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Trabue 7.85 o/NS Railroad
Project Number 8070
Franklin County, Ohio

STRUCTURE FOUNDATION EXPLORATION REPORT

Prepared for:

Franklin County Engineer's Office

970 Dublin Road
Columbus, Ohio 43215

March 2016

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I. Executive Summary

This report summarizes the subsurface exploration, engineering analyses, subgrade design, and foundation recommendations for the proposed widening of the Trabue Road Bridge in Franklin County, Ohio. The Trabue Road Bridge spans the Norfolk Southern tracks that extend south from the Buckeye Yard. The bridge is located just west of I-270 along Trabue Road and was built in 1968.

Two borings were drilled as part of this geotechnical exploration - one at each abutment. The borings were drilled between October 20 and 30, 2015. They encountered 8 inches of asphalt pavement above 4 inches of granular base material. Below the pavement layers, the borings encountered 23 to 28 feet of silt and clay embankment fill (A-6a and A-6b). Below the embankment fill, the borings encountered glacial till consisting of very stiff to hard silt and clay (A-6a and A-6b), sandy silt (A-4a) with layers of dense sand (A-3a). Groundwater was encountered at a depth of 32 feet in Boring B-1, and a saturated sand layer was encountered at a depth of 63 feet in Boring B-2. Gray weathered limestone was encountered at a depth of 87.5 feet in Boring B-1. At Boring B-2, the auger met refusal at a depth of 81 ft, which is considered to be the depth to bedrock at this location.

Based on a GB 1 subgrade evaluation and engineering judgement, we recommend standard subgrade compaction and proof rolling performed according to ODOT C&MS 204, with a sufficient quantity of Item 204, Type B granular material, and geotextile to provide a 12-inch undercut across 50 percent of the pavement area for contingency purposes. Any subgrade areas that rut more than 1 inch during proof rolling can be stabilized by undercutting. No unsuitable subgrade soils were encountered. The average design CBR for pavement design is 6.

Where the widened embankment will consist of more than a foot of new fill placed on the existing embankment side slope, special benching will be required to ensure the new fill is adequately compacted and stable.

The abutment foundations for the existing bridge are supported on H-piles and the existing pier foundations are supported on spread footings. Even though the piers for the existing bridge are supported on spread footings, we recommend that the proposed piers for the widened structure be supported on piles in order to limit differential settlement between the old and new piers. Based on the soil and bedrock conditions and the anticipated pile loads (about 350 kips ultimate bearing value), we recommend supporting the proposed widened bridge substructures on H-piles driven to refusal on bedrock. The ultimate bearing values (UBV) and estimated pile lengths for different size pipe piles and H-piles are presented in Table 3. Drilled shaft foundations were also considered but would not be cost effective due to the depth to rock.

II. Introduction

This report summarizes the subsurface exploration, engineering analyses, subgrade design, and foundation recommendations for the proposed widening of the Trabue Road Bridge in Franklin County, Ohio. The Trabue Road Bridge spans the Norfolk Southern tracks that extend south from the Buckeye Yard. The bridge is located just west of I-270 along Trabue Road and was built in 1968. The project will consist of removing and replacing the existing bridge deck. The proposed bridge deck may be wider than the existing deck in order to accommodate a shared use path along Trabue Road. Depending on the final proposed width, the project may require widening the abutments and constructing additional pier supports next to the existing piers. The widened embankment may also require the construction of a retaining wall in order to limit the right-of-way impacts.

III. Geology and Observations

The project site is located on the border between the Columbus Lowland area and the Darby Plain area of the Southern Ohio loamy till plain physiographic region. The site was covered by both the Illinoian and Wisconsinan glaciers. The Columbus Lowland is a relatively flat-lying lowland area generally sloping towards the Scioto River valley. The overburden soil at the project site consists of ground moraines deposited by the Wisconsinan glacier, cut by stream valleys. The Darby Plain is similar but tends to be more hummocky with low relief (25 ft). The natural soils are often hard or very dense due to the past weight of up to 3,000 feet of ice. The surface topography at the site is generally around elevation 900 to 905 feet outside the limits of the roadway embankment.

The underlying bedrock reportedly consists of limestone and dolomite from the Devonian-age Columbus Limestone and Delaware Limestone formations. These rocks are colored gray to brown. The bedrock topography map of Ohio from ODNR indicates that the top of bedrock elevation at the project site is between 830 and 840 feet, so the depth to bedrock is approximately 80 feet below the ground surface The portions of the maps from the Surficial Geology of Ohio and from the Bedrock Geology of Ohio are included in Exhibit A for the project site.

Although karst develops in carbonate sedimentary rocks such as limestone and dolomite, the project area is not in an area of known or probable karst according to ODNR. There are no known abandoned underground mines in the area.

IV. Exploration

Borings

Limited historic geotechnical data was provided in the original bridge plans from 1968. The historic geotechnical data consisted of two borings along the railroad lines, each about 25 feet deep.

Two borings were drilled as part of this geotechnical exploration - one at each abutment. Due to the restricted access along the railway, borings were not drilled for the piers. The borings were drilled between October 20 and 30, 2015. The boring locations are shown on the boring location plan in Exhibit B, and general information about the borings is summarized in Table 1. DHDC, Inc. drilled the borings and performed laboratory testing on select samples. The borings were drilled with a truck-mounted rotary drill rig, using hollow stem augers to advance the borings through the soil. Disturbed soil samples were obtained in accordance with the standard penetration test (AASHTO T206) at 2.5-foot intervals for a depth of 30 feet, and then at 5-foot intervals to the depth of boring. The hammer system used was a manual drop hammer with cathead. Since this is the type of hammer that is used as a reference for measuring blow counts, the drill rod energy was assumed to be 60 percent and no adjustment was made to the blow count values.

No undisturbed soil samples were obtained. Bedrock was encountered in Boring B-1, but due to the depth and anticipated foundation type, it was not cored.

Table 1 – Summary of Borings

Boring	Location	Top of Boring Elevation (ft)	Boring Depth (ft)	Water Seepage (ft)	Ground-water Depth (ft)	Top of Bedrock Depth (ft)	Top of Bedrock Elev. (ft)
B-1	West Abutment	925.8	87.5	32	32	87.0	838.8
B-2	East Abutment	919.2	81.0	63	63	81.0	838.2

Laboratory Testing

In the laboratory, soil samples were visually classified and select samples were tested for natural moisture content, plastic and liquid limits, and gradation. The results of the tests were used to classify the soil according to the ODOT classification system and to estimate engineering properties of the soil. The results of the laboratory testing are presented on the boring logs.

Hand penetrometer readings, which provide an approximate measure of the unconfined compressive strength of cohesive soil, were taken on the disturbed soil samples either in the field or in the lab. The hand penetrometer readings are reported on the boring logs in tons per square foot (tsf). In the absence of shear strength testing, the soil consistency and shear strength parameters for cohesive soils are generally estimated from the hand penetrometer readings.

Because of the short length of the project, chemical stabilization of the subgrade would not be practical. Therefore sulfate testing of the subgrade soil was not performed.

V. Findings

The following text presents generalized subsurface conditions encountered by the borings. For more detailed information, please refer to the boring logs in Exhibit B.

Soil

The historic borings from 1968 indicate that the soil near the original ground surface consisted of soft clayey topsoil. Below the topsoil the borings encountered firm, organic clay, followed by stiff to very stiff clay to a depth of 25 feet. The description of the soil is consistent with glacial till.

The borings drilled in 2015 were located on the shoulder of Trabue Road. They encountered 8 inches of asphalt pavement above 4 inches of granular base material. Below the pavement layers, the borings encountered 23 to 28 feet of silt and clay embankment fill (A-6a and A-6b). Below the embankment fill, the borings encountered glacial till consisting of very stiff to hard silt and clay (A-6a and A-6b), sandy silt (A-4a) with layers of dense sand (A-3a).

Groundwater

Groundwater was encountered at a depth of 32 feet in Boring B-1, and a saturated sand layer was encountered at a depth of 63 feet in Boring B-2. Both borings caved after removing the augers, so the water level at completion was not measured.

Bedrock

Gray weathered limestone was encountered at a depth of 87.5 feet in Boring B-1. At Boring B-2, the auger met refusal at a depth of 81 ft, which is considered to be the depth to bedrock at this location.

VI. Analyses and Recommendations

Subgrade

A subgrade evaluation was performed according to ODOT Geotechnical Bulletin GB 1: *Plan Subgrades*, which is published by the Ohio Department of Transportation, Office of Geotechnical Engineering (OGE) and last revised on January 15, 2016. The GB 1 subgrade analysis spreadsheet is presented in Exhibit C.

Based on the evaluation and engineering judgement, we recommend standard subgrade compaction and proof rolling performed according to ODOT C&MS 204, with a sufficient quantity of Item 204, Type B granular material, and geotextile to provide a 12-inch undercut across 50 percent of the pavement area for contingency purposes.

Unsuitable Subgrade Soil

The borings did not encounter any unsuitable subgrade soil. Unsuitable subgrade soils consist of the following:

- Silt, A-4b
- Elastic soils, A-2-5, A-5 and A-7-5
- Organic soils, A-8a and A-8b
- Soil with a liquid limit greater than 65
- Rock, shale, or coal

Unstable Subgrade Soil

The results of the subgrade analysis indicate that the subgrade may be unstable due to the relatively low blow counts (N_{60}) encountered in the upper 10 feet. The GB 1 analysis indicates a 12 inch deep undercut may be necessary. However, since this is based on only two borings located in the shoulder, and additional fill will be placed close to the abutments in order to raise the profile grade, we recommend the following procedure.

1. After shaping and compacting the subgrade soil, proof roll the subgrade according to ODOT C&MS 204.06. (See ODOT Manual of Procedures, Section 204 for more information about proof rolling.)
2. If the subgrade ruts more than 1 inch during proof rolling in an area, determine the appropriate depth of undercut for subgrade stabilization by using Figure B from GB 1 (shown below). Undercut to the indicated depth and in the areas where rutting exceeded 1 inch. Replace the undercut materials with ODOT 204, Geotextile Fabric and Granular Material, Type B.

We recommend that for contingency purposes, a sufficient quantity of Item 204, Type B granular material, and geotextile be included in the plans to provide a 12-inch undercut across 50 percent of the pavement area.

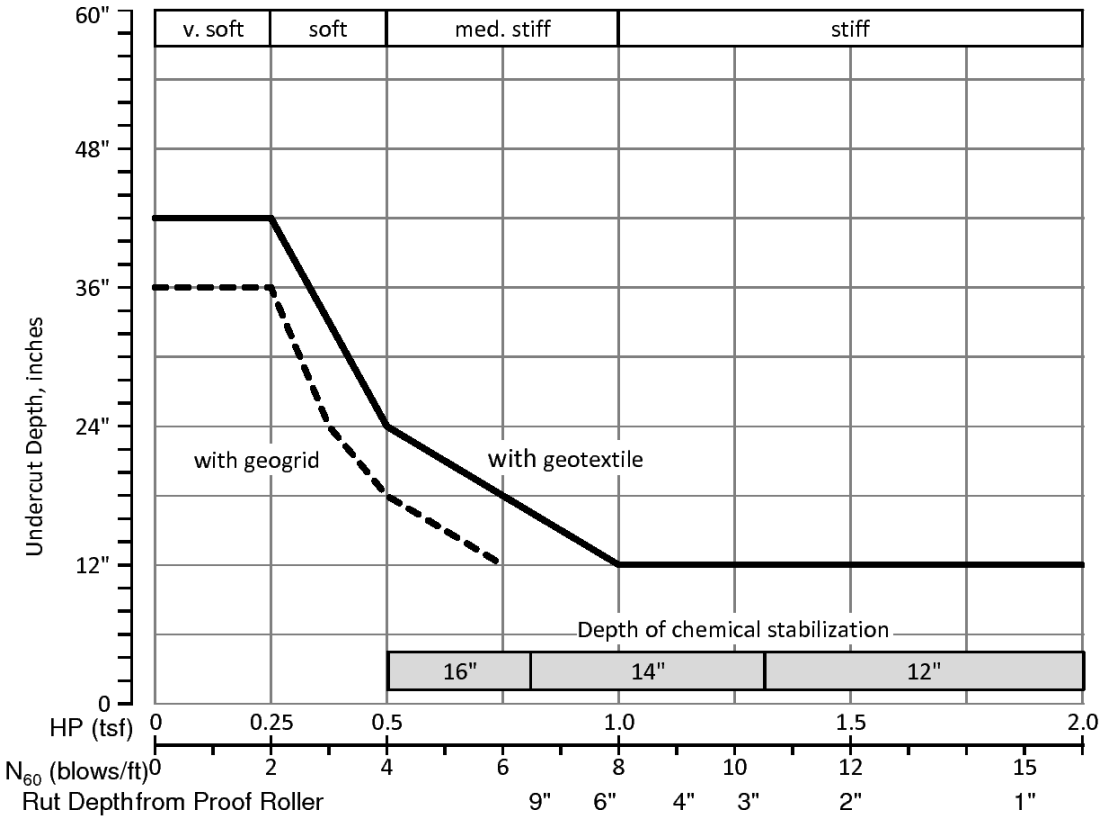


Figure B from ODOT GB 1

Pavement and Subgrade Design Parameters

The following average values are reported for pavement and subgrade design.

Table 2 – Pavement and Subgrade Design Parameters

Average N_{60L}	9
Average Plasticity Index, PI	13.4
Average Design CBR	6

Special Benching

Where the widened embankment will consist of more than a foot of new fill placed on the existing embankment side slope, special benching will be required to ensure the new fill is adequately compacted and stable. The special benching should be performed according to ODOT Geotechnical Bulletin GB 2: *Special Benching and Sidehill Embankment Fills*, which is published by the Ohio Department of Transportation, Office of Geotechnical Engineering (OGE) and last revised on July 17, 2015. The special benching for this project needs to provide a minimum 8-foot horizontal distance between the top of the bench excavation and the final proposed slope face, as shown in the figure below. This allows compaction and grading equipment to work on a level surface at any elevation from the bottom to the top of each bench.

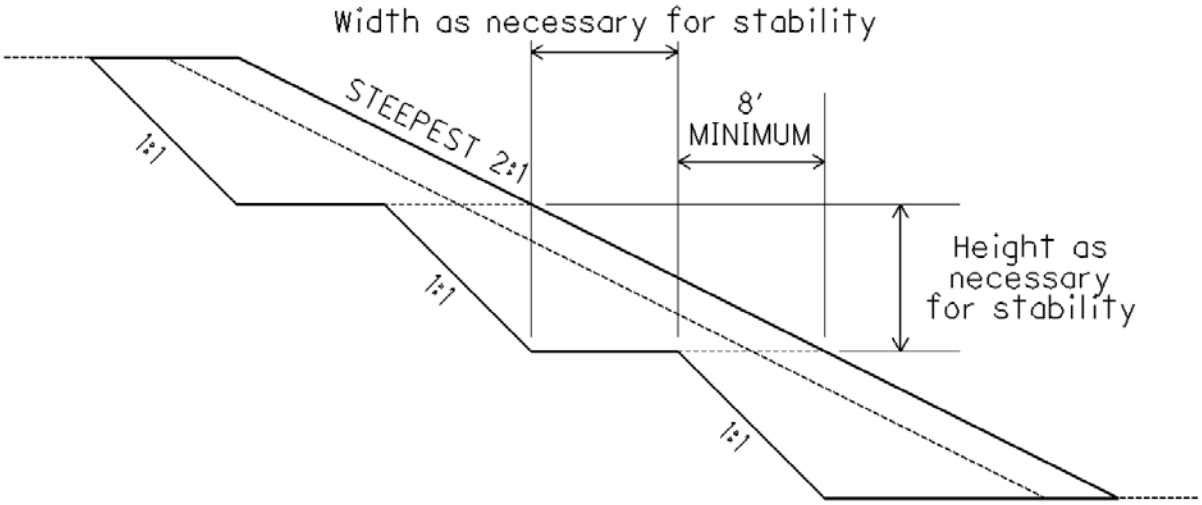


Figure 1 from ODOT GB 2

Foundations

The abutment foundations for the existing bridge are supported on 10BP42 steel piles, which are similar to today's HP 10×42 piles. The existing pier foundations are supported on spread footings with a maximum allowable bearing pressure of 6,000 psf. Even though the piers for the existing bridge are supported on spread footings, we recommend that the proposed piers for the widened structure be supported on piles in order to limit differential settlement between the old and new piers.

Based on the soil and bedrock conditions and the anticipated pile loads (about 350 kips ultimate bearing value), we recommend supporting the proposed widened bridge substructures on H-piles driven to refusal on bedrock. The ultimate bearing values (UBV) and estimated pile lengths for different size pipe piles and H-piles are presented in Table 3 below. To determine the factored resistance of the pipe piles for LRFD design, multiply the UBV by 0.7, which is the resistance factor ODOT uses for piles driven with dynamic load testing. For H-piles driven to refusal, the factored resistance is governed by the structural resistance of the pile. Consequently, the maximum factored resistances for the H-piles are given in the table.

Drilled shaft foundations were also considered but would not be cost effective due to the depth to rock.

Table 3 – Estimated Pile Lengths and Resistances

Substructure	Pile Type	Estimated pile length	Ultimate Bearing Value (Nominal Driving Resistance)	Factored pile resistance
Rear Abutment	12-inch pipe	70 ft	330 kips	231 kips
	14-inch pipe	65 ft	350 kips	245 kips
	HP 10×42	80 ft	N/A	310 kips
Piers	12-inch pipe	56 ft	330 kips	231 kips
	14-inch pipe	56 ft	350 kips	245 kips
	HP 10×42	56 ft	N/A	310 kips
Forward Abutment	12-inch pipe	60 ft	330 kips	231 kips
	14-inch pipe	55 ft	350 kips	245 kips
	HP 10×42	75 ft	N/A	310 kips

The estimated lengths were determined using the software program DRIVEN, by FHWA, and using the soil profile at B-1 for the rear abutment and piers and at B-2 for the forward abutment. The calculations are included in Exhibit D. The calculations present more detailed information about the relationship between pile length and UBV for the pipe piles. The estimated pile length in Table 3 may be adjusted to correspondingly reduce the pile capacity.

Preliminary cross-sections of the proposed widened embankment appear to indicate that a retaining wall will not be required. However, if a retaining wall is required for the shared use path, it may be supported on either pipe piles or H-piles, or may be supported on spread footings, depending on the final height of the wall and the resulting loads on the foundation. We can provide specific foundation recommendations for the retaining wall, if and when more detailed information is available.

VII. Standard of Care and Limitations

The standard of care for the engineering services performed and the consequent information presented in this report are based on the care and skill ordinarily used by reputable members of the engineering professions practicing under similar conditions at similar times and localities. No other warranties, expressed or implied, are made or intended.

The boring logs and related information included in this report are indicators of the subsurface locations only at the specific locations and times noted. In addition, the recommendations in this report are based on a limited number of subsurface samples obtained from widely spaced sampling locations. The samples may not fully indicate the nature and extent of the variations in the subsurface materials that exist between sampling locations, and the passage of time may affect subsurface conditions, including groundwater levels. If during construction conditions are encountered which vary from those presented in this report, notify E.L. Robinson Engineering of the actual conditions so that we may review the conditions encountered and, if necessary, modify our recommendations.

EXHIBITS

EXHIBIT A GEOLOGY OF PROJECT SITE

EXHIBIT B BORING LOCATION PLAN & BORING LOGS

EXHIBIT C ODOT GB-1 SUBGRADE ANALYSIS

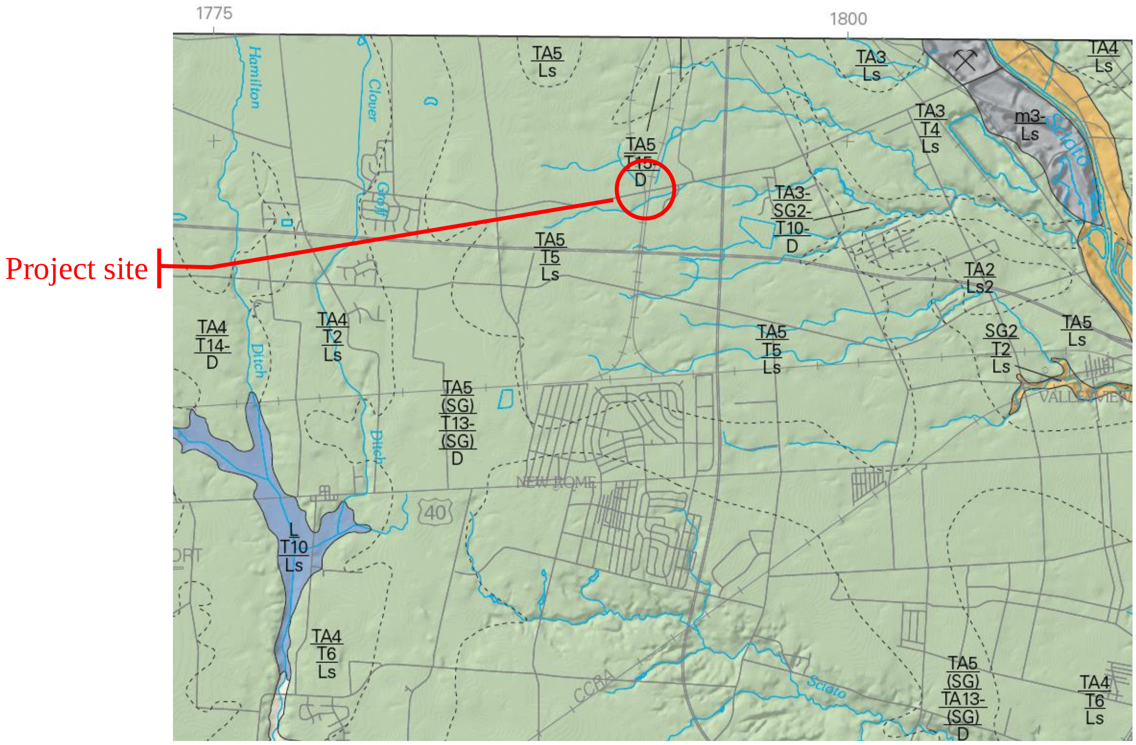
EXHIBIT D PILE CALCULATIONS

Exhibit A Geology of Project Site

Ohio Division of Geological Survey, Map No. SG-2

Surficial Geology of the Springfield 30×60 Minute Quadrangle

2005



Legend

Numbers represent the average thickness in tens of feet (3 represents 30 ft). If no number is present, the average thickness is assumed to be 1 (10 ft). The thickness may vary up to 50 percent, so T4 indicates an average thickness of 40 ft, but may vary from 20 to 60 ft. Parentheses indicate that a unit has patchy distribution and is missing in portions of that map-unit area.

Surficial Units

TA — Loam till, high carbonate content, Wisconsinan-age. May contain silt, sand, and gravel lenses. Joints/ fractures common. Darby and Caesar Tills. Common surface till.

T — Till, undifferentiated subsurface till, unspecified age. Separated from overlying till unit by its greater density (“hardpan”) or intervening non-till units.

Bedrock Units

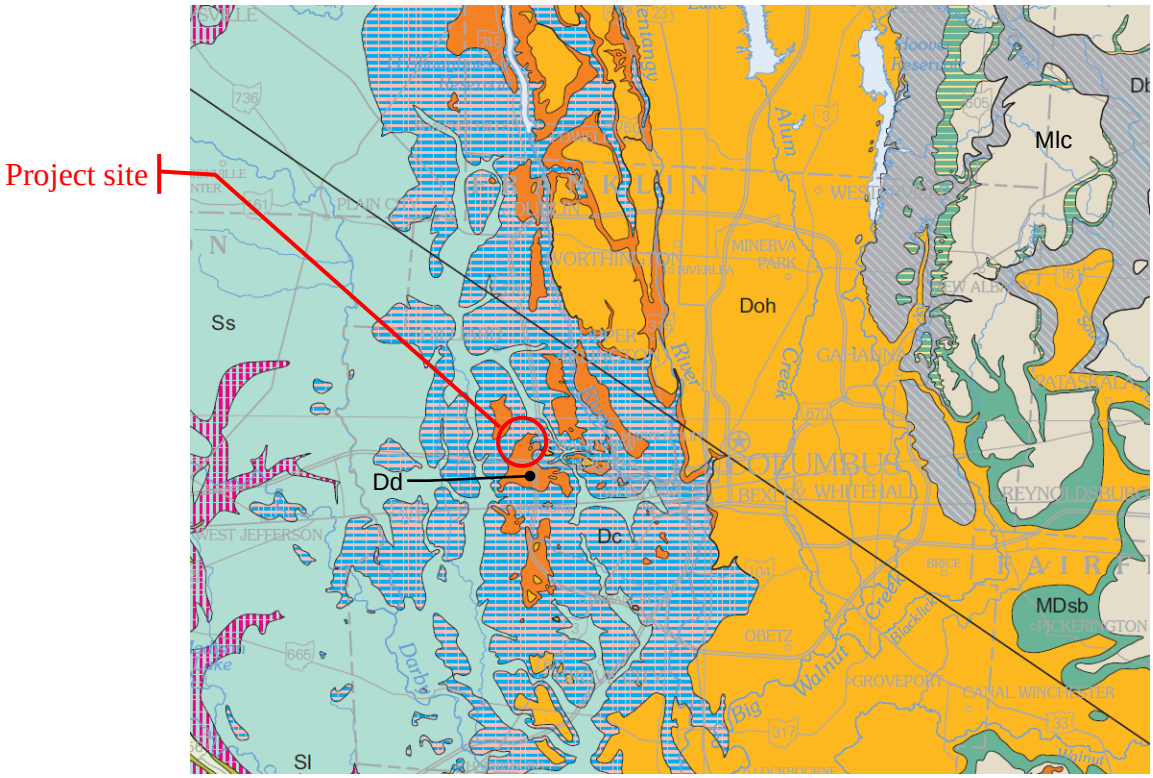
Ls — Limestone and dolomite bedrock, Devonian-age. Limestone and dolomite, thin to massive bedded, fossiliferous, may be cherty. Contains areas of well-developed karst topography; buried upper surface may be rubbley and include thick red clay. Source of aggregate. Columbus and overlying Delaware Limestones

D — Dolomite bedrock, Silurian- and/or Devonian-age. Dolomite, thin to massive bedded and rare dolomitic shale, thin to thick bedded. Contains solution features; buried upper surface may be rubbley and include thick red clay.

Ohio Division of Geological Survey, Map BG-1

Bedrock Geologic Map of Ohio

2006



Legend

Devonian Period (416 million years old)

Doh (Light orange) Ohio Shale – Unit consists generally of three members, in descending order: Cleveland, Chagrin, and Huron Members. Cleveland Member, shale; black. Chagrin Member, shale, siltstone, and very fine-grained sandstone; gray to greenish gray. Huron Member, shale; mostly black; carbonaceous; calcareous concretions common in lower portion.

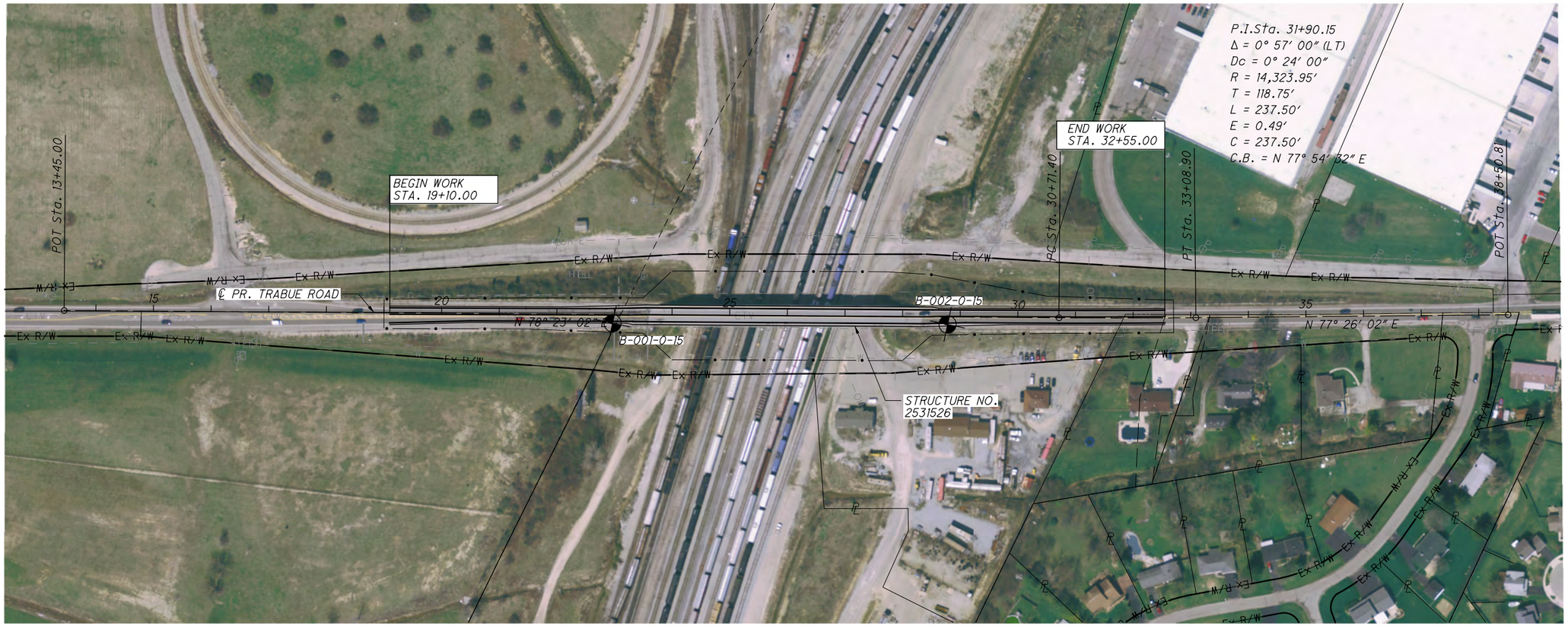
Dd (Dark orange) Delaware Limestone – Limestone, bluish gray; mostly in thin to medium beds with argillaceous partings; dolomitic; contains nodules and layers of chert.

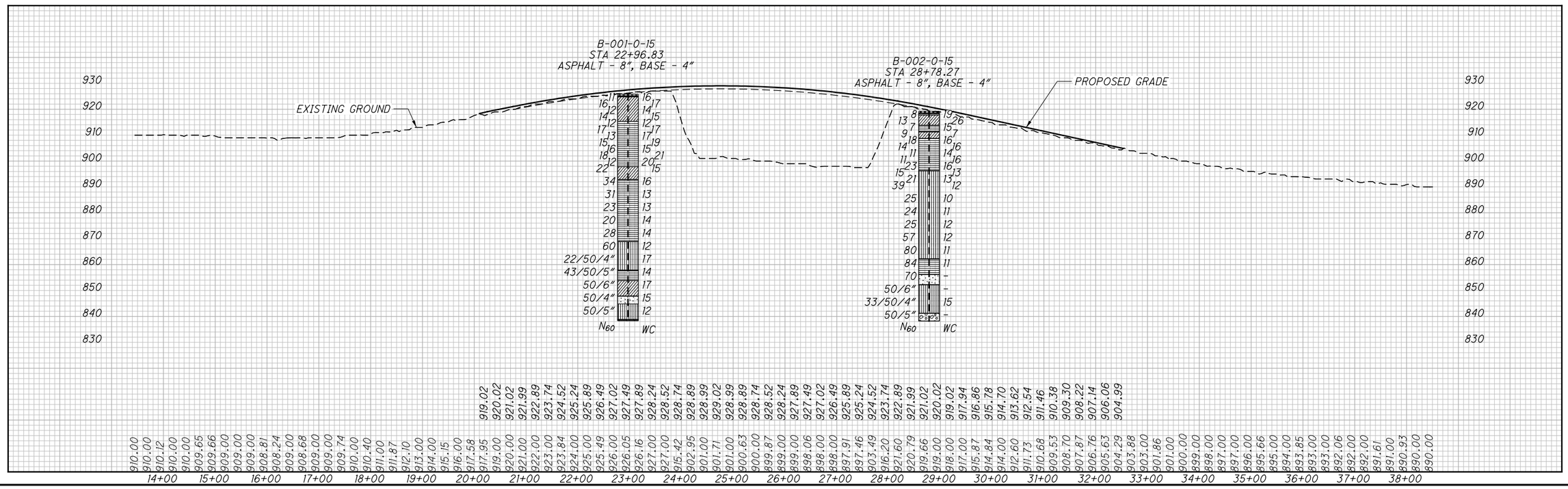
Dc (Pink and blue horizontal stripe) Columbus Limestone – Limestone and dolomite. Unit consists of two members: Delhi and Bellepoint. Delhi Member, limestone; light gray; finely to coarsely crystalline; mostly in irregular, fossiliferous beds; occasional chert nodules. Bellepoint Member, dolomite; shades of brown; finely crystalline; limy; mostly in massive beds; contains some nodules of chert and crystalline calcite; commonly contains a silicified-pebble conglomerate layer, and locally quartzose sandstone, at base of unit in central portion of state.

Silurian Period (443 million years old)

Ss (Light blue green) Salina Group – Dolomite, anhydrite, gypsum, and shale. Dolomite, shades of gray and brown; very finely crystalline; mostly in thin to medium beds and laminae; locally includes shale, anhydrite, and/or gypsum beds and laminae.

Exhibit B Boring Location Plan & Boring Logs





HORIZONTAL SCALE IN FEET
0 50 100 200

CALCULATED LJS
CHECKED PAN

TRABUE ROAD
SOIL PLAN AND PROFILE

FRA-CR27-7.85

P:\15125\Design\Geotechnical\Sheets\15125GP101.dgn 2/26/2016 3:27:27 PM pnarsavage

PROJECT: FRA-TRABUE-7.85	DRILLING FIRM / OPERATOR: DHDC / DON	DRILL RIG: CME 45B	STATION / OFFSET: 22+97, 15' RT.	EXPLORATION ID B-001
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: DHDC / A. CETINTAS	HAMMER: SAFETY HAMMER	ALIGNMENT:	
PID: SFN: 2531526 (E)	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: N/A	ELEVATION: 925.8 (MSL) EOB: 87.5 ft.	PAGE 1 OF 3
START: 10/21/15 END: 10/21/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 60	LAT / LONG: 39.983226, -83.130260	

MATERIAL DESCRIPTION AND NOTES	ELEV. 925.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (8")	925.0																	
GRANULAR BASE (4")	924.8																	
FILL: Stiff and occasionally very stiff, Dark brown to brown, **SILT** and **CLAY** (A-6a), with trace to little sand and gravel, Moist ...light organic odor and staining... ...occasional rock to coarse gravel...		1 2 3 4 5 6 7 8 9 10	4 5 6	11	44	SS-1	-	-	-	-	-	-	32	17	15	16		
			5 8 8	16	72	SS-2	-	-	-	-	-	-	33	19	14	17		
...organics = 3%			3 6 6	12	11	SS-3	-	-	-	-	-	-	-	-	-	14		
			5 6 8	14	50	SS-4	-	-	-	-	-	-	-	-	-	15		
	915.3																	
FILL: Stiff and occasionally very stiff, Mottled brown and gray,**SILTY CLAY** (A-6b), with trace to little sand ...light organic odor and staining...		11 12 13 14 15 16 17 18 19 20 21 22	5 5 7	12	100	SS-5	2.00	-	-	-	-	-	-	-	-	12		
...organics= 4%...			5 7 10	17	100	SS-6	3.00	-	-	-	-	-	38	20	18	17		
			4 5 8	13	78	SS-7	2.75	-	-	-	-	-	-	-	-	17		
			5 5 10	15	100	SS-8	2.25	-	-	-	-	-	-	-	-	19		
			4 7 9	16	83	SS-9	-	-	-	-	-	-	-	-	-	15		
	902.8																	
FILL: Very stiff, Dark bluish brown, **SILTY CLAY** (A-6b), with some sand and gravel, Moist ...moderate organic odor and staining... ...interbedded dark gray stained layers...		23 24 25	6 7 11	18	100	SS-10	-	12	6	9	45	28	34	18	16	21	A-6b (10)	
...organics = 3%...	900.3																	
FILL: Very stiff, Mottled brown and gray, **SILTY CLAY** (A-6b), with trace to little sand and gravel, Moist ...buried decompaosed small piece of wood in sample #11...	897.8	26 27 28	2 5 7	12	100	SS-11	3.00	-	-	-	-	-	-	-	-	20		
Very stiff, Grayish brown, **SILT** and**CLAY** (A-6a), with little sand and trace gravel [glacial till], Moist ...silty sand (A-3a) layer at about 32.0 feet...		29	6 11 11	22	100	SS-12	3.00	6	6	10	42	36	31	17	14	15	A-6a (10)	

PID:	SFN: 2531526 (E)	PROJECT: FRA-TRABUE-7.85	STATION / OFFSET: 22+97, 15' RT.	START: 10/21/15	END: 10/21/15	PG 2 OF 3	B-001

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
Very stiff, Grayish brown, **SILT** and**CLAY** (A-6a), with little sand and trace gravel [glacial till], Moist ...silty sand (A-3a) layer at about 32.0 feet... *(continued)*	895.8																	
...Groundwater encountered at 32.0 feet...		W																
Hard, Gray, **SILTY CLAY** (A-6b), [glacial till], Moist	892.3		10 17 17	34	89	SS-13	4.00	-	-	-	-	-	-	-	-	16		
...occasional coarse gravel and cobble...			7 14 17	31	100	SS-14	4.00	-	-	-	-	-	-	-	-	13		
			10 11 12	23	100	SS-15	3.00	10	9	16	37	28	32	15	17	13	A-6b (9)	
			5 8 12	20	100	SS-16	2.00	-	-	-	-	-	-	-	-	14		
			7 12 16	28	100	SS-17	2.50	-	-	-	-	-	-	-	-	14		
Hard, Gray, **SANDY SILT** (A-4a), with little sand and gravel [glacial till], Moist	868.8																	
...gray medium **SAND** (A-3a), with little sand layer at about 59 to 60 feet...			12 22 38	60	100	SS-18	4.00	7	6	15	42	30	23	15	8	12	A-4a (7)	

PID:	SFN: 2531526 (E)	PROJECT: FRA-TRABUE-7.85	STATION / OFFSET: 22+97, 15' RT.	START: 10/21/15	END: 10/21/15	PG 3 OF 3	B-001

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
Hard, Gray, **SANDY SILT** (A-4a), with little sand and gravel [glacial till], Moist *(continued)*	863.7	63																
		64	22 50/4"	-	100	SS-19	4.00	-	-	-	-	-	-	-	-	17		
		65																
		66																
		67																
	857.8	68																
Hard, Bluish brownish gray, **SILTY CLAY** (A-6b), with little sand and gravel [glacial till], Moist		69	43 50/5"	-	91	SS-20	4.5+	-	-	-	-	-	-	-	-	14		
		70																
		71																
	853.8	72																
Hard, Mottled brown and gray, **SILT** and **CLAY** (A-6a), with little sand and gravel [glacial till], Moist		73																
		74	50	-	100	SS-21	3.50	-	-	-	-	-	-	-	-	17		
		75																
		76																
		77																
	847.8	78																
Dense, Gray, fine to coarse **SAND** (A-3a), with trace silt, Saturated		79	50/4"	-	100	SS-22	-	-	-	-	-	-	-	-	-	15		
	844.8	80																
Hard, Gray, **SANDY SILT** (A-4a), with trace to little gravel, [glacial till], Moist		81																
		82																
		83																
		84	50/5"	-	100	SS-23	4.5+	14	9	20	43	14	18	14	4	12	A-4a (4)	
		85																
		86																
	838.8	87																
Gray, weathered **LIMESTONE**	838.3	TR EOB																
Boring discontinued at 87.5 feet due to auger refusal at 87.7 feet. Boring caved at 67 feet.																		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 2/29/16 16:20 - P:\15125\DESIGN\GEOTECHNICAL\ENGDATA\GINT\FRA-TRABUE-7.85V2.GPJ

PROJECT: FRA-TRABUE-7.85	DRILLING FIRM / OPERATOR: DHDC / DON	DRILL RIG: CME 45B	STATION / OFFSET: 28+78, 13' RT.	EXPLORATION ID B-002
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: ODOT / A. CETINTAS	HAMMER: SAFETY HAMMER	ALIGNMENT:	
PID: SFN: 2531526 (E)	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: N/A	ELEVATION: 919.2 (MSL) EOB: 81.0 ft.	PAGE 1 OF 3
START: 10/29/15 END: 10/30/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 60	LAT / LONG: 39.983564, -83.128233	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
ASPHALT (8")	919.2																	
GRANULAR BASE (4")	918.4																	
FILL: Brown, medium **SAND** (A-3a), with trace silt and gravel, Moist	918.2																	
FILL: Medium stiff to very stiff, Dark brown with trace gray, **SILT** and **CLAY** (A-6a), with trace sand and gravel, Moist ...light organic odor and staining...	917.7	1	9 6 2	8	44	SS-1	-	-	-	-	-	-	29	17	12	19		
		2																
		3																
		4	4 5 8	13	100	SS-2	3.00	-	-	-	-	-	40	29	11	26		
	913.7	5																
FILL: Medium stiff, Mottled brown and gray, **SILTY CLAY** (A-6b), with trace sand and gravel, Moist		6																
		7	2 3 4	7	78	SS-3	2.00	-	-	-	-	-	-	-	-	15		
	911.2	8																
FILL: Medium stiff, Dark bluish brown, **SILT** and **CLAY** (A-6a), with trace to little sand and gravel, Moist ...Light organic odor and staining... ...organics=2%...		9	2 4 5	9	100	SS-4	2.00	-	-	-	-	-	35	20	15	7		
	908.7	10																
FILL: Stiff and occasionally very stiff, Mottled brown and gray with spotty bluish gray, **SILTY CLAY** (A-6b), with trace to little sand and gravel, Moist ...light to moderate organic odor and staining... ...deeper samples contained higher concentration of organic staining...		11	6 8 10	18	28	SS-5	-	-	-	-	-	-	-	-	-	16		
		12																
		13																
		14	4 7 7	14	100	SS-6	3.00	-	-	-	-	-	-	-	-	16		
		15																
		16																
		17	3 5 6	11	94	SS-7	3.00	-	-	-	-	-	-	-	-	14		
		18																
...organics=2%...		19	3 5 6	11	100	SS-8	3.00	-	-	-	-	-	37	20	17	16		
		20																
		21																
		22	9 12 11	23	100	SS-9	3.00	-	-	-	-	-	-	-	-	16		
...asphalt fragments in sample #9...	896.2	23																
Stiff to hard, Mottled brown and gray, **SANDY SILT** (A-4a), with trace sand and gravel, Moist		24	3 6 9	15	78	SS-10	4.00	-	-	-	-	-	-	-	-	13		
		25																
		26																
		27	9 9 12	21	100	SS-11	4.00	-	-	-	-	-	-	-	-	13		
		28																
		29	25 30 9	39	72	SS-12	-	20	17	16	29	18	22	14	8	12	A-4a (2)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 2/29/16 16:20 - P:\15125\DESIGN\GEOTECHNICAL\ENGDATA\GINT\FRA-TRABUE-7.85V2.GPJ

PID:	SFN: 2531526 (E)	PROJECT: FRA-TRABUE-7.85	STATION / OFFSET: 28+78, 13' RT.	START: 10/29/15	END: 10/30/15	PG 2 OF 3	B-002

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
Stiff to hard, Mottled brown and gray, **SANDY SILT** (A-4a), with trace sand and gravel, Moist *(continued)*	889.2	31																
	887.2	32																
Very stiff, Dark brown, **SANDY SILT** (A-4a), with little sand and gravel [glacial till], Moist		33																
		34	9 10 15	25	100	SS-13	-	15	11	15	39	20	24	14	10	10	A-4a (5)	
	883.2	35																
Very stiff to hard, Bluish gray, **SANDY SILT** (A-4a), with little gravel [glacial till], Moist		36																
...occasional coarse gravel and cobble...		37																
		38																
		39	7 10 14	24	100	SS-14	4.00	-	-	-	-	-	-	-	-	11		
		40																
		41																
		42																
		43																
		44	6 11 14	25	100	SS-15	3.00	20	7	14	37	22	24	14	10	12	A-4a (5)	
		45																
		46																
		47																
		48																
		49	17 26 31	57	100	SS-16	4.5+	-	-	-	-	-	-	-	-	12		
		50																
		51																
		52																
	866.2	53																
Hard, Gray, **SANDY SILT** (A-4a), Moist		54	19 30 50	80	100	SS-17	4.5+	15	6	27	25	27	22	13	9	11	A-4a (3)	
		55																
		56																
	862.2	57																
Hard, Gray, **SILTY CLAY** (A-6b), with little sand and gravel [glacial till], Moist		58																
		59	27 34 50	84	100	SS-18	4.5+	-	-	-	-	-	-	-	-	11		
		60																
		61																

PID:	SFN: 2531526 (E)	PROJECT: FRA-TRABUE-7.85	STATION / OFFSET: 28+78, 13' RT.	START: 10/29/15	END: 10/30/15	PG 3 OF 3	B-002

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
	857.1																	
	856.2	63																
Dense, Gray, well graded **SAND** (A-3a), with gravel, Saturated		64	6 25 45	70	100	SS-19	-	30	9	46	10	5	-	-	-	-		
	852.2	65																
Hard, Gray, **SANDY SILT** (A-4a), interbedded thin layer of **SILTY CLAY** (A-6b), and little to some gravel, [glacial till], Moist ...with interbedded sand and gravel seams to layers...		66																
		67																
		68																
		69	50/6"	-	91	SS-20	-	13	8	12	40	27	25	15	10	15	A-4a (6)	
		70																
		71																
		72																
		73																
		74	33 50/4"	-	40	SS-21	-	-	-	-	-	-	-	-	-	-		
		75																
		76																
		77																
	841.2	78																
A mixture of gray, **SAND, GRAVEL, COBBLE** (possible rock fragments), Saturated		79	50/5"	-	0		-	-	-	-	-	-	-	-	-	-		
	838.2	80																
		EOB 81																

Boring discontinued at 81.0 feet due to auger refusal.
Boring caved at 59.5 feet.

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

Exhibit C ODOT GB-1 Subgrade Analysis

Subgrade Analysis

V. 13.00 01/15/16

Design CBR 6

Global Options		
320	R&R	No
206	CS	Option
	LS	No
206	Depth	12

Classification Counts by Sample																
R	1a	1b	3	3a	2-4	2-5	2-6	2-7	4a	4b	5	6a	6b	7-5	7-6	8a	8b
0	0	0	0	0	0	0	0	0	0	0	0	7	1	0	0	0	0
												88%	13%				
0%	0%								100%								

Surface Class		
2-5	0	
4b	0	
5	0	
7-5	0	
7-6	0	
8a	0	
8b	0	
R	0	

% Borings	
N_{60L}<= 5	0%
<=10	50%
>=20	0%
M+	50%
R	0%

% Surface	
100%	
0%	100%

UC @ Surface
Undercut
12.0
12
12

Rig	ER
A	60
B	
C	
D	
E	
F	
G	
H	

Total Borings	2
PID	
Location	FRA-Trabue Road

	N_{60}	N_{60L}		PI		Clay		M	M_{OPT}		GI
Average	11.3	9.0		13.4		45.0		16.1	15.6		9.25
Maximum	16	11	40	29	15	30	45	75	26	24	10
Minimum	7	7	29	17	11	30	45	75	7	14	8

	Boring					Subgrade		Standard Penetration						Physical Characteristics						Moisture		Class		Sulfate		Problem		Undercuts		Analysis / Comments
#	B #	Boring Location	Depth	To	Cut Fill	Depth	To	n_2	n_3	N	Rig	N_{60}	N_{60L}	LL	PL	PI	% Silt	% Clay	P 200	M	M_{OPT}	Ohio DOT	GI			w/ Class	w/ MN	UC Class	UC MN	
1	B-1	West abutment	1.0	2.5	0.0	1.0	2.5	5	6	11	A	11		32	17	15	30	45	75	16	14	6a	10				N		12	
			3.5	5.0		3.5	5.0	8	8	16		16		33	19	14	30	45	75	17	14	6a	10							
			6.0	7.5		6.0	7.5	6	6	12		12					30	45	75	14	14	6a								
			8.5	10.0		8.5	10.0	6	8	14		14	11				30	45	75	15	14	6a								
2	B-2	East abutment	1.0	2.5	0.0	1.0	2.5	6	2	8	A	8		29	17	12	30	45	75	19	14	6a	9				N		12	
			3.5	5.0		3.5	5.0	5	8	13		13		40	29	11	30	45	75	26	24	6a	8							
			6.0	7.5		6.0	7.5	3	4	7		7					30	45	75	15	16	6b					N		15	
			8.5	10.0		8.5	10.0	4	5	9		9	7	35	20	15	30	45	75	7	15	6a					N		12	
3					0.0						A																			
4					0.0						A																			
5					0.0						A																			
6					0.0						A																			
7					0.0						A																			
8					0.0						A																			
9					0.0						A																			
10					0.0						A																			

Percent passing 200 values are estimated.

Exhibit D Pile Calculations

E.L. ROBINSON
ENGINEERING

Computation for **Estimated pile lengths**
FRA-Trabue Road

Project Name **FRA-Trabue Road**

Project Number **ELR 15125**

Designer	**PAN**	Date	**March 1, 2016**
Checker	JN	Date	3/2/2016
Updater		Date	
Rechecker		Date	

File Names

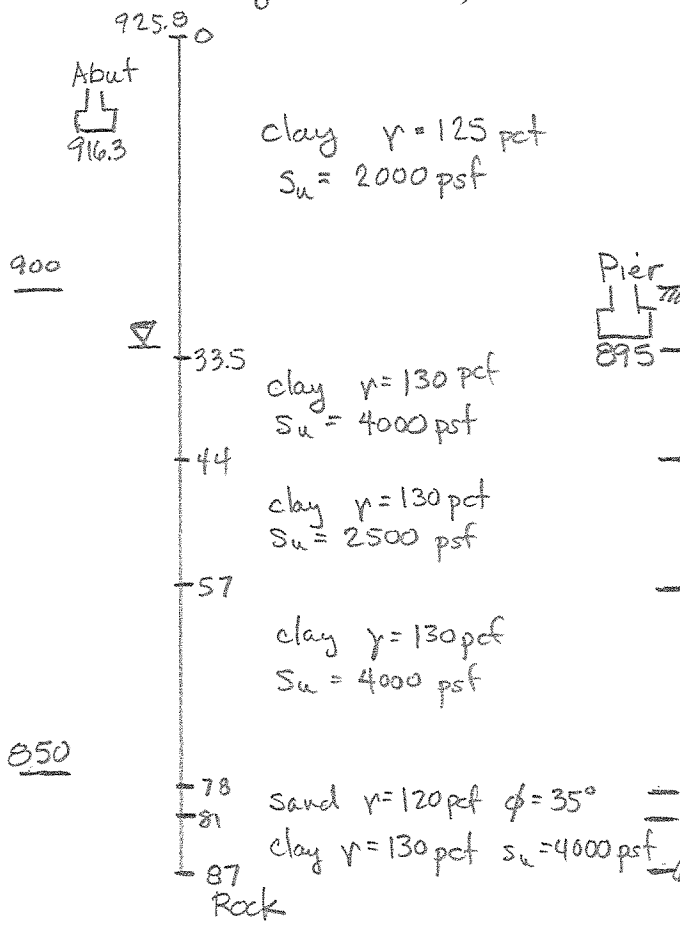
Comments

E.L. ROBINSON
ENGINEERING
1801 Watermark Drive, Suite 310 • Columbus, Ohio 43215
614-586-0642 • Fax 614-586-0648

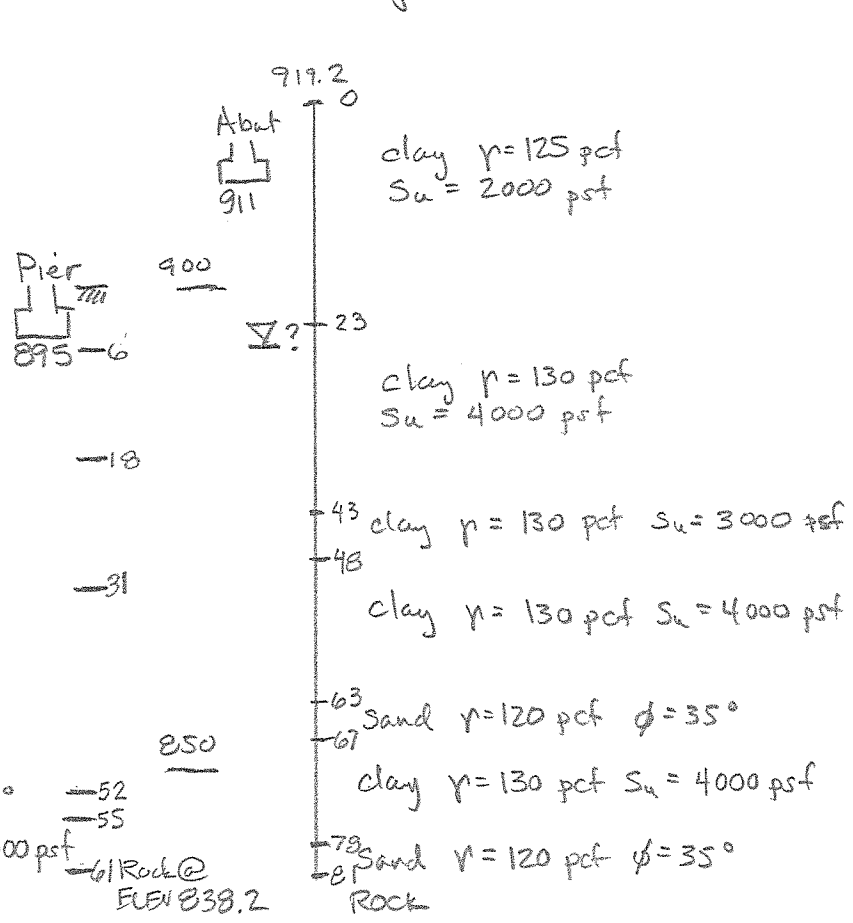
JOB FRA - Trabue Road
SHEET NO 1 OF 1
CALCULATED BY PAN DATE 3/1/2016
CHECKED BY JN DATE 3/2/2016
SCALE

Soil Profile for Driven Pile Analysis

Boring B-1 (Rear)



Boring B-2 (Fwd)



Pier

USE B-1 FOR PIERS AS MORE CONSERVATIVE

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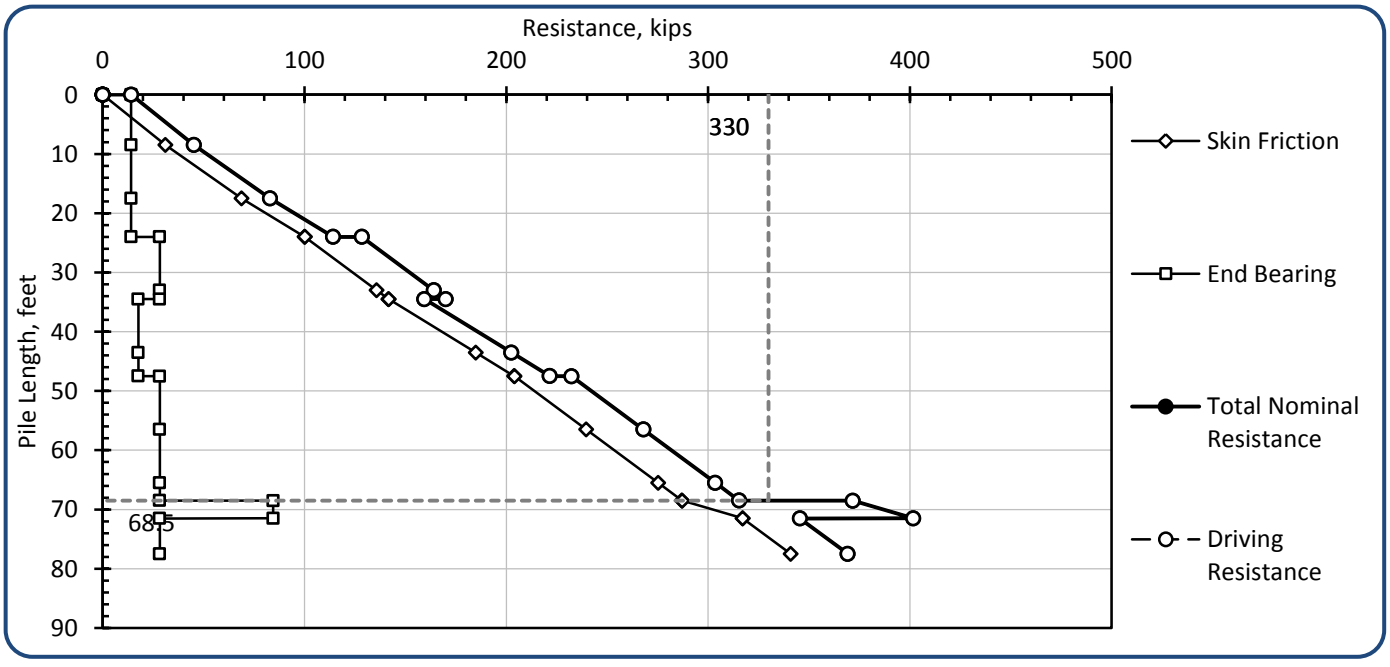
JOB	FRA-Trabue Road ELR 15125		
SHEET NO	2	OF	7
CALCULATED BY	PAN	DATE	3/1/2016
CHECKED BY	JN	DATE	3/2/2016
SUBJECT	FRA-Trabue Road		

Estimated Pile Resistances and Lengths

From DRIVEN analysis

Substructure	Rear Abut	UBV during driving	330 Kips
Boring	B-1	Estimated length	68.5 ft
Pile type	12" pipe	Nominal resistance after setup	330 Kips
Depth to top of pile	9.5 ft		

Depth	Skin Friction	End Bearing	Total Nominal Resistance	Driving Resistance	Pile Length
0.01 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
9.01 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
9.49 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
9.5 ft	0 Kips	14.14 Kips	14.14 Kips	14.14 Kips	0 ft
18.01 ft	31.15 Kips	14.14 Kips	45.28 Kips	45.28 Kips	8.51 ft
27.01 ft	68.91 Kips	14.14 Kips	83.04 Kips	83.04 Kips	17.51 ft
33.49 ft	100.1 Kips	14.14 Kips	114.24 Kips	114.24 Kips	23.99 ft
33.51 ft	100.19 Kips	28.27 Kips	128.46 Kips	128.46 Kips	24.01 ft
42.51 ft	135.82 Kips	28.27 Kips	164.09 Kips	164.09 Kips	33.01 ft
43.99 ft	141.68 Kips	28.27 Kips	169.95 Kips	169.95 Kips	34.49 ft
44.01 ft	141.77 Kips	17.67 Kips	159.44 Kips	159.44 Kips	34.51 ft
53.01 ft	184.88 Kips	17.67 Kips	202.55 Kips	202.55 Kips	43.51 ft
56.99 ft	203.95 Kips	17.67 Kips	221.62 Kips	221.62 Kips	47.49 ft
57.01 ft	204.04 Kips	28.27 Kips	232.31 Kips	232.31 Kips	47.51 ft
66.01 ft	239.66 Kips	28.27 Kips	267.94 Kips	267.94 Kips	56.51 ft
75.01 ft	275.29 Kips	28.27 Kips	303.56 Kips	303.56 Kips	65.51 ft
77.99 ft	287.09 Kips	28.27 Kips	315.36 Kips	315.36 Kips	68.49 ft
78.01 ft	287.22 Kips	84.51 Kips	371.73 Kips	371.73 Kips	68.51 ft
80.99 ft	317.11 Kips	84.51 Kips	401.62 Kips	401.62 Kips	71.49 ft
81.01 ft	317.25 Kips	28.27 Kips	345.53 Kips	345.53 Kips	71.51 ft
86.99 ft	340.92 Kips	28.27 Kips	369.2 Kips	369.2 Kips	77.49 ft



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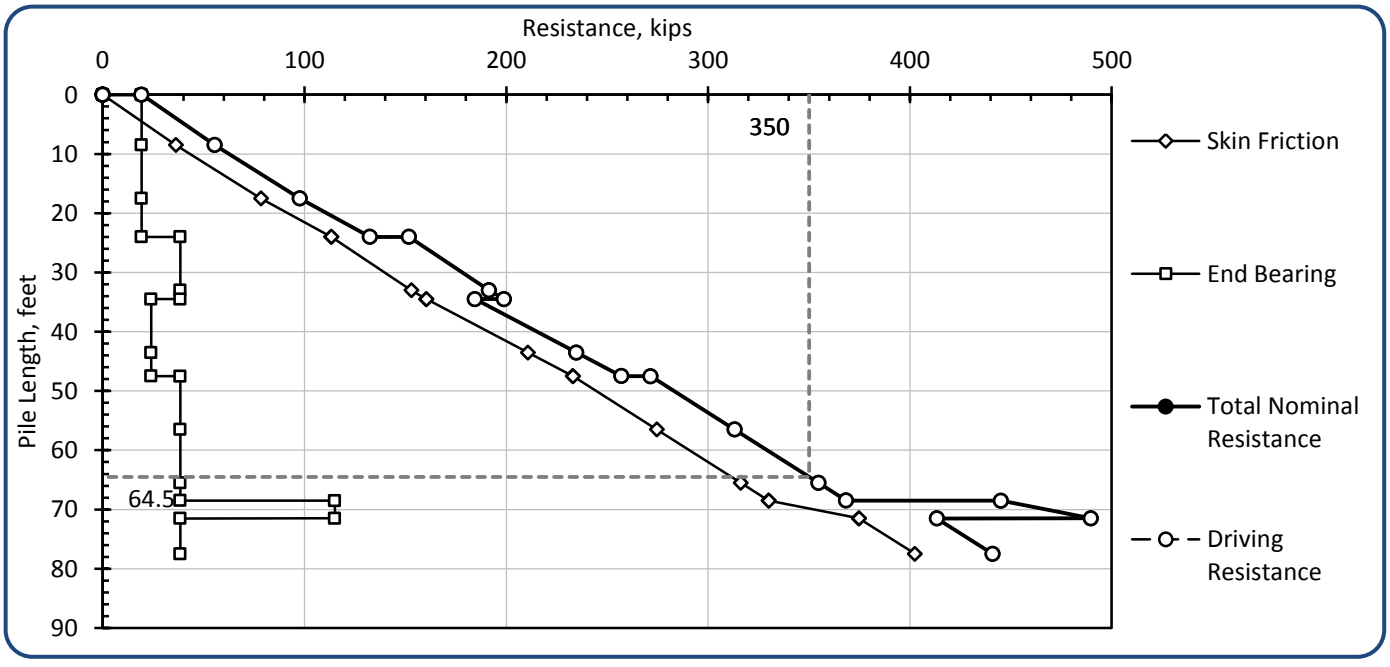
JOB FRA-Trabue Road ELR 15125
SHEET NO 3 OF 7
CALCULATED BY PAN DATE 3/1/2016
CHECKED BY JN DATE 3/2/2016
SUBJECT FRA-Trabue Road

Estimated Pile Resistances and Lengths

From DRIVEN analysis

Substructure	Rear Abut		UBV during driving	350	Kips
Boring	B-1		Estimated length	64.5	ft
Pile type	14" pipe		Nominal resistance after setup	350	Kips
Depth to top of pile	9.5	ft			

Depth	Skin Friction	End Bearing	Total Nominal Resistance	Driving Resistance	Pile Length
0.01 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
9.01 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
9.49 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
9.5 ft	0 Kips	19.24 Kips	19.24 Kips	19.24 Kips	0 ft
18.01 ft	36.34 Kips	19.24 Kips	55.58 Kips	55.58 Kips	8.51 ft
27.01 ft	78.52 Kips	19.24 Kips	97.76 Kips	97.76 Kips	17.51 ft
33.49 ft	113.27 Kips	19.24 Kips	132.51 Kips	132.51 Kips	23.99 ft
33.51 ft	113.37 Kips	38.48 Kips	151.85 Kips	151.85 Kips	24.01 ft
42.51 ft	153.02 Kips	38.48 Kips	191.5 Kips	191.5 Kips	33.01 ft
43.99 ft	160.33 Kips	38.48 Kips	198.82 Kips	198.82 Kips	34.49 ft
44.01 ft	160.44 Kips	24.05 Kips	184.49 Kips	184.49 Kips	34.51 ft
53.01 ft	210.74 Kips	24.05 Kips	234.79 Kips	234.79 Kips	43.51 ft
56.99 ft	232.99 Kips	24.05 Kips	257.04 Kips	257.04 Kips	47.49 ft
57.01 ft	233.09 Kips	38.48 Kips	271.57 Kips	271.57 Kips	47.51 ft
66.01 ft	274.65 Kips	38.48 Kips	313.14 Kips	313.14 Kips	56.51 ft
75.01 ft	316.22 Kips	38.48 Kips	354.7 Kips	354.7 Kips	65.51 ft
77.99 ft	329.98 Kips	38.48 Kips	368.46 Kips	368.46 Kips	68.49 ft
78.01 ft	330.17 Kips	115.03 Kips	445.2 Kips	445.2 Kips	68.51 ft
80.99 ft	374.67 Kips	115.03 Kips	489.7 Kips	489.7 Kips	71.49 ft
81.01 ft	374.87 Kips	38.48 Kips	413.35 Kips	413.35 Kips	71.51 ft
86.99 ft	402.49 Kips	38.48 Kips	440.97 Kips	440.97 Kips	77.49 ft



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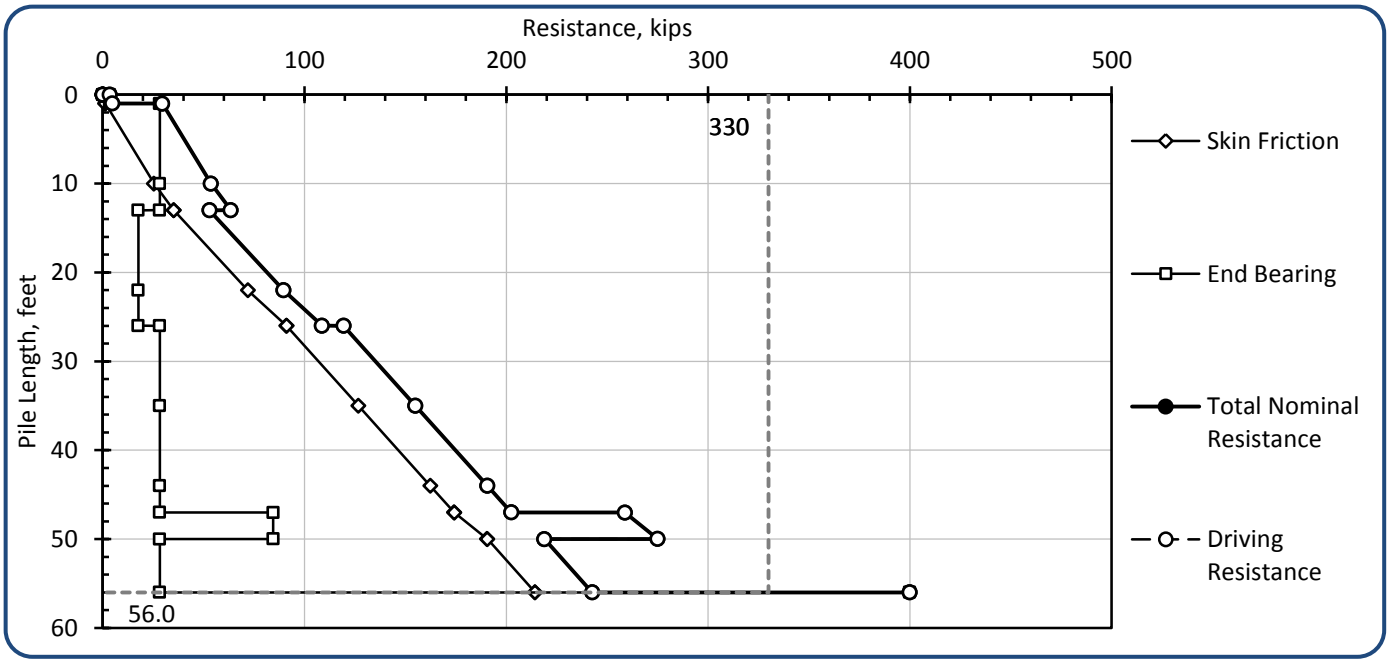
JOB FRA-Trabue Road ELR 15125
SHEET NO 4 OF 7
CALCULATED BY PAN DATE 3/1/2016
CHECKED BY JN DATE 3/2/2016
SUBJECT FRA-Trabue Road

Estimated Pile Resistances and Lengths

From DRIVEN analysis

Substructure	Pier	UBV during driving	330	Kips
Boring	B-1	Estimated length	56.0	ft
Pile type	12" pipe	Nominal resistance after setup	330	Kips
Depth to top of pile	5 ft			

Depth	Skin Friction	End Bearing	Total Nominal Resistance	Driving Resistance	Pile Length
0.01 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
4.99 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
5 ft	0 Kips	3.53 Kips	3.53 Kips	3.53 Kips	0 ft
5.99 ft	1.28 Kips	3.53 Kips	4.81 Kips	4.81 Kips	0.99 ft
6.01 ft	1.31 Kips	28.27 Kips	29.59 Kips	29.59 Kips	1.01 ft
15.01 ft	25.4 Kips	28.27 Kips	53.67 Kips	53.67 Kips	10.01 ft
17.99 ft	35.21 Kips	28.27 Kips	63.48 Kips	63.48 Kips	12.99 ft
18.01 ft	35.28 Kips	17.67 Kips	52.95 Kips	52.95 Kips	13.01 ft
27.01 ft	71.97 Kips	17.67 Kips	89.65 Kips	89.65 Kips	22.01 ft
30.99 ft	91.04 Kips	17.67 Kips	108.71 Kips	108.71 Kips	25.99 ft
31.01 ft	91.13 Kips	28.27 Kips	119.4 Kips	119.4 Kips	26.01 ft
40.01 ft	126.76 Kips	28.27 Kips	155.03 Kips	155.03 Kips	35.01 ft
49.01 ft	162.38 Kips	28.27 Kips	190.66 Kips	190.66 Kips	44.01 ft
51.99 ft	174.18 Kips	28.27 Kips	202.45 Kips	202.45 Kips	46.99 ft
52.01 ft	174.27 Kips	84.51 Kips	258.78 Kips	258.78 Kips	47.01 ft
54.99 ft	190.55 Kips	84.51 Kips	275.06 Kips	275.06 Kips	49.99 ft
55.01 ft	190.65 Kips	28.27 Kips	218.92 Kips	218.92 Kips	50.01 ft
60.99 ft	214.32 Kips	28.27 Kips	242.59 Kips	242.59 Kips	55.99 ft
61	214.32 Kips	400 Kips	400 Kips	400 Kips	56 ft



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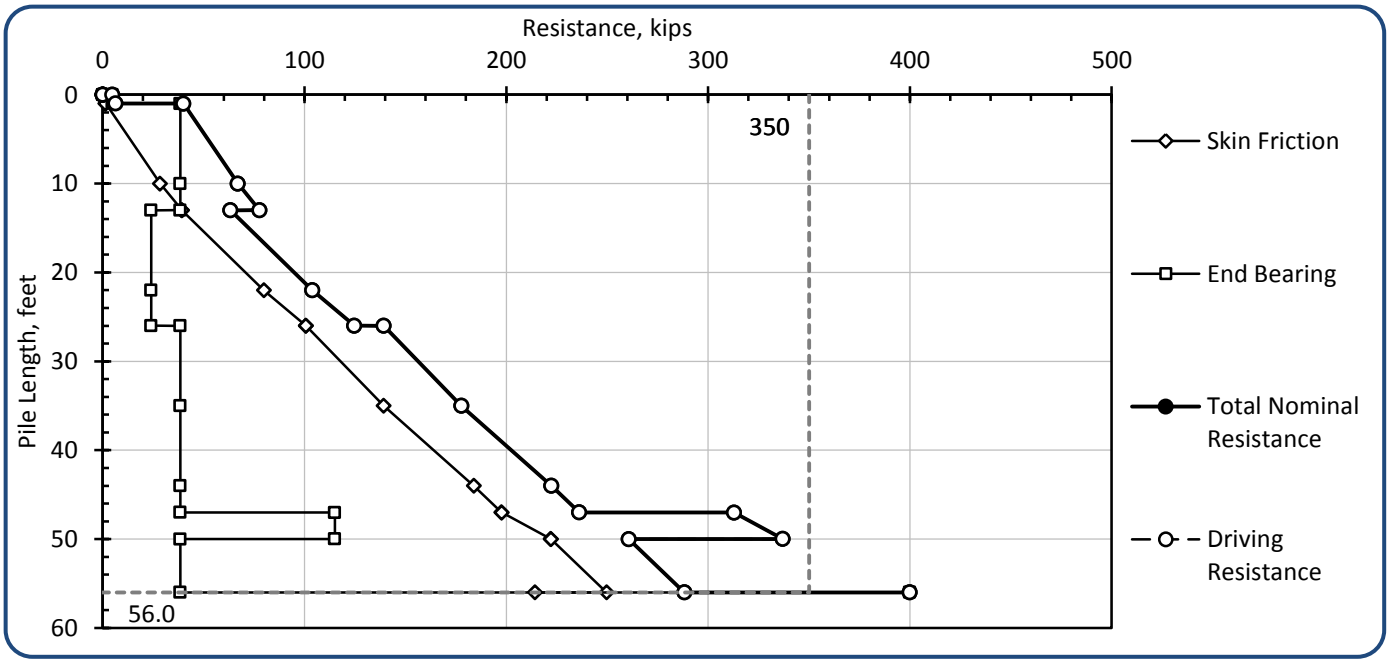
JOB FRA-Trabue Road ELR 15125
SHEET NO 5 OF 7
CALCULATED BY PAN DATE 3/1/2016
CHECKED BY JN DATE 3/2/2016
SUBJECT FRA-Trabue Road

Estimated Pile Resistances and Lengths

From DRIVEN analysis

Substructure	Pier	UBV during driving	350	Kips
Boring	B-1	Estimated length	56.0	ft
Pile type	14" pipe	Nominal resistance after setup	350	Kips
Depth to top of pile	5 ft			

Depth	Skin Friction	End Bearing	Total Nominal Resistance	Driving Resistance	Pile Length
0.01 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
4.99 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
5 ft	0 Kips	4.81 Kips	4.81 Kips	4.81 Kips	0 ft
5.99 ft	1.49 Kips	4.81 Kips	6.3 Kips	6.3 Kips	0.99 ft
6.01 ft	1.53 Kips	38.48 Kips	40.02 Kips	40.02 Kips	1.01 ft
15.01 ft	28.48 Kips	38.48 Kips	66.96 Kips	66.96 Kips	10.01 ft
17.99 ft	39.23 Kips	38.48 Kips	77.72 Kips	77.72 Kips	12.99 ft
18.01 ft	39.31 Kips	24.05 Kips	63.36 Kips	63.36 Kips	13.01 ft
27.01 ft	79.89 Kips	24.05 Kips	103.95 Kips	103.95 Kips	22.01 ft
30.99 ft	100.68 Kips	24.05 Kips	124.73 Kips	124.73 Kips	25.99 ft
31.01 ft	100.77 Kips	38.48 Kips	139.26 Kips	139.26 Kips	26.01 ft
40.01 ft	139.27 Kips	38.48 Kips	177.75 Kips	177.75 Kips	35.01 ft
49.01 ft	183.91 Kips	38.48 Kips	222.39 Kips	222.39 Kips	44.01 ft
51.99 ft	197.67 Kips	38.48 Kips	236.15 Kips	236.15 Kips	46.99 ft
52.01 ft	197.79 Kips	115.03 Kips	312.82 Kips	312.82 Kips	47.01 ft
54.99 ft	222.04 Kips	115.03 Kips	337.06 Kips	337.06 Kips	49.99 ft
55.01 ft	222.17 Kips	38.48 Kips	260.65 Kips	260.65 Kips	50.01 ft
60.99 ft	249.78 Kips	38.48 Kips	288.27 Kips	288.27 Kips	55.99 ft
61	214.32 Kips	400 Kips	400 Kips	400 Kips	56 ft



E.L. ROBINSON ENGINEERING
1801 Watermark Drive, Suite 310 • Columbus, Ohio 43215
614-586-0642 • Fax 614-586-0648

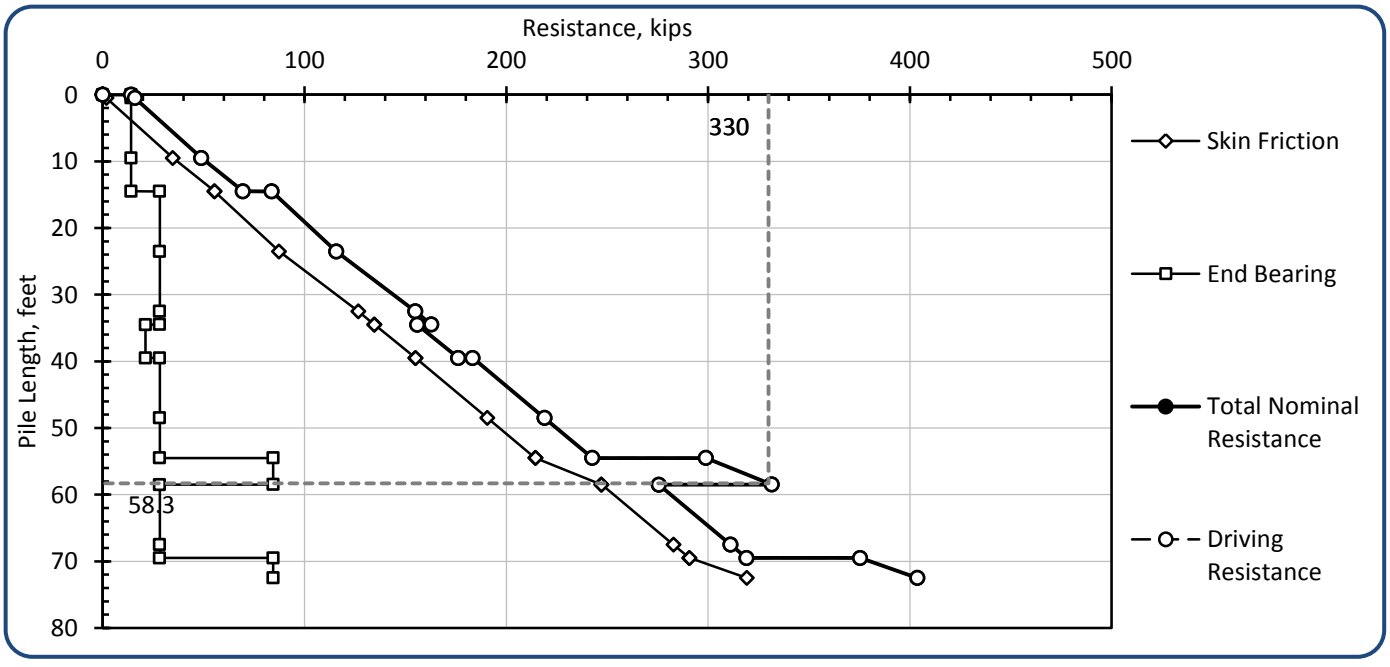
JOB	FRA-Trabue Road ELR 15125		
SHEET NO	6	OF	7
CALCULATED BY	PAN	DATE	3/1/2016
CHECKED BY	JN	DATE	3/2/2016
SUBJECT	FRA-Trabue Road		

Estimated Pile Resistances and Lengths

From DRIVEN analysis

Substructure	Forward Abut		UBV during driving	330 Kips
Boring	B-2		Estimated length	58.3 ft
Pile type	12" pipe		Nominal resistance after setup	330 Kips
Depth to top of pile	8.5 ft			

Depth	Skin Friction	End Bearing	Total Nominal Resistance	Driving Resistance	Pile Length
8.49 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
8.5 ft	0 Kips	14.14 Kips	14.14 Kips	14.14 Kips	0 ft
9.01 ft	1.87 Kips	14.14 Kips	16 Kips	16 Kips	0.51 ft
18.01 ft	34.81 Kips	14.14 Kips	48.94 Kips	48.94 Kips	9.51 ft
22.99 ft	55.42 Kips	14.14 Kips	69.55 Kips	69.55 Kips	14.49 ft
23.01 ft	55.49 Kips	28.27 Kips	83.77 Kips	83.77 Kips	14.51 ft
32.01 ft	87.43 Kips	28.27 Kips	115.71 Kips	115.71 Kips	23.51 ft
41.01 ft	126.75 Kips	28.27 Kips	155.03 Kips	155.03 Kips	32.51 ft
42.99 ft	134.59 Kips	28.27 Kips	162.86 Kips	162.86 Kips	34.49 ft
43.01 ft	134.67 Kips	21.21 Kips	155.88 Kips	155.88 Kips	34.51 ft
47.99 ft	155.01 Kips	21.21 Kips	176.21 Kips	176.21 Kips	39.49 ft
48.01 ft	155.09 Kips	28.27 Kips	183.36 Kips	183.36 Kips	39.51 ft
57.01 ft	190.71 Kips	28.27 Kips	218.99 Kips	218.99 Kips	48.51 ft
62.99 ft	214.39 Kips	28.27 Kips	242.66 Kips	242.66 Kips	54.49 ft
63.01 ft	214.51 Kips	84.51 Kips	299.01 Kips	299.01 Kips	54.51 ft
66.99 ft	247.16 Kips	84.51 Kips	331.67 Kips	331.67 Kips	58.49 ft
67.01 ft	247.29 Kips	28.27 Kips	275.56 Kips	275.56 Kips	58.51 ft
76.01 ft	282.91 Kips	28.27 Kips	311.19 Kips	311.19 Kips	67.51 ft
77.99 ft	290.75 Kips	28.27 Kips	319.02 Kips	319.02 Kips	69.49 ft
78.01 ft	290.88 Kips	84.51 Kips	375.39 Kips	375.39 Kips	69.51 ft
80.99 ft	319.27 Kips	84.51 Kips	403.78 Kips	403.78 Kips	72.49 ft



E.L. ROBINSON ENGINEERING
1801 Watermark Drive, Suite 310 • Columbus, Ohio 43215
614-586-0642 • Fax 614-586-0648

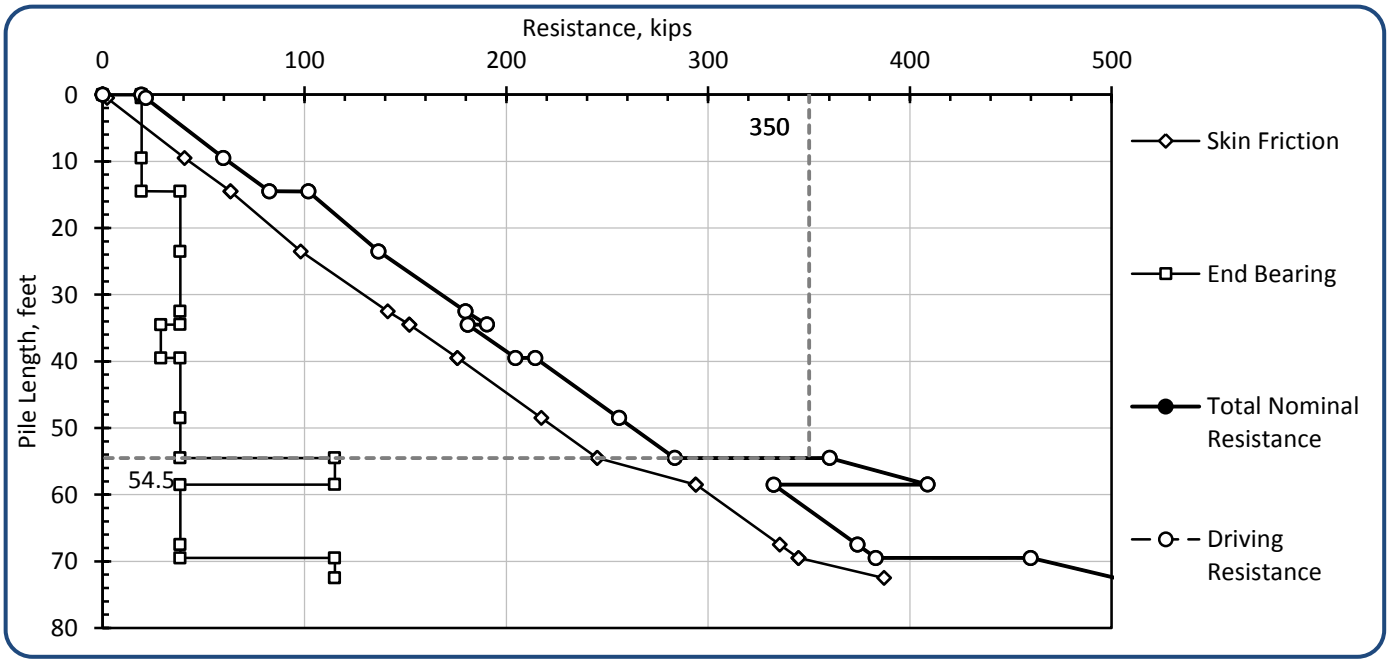
JOB	FRA-Trabue Road ELR 15125		
SHEET NO	7	OF	7
CALCULATED BY	PAN	DATE	3/1/2016
CHECKED BY	JN	DATE	3/2/2016
SUBJECT	FRA-Trabue Road		

Estimated Pile Resistances and Lengths

From DRIVEN analysis

Substructure	Forward Abut	UBV during driving	350 Kips
Boring	B-2	Estimated length	54.5 ft
Pile type	14" pipe	Nominal resistance after setup	350 Kips
Depth to top of pile	8.5 ft		

Depth	Skin Friction	End Bearing	Total Nominal Resistance	Driving Resistance	Pile Length
8.49 ft	0 Kips	0 Kips	0 Kips	0 Kips	0 ft
8.5 ft	0 Kips	19.24 Kips	19.24 Kips	19.24 Kips	0 ft
9.01 ft	2.18 Kips	19.24 Kips	21.42 Kips	21.42 Kips	0.51 ft
18.01 ft	40.61 Kips	19.24 Kips	59.85 Kips	59.85 Kips	9.51 ft
22.99 ft	63.37 Kips	19.24 Kips	82.61 Kips	82.61 Kips	14.49 ft
23.01 ft	63.45 Kips	38.48 Kips	101.94 Kips	101.94 Kips	14.51 ft
32.01 ft	98.25 Kips	38.48 Kips	136.74 Kips	136.74 Kips	23.51 ft
41.01 ft	141.37 Kips	38.48 Kips	179.85 Kips	179.85 Kips	32.51 ft
42.99 ft	151.97 Kips	38.48 Kips	190.45 Kips	190.45 Kips	34.49 ft
43.01 ft	152.07 Kips	28.86 Kips	180.93 Kips	180.93 Kips	34.51 ft
47.99 ft	175.8 Kips	28.86 Kips	204.66 Kips	204.66 Kips	39.49 ft
48.01 ft	175.89 Kips	38.48 Kips	214.37 Kips	214.37 Kips	39.51 ft
57.01 ft	217.45 Kips	38.48 Kips	255.94 Kips	255.94 Kips	48.51 ft
62.99 ft	245.07 Kips	38.48 Kips	283.55 Kips	283.55 Kips	54.49 ft
63.01 ft	245.24 Kips	115.03 Kips	360.26 Kips	360.26 Kips	54.51 ft
66.99 ft	293.86 Kips	115.03 Kips	408.89 Kips	408.89 Kips	58.49 ft
67.01 ft	294.03 Kips	38.48 Kips	332.52 Kips	332.52 Kips	58.51 ft
76.01 ft	335.6 Kips	38.48 Kips	374.08 Kips	374.08 Kips	67.51 ft
77.99 ft	344.74 Kips	38.48 Kips	383.22 Kips	383.22 Kips	69.49 ft
78.01 ft	344.93 Kips	115.03 Kips	459.95 Kips	459.95 Kips	69.51 ft
80.99 ft	387.19 Kips	115.03 Kips	502.21 Kips	502.21 Kips	72.49 ft



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\TRABUE\TRAB-RA.DVN
Project Name: FRA-Trabue Rear Abut
Project Date: 03/01/2016
Project Client: Franklin County Engineer
Computed By: P. Narsavage
Project Manager: P. Narsavage

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 9.50 ft
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	32.00 ft
	- Driving/Restrike	32.00 ft
	- Ultimate:	32.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	33.50 ft	0.00%	125.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	10.50 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
3	Cohesive	13.00 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	21.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
5	Cohesionless	3.00 ft	0.00%	120.00 pcf	35.0/35.0	Nordlund
6	Cohesive	6.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.50 ft	Cohesive	N/A	N/A	1165.00 psf	0.00 Kips
18.01 ft	Cohesive	N/A	N/A	1165.00 psf	31.15 Kips
27.01 ft	Cohesive	N/A	N/A	1252.62 psf	68.91 Kips
33.49 ft	Cohesive	N/A	N/A	1328.22 psf	100.10 Kips
33.51 ft	Cohesive	N/A	N/A	1154.00 psf	100.19 Kips
42.51 ft	Cohesive	N/A	N/A	1260.00 psf	135.82 Kips
43.99 ft	Cohesive	N/A	N/A	1260.00 psf	141.68 Kips
44.01 ft	Cohesive	N/A	N/A	1525.00 psf	141.77 Kips
53.01 ft	Cohesive	N/A	N/A	1525.00 psf	184.88 Kips
56.99 ft	Cohesive	N/A	N/A	1525.00 psf	203.95 Kips
57.01 ft	Cohesive	N/A	N/A	1260.00 psf	204.04 Kips
66.01 ft	Cohesive	N/A	N/A	1260.00 psf	239.66 Kips
75.01 ft	Cohesive	N/A	N/A	1260.00 psf	275.29 Kips
77.99 ft	Cohesive	N/A	N/A	1260.00 psf	287.09 Kips
78.01 ft	Cohesionless	7102.39 psf	20.58	N/A	287.22 Kips
80.99 ft	Cohesionless	7188.21 psf	20.58	N/A	317.11 Kips
81.01 ft	Cohesive	N/A	N/A	1260.00 psf	317.25 Kips
86.99 ft	Cohesive	N/A	N/A	1260.00 psf	340.92 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.50 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
33.49 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
33.51 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
42.51 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
43.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	17.67 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	17.67 Kips
56.99 ft	Cohesive	N/A	N/A	N/A	17.67 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
66.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
75.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
78.01 ft	Cohesionless	7102.68 psf	64.00	84.51 Kips	84.51 Kips
80.99 ft	Cohesionless	7274.32 psf	64.00	84.51 Kips	84.51 Kips
81.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
86.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.50 ft	0.00 Kips	14.14 Kips	14.14 Kips
18.01 ft	31.15 Kips	14.14 Kips	45.28 Kips
27.01 ft	68.91 Kips	14.14 Kips	83.04 Kips
33.49 ft	100.10 Kips	14.14 Kips	114.24 Kips
33.51 ft	100.19 Kips	28.27 Kips	128.46 Kips
42.51 ft	135.82 Kips	28.27 Kips	164.09 Kips
43.99 ft	141.68 Kips	28.27 Kips	169.95 Kips
44.01 ft	141.77 Kips	17.67 Kips	159.44 Kips
53.01 ft	184.88 Kips	17.67 Kips	202.55 Kips
56.99 ft	203.95 Kips	17.67 Kips	221.62 Kips
57.01 ft	204.04 Kips	28.27 Kips	232.31 Kips
66.01 ft	239.66 Kips	28.27 Kips	267.94 Kips
75.01 ft	275.29 Kips	28.27 Kips	303.56 Kips
77.99 ft	287.09 Kips	28.27 Kips	315.36 Kips
78.01 ft	287.22 Kips	84.51 Kips	371.73 Kips
80.99 ft	317.11 Kips	84.51 Kips	401.62 Kips
81.01 ft	317.25 Kips	28.27 Kips	345.53 Kips
86.99 ft	340.92 Kips	28.27 Kips	369.20 Kips

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\TRABUE\TRAB-RA.DVN
Project Name: FRA-Trabue Rear Abut
Project Date: 03/01/2016
Project Client: Franklin County Engineer
Computed By: P. Narsavage
Project Manager: P. Narsavage

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 9.50 ft
Diameter of Pile: 14.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	32.00 ft
	- Driving/Restrike	32.00 ft
	- Ultimate:	32.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	33.50 ft	0.00%	125.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	10.50 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
3	Cohesive	13.00 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	21.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
5	Cohesionless	3.00 ft	0.00%	120.00 pcf	35.0/35.0	Nordlund
6	Cohesive	6.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.50 ft	Cohesive	N/A	N/A	1165.00 psf	0.00 Kips
18.01 ft	Cohesive	N/A	N/A	1165.00 psf	36.34 Kips
27.01 ft	Cohesive	N/A	N/A	1223.43 psf	78.52 Kips
33.49 ft	Cohesive	N/A	N/A	1288.23 psf	113.27 Kips
33.51 ft	Cohesive	N/A	N/A	1075.81 psf	113.37 Kips
42.51 ft	Cohesive	N/A	N/A	1201.81 psf	153.02 Kips
43.99 ft	Cohesive	N/A	N/A	1222.53 psf	160.33 Kips
44.01 ft	Cohesive	N/A	N/A	1485.15 psf	160.44 Kips
53.01 ft	Cohesive	N/A	N/A	1525.00 psf	210.74 Kips
56.99 ft	Cohesive	N/A	N/A	1525.00 psf	232.99 Kips
57.01 ft	Cohesive	N/A	N/A	1260.00 psf	233.09 Kips
66.01 ft	Cohesive	N/A	N/A	1260.00 psf	274.65 Kips
75.01 ft	Cohesive	N/A	N/A	1260.00 psf	316.22 Kips
77.99 ft	Cohesive	N/A	N/A	1260.00 psf	329.98 Kips
78.01 ft	Cohesionless	7102.39 psf	23.33	N/A	330.17 Kips
80.99 ft	Cohesionless	7188.21 psf	23.33	N/A	374.67 Kips
81.01 ft	Cohesive	N/A	N/A	1260.00 psf	374.87 Kips
86.99 ft	Cohesive	N/A	N/A	1260.00 psf	402.49 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.50 ft	Cohesive	N/A	N/A	N/A	19.24 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	19.24 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	19.24 Kips
33.49 ft	Cohesive	N/A	N/A	N/A	19.24 Kips
33.51 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
42.51 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
43.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
56.99 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
66.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
75.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
78.01 ft	Cohesionless	7102.68 psf	64.00	115.03 Kips	115.03 Kips
80.99 ft	Cohesionless	7274.32 psf	64.00	115.03 Kips	115.03 Kips
81.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
86.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.50 ft	0.00 Kips	19.24 Kips	19.24 Kips
18.01 ft	36.34 Kips	19.24 Kips	55.58 Kips
27.01 ft	78.52 Kips	19.24 Kips	97.76 Kips
33.49 ft	113.27 Kips	19.24 Kips	132.51 Kips
33.51 ft	113.37 Kips	38.48 Kips	151.85 Kips
42.51 ft	153.02 Kips	38.48 Kips	191.50 Kips
43.99 ft	160.33 Kips	38.48 Kips	198.82 Kips
44.01 ft	160.44 Kips	24.05 Kips	184.49 Kips
53.01 ft	210.74 Kips	24.05 Kips	234.79 Kips
56.99 ft	232.99 Kips	24.05 Kips	257.04 Kips
57.01 ft	233.09 Kips	38.48 Kips	271.57 Kips
66.01 ft	274.65 Kips	38.48 Kips	313.14 Kips
75.01 ft	316.22 Kips	38.48 Kips	354.70 Kips
77.99 ft	329.98 Kips	38.48 Kips	368.46 Kips
78.01 ft	330.17 Kips	115.03 Kips	445.20 Kips
80.99 ft	374.67 Kips	115.03 Kips	489.70 Kips
81.01 ft	374.87 Kips	38.48 Kips	413.35 Kips
86.99 ft	402.49 Kips	38.48 Kips	440.97 Kips

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\TRABUE\TRAB-PR.DVN
Project Name: FRA-Trabue Pier
Project Date: 03/01/2016
Project Client: Franklin County Engineer
Computed By: P. Narsavage
Project Manager: P. Narsavage

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 5.00 ft
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	6.00 ft
	- Driving/Restrike	6.00 ft
	- Ultimate:	6.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	6.00 ft	0.00%	120.00 pcf	500.00 psf	T-79 Steel
2	Cohesive	12.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
3	Cohesive	13.00 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	21.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
5	Cohesionless	3.00 ft	0.00%	120.00 pcf	35.0/35.0	Nordlund
6	Cohesive	6.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	410.00 psf	0.00 Kips
5.99 ft	Cohesive	N/A	N/A	410.00 psf	1.28 Kips
6.01 ft	Cohesive	N/A	N/A	770.00 psf	1.31 Kips
15.01 ft	Cohesive	N/A	N/A	851.83 psf	25.40 Kips
17.99 ft	Cohesive	N/A	N/A	900.50 psf	35.21 Kips
18.01 ft	Cohesive	N/A	N/A	1140.18 psf	35.28 Kips
27.01 ft	Cohesive	N/A	N/A	1297.68 psf	71.97 Kips
30.99 ft	Cohesive	N/A	N/A	1367.32 psf	91.04 Kips
31.01 ft	Cohesive	N/A	N/A	1113.16 psf	91.13 Kips
40.01 ft	Cohesive	N/A	N/A	1260.00 psf	126.76 Kips
49.01 ft	Cohesive	N/A	N/A	1260.00 psf	162.38 Kips
51.99 ft	Cohesive	N/A	N/A	1260.00 psf	174.18 Kips
52.01 ft	Cohesionless	3829.89 psf	20.58	N/A	174.27 Kips
54.99 ft	Cohesionless	3915.71 psf	20.58	N/A	190.55 Kips
55.01 ft	Cohesive	N/A	N/A	1260.00 psf	190.65 Kips
60.99 ft	Cohesive	N/A	N/A	1260.00 psf	214.32 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	3.53 Kips
5.99 ft	Cohesive	N/A	N/A	N/A	3.53 Kips
6.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
15.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
17.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	17.67 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	17.67 Kips
30.99 ft	Cohesive	N/A	N/A	N/A	17.67 Kips
31.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
40.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
49.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
51.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
52.01 ft	Cohesionless	3830.18 psf	64.00	84.51 Kips	84.51 Kips
54.99 ft	Cohesionless	4001.82 psf	64.00	84.51 Kips	84.51 Kips
55.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
60.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	3.53 Kips	3.53 Kips
5.99 ft	1.28 Kips	3.53 Kips	4.81 Kips
6.01 ft	1.31 Kips	28.27 Kips	29.59 Kips
15.01 ft	25.40 Kips	28.27 Kips	53.67 Kips
17.99 ft	35.21 Kips	28.27 Kips	63.48 Kips
18.01 ft	35.28 Kips	17.67 Kips	52.95 Kips
27.01 ft	71.97 Kips	17.67 Kips	89.65 Kips
30.99 ft	91.04 Kips	17.67 Kips	108.71 Kips
31.01 ft	91.13 Kips	28.27 Kips	119.40 Kips
40.01 ft	126.76 Kips	28.27 Kips	155.03 Kips
49.01 ft	162.38 Kips	28.27 Kips	190.66 Kips
51.99 ft	174.18 Kips	28.27 Kips	202.45 Kips
52.01 ft	174.27 Kips	84.51 Kips	258.78 Kips
54.99 ft	190.55 Kips	84.51 Kips	275.06 Kips
55.01 ft	190.65 Kips	28.27 Kips	218.92 Kips
60.99 ft	214.32 Kips	28.27 Kips	242.59 Kips

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\TRABUE\TRAB-PR.DVN
Project Name: FRA-Trabue Pier
Project Date: 03/01/2016
Project Client: Franklin County Engineer
Computed By: P. Narsavage
Project Manager: P. Narsavage

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 5.00 ft
Diameter of Pile: 14.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	6.00 ft
	- Driving/Restrike	6.00 ft
	- Ultimate:	6.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	6.00 ft	0.00%	120.00 pcf	500.00 psf	T-79 Steel
2	Cohesive	12.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
3	Cohesive	13.00 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	21.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
5	Cohesionless	3.00 ft	0.00%	120.00 pcf	35.0/35.0	Nordlund
6	Cohesive	6.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	410.00 psf	0.00 Kips
5.99 ft	Cohesive	N/A	N/A	410.00 psf	1.49 Kips
6.01 ft	Cohesive	N/A	N/A	770.00 psf	1.53 Kips
15.01 ft	Cohesive	N/A	N/A	816.81 psf	28.48 Kips
17.99 ft	Cohesive	N/A	N/A	858.53 psf	39.23 Kips
18.01 ft	Cohesive	N/A	N/A	1095.15 psf	39.31 Kips
27.01 ft	Cohesive	N/A	N/A	1230.15 psf	79.89 Kips
30.99 ft	Cohesive	N/A	N/A	1289.85 psf	100.68 Kips
31.01 ft	Cohesive	N/A	N/A	1040.81 psf	100.77 Kips
40.01 ft	Cohesive	N/A	N/A	1166.81 psf	139.27 Kips
49.01 ft	Cohesive	N/A	N/A	1260.00 psf	183.91 Kips
51.99 ft	Cohesive	N/A	N/A	1260.00 psf	197.67 Kips
52.01 ft	Cohesionless	3829.89 psf	23.33	N/A	197.79 Kips
54.99 ft	Cohesionless	3915.71 psf	23.33	N/A	222.04 Kips
55.01 ft	Cohesive	N/A	N/A	1260.00 psf	222.17 Kips
60.99 ft	Cohesive	N/A	N/A	1260.00 psf	249.78 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	4.81 Kips
5.99 ft	Cohesive	N/A	N/A	N/A	4.81 Kips
6.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
15.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
17.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
30.99 ft	Cohesive	N/A	N/A	N/A	24.05 Kips
31.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
40.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
49.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
51.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
52.01 ft	Cohesionless	3830.18 psf	64.00	115.03 Kips	115.03 Kips
54.99 ft	Cohesionless	4001.82 psf	64.00	115.03 Kips	115.03 Kips
55.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
60.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	4.81 Kips	4.81 Kips
5.99 ft	1.49 Kips	4.81 Kips	6.30 Kips
6.01 ft	1.53 Kips	38.48 Kips	40.02 Kips
15.01 ft	28.48 Kips	38.48 Kips	66.96 Kips
17.99 ft	39.23 Kips	38.48 Kips	77.72 Kips
18.01 ft	39.31 Kips	24.05 Kips	63.36 Kips
27.01 ft	79.89 Kips	24.05 Kips	103.95 Kips
30.99 ft	100.68 Kips	24.05 Kips	124.73 Kips
31.01 ft	100.77 Kips	38.48 Kips	139.26 Kips
40.01 ft	139.27 Kips	38.48 Kips	177.75 Kips
49.01 ft	183.91 Kips	38.48 Kips	222.39 Kips
51.99 ft	197.67 Kips	38.48 Kips	236.15 Kips
52.01 ft	197.79 Kips	115.03 Kips	312.82 Kips
54.99 ft	222.04 Kips	115.03 Kips	337.06 Kips
55.01 ft	222.17 Kips	38.48 Kips	260.65 Kips
60.99 ft	249.78 Kips	38.48 Kips	288.27 Kips

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\TRABUE\TRAB-FA.DVN
Project Name: FRA-Trabue Forward Abut
Project Date: 03/01/2016
Project Client: Franklin County Engineer
Computed By: P. Narsavage
Project Manager: P. Narsavage

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 8.50 ft
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	26.00 ft
	- Driving/Restrike	26.00 ft
	- Ultimate:	26.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	23.00 ft	0.00%	125.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	20.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
3	Cohesive	5.00 ft	0.00%	130.00 pcf	3000.00 psf	T-79 Steel
4	Cohesive	15.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
5	Cohesionless	4.00 ft	0.00%	120.00 pcf	35.0/35.0	Nordlund
6	Cohesive	11.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
7	Cohesionless	3.00 ft	0.00%	120.00 pcf	35.0/35.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.50 ft	Cohesive	N/A	N/A	1165.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	1165.00 psf	1.87 Kips
18.01 ft	Cohesive	N/A	N/A	1165.00 psf	34.81 Kips
22.99 ft	Cohesive	N/A	N/A	1217.38 psf	55.42 Kips
23.01 ft	Cohesive	N/A	N/A	982.50 psf	55.49 Kips
32.01 ft	Cohesive	N/A	N/A	1129.50 psf	87.43 Kips
41.01 ft	Cohesive	N/A	N/A	1260.00 psf	126.75 Kips
42.99 ft	Cohesive	N/A	N/A	1260.00 psf	134.59 Kips
43.01 ft	Cohesive	N/A	N/A	1300.00 psf	134.67 Kips
47.99 ft	Cohesive	N/A	N/A	1300.00 psf	155.01 Kips
48.01 ft	Cohesive	N/A	N/A	1260.00 psf	155.09 Kips
57.01 ft	Cohesive	N/A	N/A	1260.00 psf	190.71 Kips
62.99 ft	Cohesive	N/A	N/A	1260.00 psf	214.39 Kips
63.01 ft	Cohesionless	5766.49 psf	20.58	N/A	214.51 Kips
66.99 ft	Cohesionless	5881.11 psf	20.58	N/A	247.16 Kips
67.01 ft	Cohesive	N/A	N/A	1260.00 psf	247.29 Kips
76.01 ft	Cohesive	N/A	N/A	1260.00 psf	282.91 Kips
77.99 ft	Cohesive	N/A	N/A	1260.00 psf	290.75 Kips
78.01 ft	Cohesionless	6740.49 psf	20.58	N/A	290.88 Kips
80.99 ft	Cohesionless	6826.31 psf	20.58	N/A	319.27 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.50 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
22.99 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
23.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
32.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
41.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
42.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
43.01 ft	Cohesive	N/A	N/A	N/A	21.21 Kips
47.99 ft	Cohesive	N/A	N/A	N/A	21.21 Kips
48.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
62.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
63.01 ft	Cohesionless	5766.78 psf	64.00	84.51 Kips	84.51 Kips
66.99 ft	Cohesionless	5996.02 psf	64.00	84.51 Kips	84.51 Kips
67.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
76.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
78.01 ft	Cohesionless	6740.78 psf	64.00	84.51 Kips	84.51 Kips
80.99 ft	Cohesionless	6912.42 psf	64.00	84.51 Kips	84.51 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.50 ft	0.00 Kips	14.14 Kips	14.14 Kips
9.01 ft	1.87 Kips	14.14 Kips	16.00 Kips
18.01 ft	34.81 Kips	14.14 Kips	48.94 Kips
22.99 ft	55.42 Kips	14.14 Kips	69.55 Kips
23.01 ft	55.49 Kips	28.27 Kips	83.77 Kips
32.01 ft	87.43 Kips	28.27 Kips	115.71 Kips
41.01 ft	126.75 Kips	28.27 Kips	155.03 Kips
42.99 ft	134.59 Kips	28.27 Kips	162.86 Kips
43.01 ft	134.67 Kips	21.21 Kips	155.88 Kips
47.99 ft	155.01 Kips	21.21 Kips	176.21 Kips
48.01 ft	155.09 Kips	28.27 Kips	183.36 Kips
57.01 ft	190.71 Kips	28.27 Kips	218.99 Kips
62.99 ft	214.39 Kips	28.27 Kips	242.66 Kips
63.01 ft	214.51 Kips	84.51 Kips	299.01 Kips
66.99 ft	247.16 Kips	84.51 Kips	331.67 Kips
67.01 ft	247.29 Kips	28.27 Kips	275.56 Kips
76.01 ft	282.91 Kips	28.27 Kips	311.19 Kips
77.99 ft	290.75 Kips	28.27 Kips	319.02 Kips
78.01 ft	290.88 Kips	84.51 Kips	375.39 Kips
80.99 ft	319.27 Kips	84.51 Kips	403.78 Kips

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\TRABUE\TRAB-FA.DVN
Project Name: FRA-Trabue Forward Abut
Project Date: 03/01/2016
Project Client: Franklin County Engineer
Computed By: P. Narsavage
Project Manager: P. Narsavage

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 8.50 ft
Diameter of Pile: 14.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	26.00 ft
	- Driving/Restrike	26.00 ft
	- Ultimate:	26.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	23.00 ft	0.00%	125.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	20.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
3	Cohesive	5.00 ft	0.00%	130.00 pcf	3000.00 psf	T-79 Steel
4	Cohesive	15.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
5	Cohesionless	4.00 ft	0.00%	120.00 pcf	35.0/35.0	Nordlund
6	Cohesive	11.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
7	Cohesionless	3.00 ft	0.00%	120.00 pcf	35.0/35.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.50 ft	Cohesive	N/A	N/A	1165.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	1165.00 psf	2.18 Kips
18.01 ft	Cohesive	N/A	N/A	1165.00 psf	40.61 Kips
22.99 ft	Cohesive	N/A	N/A	1193.23 psf	63.37 Kips
23.01 ft	Cohesive	N/A	N/A	928.81 psf	63.45 Kips
32.01 ft	Cohesive	N/A	N/A	1054.81 psf	98.25 Kips
41.01 ft	Cohesive	N/A	N/A	1180.81 psf	141.37 Kips
42.99 ft	Cohesive	N/A	N/A	1208.53 psf	151.97 Kips
43.01 ft	Cohesive	N/A	N/A	1246.72 psf	152.07 Kips
47.99 ft	Cohesive	N/A	N/A	1300.00 psf	175.80 Kips
48.01 ft	Cohesive	N/A	N/A	1260.00 psf	175.89 Kips
57.01 ft	Cohesive	N/A	N/A	1260.00 psf	217.45 Kips
62.99 ft	Cohesive	N/A	N/A	1260.00 psf	245.07 Kips
63.01 ft	Cohesionless	5766.49 psf	23.33	N/A	245.24 Kips
66.99 ft	Cohesionless	5881.11 psf	23.33	N/A	293.86 Kips
67.01 ft	Cohesive	N/A	N/A	1260.00 psf	294.03 Kips
76.01 ft	Cohesive	N/A	N/A	1260.00 psf	335.60 Kips
77.99 ft	Cohesive	N/A	N/A	1260.00 psf	344.74 Kips
78.01 ft	Cohesionless	6740.49 psf	23.33	N/A	344.93 Kips
80.99 ft	Cohesionless	6826.31 psf	23.33	N/A	387.19 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.50 ft	Cohesive	N/A	N/A	N/A	19.24 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	19.24 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	19.24 Kips
22.99 ft	Cohesive	N/A	N/A	N/A	19.24 Kips
23.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
32.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
41.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
42.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
43.01 ft	Cohesive	N/A	N/A	N/A	28.86 Kips
47.99 ft	Cohesive	N/A	N/A	N/A	28.86 Kips
48.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
62.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
63.01 ft	Cohesionless	5766.78 psf	64.00	115.03 Kips	115.03 Kips
66.99 ft	Cohesionless	5996.02 psf	64.00	115.03 Kips	115.03 Kips
67.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
76.01 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
77.99 ft	Cohesive	N/A	N/A	N/A	38.48 Kips
78.01 ft	Cohesionless	6740.78 psf	64.00	115.03 Kips	115.03 Kips
80.99 ft	Cohesionless	6912.42 psf	64.00	115.03 Kips	115.03 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.50 ft	0.00 Kips	19.24 Kips	19.24 Kips
9.01 ft	2.18 Kips	19.24 Kips	21.42 Kips
18.01 ft	40.61 Kips	19.24 Kips	59.85 Kips
22.99 ft	63.37 Kips	19.24 Kips	82.61 Kips
23.01 ft	63.45 Kips	38.48 Kips	101.94 Kips
32.01 ft	98.25 Kips	38.48 Kips	136.74 Kips
41.01 ft	141.37 Kips	38.48 Kips	179.85 Kips
42.99 ft	151.97 Kips	38.48 Kips	190.45 Kips
43.01 ft	152.07 Kips	28.86 Kips	180.93 Kips
47.99 ft	175.80 Kips	28.86 Kips	204.66 Kips
48.01 ft	175.89 Kips	38.48 Kips	214.37 Kips
57.01 ft	217.45 Kips	38.48 Kips	255.94 Kips
62.99 ft	245.07 Kips	38.48 Kips	283.55 Kips
63.01 ft	245.24 Kips	115.03 Kips	360.26 Kips
66.99 ft	293.86 Kips	115.03 Kips	408.89 Kips
67.01 ft	294.03 Kips	38.48 Kips	332.52 Kips
76.01 ft	335.60 Kips	38.48 Kips	374.08 Kips
77.99 ft	344.74 Kips	38.48 Kips	383.22 Kips
78.01 ft	344.93 Kips	115.03 Kips	459.95 Kips
80.99 ft	387.19 Kips	115.03 Kips	502.21 Kips