna and battery unit with Trimble's new H-Star™ technology to provide subfoot (30 cm) post-processed accuracy. The External Patch antenna is added to the ProXH receiver for the position of the loading plate. The External Patch antenna can be conveniently elevated with the optional baseball cap to prevent any signal blockage.

C.2.3 Air and Pavement Temperature Measuring System
A temperature monitoring probe, for automatic recording of air temperature, is an electronic (integrated circuit) sensing element in a stainless steel probe. The probe mounts on the FWD unit in a special holder with air circulation and connects to the Compact15. A non-contact Infra-Red (IR) Temperature Transmitter, for automatic recording of pavement surface temperature only, features an integrated IR-detector and digital electronics in a weather proof enclosure. The IR transmitter mounts on the FWD unit in a special holder with air circulation and connects to the Compact15. Both probe and IR transmitter have a resolution of 0.9 ºF (0.5 ºC) and accuracy within ± 1.8ºF (1 ºC) in the 0 to 158 ºF (-18 to +70ºC) range when calibrated using the provided procedure.

C.2.4 Camera Monitoring System
A battery operated independent DC-1908E multi-functional digital camera with a SD card is used for easy positioning of the loading plate or recording of the pavement surface condition at the testing locations.

C.3 SAMPLING METHODS

At the project level, the testing interval is set at 0.1 mi. (maximum) or 10 locations per uniform section in the Outside Wheel Path (OWP) = 2.5 ft ± 0.25 ft (0.76 m ± 0.08 m) for nominal 12 ft (3.7 m) wide lanes. Where a divided roadbed exists, surveys will be taken in both directions if the project will include improvements in both directions. If there is more than one lane in one direction the surveys will be taken in the outer driving lane versus the passing lane of the highway. FWD tests are performed at a constant lateral offset down the test section.

C.4 QUALITY CONTROL (QC) AND QUALITY ASSURANCE (QA)

In addition to the annual reference calibration, the relative calibration of the FWD deflection sensors is conducted monthly but not to exceed 6 weeks during the months in which the FWD unit is continually testing. The DMI is also calibrated monthly by driving the vehicle over a known distance to calculate the distance scale factor. The accuracy of the FWD air temperature and infra-red (IR) sensors are checked on a monthly basis or more frequently if the FWD operator observes "suspicious" temperature readings.

Some care in the placement of the load plate and sensors is taken by the survey crew, especially where the highway surface is rutted or cracked, to ensure that the load plate lays on a flat surface and that the load plate and all geophones lie on the same side of any visible cracks. Liberal use of comments placed

in the FWD data file at the time of data collection is required. Comments pertaining to proximity to reference markers, bridge abutments, patches, cracks, etc., are all important documentation for the individual evaluating the data.

Scheduled preventive maintenance ensures proper equipment operation and helps identify potential problems that can be corrected to avoid poor quality or missing data that results if the equipment malfunctions while on site. The routine and major maintenance procedures established by the LTPP are adopted and any maintenance has been done at the end of the day after the testing is complete and become part of the routine performed at the end of each test/travel day and on days when no other work is scheduled.

C.5 DATA ANALYSIS METHODS

C.5.1 Inputs

The two-way AADT and HCADT are required to calculate the ESALs. The state average truck percent and truck type distribution are used when HCADT is not provided. The as-built pavement information (layer type, thickness, and construction year) are required and if not provided, GPR and/or coring and boring is needed.

C.5.2 Adjustments

Temperature adjustment to the deflections measured on bituminous pavements is determined from the temperature predicted at the middle depth of the pavement using the LTPP BELLS3 model that uses the pavement surface temperature and previous day mean air temperature. The predicted middle depth temperature and the standard temperature of 80 degrees Fahrenheit are used to calculate the temperature adjustment factor for deflection data analysis. Seasonal adjustment developed by Mn/DOT is also used.

C.5.3 Methods

For bituminous pavements, the deflection data were analyzed using the American Association of State Highway and Transportation Officials' (AASHTO) method for determining the in-place (effective) subgrade and pavement strength, as well as allowable axle loads for a roadway as in the AASHTO Guide for Design of Pavement Structures, 1993 and Modulus 7.0 from Texas Department of Transportation.

C.6 TEST LIMITATIONS

C.6.1 Test Methods

The data derived through the testing program have been used to develop our opinions about the pavement conditions at your site. However, because no testing program can reveal totally what is in the subsurface, conditions between test locations and at other times, may differ from conditions described in this report. The testing we conducted identified pavement conditions only at those points where we measured pavement surface temperature, deflections, and observed pavement surface conditions. Depending on the sampling methods and sampling frequency, every location may not be tested, and some anomalies which are present in the pavement may not be noted on the testing results. If conditions encountered during construction differ from those indicated by our testing, it may be necessary to alter our conclusions and recommendations, or to modify construction procedures, and the cost of construction may be affected.

C.6.2 Test Standards

Pavement testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S01
Roadway: White Pole Rd
From: Frontier Rd
To: CTH N 72

															Effective Values		
															ISM	AREA	
Station	**Drop**	**Time**	**Air °F**	**Bit °F**	**Load**	**D1**	**D2**	**D3**	**D4**	**D4**	**D6**	**D7**	**D8**	**D9**			**Comments**
0.011	4	12:53	68.0	70.0	10067	7.59	6.04	5.59	5.00	4.54	3.70	2.94			1326	18	
0.102	4	12:55	68.0	71.0	10100	8.72	6.46	5.72	5.18	4.69	3.82	3.01			1158	17	
0.200	4	12:56	68.0	67.0	10045	6.57	5.68	5.20	4.68	4.22	3.55	2.97			1529	19	
0.306	4	12:57	68.0	78.0	10012	10.21	7.77	6.66	5.64	4.89	3.83	2.88			981	17	
0.406	4	12:58	68.0	72.0	9914	12.80	9.91	8.24	6.87	6.00	4.78	3.89			775	17	
0.494	4	12:59	68.0	71.0	10001	9.59	7.75	6.81	6.03	5.45	4.61	3.67			1043	18	
0.601	4	13:00	68.0	69.0	9990	6.94	5.85	5.43	5.05	4.72	4.12	3.42			1439	20	
0.700	4	13:01	68.0	70.0	10078	7.02	6.00	5.50	4.93	4.50	3.87	3.21			1436	19	
0.804	4	13:02	68.0	72.0	10122	6.44	5.23	4.68	4.22	3.84	3.21	2.55			1572	18	
0.908	4	13:04	68.0	68.0	10133	7.13	5.37	4.86	4.51	4.20	3.56	2.88			1421	18	
0.982	4	13:05	68.0	70.0	9903	9.27	7.03	5.60	4.25	3.57	2.73	2.13			1068	16	
1.020	4	13:06	68.0	70.0	10089	5.52	4.80	4.50	4.27	4.01	3.50	2.91			1828	20	
1.102	4	13:07	68.0	72.0	9925	10.39	9.26	8.12	6.47	5.39	3.77	2.68			955	18	
1.199	4	13:08	68.0	70.0	10001	9.55	7.90	7.03	6.11	5.33	4.27	3.43			1047	18	
1.301	4	13:10	68.0	69.0	9969	8.77	7.43	6.83	6.13	5.45	4.39	3.32			1137	19	
1.403	4	13:10	68.0	68.0	9947	5.54	4.94	4.69	4.47	4.22	3.71	3.16			1795	20	
1.501	4	13:11	68.0	74.0	10056	9.56	7.88	6.98	6.31	5.85	5.04	4.21			1052	19	
1.601	4	13:12	68.0	70.0	10012	7.40	6.56	6.14	5.80	5.46	4.82	4.12			1353	21	
1.709	4	13:13	68.0	72.0	9936	7.86	6.48	5.70	4.90	4.23	3.41	2.70			1264	18	
1.800	4	13:14	68.0	73.0	9925	12.76	9.86	8.58	7.37	6.42	5.10	3.87			778	17	
1.909	4	13:16	68.0	72.0	9848	11.67	9.16	7.72	6.19	4.98	3.47	2.55			844	16	
1.976	4	13:16	68.0	69.0	9979	6.24	5.19	4.79	4.41	4.07	3.48	2.89			1599	19	
2.011	4	13:17	68.0	71.0	10034	7.06	5.72	5.19	4.83	4.43	3.76	3.02			1421	19	
2.100	4	13:18	68.0	69.0	10034	6.16	5.39	5.07	4.73	4.41	3.80	3.20			1629	20	
2.210	4	13:19	68.0	73.0	10034	9.52	7.66	6.70	5.81	5.17	4.20	3.31			1054	18	
2.306	4	13:20	68.0	78.0	9903	6.11	5.07	4.67	4.28	3.93	3.37	2.77			1621	19	
2.396	4	13:21	68.0	72.0	9793	14.84	10.78	8.85	7.35	6.31	5.01	3.89			660	16	
2.505	4	13:22	68.0	77.0	10001	10.19	7.64	6.51	5.54	4.90	4.06	3.31			981	17	
2.602	4	13:23	68.0	77.0	9969	6.65	5.60	5.13	4.74	4.33	3.52	2.72			1499	19	
2.705	4	13:25	68.0	83.0	9936	9.33	6.35	5.31	4.43	3.82	3.11	2.46			1065	15	
2.805	4	13:26	68.0	74.0	9903	7.81	6.49	5.85	5.32	4.92	4.21	3.51			1268	19	
2.856	4	13:27	68.0	76.0	10001	7.35	5.81	5.20	4.72	4.32	3.69	3.07			1361	18	
2.886	4	13:28	68.0	75.0	9826	8.64	6.50	5.71	5.17	4.73	4.05	3.31			1137	17	
2.982	4	13:30	68.0	72.0	9859	11.29	9.82	9.07	8.38	7.69	6.52	5.29			873	20	
3.021	4	13:31	68.0	71.0	9749	9.71	8.00	7.18	6.24	5.41	4.31	3.41			1004	18	
3.099	4	13:32	68.0	72.0	9859	7.26	6.31	5.86	5.43	5.01	4.34	3.65			1358	20	
3.203	4	13:33	68.0	74.0	9826	8.88	6.76	5.98	5.35	4.85	4.07	3.30			1107	17	
3.297	4	13:34	68.0	72.0	9870	6.99	5.91	5.41	4.90	4.52	3.85	3.14			1412	19	
3.402	4	13:35	68.0	72.0	9870	10.79	8.11	7.22	6.48	5.80	4.76	3.81			915	17	
3.501	4	13:36	68.0	76.0	9673	17.01	8.90	6.95	5.78	5.02	4.09	3.17			569	14	
3.606	4	13:37	68.0	73.0	9947	10.74	8.65	7.69	6.84	6.23	5.37	4.51			926	18	
3.699	4	13:38	68.0	74.0	9969	6.58	5.65	5.18	4.79	4.41	3.85	3.18			1515	20	
3.802	4	13:39	68.0	72.0	9870	11.15	9.22	8.25	7.26	6.43	5.41	4.45			885	18	
3.901	4	13:40	68.0	73.0	9925	6.29	5.18	4.78	4.44	4.13	3.59	2.95			1578	19	
3.956	4	13:43	68.0	73.0	9903	6.51	5.27	4.75	4.33	3.97	3.38	2.80			1521	19	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S02
Roadway: White Pole Rd
From: CTH N72
To: Kelsey Rd

															Effective Values		
															ISM	AREA	
Station	**Drop**	**Time**	**Air °F**	**Bit °F**	**Load**	**D1**	**D2**	**D3**	**D4**	**D4**	**D6**	**D7**	**D8**	**D9**			**Comments**
3.996	4	13:44	68.0	72.0	10023	6.64	5.51	4.99	4.56	4.20	3.57	2.93			1509	19	
4.102	4	13:45	68.0	74.0	10067	6.91	6.11	5.75	5.43	5.11	4.48	3.78			1457	20	
4.201	4	13:46	68.0	72.0	9870	11.09	9.34	8.44	7.59	6.89	5.89	4.95			890	19	
4.305	4	13:47	68.0	74.0	10012	7.20	5.84	5.39	5.05	4.66	3.94	3.15			1391	19	
4.410	4	13:48	68.0	74.0	9859	9.78	8.07	7.38	6.61	5.98	5.05	4.12			1008	19	
4.499	4	13:49	68.0	74.0	9859	8.15	7.06	6.63	6.34	5.98	5.23	4.40			1210	20	
4.599	4	13:50	68.0	74.0	9947	5.94	5.44	5.24	5.02	4.73	4.20	3.54			1675	21	
4.700	4	13:51	68.0	74.0	9804	8.59	6.94	6.28	5.70	5.17	4.35	3.51			1141	18	
4.803	4	13:52	68.0	73.0	9837	6.86	6.20	5.94	5.69	5.41	4.61	3.85			1434	21	
4.821	4	13:55	68.0	72.0	9749	9.85	8.10	7.33	6.63	5.92	4.69	3.58			990	19	
4.900	4	13:56	68.0	79.0	9859	10.25	8.41	7.67	6.91	6.20	4.88	3.71			962	19	
4.997	4	13:57	68.0	74.0	9662	11.17	8.44	7.02	5.96	5.19	4.23	3.35			865	17	
5.102	4	13:58	68.0	74.0	9859	7.00	5.79	5.29	4.91	4.54	3.84	3.05			1408	19	
5.201	4	13:59	68.0	75.0	9859	8.40	6.85	6.21	5.67	5.24	4.47	3.67			1174	19	
5.302	4	14:00	68.0	74.0	9826	7.43	6.11	5.48	5.02	4.61	3.89	3.07			1322	19	
5.401	4	14:01	68.0	75.0	9815	9.00	6.77	5.85	5.13	4.63	3.89	3.11			1091	17	
5.494	4	14:02	68.0	75.0	9760	11.94	9.64	8.69	7.85	7.04	5.76	4.55			817	18	
5.598	4	14:04	68.0	75.0	9990	7.81	6.76	6.15	5.49	4.85	3.86	2.99			1279	19	
5.707	4	14:05	68.0	78.0	9793	7.24	5.78	5.11	4.56	4.12	3.40	2.72			1353	18	
5.800	4	14:06	68.0	73.0	9749	9.00	7.48	6.53	5.61	4.89	4.04	3.26			1083	18	
5.901	4	14:06	68.0	77.0	9925	6.39	5.48	5.10	4.74	4.35	3.68	2.97			1553	20	
6.006	4	14:07	68.0	74.0	9859	8.65	7.16	6.35	5.54	4.87	3.93	3.09			1140	18	
6.099	4	14:08	68.0	74.0	9749	9.44	8.20	7.38	6.63	6.06	5.21	4.31			1033	19	
6.196	4	14:10	68.0	75.0	9925	8.94	7.19	6.42	5.78	5.27	4.50	3.70			1110	18	
6.300	4	14:11	68.0	75.0	9804	7.83	6.65	6.17	5.72	5.28	4.48	3.61			1252	20	
6.394	4	14:12	68.0	74.0	9717	7.91	6.78	6.22	5.69	5.15	4.18	3.26			1228	19	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S03A
Roadway: White Pole Rd
From: E Grant Rd
To: 0.87 mi E

															Effective Values		
															ISM	AREA	
Station	**Drop**	**Time**	**Air °F**	**Bit °F**	**Load**	**D1**	**D2**	**D3**	**D4**	**D4**	**D6**	**D7**	**D8**	**D9**			**Comments**
6.463	4	14:13	68.0	74.0	9749	7.05	5.81	5.33	5.06	4.74	4.14	3.43			1383	19	
0.019	4	14:19	68.0	79.0	9870	7.73	6.34	5.73	5.35	4.98	4.26	3.48			1277	19	
0.103	4	14:20	68.0	83.0	10089	6.53	5.57	5.30	5.11	4.81	4.13	3.43			1545	20	
0.200	4	14:21	68.0	79.0	9925	6.28	4.95	4.42	4.03	3.67	3.01	2.31			1580	18	
0.295	4	14:22	68.0	76.0	10111	6.94	5.89	5.47	5.19	4.91	4.36	3.65			1457	20	
0.400	4	14:23	68.0	75.0	10023	7.66	6.69	6.26	5.93	5.57	4.87	4.10			1308	20	
0.499	4	14:24	68.0	74.0	9990	6.84	5.96	5.65	5.39	5.09	4.52	3.81			1461	21	
0.601	4	14:25	68.0	76.0	9958	6.88	5.98	5.36	4.89	4.54	3.91	3.24			1447	20	
0.698	4	14:26	68.0	78.0	9947	8.04	6.67	6.02	5.52	5.13	4.45	3.69			1237	19	
0.804	4	14:27	68.0	78.0	9914	8.86	7.81	7.43	7.07	6.58	5.71	4.72			1119	21	

American Engineering Testing, Inc.
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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S03B
Roadway: White Pole Rd
From: 0.87 mi E of E Grant Rd
To: 0.37 mi E

															Effective Values		
															ISM	AREA	
Station	**Drop**	**Time**	**Air °F**	**Bit °F**	**Load**	**D1**	**D2**	**D3**	**D4**	**D4**	**D6**	**D7**	**D8**	**D9**			**Comments**
0.903	4	14:28	68.0	85.0	9815	3.63	3.27	3.21	3.12	2.96	2.56	2.08			2704	21	
1.000	4	14:29	68.0	87.0	9848	4.90	4.34	4.21	4.08	3.85	3.42	2.89			2010	21	
1.095	4	14:30	68.0	88.0	10001	4.27	3.75	3.59	3.41	3.20	2.78	2.32			2342	21	
1.200	4	14:31	68.0	77.0	9947	4.25	3.88	3.80	3.69	3.49	3.11	2.61			2340	22	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S03C
Roadway: White Pole Rd
From: 0.45 mi W
To: STH 25

															Effective Values ISM	Effective Values AREA	
Station	**Drop**	**Time**	**Air °F**	**Bit °F**	**Load**	**D1**	**D2**	**D3**	**D4**	**D4**	**D6**	**D7**	**D8**	**D9**			**Comments**
1.298	4	14:32	68.0	83.0	9760	9.37	7.81	7.15	6.48	5.85	4.82	3.83			1042	19	
1.401	4	14:33	68.0	79.0	9903	5.42	4.48	4.16	3.89	3.60	3.11	2.57			1827	19	
1.508	4	14:35	68.0	75.0	9947	6.70	5.69	5.43	5.10	4.71	4.13	3.50			1485	20	
1.597	4	14:38	68.0	78.0	9870	7.62	6.07	5.34	4.60	3.92	3.13	2.48			1295	18	
1.687	4	14:39	68.0	80.0	9717	18.49	9.43	7.89	6.75	5.93	4.84	3.86			526	13	
1.687	4	14:39	68.0	79.0	9662	15.50	9.36	7.77	6.62	5.80	4.72	3.74			623	14	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S04
Roadway: White Pole Rd
From: STH 25
To: CTH P20

Station	Drop	Time	Air °F	Bit °F	Load	D1	D2	D3	D4	D4	D6	D7	D8	D9	Effective Values ISM	Effective Values AREA	Comments
0.027	4	15:02	68.0	78.0	10034	6.26	4.37	3.77	3.58	3.42	3.04	2.56			1603	17	
0.104	4	15:03	68.0	80.0	9760	11.34	8.02	6.67	6.46	6.18	5.54	4.67			861	17	
0.104	4	15:04	68.0	80.0	9706	10.72	7.87	6.66	6.44	6.16	5.52	4.65			905	17	
0.204	4	15:05	68.0	78.0	9804	10.41	7.70	6.70	6.30	5.86	5.00	4.09			942	17	
0.306	4	15:06	68.0	81.0	9629	15.15	11.27	8.84	7.28	6.20	4.82	3.64			636	16	
0.399	4	15:07	68.0	76.0	9673	12.44	9.96	7.86	6.89	6.08	5.23	4.27			778	17	
0.502	4	15:08	68.0	79.0	9684	13.48	9.12	7.26	6.61	5.98	5.03	4.07			718	16	
0.602	4	15:09	68.0	77.0	9563	14.43	9.19	7.74	7.14	6.67	5.88	4.98			663	16	
0.703	4	15:10	68.0	78.0	9804	14.23	9.64	8.19	7.20	6.40	5.32	4.29			689	16	
0.799	4	15:11	68.0	77.0	9596	16.19	10.87	8.89	7.19	6.07	4.71	3.52			593	15	
0.906	4	15:12	68.0	77.0	9771	12.04	9.71	8.52	7.56	6.72	5.64	4.30			812	18	
0.989	4	15:13	68.0	85.0	9782	9.90	6.72	6.09	5.80	5.41	4.61	3.75			988	17	
1.019	4	15:14	68.0	82.0	9662	18.05	16.10	14.35	10.82	9.22	6.63	4.50			535	17	
1.109	4	15:15	68.0	77.0	9815	12.33	7.25	6.35	5.94	5.50	4.72	3.89			796	15	
1.205	4	15:16	68.0	77.0	9771	13.21	10.28	9.36	8.75	7.98	6.67	5.37			740	18	
1.303	4	15:17	68.0	79.0	9695	9.99	7.21	6.88	6.74	6.33	5.50	4.55			970	18	
1.401	4	15:18	68.0	77.0	9662	9.01	7.03	6.68	6.48	6.11	5.56	4.75			1072	19	
1.402	4	15:18	68.0	77.0	9607	8.46	6.96	6.58	6.38	6.07	5.41	4.65			1136	20	
1.500	4	15:19	68.0	78.0	9673	8.15	6.28	6.00	5.94	5.69	5.14	4.40			1187	19	
1.606	4	15:20	68.0	76.0	9629	9.46	6.89	6.00	5.59	5.31	4.65	3.91			1018	17	
1.699	4	15:21	68.0	78.0	9815	17.05	12.09	10.10	8.67	7.62	6.32	5.05			576	16	
1.802	4	15:22	68.0	82.0	9552	14.87	11.31	9.55	8.54	7.75	6.39	5.00			642	17	
1.896	4	15:23	68.0	74.0	9574	13.09	9.80	7.98	7.70	6.88	5.78	4.61			731	17	
1.992	4	15:24	68.0	77.0	9738	13.36	9.18	8.24	7.54	6.82	5.65	4.55			729	16	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S05
Roadway: White Pole Rd
From: CTH P20
To: Sheridan St

Station	Drop	Time	Air °F	Bit °F	Load	D1	D2	D3	D4	D4	D6	D7	D8	D9	Effective Values ISM	Effective Values AREA	Comments
2.100	4	15:26	68.0	77.0	10001	12.27	8.80	7.95	7.57	7.07	6.11	5.07			815	17	
2.200	4	15:27	68.0	81.0	9859	11.03	5.89	5.05	4.81	4.50	3.86	3.19			894	16	
2.299	4	15:28	68.0	79.0	9837	10.78	7.14	6.20	5.75	5.26	4.53	3.70			913	16	
2.408	4	15:29	68.0	84.0	9870	8.34	6.42	5.54	4.76	4.17	3.41	2.78			1183	17	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S06
Roadway: White Pole Rd
From: Adair St (Menlo)
To: 340th St

															Effective Values		
															ISM	AREA	
Station	**Drop**	**Time**	**Air °F**	**Bit °F**	**Load**	**D1**	**D2**	**D3**	**D4**	**D4**	**D6**	**D7**	**D8**	**D9**			**Comments**
0.010	4	15:34	68.0	81.0	9837	13.40	8.55	6.91	5.81	5.17	4.35	3.58			734	16	
0.102	4	15:36	68.0	79.0	9443	27.42	20.81	16.84	13.35	11.36	9.37	7.56			344	17	
0.198	4	15:37	68.0	80.0	9870	15.72	9.77	8.28	7.49	6.78	5.52	4.27			628	16	
0.299	4	15:38	68.0	78.0	9815	9.45	8.09	7.44	7.15	6.62	5.43	4.28			1039	20	
0.405	4	15:39	68.0	62.0	9706	10.29	7.97	6.98	6.24	5.66	4.80	3.83			943	18	
0.504	4	15:40	68.0	77.0	9749	9.54	8.15	7.27	6.80	6.31	5.21	4.07			1022	19	
0.608	4	15:41	68.0	76.0	9497	14.52	11.82	9.64	8.41	7.40	5.67	4.11			654	17	
0.702	4	15:42	68.0	74.0	9738	13.25	9.43	8.18	7.76	7.04	6.41	4.97			735	17	
0.806	4	15:43	68.0	75.0	9454	10.33	8.10	7.10	6.42	5.82	4.80	3.79			915	18	
0.898	4	15:44	68.0	75.0	9804	12.66	8.76	7.68	7.37	6.99	6.05	4.95			774	17	
0.997	4	15:45	68.0	75.0	9706	14.91	10.85	9.02	8.21	7.42	6.19	5.13			651	16	
1.103	4	15:46	68.0	74.0	9717	14.01	9.53	8.26	7.70	7.06	5.89	4.78			694	16	
1.194	4	15:46	68.0	78.0	9782	12.94	8.91	7.48	6.94	6.38	5.32	4.15			756	16	
1.302	4	15:47	68.0	77.0	9662	13.78	10.43	9.32	8.41	7.51	5.89	4.37			701	17	
1.400	4	15:49	68.0	78.0	9804	14.00	9.93	8.48	7.91	7.42	6.51	5.49			700	17	
1.505	4	15:50	68.0	76.0	9903	10.63	7.54	6.70	6.37	5.99	5.02	4.01			932	17	
1.604	4	15:51	68.0	79.0	9837	15.50	11.72	10.26	8.98	7.77	5.76	4.04			635	17	
1.694	4	15:52	68.0	77.0	9640	8.70	7.14	6.26	5.58	5.05	4.26	3.48			1108	18	
1.805	4	15:53	68.0	85.0	9717	12.23	8.24	6.97	6.24	5.72	5.08	3.96			795	16	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S07
Roadway: White Pole Rd
From: 340th St
To: N Adair St (Stuart)

															Effective Values ISM	AREA	
Station	**Drop**	**Time**	**Air °F**	**Bit °F**	**Load**	**D1**	**D2**	**D3**	**D4**	**D4**	**D6**	**D7**	**D8**	**D9**			**Comments**
1.894	4	15:55	68.0	79.0	9574	12.02	8.33	7.01	6.39	5.80	4.83	3.83			797	16	
1.998	4	15:56	68.0	75.0	9771	13.65	9.85	8.37	7.67	7.06	5.86	4.56			716	17	
2.101	4	15:57	68.0	74.0	9585	18.77	12.48	9.46	7.30	6.09	5.03	4.10			511	15	
2.211	4	15:58	68.0	74.0	9738	12.03	9.27	7.63	6.48	5.70	4.72	3.81			809	17	
2.307	4	15:59	68.0	74.0	9662	15.23	11.09	9.12	7.63	6.64	5.39	4.31			634	16	
2.410	4	16:00	68.0	77.0	9925	9.87	7.72	6.97	6.59	6.15	5.22	4.14			1006	18	
2.503	4	16:01	68.0	74.0	9848	14.85	12.19	10.81	9.95	9.22	8.08	6.74			663	19	
2.595	4	16:04	68.0	74.0	9684	10.41	7.53	6.63	6.27	5.77	4.97	4.04			930	17	
2.714	4	16:05	68.0	75.0	9749	10.77	7.90	7.27	7.11	6.71	5.81	4.80			905	18	
2.806	4	16:06	68.0	73.0	9837	11.95	8.69	8.05	7.79	7.20	6.18	5.04			823	18	
2.905	4	16:07	68.0	75.0	9728	14.95	11.02	9.40	8.30	7.48	6.32	4.83			651	17	
3.004	4	16:08	68.0	74.0	9651	12.81	10.09	8.91	8.44	7.92	6.91	5.76			753	18	
3.100	4	16:09	68.0	75.0	9793	12.33	8.91	7.99	7.68	7.29	6.40	5.35			794	17	
3.200	4	16:10	68.0	76.0	9684	13.86	10.31	9.43	9.28	8.58	6.80	5.43			699	18	
3.300	4	16:10	68.0	75.0	9673	15.83	11.69	9.89	9.10	8.55	7.44	6.04			611	17	
3.403	4	16:12	68.0	76.0	9574	14.83	11.37	9.68	8.86	8.23	7.15	5.93			646	17	
3.498	4	16:13	68.0	77.0	9618	13.81	9.95	8.40	7.93	7.22	6.17	5.11			696	17	
3.606	4	16:14	68.0	75.0	9519	16.72	12.81	10.26	8.38	7.20	6.01	4.73			569	16	
3.712	4	16:15	68.0	75.0	9717	13.49	9.15	8.00	7.65	7.22	6.25	5.16			720	16	
3.800	4	16:15	68.0	76.0	9508	11.53	8.15	6.90	6.51	6.07	5.15	4.19			825	17	
3.897	4	16:16	68.0	73.0	9771	9.35	7.07	6.41	6.19	5.86	5.19	4.42			1045	18	
3.897	4	16:17	68.0	72.0	9629	9.23	7.01	6.37	6.15	5.83	5.15	4.38			1043	18	
4.008	4	16:18	68.0	82.0	9695	8.65	6.78	6.27	6.12	5.81	5.16	4.35			1121	19	
4.100	4	16:19	68.0	79.0	9958	7.66	5.65	5.34	5.22	4.90	4.30	3.59			1300	18	
4.167	4	16:20	68.0	79.0	9497	10.74	7.79	6.52	5.81	5.37	4.67	3.85			884	16	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S08A
Roadway: Wagon Rd
From: N 10th St
To: 2.06 mi N

Station	Drop	Time	Air °F	Bit °F	Load	D1	D2	D3	D4	D4	D6	D7	D8	D9	Effective Values ISM	Effective Values AREA	Comments
0.018	1,2,3,4 Averaged	16:26	68	73.6	6244	7.28	7.08	6.78	6.41	5.83	4.78	3.61	2.58		858	22	
0.096	1,2,3,4 Averaged	16:27	68	78.8	6411	5.6	5.42	5.2	4.83	4.36	3.49	2.63	1.96		1145	22	
0.199	1,2,3,4 Averaged	16:36	68	74.9	6458	5.83	5.69	5.43	5.1	4.64	3.81	2.95	2.26		1108	22	
0.306	1,2,3,4 Averaged	16:37	68	74.8	6463	6.31	5.94	5.64	5.25	4.71	3.77	2.84	2.13		1024	21	
0.403	1,2,3,4 Averaged	16:38	68	73.1	6534	5.79	5.57	5.31	4.97	4.52	3.68	2.83	2.17		1128	22	
0.511	1,2,3,4 Averaged	16:39	68	72.2	6466	7.36	6.91	6.56	6.08	5.42	4.3	3.2	2.38		879	21	
0.602	1,2,3,4 Averaged	16:40	68	73.2	6490	6.5	5.94	5.64	5.19	4.65	3.72	2.81	2.14		998	21	
0.713	1,2,3,4 Averaged	16:41	68	78.8	6256	6.17	5.86	5.59	5.21	4.76	3.89	3	2.31		1014	22	
0.799	1,2,3,4 Averaged	16:42	68	73.9	6217	6.12	5.93	5.68	5.38	4.94	4.15	3.3	2.59		1016	22	
0.898	1,2,3,4 Averaged	16:43	68	72	6236	4.87	4.69	4.41	4.05	3.67	2.96	2.26	1.75		1280	21	
1.039	1,2,3,4 Averaged	16:45	68	74.6	6244	5.5	5.24	4.99	4.65	4.23	3.46	2.66	2.03		1135	22	
1.106	1,2,3,4 Averaged	16:46	68	74.4	6379	5.73	5.55	5.3	5	4.54	3.73	2.81	2		1113	22	
1.203	1,2,3,4 Averaged	16:47	68	74.4	6447	5.01	4.65	4.42	4.08	3.64	2.88	2.16	1.62		1287	21	
1.302	1,2,3,4 Averaged	16:48	68	72.5	6514	4.52	4.3	4.13	3.92	3.6	3.03	2.44	1.95		1441	22	
1.397	1,2,3,4 Averaged	16:49	68	71.4	6339	5.25	5.04	4.8	4.52	4.11	3.44	2.76	2.22		1207	22	
1.496	1,2,3,4 Averaged	16:50	68	71.3	6315	4.81	4.47	4.2	3.85	3.4	2.65	1.94	1.45		1313	21	
1.607	1,2,3,4 Averaged	16:51	68	77.3	6344	6.58	6.14	5.8	5.36	4.81	3.82	2.88	2.15		964	21	
1.695	1,2,3,4 Averaged	16:53	68	72.7	6161	5.57	5.31	5.1	4.8	4.38	3.62	2.8	2.17		1106	22	
1.803	1,2,3,4 Averaged	16:54	68	73.5	6148	5.57	5.41	5.22	4.96	4.55	3.8	2.97	2.26		1104	22	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S08C
Roadway: Wagon Rd
From: 2.44 mi S
To: Bridge

Station	Drop	Time	Air °F	Bit °F	Load	D1	D2	D3	D4	D4	D6	D7	D8	D9	Effective Values ISM	Effective Values AREA	Comments
2.296	1,2,3,4 Averaged	16:57	68	73.54	6280	6.5	5.82	5.44	4.91	4.31	3.3	2.41	1.82		964	20	
2.401	1,2,3,4 Averaged	16:58	68	71.02	6241	5.32	4.8	4.72	4.43	3.99	3.19	2.43	1.86		1167	21	
2.401	1,2,3,4 Averaged	16:59	68	71.24	6129	5.33	4.89	4.69	4.34	3.91	3.15	2.42	1.85		1159	21	
2.495	1,2,3,4 Averaged	17:00	68	70.75	6323	5.89	5.61	5.29	4.93	4.43	3.53	2.62	1.94		1068	21	
2.6	1,2,3,4 Averaged	17:01	68	70.3	6228	4.47	4.18	3.95	3.65	3.26	2.63	2.03	1.58		1402	21	
2.7	1,2,3,4 Averaged	17:02	68	74.84	6331	5.81	5.82	5.66	5.56	4.72	3.54	2.52	1.78		1083	23	
2.798	1,2,3,4 Averaged	17:03	68	73	6331	5.22	4.94	4.72	4.41	3.99	3.25	2.5	1.92		1225	21	
2.898	1,2,3,4 Averaged	17:04	68	72.57	6296	4.74	4.52	4.3	3.97	3.59	2.91	2.28	1.8		1322	21	
3.002	1,2,3,4 Averaged	17:05	68	73.83	6133	4.6	4.38	4.2	3.96	3.59	2.95	2.35	1.85		1353	22	
3.101	1,2,3,4 Averaged	17:06	68	71.87	6331	6.08	5.89	5.59	5.24	4.76	3.9	3.04	2.34		1047	22	
3.203	1,2,3,4 Averaged	17:07	68	68.65	6384	5.52	5.28	5.03	4.72	4.26	3.48	2.68	2.02		1166	22	
3.299	1,2,3,4 Averaged	17:08	68	70.66	6225	5.55	5.31	5.08	4.75	4.28	3.47	2.67	2.06		1124	22	
3.401	1,2,3,4 Averaged	17:09	68	70.2	6217	5.19	4.94	4.75	4.46	4.07	3.36	2.63	2.05		1206	22	
3.512	1,2,3,4 Averaged	17:10	68	69.37	6315	5.46	5.18	4.88	4.51	4.07	3.26	2.54	1.96		1156	21	
3.596	1,2,3,4 Averaged	17:12	68	70.65	6201	5	4.84	4.62	4.35	3.96	3.29	2.57	1.96		1228	22	
3.699	1,2,3,4 Averaged	17:13	68	68.22	6276	5.64	5.39	5.11	4.78	4.33	3.57	2.79	2.13		1115	22	
3.808	1,2,3,4 Averaged	17:13	68	69.19	6514	4.96	4.75	4.59	4.34	3.97	3.31	2.58	2		1313	22	
3.901	1,2,3,4 Averaged	17:14	68	70.34	6434	5.79	5.32	5.02	4.59	4.11	3.24	2.44	1.81		1116	21	
3.996	1,2,3,4 Averaged	17:15	68	71.06	6423	4.5	4.28	4.12	3.92	3.59	3.04	2.43	1.91		1429	22	
4.089	1,2,3,4 Averaged	17:17	68	74.93	6209	5.76	5.48	5.24	4.88	4.42	3.57	2.73	2.07		1070	22	
4.198	1,2,3,4 Averaged	17:18	68	73.17	6113	5.27	5.08	4.87	4.61	4.23	3.52	2.76	2.1		1149	22	
4.305	1,2,3,4 Averaged	17:19	68	74.12	6106	4.54	4.41	4.19	3.96	3.63	3.02	2.38	1.82		1331	22	
4.399	1,2,3,4 Averaged	17:19	68	73.17	6156	4.45	4.17	3.92	3.56	3.14	2.41	1.79	1.33		1369	21	
4.507	1,2,3,4 Averaged	17:20	68	66.31	5820	5.67	5	4.59	4.14	3.62	2.78	2.05	1.53		1020	20	
4.597	1,2,3,4 Averaged	17:21	68	68.85	6249	3.84	3.72	3.55	3.33	3.02	2.48	1.95	1.54		1594	22	
4.671	1,2,3,4 Averaged	17:22	68	74.23	6415	5.48	5.19	4.96	4.63	4.17	3.4	2.65	2.03		1169	21	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S09
Roadway: Wagon Rd
From: Bridge
To: 280th Rd

Station	Drop	Time	Air °F	Bit °F	Load	D1	D2	D3	D4	D4	D6	D7	D8	D9	Effective Values ISM	Effective Values AREA	Comments
4.799	1,2,3,4 Averaged	17:24	68	70.68	6471	4.7	4.39	4.15	3.86	3.48	2.87	2.26	1.81		1369.44	21.121	
4.898	1,2,3,4 Averaged	17:26	68	70.43	6299	4.38	4.07	3.83	3.54	3.16	2.52	1.94	1.54		1438.18	20.863	
4.995	1,2,3,4 Averaged	17:27	68	74.25	6280	5.07	4.83	4.6	4.3	3.91	3.22	2.57	2.07		1247.01	21.587	
5.193	1,2,3,4 Averaged	17:28	68	73.89	6355	6.01	5.63	5.33	4.94	4.44	3.62	2.8	2.14		1065.12	21.073	
5.195	1,2,3,4 Averaged	17:29	68	74.16	6193	4.23	4.11	3.94	3.72	3.43	2.87	2.3	1.8		1471.49	22.032	
5.297	1,2,3,4 Averaged	17:30	68	74.43	6268	3.49	3.39	3.25	3.11	2.89	2.51	2.07	1.72		1807.82	22.187	
5.397	1,2,3,4 Averaged	17:31	68	75.24	6336	4.68	4.5	4.32	4.06	3.68	3.04	2.38	1.88		1343.84	21.759	
5.491	1,2,3,4 Averaged	17:33	68	74.77	6360	4.37	3.99	3.77	3.45	3.05	2.37	1.75	1.3		1437.87	20.523	
5.603	1,2,3,4 Averaged	17:34	68	74.19	6307	3.96	3.67	3.55	3.3	2.95	2.38	1.84	1.42		1580.13	21.263	
5.694	1,2,3,4 Averaged	17:35	68	74.75	6264	4.09	3.85	3.67	3.43	3.1	2.58	2.06	1.69		1522.05	21.174	
5.8	1,2,3,4 Averaged	17:36	68	70.61	6339	5.77	5.51	5.26	4.92	4.44	3.61	2.79	2.12		1100.52	21.559	
5.901	1,2,3,4 Averaged	17:37	68	67.86	6204	5.99	5.49	5.16	4.72	4.2	3.28	2.44	1.76		1020.01	20.64	
6	1,2,3,4 Averaged	17:38	68	70.63	6268	5.96	5.64	5.34	4.94	4.39	3.49	2.61	1.98		1050.84	21.229	
6.102	1,2,3,4 Averaged	17:39	68	73.35	6252	4.31	4.13	3.99	3.73	3.43	2.86	2.24	1.74		1456.39	21.932	
6.198	1,2,3,4 Averaged	17:41	68	70.57	6384	4.41	4.25	4.09	3.87	3.56	2.91	2.24	1.73		1441.6	21.961	
6.297	1,2,3,4 Averaged	17:42	68	70.38	6503	4.25	4.03	3.86	3.6	3.25	2.62	2.02	1.55		1523.73	21.548	
6.404	1,2,3,4 Averaged	17:43	68	68.25	6296	5.47	5.22	5	4.65	4.23	3.49	2.75	2.2		1163.2	21.621	
6.492	1,2,3,4 Averaged	17:44	68	67.87	6379	4.19	3.97	3.79	3.6	3.26	2.7	2.15	1.71		1522.61	21.481	
6.592	1,2,3,4 Averaged	17:45	68	67.96	6426	4.86	4.53	4.35	4.07	3.7	3.07	2.44	1.96		1331.8	21.427	

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AET Project No. P-0020125
County: Guthrie, IA
Test Date: May 1, 2023
Section: S10
Roadway: Wagon Rd
From: 280th Rd
To: CTH F51 N Jct

Station	Drop	Time	Air °F	Bit °F	Load	D1	D2	D3	D4	D4	D6	D7	D8	D9	Effective Values ISM	Effective Values AREA	Comments
6.7	1,2,3,4 Averaged	17:46	68	66.61	6276	4.12	3.89	3.69	3.41	3.07	2.45	1.89	1.48		1511	21	
6.799	1,2,3,4 Averaged	17:48	68	66.24	6252	4.45	4.2	3.96	3.65	3.3	2.66	2.09	1.64		1391	21	
6.904	1,2,3,4 Averaged	17:49	68	65.93	6482	4.96	4.69	4.49	4.19	3.79	3.12	2.43	1.89		1304	22	
6.997	1,2,3,4 Averaged	17:50	68	69.73	6241	5.52	5.22	4.92	4.56	4.1	3.31	2.59	2.04		1134	21	
7.096	1,2,3,4 Averaged	17:51	68	66.22	6431	5.12	4.87	4.57	4.21	3.76	3	2.31	1.8		1251	21	
7.204	1,2,3,4 Averaged	17:52	68	67.77	6395	4.89	4.57	4.37	4.09	3.71	3.04	2.37	1.88		1306	21	
7.302	1,2,3,4 Averaged	17:53	68	66.13	6355	5.28	4.92	4.68	4.33	3.86	3.07	2.38	1.87		1213	21	
7.403	1,2,3,4 Averaged	17:54	68	66.58	6283	5.61	5.32	5	4.67	4.16	3.35	2.54	1.98		1116	21	
7.501	1,2,3,4 Averaged	17:55	68	66.63	6403	5.34	5.07	4.81	4.49	4.02	3.28	2.56	2		1196	21	
7.598	1,2,3,4 Averaged	17:56	68	68.07	6304	5.72	5.41	5.09	4.7	4.16	3.25	2.39	1.77		1098	21	
7.699	1,2,3,4 Averaged	17:57	68	71.56	6379	5.63	5.43	5.2	4.86	4.42	3.65	2.91	2.32		1134	22	
7.796	1,2,3,4 Averaged	17:58	68	71.94	6463	4.56	4.36	4.13	3.84	3.44	2.76	2.07	1.6		1402	21	
7.9	1,2,3,4 Averaged	17:59	68	65.3	6371	4.07	3.82	3.65	3.43	3.14	2.61	2.08	1.67		1590	22	
7.997	1,2,3,4 Averaged	18:00	68	64.02	6450	5.3	5.06	4.83	4.49	4.07	3.31	2.61	2.04		1220	22	
8.1	1,2,3,4 Averaged	18:01	68	63.36	6447	4.72	4.44	4.2	3.91	3.52	2.87	2.24	1.79		1359	21	
8.2	1,2,3,4 Averaged	18:02	68	65.25	6196	4.98	4.73	4.5	4.18	3.77	3.06	2.37	1.87		1238	21	
8.298	1,2,3,4 Averaged	18:03	68	63.23	6490	5	4.78	4.55	4.23	3.82	3.09	2.35	1.79		1291	22	
8.407	1,2,3,4 Averaged	18:04	68	62.62	6360	5.19	4.78	4.5	4.15	3.7	2.96	2.28	1.76		1237	21	
8.495	1,2,3,4 Averaged	18:05	68	61.68	6439	4.57	4.37	4.12	3.85	3.52	2.94	2.34	1.9		1417	21	
8.601	1,2,3,4 Averaged	18:06	68	65.03	6347	4.57	4.33	4.16	3.91	3.56	2.97	2.37	1.89		1400	22	
8.694	1,2,3,4 Averaged	18:07	68	63.57	6530	5.51	5.34	5.17	4.96	4.64	4.05	3.39	2.79		1203	22	
8.794	1,2,3,4 Averaged	18:08	68	63.19	6426	6.36	5.74	5.42	4.93	4.37	3.43	2.56	1.95		1025	20	
8.898	1,2,3,4 Averaged	18:09	68	65.05	6307	5.09	4.86	4.63	4.35	3.96	3.28	2.56	1.98		1244	22	
9.001	1,2,3,4 Averaged	18:10	68	64.54	6307	5.19	4.94	4.78	4.49	4.1	3.38	2.64	2		1226	22	
9.124	1,2,3,4 Averaged	18:12	68	63.97	6328	4.23	4.08	3.91	3.71	3.41	2.89	2.37	1.89		1514	22	
9.192	1,2,3,4 Averaged	18:13	68	64.09	6479	5.59	5.27	4.91	4.42	3.86	2.92	2.12	1.56		1157	21	
9.295	1,2,3,4 Averaged	18:14	68	64.15	6411	9.69	8.32	7.47	6.46	5.41	3.8	2.59	1.83		664	19	
9.396	1,2,3,4 Averaged	18:16	68	65.3	6439	3.86	3.61	3.45	3.27	3	2.53	2.07	1.7		1689	21	
9.495	1,2,3,4 Averaged	18:17	68	66.07	6264	3.48	3.3	3.2	3.04	2.79	2.36	1.9	1.53		1806	22	
9.555	1,2,3,4 Averaged	18:18	68	66.11	6328	3.84	3.68	3.55	3.35	3.08	2.59	2.08	1.65		1650	22	

Appendix D

Geotechnical Report Limitations and Guidelines for Use

Appendix D
Geotechnical Report Limitations and Guidelines for Use
Report No. P-0020125

D.1 REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by GBA[1], of which, we are a member firm.

D.2 RISK MANAGEMENT INFORMATION

D.2.1 Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. And no one, not even you, should apply the report for any purpose or project except the one originally contemplated.

D.2.2 Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

D.2.3 A Geotechnical Engineering Report is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a few unique, project-specific factors when establishing the scope of a study. Typically, factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a rule, always inform your geotechnical engineer of project changes, even minor ones, and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

D.2.4 Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical engineering report whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

1 Geoprofessional Business Association, 15800 Crabbs Branch Way, Suite 300, Rockville, MD 20855
Telephone: 301/565-2733: www.geoprofessional.org

D.2.5 Most Geotechnical Findings Are Professional Opinions
Site exploration identified subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

D.2.6 A Geotechnical Engineering Report Is Subject to Misinterpretation
Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

D.2.7 Do Not Redraw the Engineer's Logs
Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognizes that separating logs from the report can elevate risk.

D.2.8 Give Contractors a Complete Report and Guidance
Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In the letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure contractors having sufficient time to perform additional study. Only then might you be able to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

D.2.9 Read Responsibility Provisions Closely
Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

D.2.10 Geoenvironmental Concerns Are Not Covered
The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.