Geotechnical Report and Resistivity

Verizon Wireless EV Barlow

2244 Steve Denton Road
Barlow, Kentucky

August 30, 2018

Prepared For:

Verizon Wireless
250 East 96th Street
Suite 175
Indianapolis, Indiana

Prepared By:

GPD GROUP®
Glaus, Pyle, Schomer, Burns & DeHaven, Inc.

"…truth, commitment, dedication and beauty in themselves speak what no words can." - Iacavos

SUBSURFACE INVESTIGATION & GEOTECHNICAL RECOMMENDATIONS

EV BARLOW – CELL TOWER
2244 STEVE DENTON ROAD
BARLOW, KENTUCKY
A&W PROJECT NO: 18IN0510

PREPARED FOR:
GPD GROUP
INDIANAPOLIS, INDIANA

PREPARED BY:
ALT & WITZIG ENGINEERING, INC.
GEOTECHNICAL DIVISION

AUGUST 30, 2018

Alt & Witzig Engineering, Inc.
4105 West 99th Street • Indianapolis • Indiana • 46032
Ph (317) 875-7000 • Fax (317) 876-3705

August 30, 2018

GPD Group
8275 Allison Pointe Trail, Suite 220
Indianapolis, Indiana 46250
ATTN: Ms. Traci Preble

Report of Subsurface Investigation & Geotechnical Recommendations

RE: EV Barlow – Cell Tower
2244 Steve Denton Road
Barlow, Kentucky
Alt & Witzig File: **18IN0510**

Dear Ms. Preble:

In compliance with your request, we have completed a subsurface investigation and geotechnical evaluation for the above referenced project. It is our pleasure to transmit herewith one (1) electronic copy of our report.

The purpose of this subsurface investigation was to determine the various soils profile components and the engineering characteristics of the materials encountered in order to provide information to be used for preparing a foundation for the proposed cellular tower and equipment building.

Project Description

It is anticipated that a new 285-foot tall self-support cell tower will be constructed at this site. A prefabricated equipment building will also be constructed at this site

The site is located west of State Road 1105 and approximately one-hundred (100) feet south of Sallie Crice Road near Barlow, Kentucky (Exhibit 1). The site may be located using the Barlow Quadrangle, Kentucky-Illinois 7½ minute topographic map.

Based upon the project plans provided by GPD to Alt & Witzig Engineering, the ground surface elevation at the tower center is taken to be 348.0' AMSL. All depths referred to in this report and on the Boring Logs are referenced from the existing ground surface.

Exhibit 1: 2017 Aerial Photograph with Overlay

Field Methods

The field investigation included a reconnaissance of the project site, performing one (1) soil boring (B-1) for the proposed tower and one (1) soil boring for the equipment building (B-2), performing standard penetration tests, and obtaining soil samples retained in the standard split-spoon sampler. The apparent groundwater level at the boring location was also determined.

The soil boring was performed with an all terrain vehicle-mounted drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. The advancement of the borings was temporarily stopped at regular intervals in order to perform standard penetration tests in accordance with ASTM Procedure D-1586. The standard penetration test involves driving a split spoon soil sampler into the ground by dropping a 140-pound hammer, thirty (30) inches. The number of hammer drops required to advance the split-spoon sampler one (1) foot into the soil is defined as the standard penetration value. The soil samples retained in the split-spoon sampling device as a result of the penetration tests were obtained, classified, and labeled for further laboratory investigation.

Laboratory Investigation

A laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials at the site of the proposed tower. The laboratory testing program included:

- Visual classification of soils.
- Moisture content determination in accordance with ASTM D-2216.
- Samples of the cohesive soil were frequently tested in unconfined compression by use of a calibrated spring testing machine.
- A pocket penetrometer was used as an aid in determining the strength of the soil.

The values of the unconfined compressive strength as determined on soil samples from the split-spoon sampling must be considered approximate recognizing the manner in which they were obtained since the split-spoon sampling techniques provide a representative but somewhat disturbed soil sample.

Site Specific Subsurface Conditions

At the ground surface, the borings encountered approximately six (6) inches of topsoil. Beneath the topsoil, the borings encountered very soft to stiff silty clays with varying amounts of sand and gravel extending to depths of twenty-three and one-half (23½) feet (Elev. 319.5 feet) in boring B-1 and ten (10) feet (Elev. 338.0 feet) in boring B-2. In boring B-1, these soils transitioned into a hard consistency that extended to a depth of twenty-eight and one-half (28½) feet. At this depth, dry, very dense, clayey sand was encountered to the termination depth of the boring at thirty-seven (37) feet, where auger refusal was encountered. Detailed soil descriptions at the boring location have been included on the *Boring Logs* in the Appendix of this report.

Bedrock

The site is located along the Mississippi Embayment of the Mississippi Alluvial Plain within the Jackson Purchase Region of Kentucky. This part of Kentucky is relatively flat-lying, with numerous lakes, ponds, sloughs, and swamps. Geologic maps published by the US Geological Service indicate the Mississippi Embayment is the northward continuation of the fluvial sediments of the Mississippi River Delta. The current sedimentary area was formed in the Cretaceous and early Cenozoic periods by the filling with sediment of an existing basin. The soils in this region consists primarily of loess. The underlying bedrock in this region consists primarily of limestone formed in the Ordovician period.

Groundwater

Water level observations made during and upon completion of drilling operations yielded dry boreholes. These measurements are noted on the *Boring Logs* presented herewith. The exact location at which water is encountered should be anticipated to fluctuate somewhat depending upon normal seasonal variations in precipitation and surface runoff.

It should be noted that the groundwater level measurement recorded on the individual *Boring Logs* in the Appendix of this report is accurate for the specific date on which the measurements was performed. It must be understood that the groundwater level will fluctuate throughout the year. The *Boring Logs* do not indicate these fluctuations.

Seismic Parameters

An evaluation of the seismic site class has been performed for this site. The State of Kentucky has integrated the 2015 International Building Code into the Indiana Building Code (IBC). The seismic site class is determined by averaging soil conditions within the top 100 feet with respect to the shear wave velocity in accordance with ASCE 7. Our evaluation is based on data obtained for borings performed to depths of 33 feet at this site and information provided by the Indiana Geological Survey for a depth of 100 feet. A detailed report generated by the USGS Earthquake Hazard program (http://earthquake.usgs.gov/designmaps/us/application.php) has been attached to this letter. Following are the summarized requested seismic parameters.

Seismic Parameters

Site Soil Classification	Site Class D
MCE Spectral Response Accelerations	$S_s = 2.506$ $S_1 = 0.951$
Site Coefficients	$F_a = 1.0$ $F_v = 1.5$

Geotechnical Recommendations

Information provided by GPD Group indicates that the proposed 285-foot self-support cell tower will be constructed in the general vicinity of soil boring B-1; and an equipment building will be constructed in the general vicinity of boring B-2. Our experience with this type of structure indicates that the structural loads of the tower will be supported by an extended mat foundation or a caisson system and the buildings will be supported by conventional spread footings and continuous wall footings. It is recommended that a representative of Alt & Witzig Engineering, Inc. be on-site to monitor the excavation and inspect the base of the foundations.

Tower Foundation Recommendations

Extended Footing or Extended Mat Foundation

If spread footings are desired, they should be founded at a minimum depth of four (4) feet below existing grade. The soil parameters presented in *Table 1* may be utilized for the design of a shallow foundation.

Table 1: Shallow Foundation Soil Parameters

Soil Description	Depth Below Existing Grade (feet)	Allowable Bearing Pressure (psf) FS=3	Unit Weight (pcf)	C (psf)/ Φ (º)	Adhesion (psf)
Silty Clay	4-9	3,000	120	2,000	1250

It is anticipated that lateral wind loads and overturning moments will act on the spread footing. To help resist the overturning moment, it may be necessary to place a larger footing than necessary for bearing capacity. Also, any soil placed above the footing may be considered to help resist overturning moments if compacted to a minimum of 98 percent of the maximum dry density as determined from ASTM D-698 (Standard Proctor).

Depending upon the time of the year that the excavations are made, seepage from surface runoff may occur. Since these foundation materials tend to soften/loosen when exposed to free water, every effort should be made to keep the excavations dry should water be encountered. It is also recommended that concrete for footings be poured as soon as possible after the excavations are complete. A mud mat may be placed to provide the contractors a firm working surface and protect the exposed subgrade soils from softening.

Caissons/Drilled Piers

A caisson type foundation is advantageous to use when it is necessary to resist large overturning moments such as those caused by wind loads against the proposed structure. As an alternative to a shallow foundation system, a caisson type foundation system may be considered to support this tower structure. A straight shaft caisson/drilled pier may be considered. If a caisson or drilled shaft is used to support the structure, it should be designed using the soil parameters provided in *Table 2*.

Table 2: Deep Foundation Soil Parameters

Soil Type	**Depth Below Grade (Feet)**	**Allowable Skin Friction for Gravity Loads SF=2**	**Design End Bearing Pressure SF=3**	**Effective Unit Weight (pcf)**	**C (psf) / Φ (º)**
Silty Clay	6 – 23.5	600 psf	NA	120 pcf	2000 psf
Hard Silty Clay	23.5 – 28.5	600 psf	4,000 psf	130 pcf	2000 psf
Clayey Sand	28.5+	1000 psf	4,000 psf	130 pcf	28°

*Skin friction may be utilized in shaft compression and tension. The top one-shaft diameter should be neglected.

Equipment Building Foundation Recommendations

A net allowable bearing pressure of **2,000 psf** is recommended for dimensioning continuous wall footings at this site. The above-suggested bearing pressure is provided assuming the footings will be founded on medium stiff natural soils or properly compacted fill materials at a minimum depth of three (3) feet below grade.

Equipment Building Slab Recommendations

This structure will be a slab-on-grade supported by natural soils and/or compacted fill materials. In those areas where the existing grade is lower than the design floor elevation, a well-compacted structural fill will be necessary to raise the site to the desired grade. The fill material shall consist of INDOT No. 53 Stone.

After the building areas have been raised to the proper elevation, a granular fill should be placed immediately beneath the floor slab. It is recommended that all material placed in the floor slab areas be compacted to a density of 100 percent of maximum dry density in accordance with ASTM D-698. Recommendations for proper filling procedures are presented later in the Appendix of this report.

Statement of Limitations

Our subsurface investigation was conducted in accordance with guidelines set forth in the scope of services and applicable industry standards.

An inherent limitation of any geotechnical engineering study is that conclusions must be drawn on the basis of data collected at a limited number of discrete locations. The geotechnical parameters provided in this report were developed from the information obtained from the test borings that depict subsurface conditions only at these specific locations and on the particular date indicated on the boring logs. Soil conditions at other locations may differ from conditions encountered at these boring locations and groundwater levels shall be expected to vary with time. The nature and extent of variations between the borings may not become evident until the course of construction.

Often, because of design and construction details that occur on a project, questions rise concerning the soil conditions. If we can give further service in these matters, please contact us at your convenience.

Very truly yours,

Alt & Witzig Engineering, Inc.

David M. Shumate
Staff Geologist

David C. Harness, P.E.

STATE OF KENTUCKY
D.C.
HARNESS
20569
LICENSED
PROFESSIONAL ENGINEER

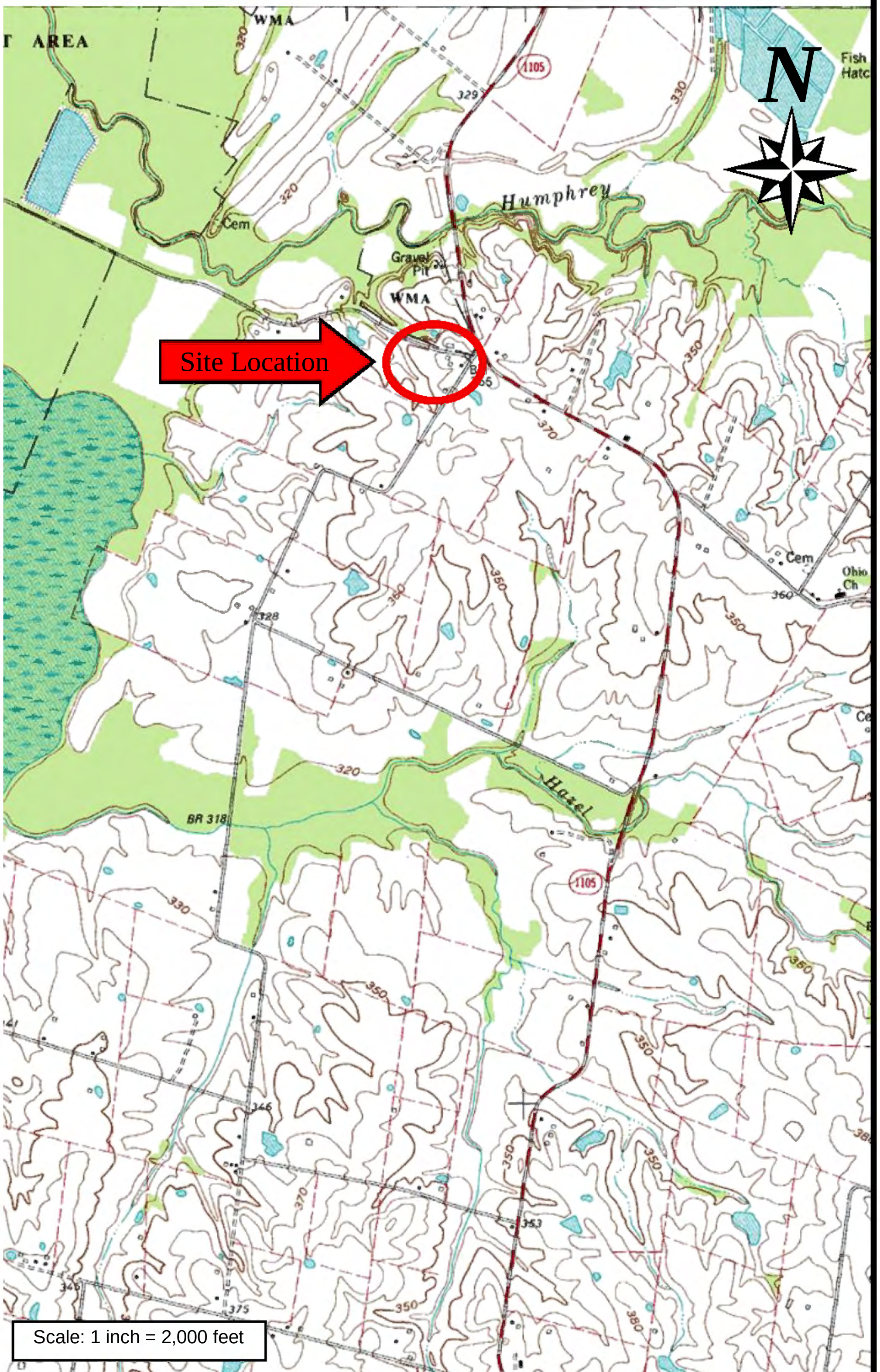
APPENDIX

Recommended Specifications for Compacted Fills and Backfills
Site Location Map
Boring Location Plan
Boring Logs
General Notes
USGS Design Maps Summary
Custom Soil Resource Report for Ballard and McCracken Counties, Kentucky

RECOMMENDED SPECIFICATIONS FOR COMPACTED FILLS AND BACKFILLS

All fill shall be formed from material free of vegetable matter, rubbish, large rock, and other deleterious material. Prior to placement of fill, a sample of the proposed fill material should be submitted to the soils engineer for his approval. The fill material should be placed in layers not to exceed eight (8) inches in loose thickness and should be sprinkled with water as required to secure specified compactions. Each layer should be uniformly compacted by means of suitable equipment of the type required by the materials composing the fill. Under no circumstances should a bulldozer or similar tracked vehicles be used as compacting equipment. Material containing an excess of water so the specified compaction limits cannot be attained should be spread and dried to a moisture content which will permit proper compaction. All fill should be compacted to the specified percent of the maximum density obtained in accordance with ASTM density Test D-698 (100 percent of maximum dry density below and above the base of footing elevation). Should the results of the in-place density tests indicate that the specified compaction limits are not obtained; the areas represented by such tests should be reworked and retested as required until the specified limits are reached.

SITE LOCATION MAP



USGS Topographic Map:
Barlow Quadrangle

PROJECT: **EV Barlow-Cell Tower**
LOCATION: 2244 Steve Denton Road
CLIENT: **GPD Group**
A&W File No.: 18IN0510

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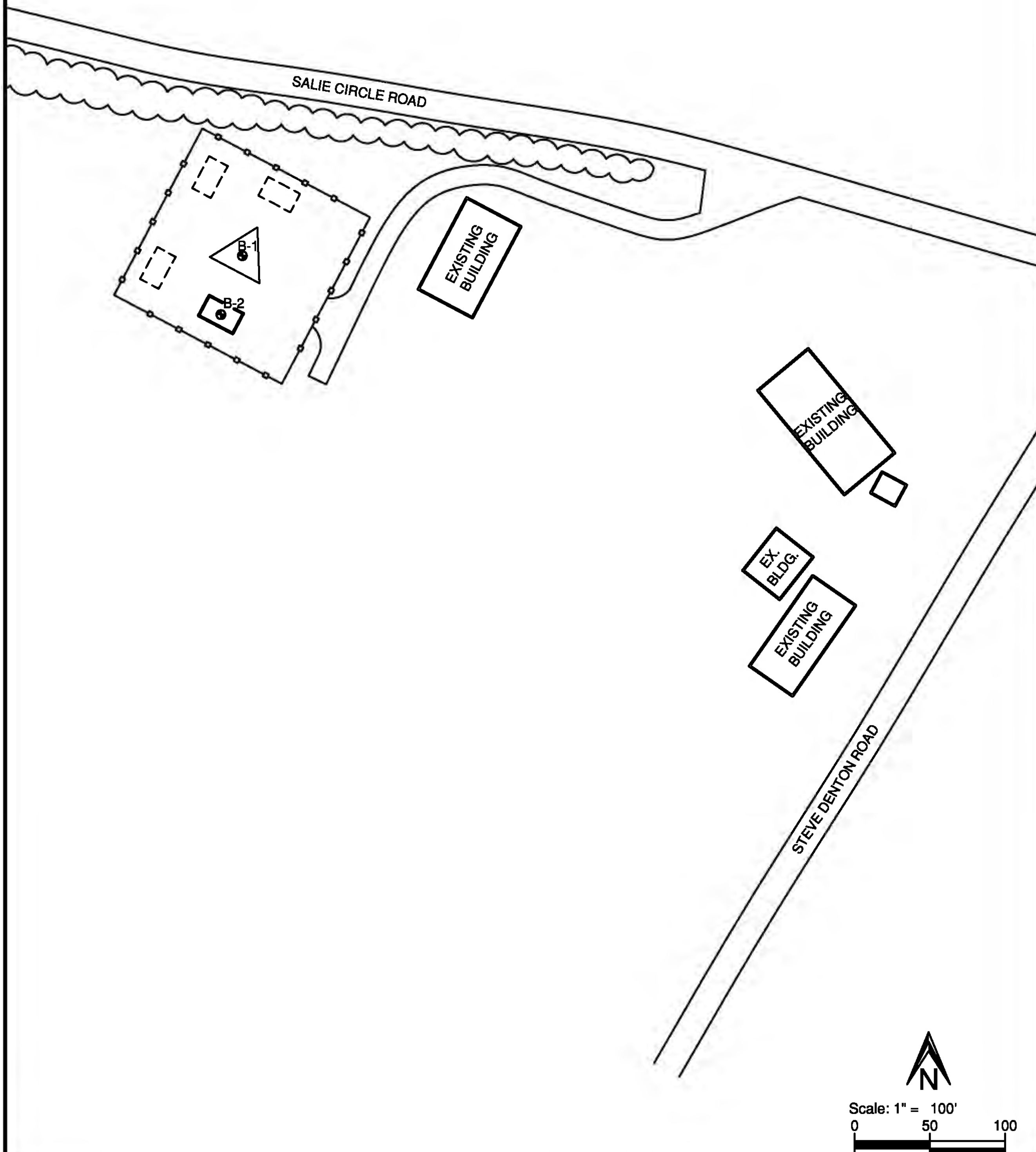
Last Modified: 8/17/2018 9:51 AM



BORING LOCATION PLAN

PROJECT NAME: EV Barlow-Cell Tower
LOCATION: 2244 Steve Denton Road
PREPARED FOR: GPD Group
PROJECT NO: 18IN0510

Project Manager: DS
Checked By: DH
Drawn By: JT
Date: 08/18

Alt & Witzig Engineering, Inc.
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BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **GPD Group**

PROJECT NAME **EV Barlow Cell Tower**

PROJECT LOCATION **Barlow, Kentucky**

BORING # **B-1**

ALT & WITZIG FILE # **18IN0510**

Latitude 37.11175 Longitude -89.045767

DRILLING and SAMPLING INFORMATION

Date Started	**8/7/18**	Hammer Wt.	**140** lbs.
Date Completed	**8/7/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**S. Champion**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION SURFACE ELEVATION 348.0	Strata Depth	Sample No.	Sample Type	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % *Dry Unit Weight (pcf)*	Remarks
347.5	TOPSOIL	0.5	1	SS	9		4.5	17.6	
	Brown Silty CLAY		2	SS	10		4.0	14.0	
			3	SS	8		3.0	22.6	
			4	SS	9		2.5	24.8	
			5	SS	3		1.0	26.5	
			6	SS	7		0.5	26.3	
			8	SS	13	2.3	2.5	28.5	
324.5		23.5							
	Brownish Red Silty CLAY with Sand and Gravel		9	SS	74		2.0	19.2	
319.5		28.5							
	Brownish Red Clayey SAND with Gravel		10	SS	86				
			11	SS	71				
	End of Boring at 35 feet								
311.0		37.0							

Sample Type
- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

Groundwater
- ○ During Drilling *Dry ft.*
- ▽ At Completion *Dry ft.*

Boring Method
- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- DC - Driving Casing
- MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **GPD Group**
PROJECT NAME **EV Barlow Cell Tower**
PROJECT LOCATION **Barlow, Kentucky**

BORING # **B-2**
ALT & WITZIG FILE # **18IN0510**
Latitude 37.11167 Longitude -89.045823

DRILLING and SAMPLING INFORMATION

Date Started	8/7/18	Hammer Wt.	140 lbs.
Date Completed	8/7/18	Hammer Drop	30 in.
Boring Method	HSA	Spoon Sampler OD	2 in.
Driller	S. Champion	Rig Type	D-50 Track ATV

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION SURFACE ELEVATION 348.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
347.5	TOPSOIL	0.5		1	SS			11		4.5	15.8	
	Brown Silty CLAY			2	SS			11		3.0	23.0	
				3	SS			9	1.2	2.5	24.8	
			5	4	SS			8		2.0	26.5	
338.0		10.0	10	5	SS			3			29.5	
	End of Boring at 10 feet											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
▽ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

MATERIAL GRAPHICS LEGEND

CL-ML	USCS Low Plasticity Silty Clay
SC	USCS Clayey Sand
TOPSOIL	TOPSOIL

SOIL PROPERTY SYMBOLS

N: *Standard "N" penetration value. Blows per foot of a 140-lb hammer falling 30" on a 2" O.D. split-spoon.*

Qu: *Unconfined Compressive Strength, tsf*

PP: *Pocket Penetrometer, tsf*

LL: *Liquid Limit, %*

PL: *Plastic Limit, %*

PI: *Plasticity Index, %*

DRILLING AND SAMPLING SYMBOLS

GROUNDWATER SYMBOLS

○ *Apparent water level noted while drilling.*

▽ *Apparent water level noted upon completion.*

▼ *Apparent water level noted upon delayed time.*

SAMPLER SYMBOLS

☒ SS: Split Spoon

RELATIVE DENSITY & CONSISTANCY CLASSIFICATION (NON-COHESIVE SOILS)

TERM	*BLOWS PER FOOT*
Very Loose	0 - 5
Loose	6 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	>51

RELATIVE DENSITY & CONSISTANCY CLASSIFICATION (COHESIVE SOILS)

TERM	*BLOWS PER FOOT*
Very Soft	0 - 3
Soft	4 - 5
Medium Stiff	6 - 10
Stiff	11 - 15
Very Stiff	16 - 30
Hard	>31

Alt & Witzig Engineering, Inc.
4105 West 99th St.
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GENERAL NOTES

Project: EV Barlow Cell Tower

Location: Barlow, Kentucky

Number: 18IN0510

USGS Design Maps Summary Report

User–Specified Input

Report Title 18IN0510
Wed August 15, 2018 15:23:27 UTC

Building Code Reference Document 2012/2015 International Building Code
(which utilizes USGS hazard data available in 2008)

Site Coordinates 37.11175°N, 89.04577°W

Site Soil Classification Site Class D – "Stiff Soil"

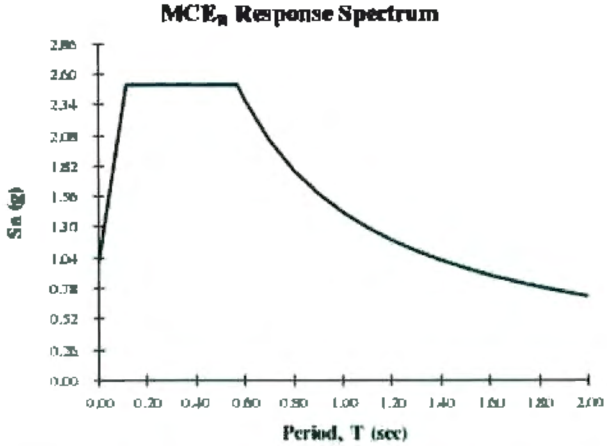
Risk Category I/II/III

USGS–Provided Output

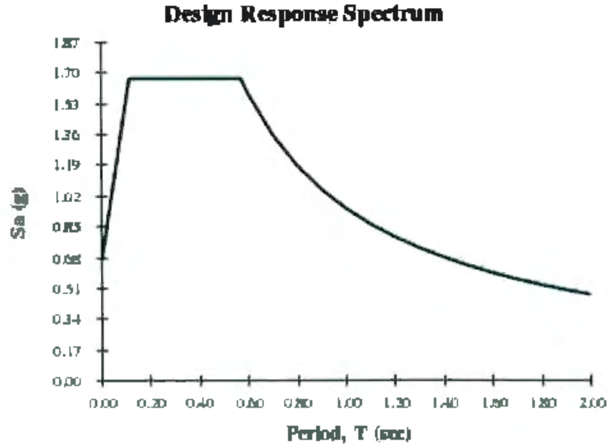
S_S =	2.506 g	S_{MS} =	2.506 g	S_{DS} =	1.671 g
S_1 =	0.951 g	S_{M1} =	1.426 g	S_{D1} =	0.951 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

MCE_R Response Spectrum



Design Response Spectrum



USGS Design Maps Detailed Report

2012/2015 International Building Code (37.11175°N, 89.04577°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1] $S_S = 2.506$ g

From Figure 1613.3.1(2) [2] $S_1 = 0.951$ g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index $PI > 20$, • Moisture content $w \geq 40\%$, and • Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 2.506 g, F_a = 1.000

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.951 g, F_v = 1.500

Equation (16-37): $S_{MS} = F_aS_S = 1.000 \times 2.506 = 2.506$ g

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Equation (16-38): $S_{M1} = F_vS_1 = 1.500 \times 0.951 = 1.426$ g

---

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39): $S_{DS} = ⅔\, S_{MS} = ⅔ \times 2.506 = 1.671$ g

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Equation (16-40): $S_{D1} = ⅔\, S_{M1} = ⅔ \times 1.426 = 0.951$ g

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Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.671 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.951 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = E

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf
2. *Figure 1613.3.1(2)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Ballard and McCracken Counties, Kentucky

18IN0510

August 15, 2018

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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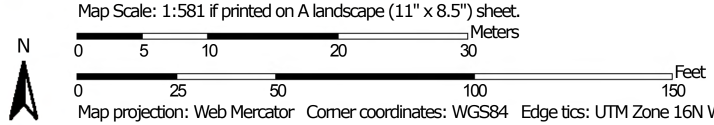
Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:581 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Ballard and McCracken Counties, Kentucky
Survey Area Data: Version 11, Oct 3, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 13, 2011—Oct 7, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
GrB2	Grenada silt loam, 2 to 6 percent slopes, eroded	0.2	21.8%
GrC3	Grenada silt loam, 6 to 12 percent slopes, severely eroded	0.9	78.2%
Totals for Area of Interest		**1.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Ballard and McCracken Counties, Kentucky

GrB2—Grenada silt loam, 2 to 6 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2wn5t
Elevation: 310 to 640 feet
Mean annual precipitation: 52 to 62 inches
Mean annual air temperature: 48 to 69 degrees F
Frost-free period: 175 to 244 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Grenada, eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Grenada, Eroded

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-silty noncalcareous loess

Typical profile

Ap - 0 to 5 inches: silt loam
Bw - 5 to 21 inches: silt loam
E - 21 to 28 inches: silt loam
Btx/E - 28 to 38 inches: silt loam
Btx - 38 to 80 inches: silt loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 17 to 36 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 32 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: Northern Loess Fragipan Upland - PROVISIONAL (F134XY012AL)
Hydric soil rating: No

Minor Components

Calloway

Percent of map unit: 6 percent
Landform: Flats
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Collins

Percent of map unit: 4 percent
Landform: Flood-plain steps
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

GrC3—Grenada silt loam, 6 to 12 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: 1qls1
Elevation: 320 to 500 feet
Mean annual precipitation: 40 to 56 inches
Mean annual air temperature: 46 to 69 degrees F
Frost-free period: 177 to 222 days
Farmland classification: Not prime farmland

Map Unit Composition

Grenada, severely eroded, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Grenada, Severely Eroded

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Thick fine-silty noncalcareous loess

Typical profile

H1 - 0 to 4 inches: silt loam
H2 - 4 to 18 inches: silt loam
H3 - 18 to 22 inches: silt loam
H4 - 22 to 32 inches: silt loam
H5 - 32 to 80 inches: silt loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: 18 to 23 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Purchase, severely eroded

Percent of map unit: 7 percent
Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Calloway

Percent of map unit: 4 percent
Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Falaya

Percent of map unit: 2 percent
Landform: Drainageways
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Collins

Percent of map unit: 2 percent
Landform: Drainageways
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Alt & Witzig Engineering, Inc.
4105 West 99th Street • Indianapolis • Indiana • 46032
Ph (317) 875-7000 • Fax (317) 876-3705

August 30, 2018

GPD Group
8275 Allison Pointe Trail, Suite 220
Indianapolis, Indiana 46250
ATTN: Ms. Traci Preble

Resistivity Results

RE: EV Barlow – Cell Tower
2244 Steve Denton Road
Barlow, Kentucky
Alt & Witzig File: **18IN0510**

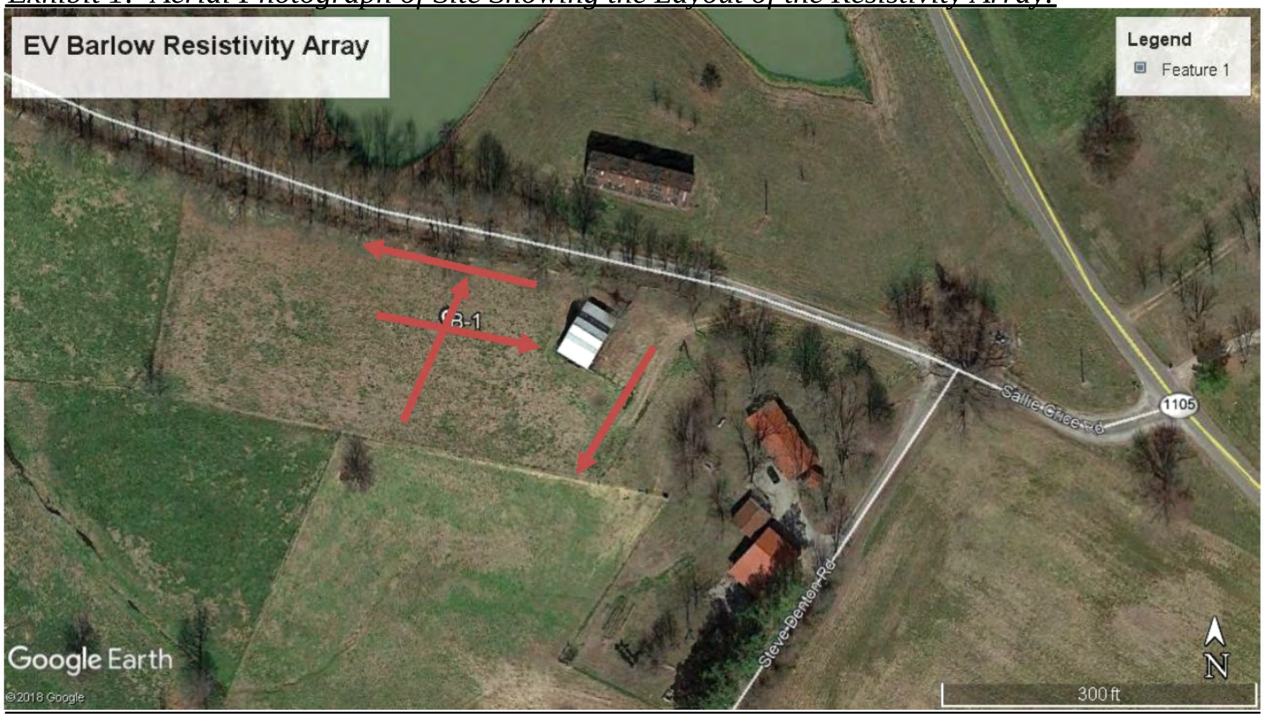
Dear Ms. Preble:

To aid in the design of the grounding equipment for the referenced project, soil resistivity tests were performed at the site. The resistivity testing was performed using an AEMC Model 6472 Soil Resistance Meter per ASTM G-57 (The Wenner Vertical Profiling Method). A qualified technician familiar with this equipment and testing procedure performed the appropriate test to obtain the resistivity values at multiple depths. Alt & Witzig Engineering, Inc. was able to gather the necessary resistivity information in all four (4) directions.

The Wenner Vertical Profiling Method was used by centering the potential electrodes on a traverse line between the current electrodes and maintaining an equal "a" spacing between the electrodes. The depths of interests or "a" spacing of 2½ feet, 5 feet, 12½ feet, 20 feet and 50 feet.

The resistivity test was performed on August 28, 2018. The weather during data collection was between 80 and 92 degrees and sunny. The measurements were taken in general vicinity of the proposed tower location and approximately one-hundred (100) feet south of Sallie Crice Road. The layouts of the arrays are shown below in *Exhibit 1*.

Exhibit 1: Aerial Photograph of Site Showing the Layout of the Resistivity Array.



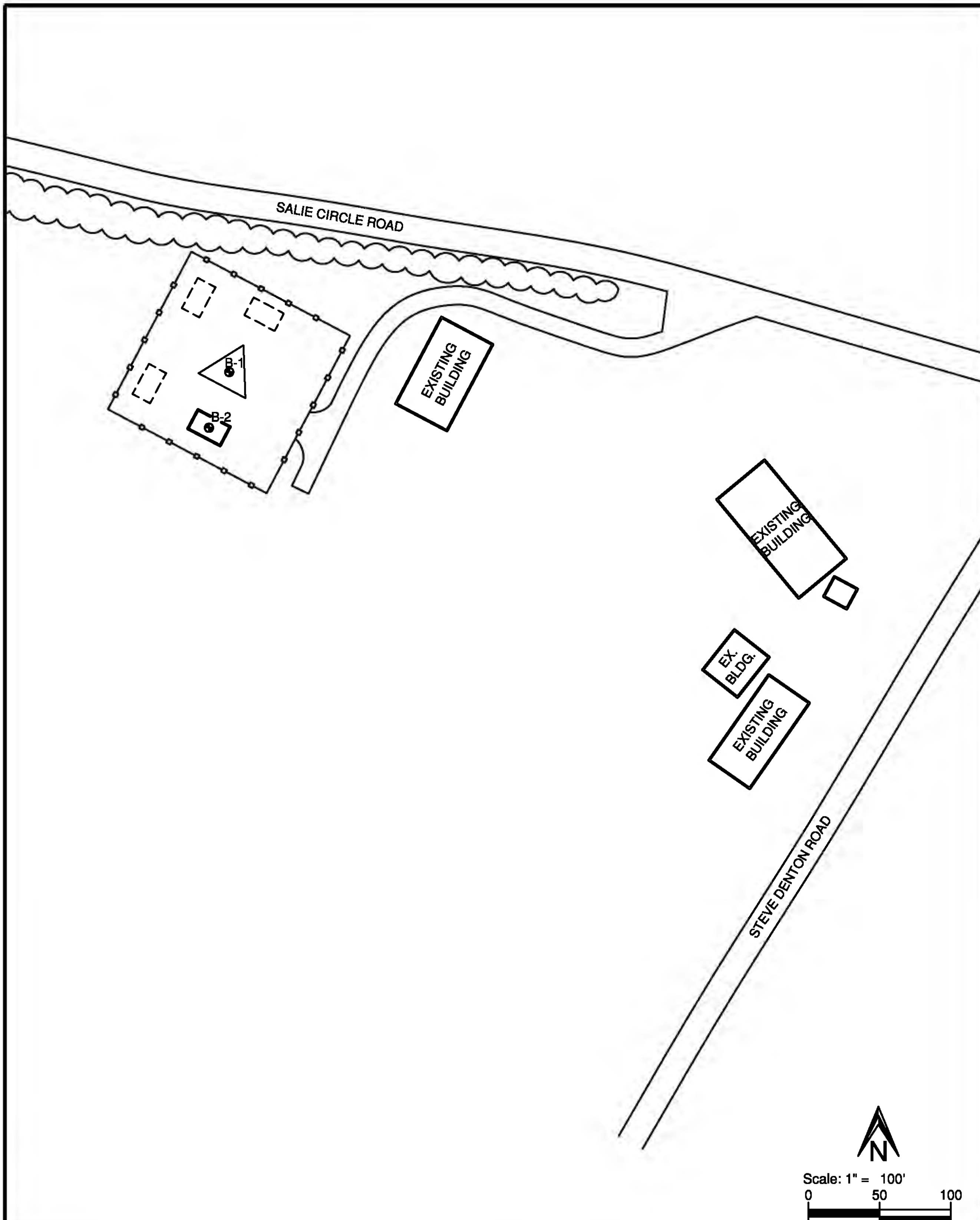
We appreciate the opportunity to be of service to you on this project. If we can give further service in these matters, please contact us at your convenience.

Very truly yours,
Alt & Witzig Engineering, Inc.

David M. Shumate
Geologist

David C. Harness, P.E.
Sr. Geotechnical Engineer

Attachments:
Boring Location Plan
Resistivity Testing Results



BORING LOCATION PLAN

PROJECT NAME: EV Barlow-Cell Tower
LOCATION: 2244 Steve Denton Road
PREPARED FOR: GPD Group
PROJECT NO: 18IN0510

Project Manager: DS
Checked By: DH
Drawn By: JT
Date: 08/18

AW Alt & Witzig Engineering, Inc.
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RESISTIVTIY TESTING

WENNER 4-ELECTRODE METHOD

ASTM G57

A&W Project ID: 18IN0510 **Site Location:** EV Barlow

A&W Field Technician:	L. Folz	Engineer:	*D. Harness*
Weather Conditions	Sunny	Meter Used	AEMC 6472
Air Temperature:	80 - 92	Ground Condition:	Corn Field
Start Date	8/28/2018	Start Time	10:30am
End Date	8/28/2018	End Time	2:30pm

Where, ρ = *resistivity in* $\Omega \cdot cm$
a = *electrode separation, ft*
R = *resistance,* Ω

$$\rho, \Omega \cdot cm = 191.5aR$$

Important notes:

(1) large, nonconductive bodies shall not be included in the survey. Nonconductive bodies include: frozen soil, boulders, concrete foundations,

(2) conductive structures such as pipes and cables shall not be within 1/2 a of the electrode span unless they are at right angles to the span.

Location	Spacing between electrodes, a (ft)	range switch	Dial Reading	Resistance, R *ohms*	Multiplier	Resistivity, ρ Ω·cm
NORTH	2.5	1	14.13	14.13	478.75	6,765
	5	1	6.818	6.818	957.5	6,528
	12.5	1	2.06	2.06	2393.75	4,931
	20	1	1.459	1.459	3830	5,588
	50	1	0.778	0.778	9575	7,449
SOUTH	2.5	1	9.242	9.242	478.75	4,425
	5	1	6.048	6.048	957.5	5,791
	12.5	1	2.196	2.196	2393.75	5,257
	20	1	1.466	1.466	3830	5,615
	50	1	0.828	0.828	9575	7,928
EAST	2.5	1	25.94	25.94	478.75	12,419
	5	1	7.36	7.36	957.5	7,047
	12.5	1	4.23	4.23	2393.75	10,126
	20	1	0.866	0.866	3830	3,317
	50	1	0.675	0.675	9575	6,463
WEST	2.5	1	55.44	55.44	478.75	26,542
	5	1	14.82	14.82	957.5	14,190
	12.5	1	2.311	2.311	2393.75	5,532
	20	1	1.355	1.355	3830	5,190
	50	1	1.064	1.064	9575	10,188