Pro Geotech, Inc.

3201 E. Royalton Road • Cleveland, Ohio 44147 • 440-717-1415 • fax 440-717-1416 • www.progeotech.com

February 3, 2014

Mr. Naiel Hussein, P.E.
Parsons Brinckerhoff
2545 Farmers Drive, Suite 350
Columbus, Ohio 43235

Reference: **Final Subsurface Exploration Report for HAN-75-14.39**
Bridge No. HAN-68-1585 over Proposed Lima Avenue
Findlay, Hancock County, Ohio
PID No. 87005
PGI Project No. G13011G

Dear Mr. Hussein:

Enclosed please find our Final Subsurface Exploration Report for the above referenced project. Our services included a geotechnical field exploration, laboratory testing, engineering analysis, and related design and construction recommendations. These services have been provided in accordance with our proposal dated January 16, 2013. It is important that the items under "**Limitations**" be precisely followed and complied with.

We appreciate the opportunity of working with you on this project and we invite you to contact us at (440) 717-1415 when we can be of further assistance.

Respectfully,

PRO GEOTECH, INC.

Shan Sivakumaran, P.E.
Project Manager/Geotechnical Engineer

Walid I. Najjar, P.E.
Senior Geotechnical Engineer

Enclosure
G13011Grpt/HAN-75-1585Bridge/SS/2/3/2014

FINAL
SUBSURFACE EXPLORATION REPORT
FOR HAN-75-14.39
BRIDGE NO. HAN-68-1585 OVER PROPOSED LIMA AVENUE

HANCOCK COUNTY, OHIO
PGI PROJECT NO. G13011G
PID NO. 87005

PREPARED FOR:

PARSONS BRINCKERHOFF

PREPARED BY:

PRO GEOTECH, INC.

FEBRUARY 3, 2014

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY **1**

2.0 INTRODUCTION **3**
- 2.1 Project Description 3
- 2.2 Scope of Services 5

3.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT SITE **6**
- 3.1 Geology 6
- 3.2 Observations 7

4.0 EXPLORATION **8**
- 4.1 Historic and Project Exploration Program 8
- 4.2 Laboratory Testing Program 9

5.0 FINDINGS **10**
- 5.1 Subsurface Soil Conditions 10
- 5.2 Bedrock Conditions 11
- 5.3 Groundwater Conditions 12

6.0 ANALYSIS AND RECOMMENDATIONS **12**
- 6.1 Bridge Foundation Systems 13
- 6.2 Lateral Earth Pressures and Abutment Drainage 14
- 6.3 Approach Slab Design Parameters 14
- 6.4 Groundwater Management 15
- 6.5 Earthwork and Construction Monitoring 15

7.0 LIMITATIONS **16**

LIST OF TABLES

5.2.1 Bedrock Information 11
5.2.2 Unconfined Compressive Strength Test Results of Rock Core Specimen… 12
6.1.1 Estimated Design Parameters at Strength Limit State for Spread Footing… 13

LIST OF FIGURES

2.1 Project Site Location Map 4

APPENDICES

A Boring Location Plan
Drilling Logs
Test Boring Profile

B Laboratory Test Results

Unconfined Compressive Strength of the Rock Core

Rock Core Samples Pictures

Rock Mass Rating Spreadsheets

Nominal Bearing Resistance and Settlement Analyses Spreadsheets

Geotechnical Design Check List

Laboratory Test Standards

ODOT Soil Classification System

1.0 EXECUTIVE SUMMARY

This report has been prepared for the HAN-75-14.39 project which calls for replacement of the U.S. Route 68 (US 68) mainline Bridge No. HAN-68-1585 over Proposed Lima Avenue as part of redesigning the US 68/Lima Avenue Interchange in Findlay, Hancock County, Ohio. A total of four (4) test borings identified as B-083-0-13, B-084-0-13, B-086-0-13, and B-087-0-13 were advanced for bridge foundation design purposes. Test borings B-083-0-13 and B-084-0-13 were advanced in the vicinity of the proposed rear abutment and wing walls while test borings B-086-0-13 and B-087-0-13 were advanced in the vicinity of the proposed forward abutment and wing walls. These structural test borings were advanced to approximate depths ranging from 14.0 to 25.0 feet below the existing ground or US 68 pavement surfaces.

<u>Subsurface soil Conditions</u>: All of the subsurface soils encountered in the test borings were cohesive in nature. The subsurface soils encountered in test borings consisting both fill material and natural soils. The fill material consisted of silty clay (A-6b), and clay (A-7-6). The approximate depth of the fill materials ranged from 3.7 feet in test boring B-083-0-13 to 11.5 feet in B-086-0-13. Natural soils encountered above bedrock in the test borings consisted of silty clay (A-6b). Bedrock was encountered in all test boring locations at approximate depths of 3.7 feet and 0.7 feet below the existing US 68 embankment toes in test borings B-083-0-13 and B-087-0-13, respectively and 11.0 feet and 12.2 feet below the US 68 shoulder in test borings B-084-0-13 and B-086-0-13, respectively. The laboratory test results indicated that the moisture contents of the tested soil samples ranged from 14% to 24% and the consistency ranged from "medium stiff" to "very stiff".

<u>Bedrock Condition</u>: Bedrock was encountered in all of the test borings. The core samples consisted of dolomite of the Tymochtee/Greenfield Group. The dolomite was light gray, moderately to slightly weathered, and strong to very strong. Bedding within the dolomite was generally very thin to thin and was highly fractured to moderately fractured with few angular fractures. The fractures were typically tight to narrow and slightly rough to very rough. The compressive strength of the core specimens ranged from 13,781 psi in test boring B-086-0-13 to 19,636 psi in test boring B-087-0-13 which characterizes them as “strong” to “very strong”, respectively. The Rock Quality Designation (RQD) for the core samples ranged from 32% to 43% and averaged 39% based on individual runs. The Rock Mass Rating

obtained for the bedrock core samples according to LRFD Table 10.4.6.4-1 varied from 48 to 53 and is classified as “Fair Rock”.

Bridge Foundation Systems: Since bedrock was encountered at the test boring locations at relatively shallow depths below the proposed Lima Avenue, the proposed superstructure loads may be transferred to the underlying bedrock by means of shallow foundations. Shallow foundation systems consisting of spread footings may be used to transfer the loads to the underlying bedrock at the proposed abutment locations. Table 6.1.1 summarizes the nominal bearing resistance on bedrock and founding elevation at each test boring location so that PB personnel can verify the bearing pressure at Strength, Extreme Limit, and Service States.

Table 6.1.1 – Estimated Design Parameters at Strength Limit State for Spread Footings

Boring No.	Substructure Location	Top of Bedrock Elevation (feet)	Proposed Bearing Elevation (feet)	Nominal Resistance (ksf)
B-083-0-13	Rear Abutment	786.4±	785.9	46.0
B-084-0-13	Rear Abutment	787.2±	786.7	47.0
B-086-0-13	Forward Abutment	788.9±	788.4	44.0
B-087-0-13	Forward Abutment	786.8±	786.3	62.0

Settlement of the proposed footings at the abutment locations will be due to elastic compression of bedrock. Based on the settlement analysis, it is estimated that the maximum total settlement and differential settlement will not exceed one inch and one-half of an inch, respectively. If any soil and severely weathered bedrock is encountered, it should be removed as directed by an on-site geotechnical engineer and replaced with concrete.

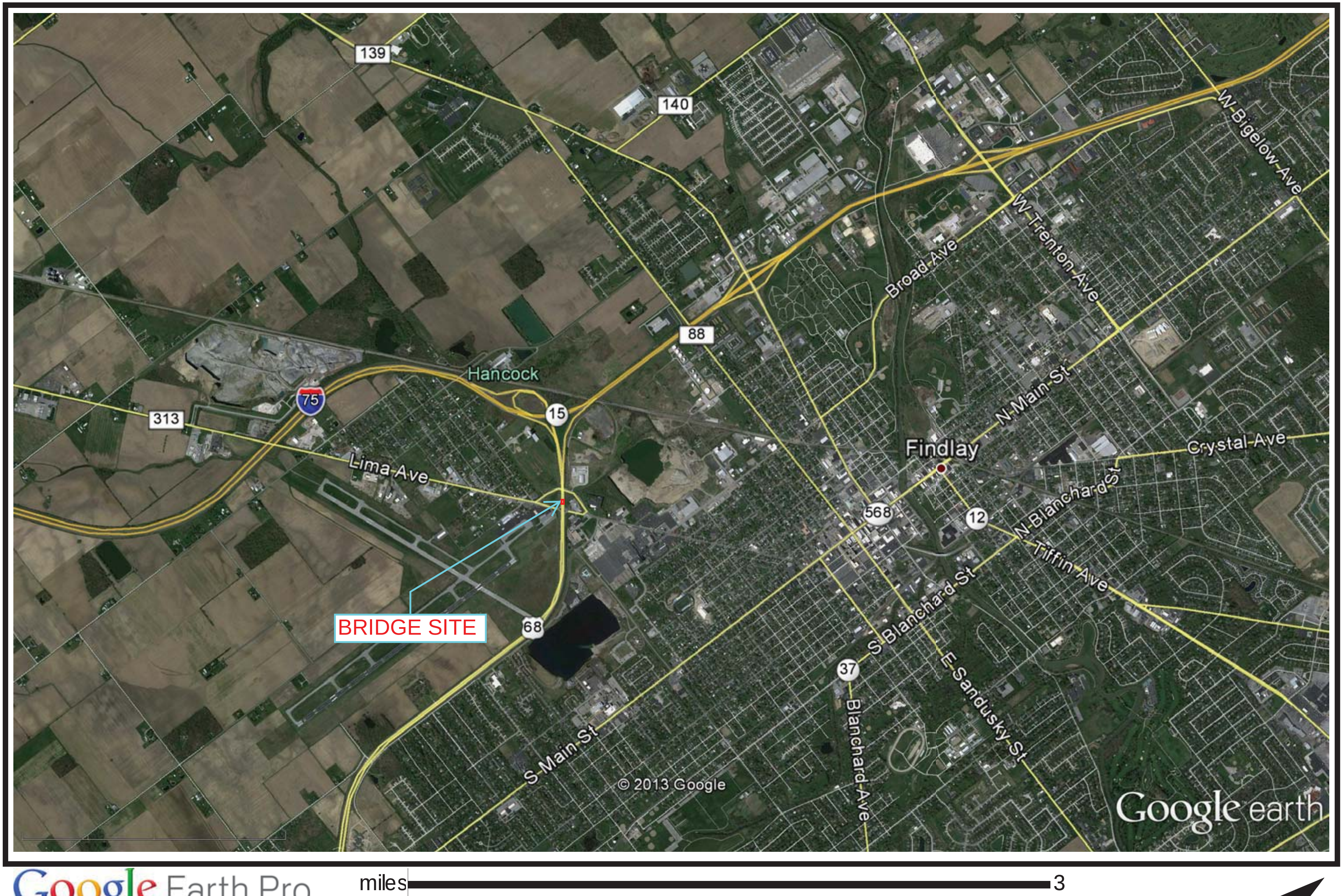
2.0 INTRODUCTION

This report has been prepared for the HAN-75-14.39 project which calls for replacement of the U.S. Route 68 (US 68) mainline Bridge No. HAN-68-1585 over Proposed Lima Avenue as part of redesigning the US 68/Lima Avenue Interchange in Findlay, Hancock County, Ohio. It represents the intent of Parsons Brinckerhoff (PB) the design engineer, and the Ohio Department of Transportation (ODOT), the owner, to secure subsurface information at the selected locations in accordance with ODOT's *Specifications for Geotechnical Exploration*s, and to obtain recommendations regarding geotechnical factors pertaining to the design and construction of this project.

2.1 Project Description

Present plans call for the design and construction of the proposed Bridge No. HAN-68-1585 which will carry US 68 mainline vehicular traffic over Proposed Lima Avenue. The design information provided by PB personnel indicates that the proposed replacement bridge will be constructed approximately 275 feet east of the existing US 68 bridge over Lima Avenue. The proposed bridge will be a single span structure with an approximate span length of 105 feet. The proposed superstructure will be wide flange pre-stressed concrete I beams with reinforced concrete decking on cast-in-place semi-integral reinforced wall abutments. The bridge is to be designed using LRFD Bridge Design Specifications. The Site Location Map is shown in Figure 2.1.

This report has been developed based on the field exploration program, laboratory testing, and information secured for site-specific studies. It must be noted that, as with any exploration program, the site exploration identifies actual subsurface conditions only at those locations where samples were obtained. The data derived through sampling and laboratory testing is reduced by geotechnical engineers and geologists who then render an opinion regarding the overall subsurface conditions and their likely reaction on the site. The actual site conditions may differ from those inferred to exist. Therefore, although a fair amount of subsurface data has been assembled during this exploration, this report may not provide all of the geotechnical data needed for construction of this project. This report was prepared using English units.



PROJECT: HAN-75-14.39
US 68 MAINLINE BRIDGE NO. HAN-68-1585 OVER PRO. LIMA AVE
SITE LOCATION MAP (FIGURE 2.1)

2.2 Scope of Services

The scope of services for this project was in accordance with Pro Geotech, Inc. (PGI) Proposal No. PG12067 dated January 16, 2013 and governed by ODOT's *Specifications for Geotechnical Explorations* dated January 2007 and updated January 20, 2012 and ODOT's Bridge Design Manual, issued in 2007 and AASHTO LRFD Bridge Design Specifications, 6th Edition hereafter referred to as ODOT Specifications. Our scope of services consisted of the execution of the following tasks:

Phase I – Planning and Marking Test Borings, which primarily consisted of planning the field portion of our subsurface exploration, performing a site reconnaissance to evaluate the proposed project site from a geotechnical standpoint, reviewing and compiling all existing geology of the project site obtained from ODOT and ODNR sources, marking the test boring locations, obtaining necessary permits, and notifying the Ohio Utility Protection Services (OUPS) about the proposed drilling operations.

Phase II - Test Boring and Sampling Program, which primarily consisted of field verification of the test boring locations with regards to the underground utilities, advancing the test borings at the site, conducting field tests, sampling the subsurface materials, and preparing field drilling logs.

Our scope of services included advancing four (4) test borings for bridge foundation design purposes in the vicinity of proposed Bridge No. HAN-75-1585 over proposed Lima Avenue. These structural test borings were to be advanced to approximate depths ranging from 30.0 feet to 35.0 feet below the existing ground surface or US 68 pavement shoulders, and included obtaining 10 feet to 15 feet of rock core at each boring location. All test borings were advanced in accordance with the ODOT *Specifications for Geotechnical Explorations*. The groundwater conditions were monitored during and upon completion of the drilling operations. PGI provided all of the traffic control needed during the fieldwork.

Phase III - Testing Program, which consisted of performing soil classification and engineering properties tests on selected soil and rock samples, and classifying the soils in accordance with the ODOT Soil Classification System.

Phase IV - Geotechnical Exploration Report, which included the following:

- A brief description of the project and our exploration methods
- Typed drilling logs and laboratory test results

- A description of subsurface soil, rock, and groundwater conditions
- Discussions pertaining to earthwork considerations, groundwater management, and construction monitoring
- Foundation recommendations for the bridges and retaining walls including shallow and deep foundations
- Preparation of ODOT Geotechnical Design Checklists
- Preparation of Geotechnical Structure Foundation Exploration Plans

The scope of services did not include any environmental assessments for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater or air, on, below, or around this site. Any statement in this report or on the boring logs regarding odors, colors or unusual or suspicious items or conditions is strictly for the client's information.

3.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT SITE

3.1 Geology

Based on information obtained from the Physiographic Regions of Ohio, the project site lies on the Huron-Erie Lake Plains Section of the Central Lowland Province. The project site is located within the Findlay Embayment District of the Maumee Lake Plains Region of the Huron-Erie Lake Plains Section. The project site is located at approximate elevations ranging from 787 feet to 800 feet. According to Bulletin 44, *Geology of Water in Ohio* (issued in 1943 and reprinted in 1968), both the Illinoian and Wisconsin Glaciers passed over the area and left a coating of drift materials less than 25 feet in thickness. The main geologic deposit of the project site consists of silty to gravelly Wisconsinan-age lacustrine deposits and wave-planed clay till; ground moraine, flat to gently undulating over Dolomite bedrock of Silurian-age. Based on the *Soil Survey of Hancock County, Ohio* and from the *U.S. Department of Agriculture, Natural Resource Conservation Service* website, the natural site soils in the vicinity of the project area consist primarily of layers of loam, clay loam, fine sandy loam, silty clay loam, and silty clay. These soils are classified as A-4, A-6, and A-7 based on the AASHTO Soil Classification System. However, the project site has incurred cut and fill operations due to construction of existing US 68. Thus the composition of the surface and subsurface soils has changed from natural in most areas.

Based on information obtained from the Ohio Geological Survey, bedrock in the vicinity of the project site was deposited during the Upper and Lower Silurian Period of the Paleozoic Era and is expected to consist of Tymochtee/Greenfield Group dolomite. Tymochtee Group dolomite is described as shades of gray and brown, very finely crystalline which occurs as thin to massive beds with carbonaceous shale laminae and beds. Greenfield Group dolomite is described as shades of gray and brown; very finely to coarsely crystalline which occurs as massive beds to laminae; argillaceous and locally brecciated in the lower portion. According to ODNR's Ohio Gas and Oil Wells Locator website, many active and abandoned wells are located in the vicinity of the project site. According to ODNR's Ohio Mines Locator website, no abandoned underground or surface mines are present in the immediate vicinity of the project site. Based on the Ohio Division of Geological Survey Interactive Map of Ohio Mineral Industries, an active limestone industrial quarry is located approximately 0.4 miles southwest of the project site. According to ODNR, the project site is located outside of the "Probable Karst Regions" of Ohio and outside of the "Landslide-Prone Areas" of Ohio. According to ODNR website, two (2) earthquakes occurred within Hancock County; one in 1990 with a magnitude of 2.3 Richter Scale and another in 2011 with a magnitude of 2.4 Richter Scale. Their epicenters were located respectively approximately 8.8 miles to the northeast in Big Lick Township and 14.2 miles to the south in Delaware Township.

3.2 Observations

The reconnaissance of the project site was performed by one of PGI's geotechnical engineers in July 2013. The project site is located in a rural area with the closest building located within an approximate distance of 800 feet from the bridge site. The embankment section at the existing US 68 mainline bridge approach generally appeared to be in good condition. Some minor surface erosion observed was observed around the guard rail posts in the vicinity of test boring locations B-084-0-13 and B-086-0-13. No visible signs of embankment slope instability were observed and embankment settlement was not observed. Bedrock was exposed along the drainage ditch on the south side of US 68. The existing bridge consists of four-span continuous steel beam concrete decking on abutments and piers and appeared to be in good condition. The concrete pier columns and caps generally appeared to be in good condition. Surface cracks, very light in frequency were observed on exposed abutments surfaces. Longitudinal and traverse cracks, very light in frequency, were observed along the top concrete deck surface.

4.0 EXPLORATION

4.1 Historic and Project Exploration Program

No Historical Records of a geotechnical exploration were available from the ODOT Geotechnical Documents Management System ftp site for the existing US 68 mainline bridge over Lima Avenue. In order to explore the subsurface conditions at the project site, drilling, sampling, and field testing operations were performed in June and July 2013. A total of four (4) test borings identified as B-083-0-13, B-084-0-13, B-086-0-13, and B-087-0-13 were advanced for bridge foundation design purposes. Test borings B-083-0-13 and B-084-0-13 were advanced in the vicinity of the proposed rear abutment and wing walls while test borings B-086-0-13 and B-087-0-13 were advanced in the vicinity of the proposed forward abutment and wing walls. Test boring B-083-0-13 was advanced at the toe of the embankment slope of US 68 NB while test boring B-087-0-13 was advanced at the toe of the embankment slope of US 68 SB. Test boring B-084-0-13 was advanced on the shoulder berm of the existing exit ramp from US 68 SB to Lima Avenue while test boring B-086-0-13 was advanced on the paved shoulder of the existing entrance ramp from Lima Avenue to US 68 NB. These structural test borings were advanced to approximate depths ranging from 14.0 to 25.0 feet below the existing ground or US 68 pavement surfaces.

The test borings were marked in the field by PGI based on boring location plans developed by PGI personnel and after obtaining approval from PB personnel. Site geometry, utility locations, overhead height, and accessibility were also taken into account when locating the test borings. At the time of test boring location selection, the vertical soil sampling intervals were determined based on the needs for design and construction of the project. Two (2) All Terrain Vehicle (ATV) mounted drill rigs; a Diedrich 50 and Diedrich 90 were used to advance the test borings. All borings were advanced using 3.25-inch inside diameter, continuous flight hollow stem augers (HSA). Representative disturbed samples of the soils were collected at intervals in accordance with the ODOT Specifications. A standard 2.0-inch outside diameter split-barrel sampler was driven into the soil by means of a 140-lb hammer falling freely through a distance of 30-inches in accordance with the Standard Penetration Test (ASTM D 1586). Where bedrock was encountered, all test borings were advanced and the rock was sampled using type NX series core barrels, water method. All test borings were monitored for the presence of groundwater during drilling operations. All test borings were backfilled with compacted soil cuttings at the end of drilling operations for safety purposes.

Latitude/longitude and northing/easting coordinates, stations and offsets, and surface elevations at the drilled test boring locations were provided to PGI by PB personnel. The typed drilling logs, Boring Location

Map, and soil boring profiles are included in Appendix A. Northing and easting coordinates shown on the Soil Boring Profile sheets are grid. A project adjustment factor (PAF) of 1.00009818 was used to convert the grid coordinates to ground coordinates for this project. The typed drilling logs are included in Appendix A. These logs show the SPT resistance values (N-values) for each soil sample taken in the test borings and present the classification and description of soils encountered at various depths in the test borings. The N-values as measured in the field have been corrected to an equivalent rod energy ratio of 60% (N_{60}) in accordance with ODOT's *Specifications for Geotechnical Explorations*. The sample depth shown on the logs and laboratory test results indicate the top of each sampling or testing interval.

4.2 Laboratory Testing Program

All soil and rock samples obtained during the drilling and sampling operations were returned to PGI's geotechnical soils laboratory in Cleveland, Ohio. Upon arrival, the samples were visually examined and classified by a geotechnical engineer and a geologist to verify the classifications made in the field and to note any additional characteristics, which may not have been observed in the field.

Moisture content determination tests were performed on all soil samples as per ODOT specifications. Additional laboratory soil tests were performed on selected soil samples for the purpose of soil classification and for analysis of engineering characteristics. These tests consisted of Particle-Size Analysis, Liquid and Plastic Limit, Plasticity Index Determination of Soils, and Compressive Strength of Rock Core Samples. All laboratory tests were performed in accordance with the ASTM or other standards listed in "Laboratory Test Standards" located in Appendix B. The results of the laboratory tests are also included in Appendix B. The soils were classified in accordance with the ODOT Soil Classification System, a description of which is also included in Appendix B.

Upon completion of the laboratory testing, all samples were placed in storage at PGI's Cleveland facility. Unless otherwise requested in writing, the soil and rock samples will be retained through completion and ODOT approval of Stage 2 Plans.

5.0 FINDINGS

5.1 Subsurface Soil Conditions

The surficial and subsurface soil conditions in the vicinity of this proposed bridge were determined from the soil information obtained from project test borings B-083-0-13, B-084-0-13, B-086-0-13, and B-087-0-13. Test borings B-083-0-13 and B-087-0-13 were advanced at the toe of the embankment slopes along US 68 through 4 inches and 8 inches of topsoil, respectively. Test boring B-084-0-13 was advanced through the berm along the US 68 shoulder consisting of 12 inches of gravel and stone fragments with sand and silt base material. Test boring B-086-0-13 was advanced through US 68 pavement shoulder consisting of 9.5 inches of asphalt over 12 inches of crushed limestone base material. All of the subsurface soils encountered in the test borings were cohesive in nature. The subsurface soils encountered in test boring B-083-0-13 consisted entirely of fill material below the topsoil. Test borings B-084-013 and B-086-0-13 consisted of both fill materials and natural soils. Test boring B-087-0-13 consisted of 8 inches of topsoil above the bedrock. The fill material consisted of silty clay (A-6b), and clay (A-7-6). The approximate depth of the fill materials ranged from 3.7 feet in test boring B-083-0-13 to 11.5 feet in B-086-0-13. Natural soils encountered above bedrock in the test borings consisted of silty clay (A-6b). Bedrock was encountered in all test boring locations at approximate depths of 3.7 feet and 0.7 feet below the existing US 68 embankment toes in test borings B-083-0-13 and B-087-0-13, respectively and 11.0 feet and 12.2 feet below the US 68 shoulder in test borings B-084-0-13 and B-086-0-13, respectively. All of the test borings were terminated after obtaining rock core samples.

The laboratory test results indicated that the moisture contents of the tested soil samples ranged from 14% to 24% and the consistency ranged from "medium stiff" to "very stiff". Both of the cohesive soil samples tested for Atterberg Limits had natural moisture contents greater their plastic limits but less than their liquid limits. Normally, soils with moisture contents greater than or equal to their liquid limits are in a liquid state and have no shear strength. Soils with moisture contents greater than or equal to their plastic limits and less than their liquid limits are in a plastic state, and have the potential of volume change under certain loading conditions. For specific conditions at various depths, please refer to the individual test boring logs located in Appendix A of this report. For complete moisture contents and Atterberg limit test results, please refer to the laboratory test results in Appendix B.

5.2 Bedrock Conditions

Bedrock was encountered in all of the test borings. Bedrock was split spoon sampled until little or no penetration or recovery was encountered. Bedrock core samples were then obtained using NX diamond impregnated core barrels. The coring operations were performed in accordance with the procedure for Diamond Core Drilling for Site Investigations (ASTM D 2113). The core samples consisted of dolomite of the Tymochtee/Greenfield Group. The dolomite was light gray, moderately to slightly weathered, and strong to very strong. Bedding within the dolomite was generally very thin to thin and was highly fractured to moderately fractured with few angular fractures. No slickensides were observed and the fractures were typically tight to narrow and slightly rough to very rough. The compressive strength of the core specimens ranged from 13,781 psi in test boring B-086-0-13 to 19,636 psi in test boring B-087-0-13 which characterizes them as “strong” to “very strong”, respectively.

The Rock Quality Designation (RQD) for the core samples ranged from 32% to 43% and averaged 39% based on individual runs. The results of these measurements are summarized in Table 5.2.1. Table 5.2.2 summarizes the results of compressive strength tests performed at the laboratory on the rock core specimens at various depths. The Rock Mass Rating obtained for the bedrock core samples according to LRFD Table 10.4.6.4-1 varied from 48 to 53 and is classified as “Fair Rock”. The Rock Mass Rating spreadsheets are included in Appendix B. Refer to the drilling logs in Appendix A and rock core photos in Appendix B for additional bedrock information. Also refer to “Bedrock Descriptions” in Appendix B for general bedrock information.

Table 5.2.1 – Bedrock Information

Boring Number	Rock Core Run No.	Top of Bedrock Elevations (ft)	Top of Rock Core Run Elevations (ft)	Length of Core Run (ft)	Recovery (%)	RQD (%)
B-083-0-13	NX-1	786.4	785.1	10.0	100	38
B-084-0-13	NX-1	787.2	787.0	10.0	100	32
B-086-0-13	NX-1	788.9	786.1	10.0	100	43
B-087-0-13	NX-1	786.8	783.5	10.0	100	41

Elevations were provided by PB personnel

Table 5.2.2 – Compressive Strength Test Results of Rock Core Specimens

Boring Number	Specimen Depth (ft)	Rock Type	Unit Weight (pcf)	Compressive Strength (psi)
B-083-0-13	14.2	Dolomite	165.51	14,427
B-084-0-13	17.7	Dolomite	165.75	14,787
B-086-0-13	21.2	Dolomite	165.57	13,781
B-087-0-13	6.8	Dolomite	169.67	19,636

5.3 Groundwater Conditions

The groundwater levels were monitored in all of the test boring locations during drilling operations. Groundwater was not encountered during drilling operations in any of the test borings advanced during our field work. Groundwater levels were not recorded upon completion of drilling operations due to water used for rock coring. It should be noted that groundwater elevations are subject to seasonal fluctuations. Groundwater monitoring wells are essential to accurately define the position of the groundwater table; however, installation of monitoring wells was not included in our scope of services. All test borings were backfilled upon completion for safety purposes.

6.0 ANALYSIS AND RECOMMENDATIONS

Based upon the findings of the field exploration program, laboratory testing, and subsequent engineering analysis, the following sections have been prepared to address the geotechnical aspects related to the design and construction of the US 68 Mainline Bridge No. HAN-68-1585 over proposed Lima Avenue. Based on the site plan provided by PB personnel, the footing bottom bearing elevation of the rear and forward abutments will be at 786.2 feet and 786.5 feet, respectively. Fill materials will be placed on both sides of the bridge approaches to raise the existing grade to the proposed subgrade elevation. The approximate thickness of the fill material will be 14.2 feet at the rear abutment approach and 10.5 feet at the forward abutment approach. The foundation recommendations are provided in accordance with the ODOT *Bridge Design Manual* issued in 2007 and 6th Edition of the *AASHTO LRFD Bridge Design Specifications* (2010).

6.1 Bridge Foundation Systems

Soil and rock information obtained from structural test borings B-083-0-13, B-084-0-13, B-086-0-13, and B-087-0-13 were used to provide foundation recommendations for the proposed bridge. As outlined in Section 5.1 - "Subsurface Soil Conditions", the top of bedrock was encountered at approximate depths of 3.7 feet and 0.7 feet below the existing US 68 embankment toe in test boring B-083-0-13 and B-087-0-13 locations, respectively and at approximate depths of 11.0 feet and 12.2 feet below the existing US 68 shoulder in test boring B-086-0-13 and B-087-0-13 locations, respectively. Bedrock at these boring locations consists of dolomite and was encountered to termination depth in all four test borings. The Rock Mass Rating obtained for the bedrock core samples according to LRFD Table 10.4.6.4-1 varied from 48 to 53 and is considered as “Fair Rock”. Since bedrock was encountered at the test boring locations at relatively shallow depths below the proposed Lima Avenue, the proposed superstructure loads may be transferred to the underlying bedrock by means of shallow foundations.

Shallow foundation systems consisting of spread footings may be used to transfer the loads to the underlying bedrock at the proposed abutment locations. Bearing resistance for spread footings on bedrock was evaluated using a semi-empirical method at each abutment location. The nominal bearing resistance analysis spreadsheets are included in Appendix B. Table 6.1.1 summarizes the nominal bearing resistance on bedrock and founding elevation at each test boring location so that PB personnel can verify the bearing pressure at Strength, Extreme Limit, and Service States. A Resistance Factor (ϕ) of 0.45 should be applied to compute the Factored Bearing Resistance at the Strength Limit State. A Resistance Factor (ϕ) of 1.0 should be used to compute the Factored Bearing Resistance at the Service Limit State.

Table 6.1.1 – Estimated Design Parameters at Strength Limit State for Spread Footings

Boring No.	Substructure Location	Top of Bedrock Elevation (feet)	Proposed Bearing Elevation (feet)	Nominal Resistance (ksf)
B-083-0-13	Rear Abutment	786.4±	785.9	46.0
B-084-0-13	Rear Abutment	787.2±	786.7	47.0
B-086-0-13	Forward Abutment	788.9±	788.4	44.0
B-087-0-13	Forward Abutment	786.8±	786.3	62.0

A presumptive nominal bearing resistance of 35 ksf from the LRFD Table C10.6.2.6.1-1 was used for dolomite bedrock to calculate the settlement at the Service Limit State. Settlement of the proposed footings at the abutment locations will be due to elastic compression of bedrock. Based on the settlement analysis, it is estimated that the maximum total settlement and differential settlement will not exceed one inch and one-half of an inch, respectively. The settlement calculations are shown on the nominal bearing resistance analysis spreadsheets included in Appendix B. Since the proposed spread footings will be placed on relatively level ground, and shear failure is not anticipated along the foundation bedrock joints, global stability of the footings is not a concern. The proposed footings supported abutments may experience sliding caused by lateral loads. Therefore all abutment footings should be keyed into bedrock a minimum of 3 inches in accordance with requirements of Section 204.1, 303.4.1.1, and 606.7 of the *2007 ODOT Bridge Design Manual*. Since the proposed abutments footings will bear directly on bedrock, they will not be susceptible to frost heave. Please note that the top elevation of the dolomite/limestone bedrock may vary with location, and slight adjustments of footing depth may be required in the field. The bedrock footing subgrade should be examined by a competent geotechnical engineer to verify that the maximum factored resistance is being complied with. If any soil and severely weathered bedrock is encountered, it should be removed as directed by an on-site geotechnical engineer and replaced with concrete.

6.2 Lateral Earth Pressures and Abutment Drainage

The bridge abutments must be designed to resist lateral pressures exerted by both dead and live loads. The active lateral earth pressures exerted behind the bridge abutments may be approximated by an equivalent fluid weighing 40 pcf above the water table and 80 pcf below the water table; provided that level ground exists behind the abutments and that no surcharge loads are placed behind the walls. Freely draining material must be placed behind the abutment wing walls in accordance with ODOT Item 518 - "Drainage of Structures". The porous backfill should be placed a minimum of two (2) feet in thickness normal to these walls. It is suggested that filter fabric, ODOT Item 712.09, Type A, be placed between Item 518 porous backfill material and Item 203 embankment material. This will ensure that fine particles do not migrate into the voids of the porous backfill.

6.3 Approach Slab Design Parameters

During construction of the project, the proposed approach slabs will be constructed on the embankment fill materials because the existing embankment grade is to be raised to proposed subgrade. Therefore, the soil parameters derived from the actual fill soils should be used for pavement design. Representative samples of proposed borrow materials should be tested and CBR values should be derived prior to construction.

6.4 Groundwater Management

Groundwater was not encountered in any of the test borings during drilling operations. Therefore, water infiltration is not anticipated during the excavation for structures. However, it must be noted that the groundwater levels during construction may vary due to seasonal fluctuations, and groundwater may occur where not encountered previously. Groundwater levels were not recorded upon completion of drilling operations due to water used for rock coring.

6.5 Earthwork and Construction Monitoring

All excavation and backfilling operations should be conducted in accordance with ODOT's *Construction and Materials Specifications*, Item 503 - "Excavation for Structures" issued in January 2013 and under the supervision of competent geotechnical personnel. All excavations should comply with all current and applicable local, state, and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration (OSHA). The proposed cut slopes for the structure foundation excavation must be constructed using a two (2) horizontal to one (1) vertical slope in cohesive soils. Soil and rock excavations are expected during construction of the project. It is expected that some harder, less weathered bedrock will be present during bridge footing excavation. Therefore special drilling equipment should be required.

All fill material must be approved by a qualified geotechnical engineer prior to placement. The fill materials should be placed in lifts of eight (8) inches in thickness (loose measure) and be compacted to an unyielding condition in accordance with ODOT 203.07 “Compaction and Moisture Requirements” specifications. The top 12 inches of the fill in pavement subgrade areas should be placed in lifts of eight (8) inches in thickness (loose measure) and be compacted to an unyielding condition in accordance with ODOT 204.03 “Compaction of the Subgrade” specifications. All in-place density tests should be performed as per Supplement 1015 “Compaction Testing of Unbound Materials” during earthwork construction. The tests should be performed by a qualified soil technician in accordance with the appropriate ASTM procedures.

7.0 LIMITATIONS

This report is subject to the following conditions and limitations:

7.1 The subsurface conditions described are based on an examination of the soil and rock samples at the sampling intervals. Varying soil deposits, including fill material, may exist between the sampling intervals and between the test boring locations. Variation in subsurface conditions from those indicated in this report may become apparent during the earthwork and/or installation of the foundations. Such variations may require changes and/or modifications in our recommendations. Such changes may cause time delays and/or additional costs. Owners must be made aware of these limitations and must incorporate them in the design budget and scheduling of the project.

7.2 The design of the proposed project does not vary from the technical information provided and specified in this report. All changes in the design must be reviewed by our geotechnical engineers. PGI cannot assume any responsibility for interpretations made by others of the subsurface conditions and their behavior based on this report.

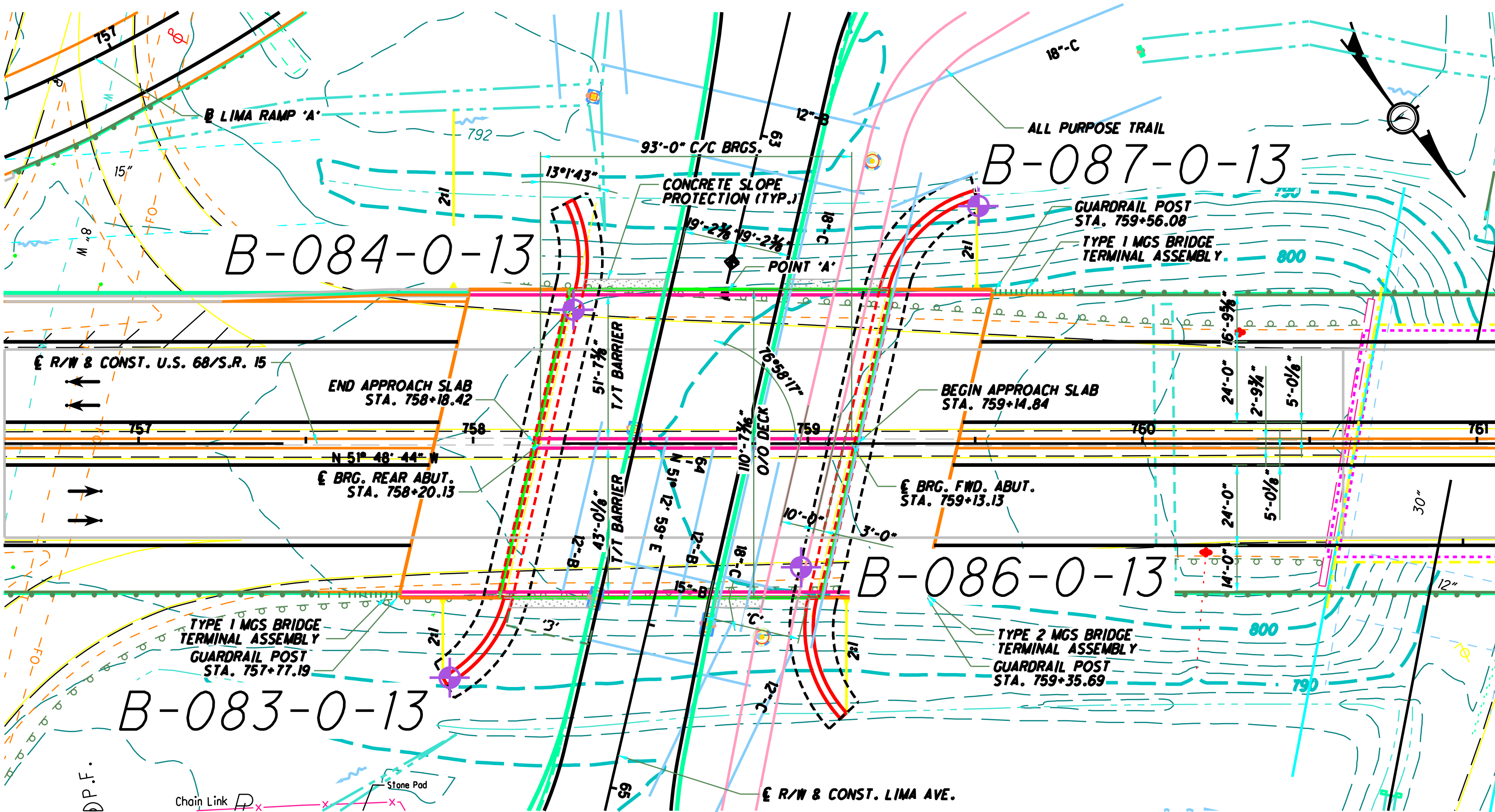
7.3 All earthwork and foundation construction must be performed under the supervision of a Professional Engineer in accordance with ODOT Construction Specifications.

7.4 The subsurface exploration for this project is strictly from a geotechnical standpoint. An environmental site assessment was not included in the scope of these geotechnical services.

7.5 All sheeting, shoring, and bracing of trenches, pits and excavations should be made the responsibility of the contractor and should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration (OSHA).

APPENDICES

APPENDIX A



BORING LOCATION PLAN

U.S. 68 BRIDGE NO. HAN-068-1585 OVER PROPOSED LIMA AVE.

HAN-75-14.39

PID No. 87005

PROJECT: HAN-75-14.39 TYPE: BRIDGE REPLACEMENT PID: 87005 BR ID: HAN-68-1585 START: 7/29/13 END: 7/29/13	DRILLING FIRM / OPERATOR: B-M / JOSH DEAN SAMPLING FIRM / LOGGER: PGI / W. NAJJAR DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT/NX	DRILL RIG: DIEDRICH D-90 ATV HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 9/18/12 ENERGY RATIO (%): 80.2	STATION / OFFSET: 757+93.3, 70.4' RT ALIGNMENT: US 68 BASELINE ELEVATION: 790.1 (MSL) EOB: 15.0 ft. COORD: 41.023545620, 83.667281450

EXPLORATION ID B-083-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 790.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
TOPSOIL (4" THICK)	789.7																	
MEDIUM STIFF, DARK BROWN, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS & ROOTS, FILL, DAMP	786.4	1–2	1 2 2	5	83	SS-1	1.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
POSSIBLE DOLOMITE BEDROCK NOTE: AUGERED TO 5.0' AND STARTED CORING BEDROCK	785.1	TR (4)	50/3"	-	67	SS-2	4.5+	-	-	-	-	-	-	-	-	18	A-6b (V)	
DOLOMITE, LIGHT GRAY, MODERATELY TO SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, JOINTED, HIGHLY TO MODERATELY FRACTURED, FEW ANGULAR FRACTURES, APERTURE WIDTH TIGHT TO NARROW, SLIGHTLY TO VERY ROUGH. @14.2'; UNIT WEIGHT = 165.51 lbs/ft^3, COMPRESSIVE STRENGTH = 14,427 psi	775.1	5–15 EOB	38		100	NX-1											CORE	

NOTES: NO GROUNDWATER WAS ENCOUNTERED DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION DUE TO ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH AUGER CUTTINGS

PROJECT: HAN-75-14.39	DRILLING FIRM / OPERATOR: OTB / JOHN	DRILL RIG: DIEDRICH D-50 ATV	STATION / OFFSET: 758+30.4, 39.2' LT
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PGI / F.BUSHER	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: US 68 BASELINE
PID: 87005 BR ID: HAN-68-1585	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/10/11	ELEVATION: 798.2 (MSL) EOB: 21.2 ft.
START: 6/21/13 END: 6/21/13	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 81.7	COORD: 41.023368470, 83.667629530

EXPLORATION ID B-084-0-13

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 798.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
GRAVEL AND ROCK FRAGMENTS WITH SAND AND SILT (BERM MATERIAL)	797.2																	
MEDIUM STIFF TO VERY STIFF, DARK BROWN TO BROWN, **SILTY CLAY**, LITTLE SAND, TRACE ROCK FRAGMENTS, FILL, MOIST TO DAMP		1 - 2	2 3 3	8	100	SS-1	4.5+	2	3	15	37	43	33	17	16	19	A-6b (10)	
@3.5'; VERY STIFF, BROWN, DAMP		3 - 5	4 5 8	18	100	SS-2	4.5+	-	-	-	-	-	-	-	-	15	A-6b (V)	
@6.0'; BROWN AND BLACK, DAMP		6 - 7	2 2 3	7	100	SS-3	2.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
@8.0'; COBBLE WITH WOOD	789.7	8																
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE ROCK FRAGMENTS, DAMP		9 - 10	4 5 9	19	100	SS-4	3.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
@11.0', NO SPLIT SPOON RECOVERY	787.2	TR 11	50/2"	-	0	SS-5	-	-	-	-	-	-	-	-	-	-		
POSSIBLE DOLOMITE BEDROCK @11.2'; STARTED CORING BEDROCK	787.0																	
DOLOMITE, LIGHT GRAY, MODERATELY TO SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, JOINTED, HIGHLY TO MODERATELY FRACTURED, FEW ANGULAR FRACTURES, APERTURE WIDTH TIGHT TO NARROW, SLIGHTLY TO VERY ROUGH. @17.7'; UNIT WEIGHT = 165.75 lbs/ft^3, COMPRESSIVE STRENGTH = 14,787 psi	777.0	12 - 21 EOB	32		100	NX-1											CORE	

NOTES: NO GROUNDWATER WAS ENCOUNTERED DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION DUE TO ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH SOIL CUTTINGS

PROJECT: HAN-75-14.39	DRILLING FIRM / OPERATOR: OTB / JOHN	DRILL RIG: DIEDRICH D-50 ATV	STATION / OFFSET: 758+97.6, 36.8' RT	EXPLORATION ID B-086-0-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PGI / F.BUSHER	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: US 68 BASELINE	
PID: 87005 BR ID: HAN-68-1585	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/10/11	ELEVATION: 801.1 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1
START: 6/20/13 END: 6/21/13	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 81.7	COORD: 41.023646320, 83.667655620	

MATERIAL DESCRIPTION AND NOTES	ELEV. 801.1	DEPTHS
ASPHALT PAVEMENT (9.5" THICK)	800.3	
ODOT 304 CRUSHED LIMESTONE BASE	799.3	
MEDIUM STIFF TO STIFF, GREENISH GRAY TO BROWN, **CLAY**, LITTLE SAND, FILL, MOIST TO DAMP @4.0'; STIFF, BROWN, DAMP @6.0'; BROWN AND BLACK, LITTLE SAND	794.1	
STIFF, BROWN TO GREENISH GRAY, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE ROCK FRAGMENTS, FILL, DAMP @9.0'; GREENISH GRAY, SOME SAND, AND ROOTS	789.6	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, DAMP	788.9	TR
LIGHT GRAY DOLOMITE BEDROCK NOTE; AUGERED TO 15.0' AND STARTED CORING BEDROCK	786.1	
DOLOMITE, LIGHT GRAY, MODERATELY TO SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, JOINTED, HIGHLY TO MODERATELY FRACTURED, FEW ANGULAR FRACTURES, APERTURE WIDTH TIGHT TO NARROW, SLIGHTLY TO VERY ROUGH; RQD 43%, REC 100%. @21.2'; UNIT WEIGHT = 165.57 lbs/ft^3, COMPRESSIVE STRENGTH = 13,781 psi	776.1	EOB 25

Depth (ft)	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
2–3.5	2 2 3	7	67	SS-1	3.25	0	3	12	37	48	43	17	26	22	A-7-6 (15)	
4–5.5	2 5 5	14	72	SS-2	4.5+	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
6.5–8	4 5 5	14	100	SS-3A&B	3.75	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
					4.5+	-	-	-	-	-	-	-	-	14	A-6b (V)	
9–10.5	2 4 5	12	100	SS-4	3.00	-	-	-	-	-	-	-	-	19	A-6b (V)	
11.5–12	6 50/5"	-	73	SS-5	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
15–25	43		100	NX-1											CORE	

NOTES: NO GROUNDWATER WAS ENCOUNTERED DURING DRILLING OPERATIONS AND NO READING WAS TAKEN UPON COMPLETION DUE TO ROCK CORING OPERATIONS..

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PAVEMENT WAS REPLACED WITH ASPHALT COLD PATCH; HOLE WAS BACKFILLED WITH AUGER CUTTINGS

PROJECT: HAN-75-14.39	DRILLING FIRM / OPERATOR: OTB / JOHN	DRILL RIG: DIEDRICH D-50 ATV	STATION / OFFSET: 759+51.1, 71.2' LT
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PGI / F.BUSHER	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: US 68 BASELINE
PID: 87005 BR ID: HAN-68-1585	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/10/11	ELEVATION: 787.5 (MSL) EOB: 14.0 ft.
START: 6/17/13 END: 6/18/13	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 81.7	COORD: 41.023499920, 83.668047240

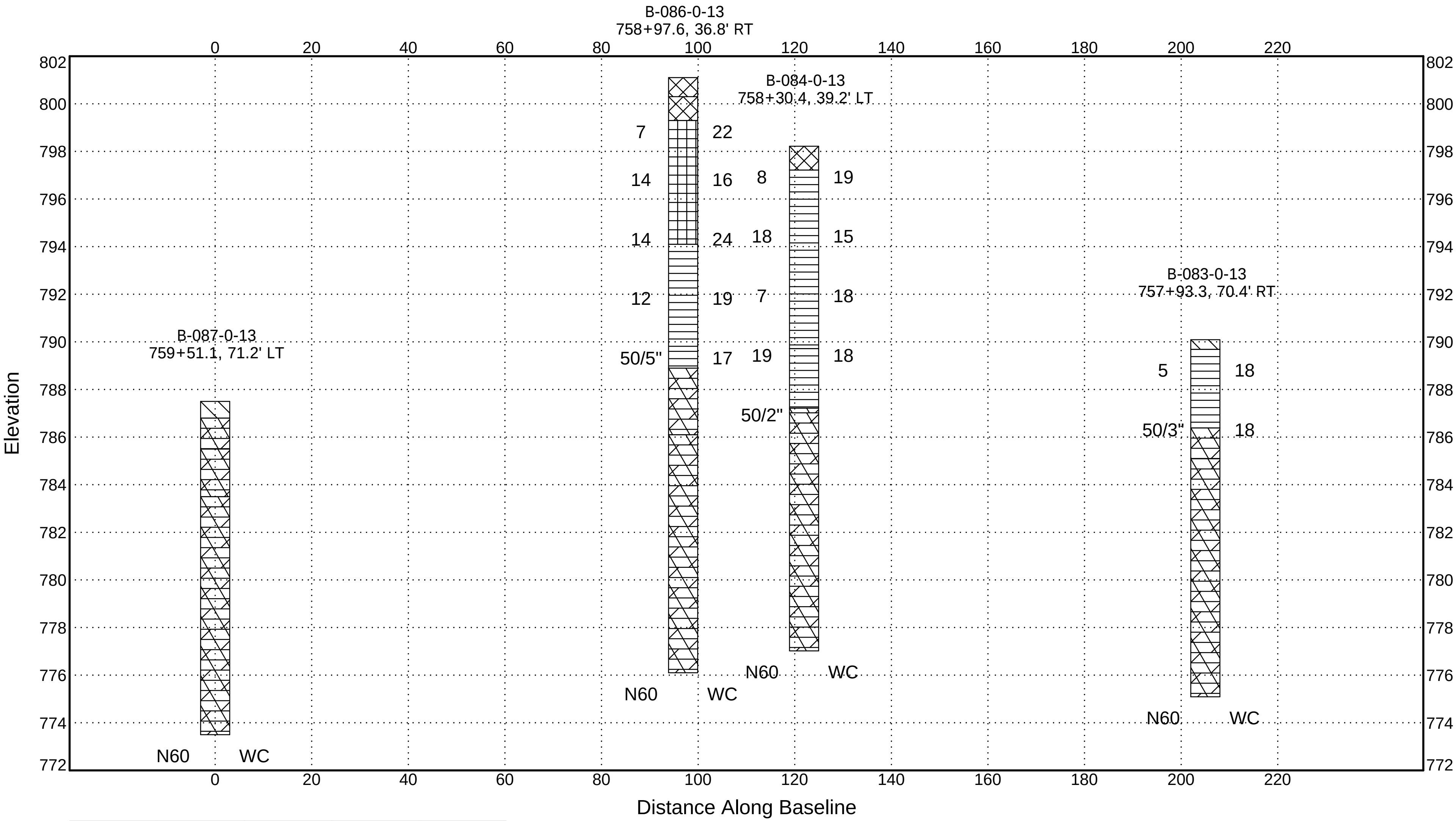
EXPLORATION ID B-087-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 787.5	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
TOPSOIL (8.0" THICK)	786.8	TR																
LIGHT GRAY DOLOMITE BEDROCK	785.5																	
NOTE: AUGERED AND ROLLER BIT TO 4.0' AND STARTED CORING BEDROCK	783.5																	
DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, VERY STRONG, THIN BEDDED, JOINTED, FRACTURED TO MODERATELY FRACTURED, FEW ANGULAR FRACTURES, APERTURE WIDTH TIGHT TO NARROW, SLIGHTLY TO VERY ROUGH. @6.8'; UNIT WEIGHT = 169.67 lbs/ft^3, COMPRESSIVE STRENGTH = 19,636 psi	773.5	EOB 14	41		100	NX-1											CORE	

NOTES: NO GROUNDWATER WAS ENCOUNTERED DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION DUE TO ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH AUGER CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11)-OH DOT GDT-2/3/14 18:48-\\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1585-LIMA AVE.GPJ



Borehole	North	East	Elev.	Depth
B-083-0-13	496497	1646435	790.1	15.0
B-084-0-13	496434	1646338	798.2	21.2
B-086-0-13	496535	1646332	801.1	25.0
B-087-0-13	496484	1646224	787.5	14.0

DISTANCES:
Beginning 0
Ending 220
VIEWING ANGLES (degrees):
Horizontal 0.0
Vertical 0.0

Position	North	East
Left, Front	496508	1646228
Right, Front	496466	1646444
Left, Back	496508	1646228
Right, Back	496466	1646444

SOIL AND ROCK BORINGS PROFILE

HAN-75-14.39 - BRIDGE NO. HAN-68-1585

FINDLAY, Ohio

PROJECT #	DATE	PLATE
87005	Feb 14	1

APPENDIX B

Boring Number	Sample Number	Depth (ft)	Water Content %	Liquid Limit %	Plastic Limit %	Plast. Index	Specific Gravity	Agg. %	Coarse Sand %	Fine Sand %	Silt %	Silt&Clay Comb. %	Clay %	Soil Description	Class. Symbol
B-083-0-13	SS-1	1.0	18											DARK BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGS & ROOTS (FILL)	A-6b (V)
B-083-0-13	SS-2	3.5	18											DARK BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6b (V)
B-084-0-13	SS-1	1.0	19	33	17	16		2	3	15	38	80	43	DARK BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6b (10)
B-084-0-13	SS-2	3.5	15											BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6b (V)
B-084-0-13	SS-3	6.0	18											BROWN AND BLACK SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6b (V)
B-084-0-13	SS-4	8.5	18											BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6b (V)
B-086-0-13	SS-1	2.0	22	43	17	26		0	3	12	37	85	48	GREENISH GRAY CLAY, LITTLE SAND (FILL)	A-7-6 (15)
B-086-0-13	SS-2	4.0	16											BROWN CLAY, LITTLE SAND (FILL)	A-7-6 (V)
B-086-0-13	SS-3A	6.5	24											BROWN AND BLACK CLAY, LITTLE SAND (FILL)	A-7-6 (V)
B-086-0-13	SS-3B	7.0	14											BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6b (V)
B-086-0-13	SS-4	9.0	19											GREENISH GRAY SILTY CLAY, SOME SAND, TRACE STONE FRAGS & ROOTS (FILL)	A-6b (V)
B-086-0-13	SS-5	11.5	17											BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6b (V)

Pro Geotech, Inc.

TR.-TRACE, BR.-BROWN, LI.-LITTLE,
S/F-STONE FRAGMENTS, SO.-SOME,
RB-ROADBASE, NP-NON-PLASTIC,
POSS-POSSIBLE, MOD-MODERATELY

Summary of Laboratory Results

Client: PARSONS BRINKERHOFF
Project: HAN-75-14.39 - Bridge No. HAN-68-1585
Location: FINDLAY, Ohio
PID Number: 87005

Pro Geotech, Inc.

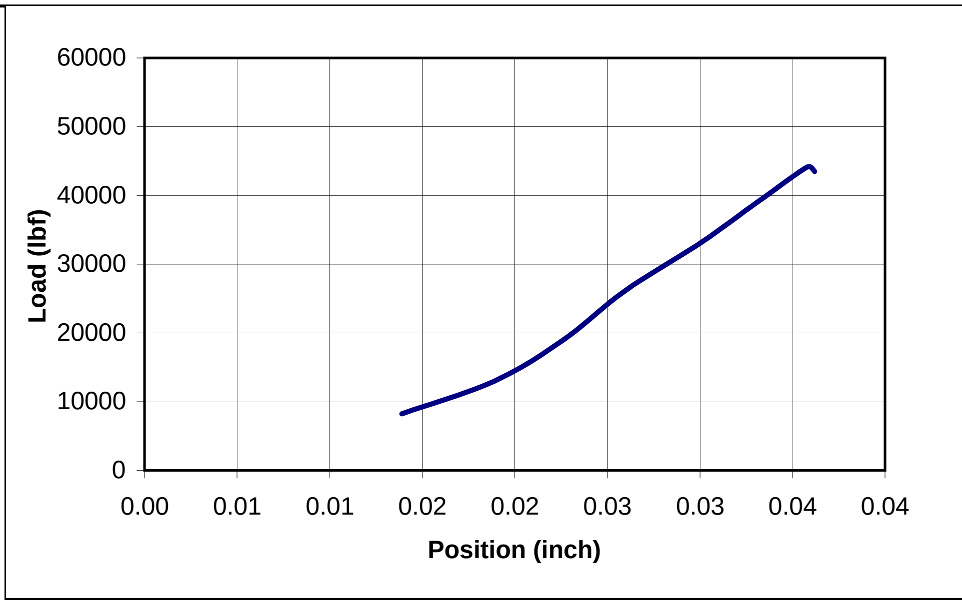
Compressive Strength of Rock
ASTM D 7012

PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/16/2013
BORING NUMBER	B-083-0-13	TOP DEPTH (FT)	14.2	BOTTOM DEPTH (FT)	14.5
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	68	SECTION	15.85
STATION	757+93	OFFSET	70'	OFFSET DIRECTION	RT

FORMATION	TYMOCHTEE / GREENFIELD GROUP
DESCRIPTION	DOLOMITE, LIGHT GRAY, MODERATELY TO SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, JOINTED, HIGHLY TO MODERATELY FRACTURED, FEW ANGULAR FRACTURES, APERTURE WIDTH TIGHT TO NARROW, SLIGHTLY TO VERY ROUGH

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		
1	3.915	1.965	LENGTH/DIAMETER	1.99
2	3.930	1.970	CORRECTION FACTOR	1.00
3	3.915	1.985	AREA (SQ. INCH)	3.058
AVERAGE	3.920	1.973	MASS (GRAMS)	520.87
			UNIT WEIGHT (LBS/FT^3)	165.51

MAXIMUM LOAD (LBS)	44160
COMPRESSIVE STRENGTH (PSI)	14427
TIME OF TEST (MINUTES)	3:10
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER



BEFORE TESTING	AFTER FAILURE

Pro Geotech, Inc.

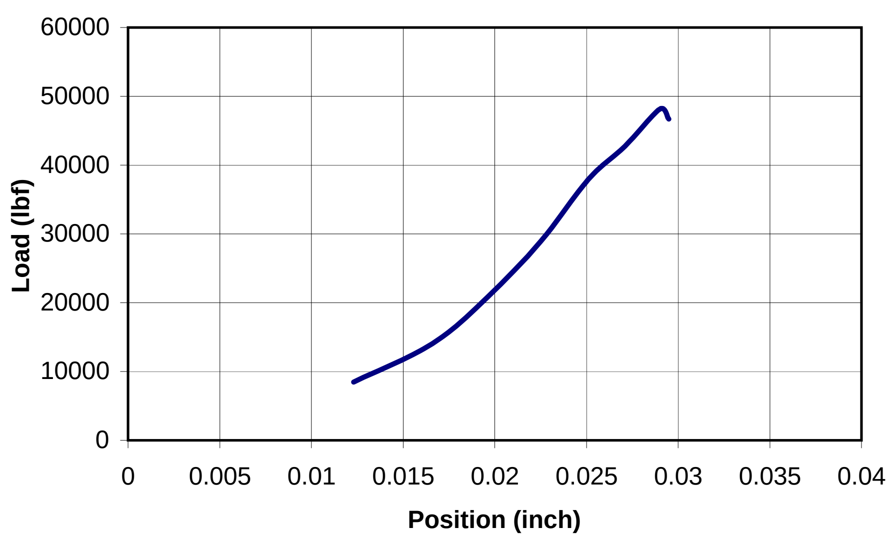
Compressive Strength of Rock
ASTM D 7012

PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/6/2013
	STRUCTURE				
BORING NUMBER	B-084-0-13	TOP DEPTH (FT)	17.7	BOTTOM DEPTH (FT)	18
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	68	SECTION	15.85
STATION	758+30	OFFSET	39'	OFFSET DIRECTION	LT

FORMATION	TYMOCHTEE / GREENFIELD GROUP
DESCRIPTION	DOLOMITE, LIGHT GRAY, MODERATELY TO SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, JOINTED, HIGHLY TO MODERATELY FRACTURED, FEW ANGULAR FRACTURES, APERTURE WIDTH TIGHT TO NARROW, SLIGHTLY TO VERY ROUGH

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)			
				LENGTH/DIAMETER	1.82
1	3.593	2.023		CORRECTION FACTOR	1.01
2	3.576	2.022		AREA (SQ. INCH)	3.215
3	3.857	2.025		MASS (GRAMS)	514.17
AVERAGE	3.675	2.023		UNIT WEIGHT (LBS/FT^3)	165.75

MAXIMUM LOAD (LBS)	48120
COMPRESSIVE STRENGTH (PSI)	14787
TIME OF TEST (MINUTES)	3:00
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER



BEFORE TESTING

AFTER FAILURE

Pro Geotech, Inc.

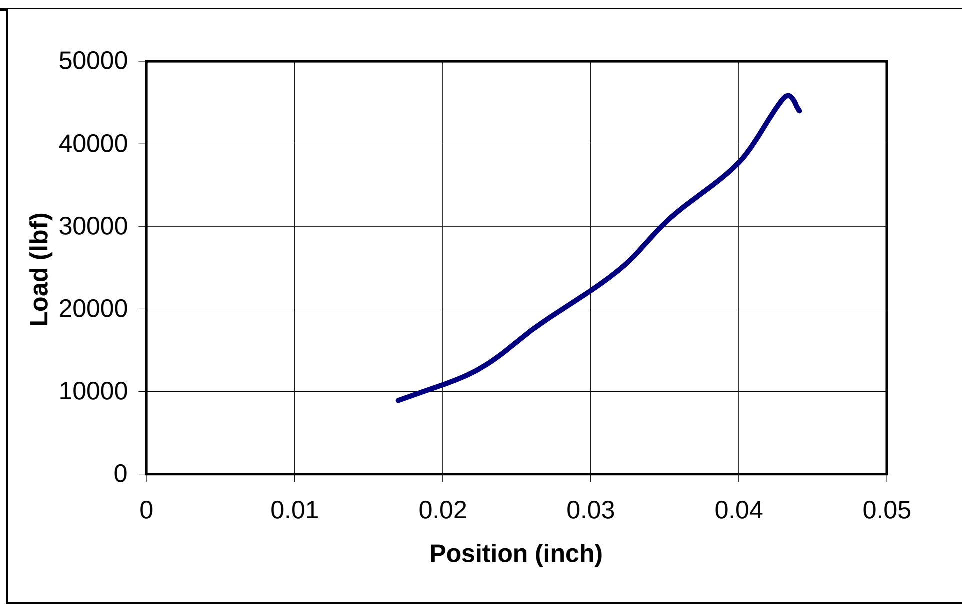
Compressive Strength of Rock
ASTM D 7012

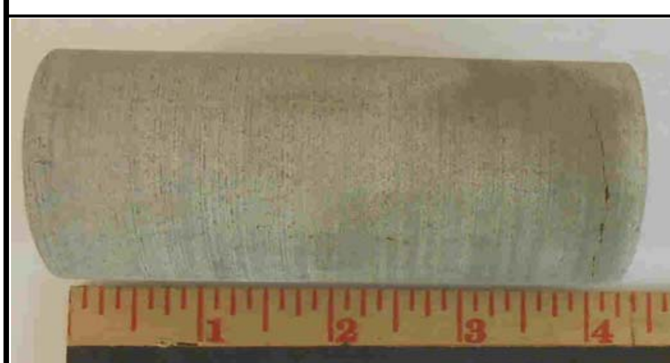
PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/6/2013
	STRUCTURE	LIMA AVENUE BRIDGE			
BORING NUMBER	B-086-0-13	TOP DEPTH (FT)	21.2	BOTTOM DEPTH (FT)	21.5
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	68	SECTION	15.85
STATION	758+98	OFFSET	37'	OFFSET DIRECTION	RT

FORMATION	TYMOCHTEE / GREENFIELD GROUP
DESCRIPTION	DOLOMITE, LIGHT GRAY, MODERATELY TO SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, JOINTED, HIGHLY TO MODERATELY FRACTURED, FEW ANGULAR FRACTURES, APERTURE WIDTH TIGHT TO NARROW, SLIGHTLY TO VERY ROUGH

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		
1	3.945	2.052	LENGTH/DIAMETER	1.92
2	3.935	2.045	CORRECTION FACTOR	1.00
3	3.934	2.049	AREA (SQ. INCH)	3.296
AVERAGE	3.938	2.049	MASS (GRAMS)	564.17
			UNIT WEIGHT (LBS/FT^3)	165.57

MAXIMUM LOAD (LBS)	45649
COMPRESSIVE STRENGTH (PSI)	13781
TIME OF TEST (MINUTES)	3:20
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER





BEFORE TESTING

AFTER FAILURE

Pro Geotech, Inc.

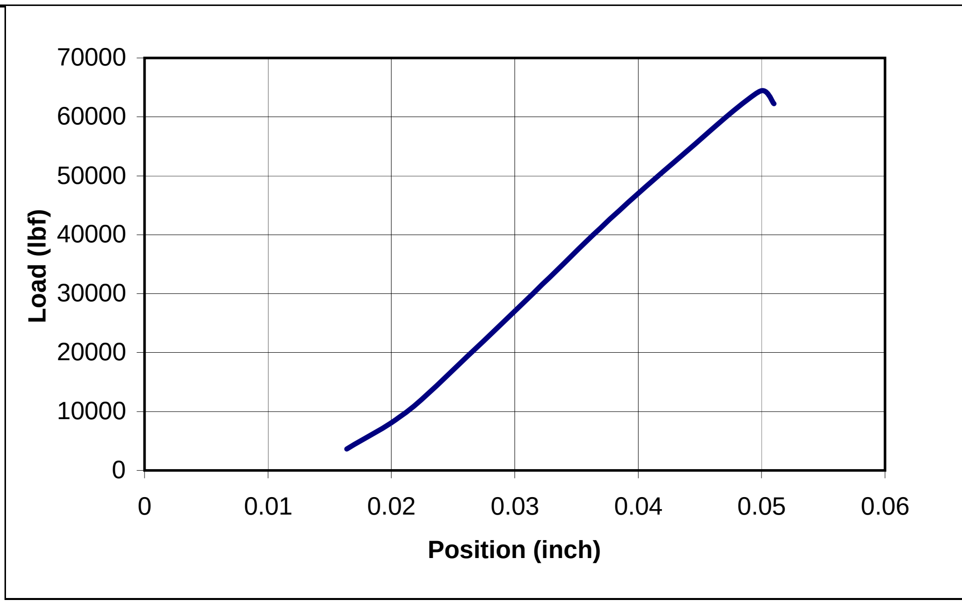
Compressive Strength of Rock
ASTM D 7012

PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/17/2013
	STRUCTURE				
BORING NUMBER	B-087-0-0-13	TOP DEPTH (FT)	6.8	BOTTOM DEPTH (FT)	7.1
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	68	SECTION	15.85
STATION	759+51	OFFSET	71	OFFSET DIRECTION	LT

FORMATION	TYMOCHTEE / GREENFIELD GROUP
DESCRIPTION	DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, STRONG, THIN BEDDED, JOINTED, FRACTURED TO MODERATELY FRACTURED, FEW ANGULAR FRACTURES, APERTURE WIDTH TIGHT TO NARROW, SLIGHTLY TO VERY ROUGH

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		
1	4.013	2.043	LENGTH/DIAMETER	1.97
2	4.031	2.039	CORRECTION FACTOR	1.00
3	4.028	2.038	AREA (SQ. INCH)	3.269
			MASS (GRAMS)	585.77
AVERAGE	4.024	2.040	UNIT WEIGHT (LBS/FT^3)	169.67

MAXIMUM LOAD (LBS)	64288
COMPRESSIVE STRENGTH (PSI)	19636
TIME OF TEST (MINUTES)	3:10
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER



BEFORE TESTING

AFTER FAILURE

COMPANY: PGI DRILLED BY: B-M
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-68-1585 over Proposed Lima Ave.
BORING: B-083-0-13 BOX 1/1
DATE of CORING: 7/29/13
RUN-1: 4.0' - 14.0'
REC: 100% RQD: 38%

COMPANY: PGI DRILLED BY: OTB
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-68-1585 over Proposed Lima Ave.
BORING: B-084-0-13 BOX 1/1
DATE of CORING: 6/21/13
RUN-1: 11.2' - 21.2'
REC: 100% RQD: 32%

COMPANY: PGI	DRILLED BY: OTB
PROJECT: HAN-75-14.39	
BRIDGE NO.: HAN-68-1585 over Proposed Lima Ave.	
BORING: B-086-0-13 BOX 1/1	
DATE of CORING: 6/20/13	
RUN-1: 15.0' - 25.0'	
REC: 100% RQD: 43%	

COMPANY: PGI DRILLED BY: OTB
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-68-1585 over Proposed Lima Ave.
BORING: B-087-0-13 BOX 1/1
DATE of CORING: 6/17/13
RUN-1: 4.0' - 14.0'
REC: 100% RQD: 41%

ROCK MASS RATING From Table 10.4.6.4-1	
Project: HAN-75-14.39	**Project No.:** G13011G
Structure: US 68 Mainline BridgeNo. HAN-68-1585 over Proposed Lima Ave.	
Boring No.: B-083-0-13	**Substructure Unit:** Rear Abutment
Strength of Intact Rock Material	
Uniaxial Compressive Strength	2077
Relative Rating	7
Drill Core Quality RQD	
RQD	38%
Relative Rating	6
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	8
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	19
Ground water Conditions	
Relative Rating	10
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	50
Class No	III
Description	Fair Rock
Boring No.: B-084-0-13	**Substructure Unit:** Rear Abutment
Strength of Intact Rock Material	
Uniaxial Compressive Strength	2129 ksf
Relative Rating	7
Drill Core Quality RQD	
RQD	32%
Relative Rating	6
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	7
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	18
Ground water Conditions	
Relative Rating	10
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	48
Class No	III
Description	Fair Rock

ROCK MASS RATING From Table 10.4.6.4-1	
Project: HAN-75-14.39	**Project No.:** G13011G
Structure: US 68 Mainline BridgeNo. HAN-68-1585 over Proposed Lima Ave.	
Boring No.: B-086-0-13	**Substructure Unit:** Forward Abutment
Strength of Intact Rock Material	
Uniaxial Compressive Strength	1984
Relative Rating	6
Drill Core Quality RQD	
RQD	43%
Relative Rating	7
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	8
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	19
Ground water Conditions	
Relative Rating	10
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	50
Class No	III
Description	Fair Rock
Boring No.: B-087-0-13	**Substructure Unit:** Forward Abutment
Strength of Intact Rock Material	
Uniaxial Compressive Strength	2827 ksf
Relative Rating	9
Drill Core Quality RQD	
RQD	41%
Relative Rating	7
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	8
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	19
Ground water Conditions	
Relative Rating	10
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	53
Class No	III
Description	Fair Rock

Bearing Resistence and Settlement Analyses of Footing on Jointed Rock

Project: HAN-75-14.39-HAN-75-1585 **Project No.:** G13011G

Boring No.: B-083-0-13 **Substructure Unit:** Rear Abutment

Rock Parameters	
Rock Mass Rating (RMR) (From LRFD Table 10.4.6.4.1)	50
Class No. (From LRFD Table 10.4.6.4.3)	III
Quality Description (From LRFD Table 10.4.6.4.3)	Fair Rock
Uniaxial Compressive Strength of Rock (q_u, ksf) (From Laboratory Test (ASTM D 7012))	2077
Presumptive Bearing Resistence for Spread Footing at Service Limit State (ksf) (From LRFD Table C10.6.2.6.1-1)	35
Nominal Resistance of Concrete (ksf) = $0.3*f'_c$	173
N_{ms} (From Table 4.4.8.1.2A) AASHTO Standard Specifications - 17th Edition, 2002	0.049
Poisson's Ratio of Intact Rock (From LRFD Table C10.4.6.5-2)	0.14
Average Elastic Modulus for Intact Rock, E_i (ksi) (From Load vs Displacement from Lab Test, ASTM D 7012)	2349
Elastic Modulus of Rock Mass, E_m (ksi) (From LRFD Eq 10.4.6.5-1)	1450
Reduction Factor (E_m/E_i) (From LRFD Table 10.4.6.5-1)	0.11
Elastic Modulus of Rock Mass (E_m) (ksi) (From LRFD Eq 10.4.6.5-2)	258
Assumed Em (ksi)	250
Nominal Bearing Resistence	**N_{ms} Method (At the Strength Limit State)**
Effective Length of Footing, L (feet)	93
Effective Width of Footing, B (feet)	13.5
L/B	6.9
Type of Footing	Spread, Rectangular
Depth of Footing Below Ground, D (feet)	5.25
Unit Weight of Soil above base of footing, y_q (pcf)	125
Unit Weight of Rock below base of footing, y_y (pcf)	165
Nominal Bearing Resistence (ksf) (From Eq 4.4.8.1.2-1 and $Q_{ult} = Q_{nom}$) AASHTO Standard Specifications - 17th Edition, 2002	102
Resistance Factor (From LRFD Table 10.5.5.2.2-1)	0.45
Factored Resistence (ksf)	46
Settlement Analysis (From LRFD Eq 10.6.2.4.4-1)= $q_o(1-v^2)((B*I_p/(144*E_m))$ **(At the Service Limit State)**	
Regidity Factors, B_z for L/B (For Regid Footing) (From LRFD Table 10.6.2.4.2-1)	1.27
Influence Coefficient, $I_p = L/B)^{1/2}/B_z$ (From LRFD Eq 10.6.2.4.4-4)	2.067
Nominal Bearing Rsistence (ksf)	35
Elastic Settlement p (inches)	0.319

Bearing Resistence and Settlement Analyses of Footing on Jointed Rock	
Project: HAN-75-14.39-HAN-75-1585	**Project No.:** G13011G
Boring No.: B-084-0-13	**Substructure Unit:** Rear Abutment
Rock Parameters	
Rock Mass Rating (RMR) (From LRFD Table 10.4.6.4.1)	48
Class No. (From LRFD Table 10.4.6.4.3)	III
Quality Description (From LRFD Table 10.4.6.4.3)	Fair Rock
Uniaxial Compressive Strength of Rock (q_u, ksf) (From Laboratory Test (ASTM D 7012))	2129
Presumptive Bearing Resistence for Spread Footing at Service Limit State (ksf) (From LRFD Table C10.6.2.6.1-1)	35
Nominal Resistance of Concrete (ksf) = $0.3*f'_c$	173
N_{ms} (From Table 4.4.8.1.2A) AASHTO Standard Specifications - 17th Edition, 2002	0.049
Poisson's Ratio of Intact Rock (From LRFD Table C10.4.6.5-2)	0.14
Average Elastic Modulus for Intact Rock, E_i (ksi) (From Load vs Displacement from Lab Test, ASTM D 7012)	3380
Elastic Modulus of Rock Mass, E_m (ksi) (From LRFD Eq 10.4.6.5-1)	1292
Reduction Factor (E_m/E_i) (From LRFD Table 10.4.6.5-1)	0.09
Elastic Modulus of Rock Mass (E_m) (ksi) (From LRFD Eq 10.4.6.5-2)	304
Assumed Em (ksi)	300
Nominal Bearing Resistence	**N_{ms} Method (At the Strength Limit State)**
Effective Length of Footing, L (feet)	93
Effective Width of Footing, B (feet)	13.5
L/B	6.9
Type of Footing	Spread, Rectangular
Depth of Footing Below Ground, D (feet)	5.25
Unit Weight of Soil above base of footing, y_q (pcf)	125
Unit Weight of Rock below base of footing, y_y (pcf)	165
Nominal Bearing Resistence (ksf) (From Eq 4.4.8.1.2-1 and $Q_{ult} = Q_{nom}$) AASHTO Standard Specifications - 17th Edition, 2002	104
Resistance Factor (From LRFD Table 10.5.5.2.2-1)	0.45
Factored Resistence (ksf)	47
Settlement Analysis (From LRFD Eq 10.6.2.4.4-1)= $q_o(1-v^2)((B*I_p/(144*E_m))$ (**At the Service Limit State**)	
Regidity Factors, B_z for L/B (For Regid Footing) (From LRFD Table 10.6.2.4.2-1)	1.27
Influence Coefficient, $I_p = L/B)^{1/2}/B_z$ (From LRFD Eq 10.6.2.4.4-4)	2.067
Nominal Bearing Rsistence (ksf)	35
Elastic Settlement p (inches)	0.266

Bearing Resistence and Settlement Analyses of Footing on Jointed Rock

Project: HAN-75-14.39-HAN-75-1585 **Project No.:** G13011G

Boring No.: B-086-0-13 **Substructure Unit:** Forward Abutme

Rock Parameters	
Rock Mass Rating (RMR) (From LRFD Table 10.4.6.4.1)	50
Class No. (From LRFD Table 10.4.6.4.3)	III
Quality Description (From LRFD Table 10.4.6.4.3)	Fair Rock
Uniaxial Compressive Strength of Rock (q_u, ksf) (From Laboratory Test (ASTM D 7012))	1984
Presumptive Bearing Resistence for Spread Footing at Service Limit State (ksf) (From LRFD Table C10.6.2.6.1-1)	35
Nominal Resistance of Concrete (ksf) = $0.3*f'_c$	173
N_{ms} (From Table 4.4.8.1.2A) AASHTO Standard Specifications - 17th Edition, 2002	0.049
Poisson's Ratio of Intact Rock (From LRFD Table C10.4.6.5-2)	0.14
Average Elastic Modulus for Intact Rock, E_i (ksi) (From Load vs Displacement from Lab Test, ASTM D 7012)	2226
Elastic Modulus of Rock Mass, E_m (ksi) (From LRFD Eq 10.4.6.5-1)	1450
Reduction Factor (E_m/E_i) (From LRFD Table 10.4.6.5-1)	0.126
Elastic Modulus of Rock Mass (E_m) (ksi) (From LRFD Eq 10.4.6.5-2)	280
Assumed Em (ksi)	250
Nominal Bearing Resistence	**N_{ms} Method (At the Strength Limit State)**
Effective Length of Footing, L (feet)	93
Effective Width of Footing, B (feet)	13.5
L/B	6.9
Type of Footing	Spread, Rectangular
Depth of Footing Below Ground, D (feet)	4.7
Unit Weight of Soil above base of footing, y_q (pcf)	125
Unit Weight of Rock below base of footing, y_y (pcf)	165
Nominal Bearing Resistence (ksf) (From Eq 4.4.8.1.2-1 and $Q_{ult} = Q_{nom}$) AASHTO Standard Specifications - 17th Edition, 2002	97
Resistance Factor (From LRFD Table 10.5.5.2.2-1)	0.45
Factored Resistence (ksf)	44
Settlement Analysis (From LRFD Eq 10.6.2.4.4-1)= $q_o(1-v^2)((B*I_p/(144*E_m))$ **(At the Service Limit State)**	
Regidity Factors, B_z for L/B (For Regid Footing) (From LRFD Table 10.6.2.4.2-1)	1.27
Influence Coefficient, $I_p = L/B)^{1/2}/B_z$ (From LRFD Eq 10.6.2.4.4-4)	2.067
Nominal Bearing Rsistence (ksf)	35
Elastic Settlement p (inches)	0.319

Bearing Resistence and Settlement Analyses of Footing on Jointed Rock

Project: HAN-75-14.39-HAN-75-1585	**Project No.:** G13011G
Boring No.: B-087-0-13	**Substructure Unit:** Forward Abutme

Rock Parameters	
Rock Mass Rating (RMR) (From LRFD Table 10.4.6.4.1)	53
Class No. (From LRFD Table 10.4.6.4.3)	III
Quality Description (From LRFD Table 10.4.6.4.3)	Fair Rock
Uniaxial Compressive Strength of Rock (q_u, ksf) (From Laboratory Test (ASTM D 7012))	2827
Presumptive Bearing Resistence for Spread Footing at Service Limit State (ksf) (From LRFD Table C10.6.2.6.1-1)	35
Nominal Resistance of Concrete (ksf) = 0.3*f'_c	173
N_{ms} (From Table 4.4.8.1.2A) AASHTO Standard Specifications - 17th Edition, 2002	0.049
Poisson's Ratio of Intact Rock (From LRFD Table C10.4.6.5-2)	0.14
Average Elastic Modulus for Intact Rock, E_i (ksi) (From Load vs Displacement from Lab Test, ASTM D 7012)	2301
Elastic Modulus of Rock Mass, E_m (ksi) (From LRFD Eq 10.4.6.5-1)	1723
Reduction Factor (E_m/E_i) (From LRFD Table 10.4.6.5-1)	0.12
Elastic Modulus of Rock Mass (E_m) (ksi) (From LRFD Eq 10.4.6.5-2)	276
Assumed Em (ksi)	250
Nominal Bearing Resistence	**N_{ms} Method (At the Strength Limit State)**
Effective Length of Footing, L (feet)	93
Effective Width of Footing, B (feet)	13.5
L/B	6.9
Type of Footing	Spread, Rectangular
Depth of Footing Below Ground, D (feet)	4.7
Unit Weight of Soil above base of footing, y_q (pcf)	125
Unit Weight of Rock below base of footing, y_y (pcf)	169
Nominal Bearing Resistence (ksf) (From Eq 4.4.8.1.2-1 and $Q_{ult} = Q_{nom}$) AASHTO Standard Specifications - 17th Edition, 2002	139
Resistance Factor (From LRFD Table 10.5.5.2.2-1)	0.45
Factored Resistence (ksf)	62
Settlement Analysis (From LRFD Eq 10.6.2.4.4-1)= $q_o(1-v^2)((B*I_p/(144*E_m))$ **(At the Service Limit State)**	
Regidity Factors, B_z for L/B (For Regid Footing) (From LRFD Table 10.6.2.4.2-1)	1.27
Influence Coefficient, $I_p = L/B)^{1/2}/B_z$ (From LRFD Eq 10.6.2.4.4-4)	2.067
Nominal Bearing Rsistence (ksf)	35
Elastic Settlement p (inches)	0.319

VI.D. Geotechnical Reports

C-R-S: HAN-75-14.39-Bridge No. HAN-68-1585	PID: 87005	Reviewer: SS	Date: 2/3/2014

General		
Y $\boxed{N}$ X 1	Has the first complete version of a geotechnical report being submitted been labeled as 'Draft'?	
$\boxed{Y}$ N X 2	Subsequent to ODOT's review and approval, has the complete version of the revised geotechnical report being submitted been labeled 'Final'?	
$\boxed{Y}$ N X 3	Have all geotechnical reports being submitted been titled correctly as prescribed in Section 705.1 of the SGE?	
$\boxed{Y}$ N X 4	Have all geotechnical reports included each of the sections as described in Sections 705.2 through 705.8.4 of the SGE?	

Notes:

IV.A Foundations/Structures - Non-bridge Applications

C-R-S: HAN-68-14.39- Bridge No. HAN-68-1585	PID: 87005	Reviewer: SS	Date: 2/3/2014

If you do not have such a foundation or structure on the project, you do not have to fill out this checklist.

Soil and Bedrock Strength Data		
Y N $\boxed{X}$ 1	Has the shear strength of the foundation soils been determined? Check method used: 9 laboratory shear tests 9 estimation from SPT or field tests	Foundation on bedrock
Y N $\boxed{X}$ 2	Have sufficient soil shear strength, consolidation, and other parameters been determined so that the required allowable loads for the foundation/structure can be designed?	
$\boxed{Y}$ N X 3	Has the shear strength of the foundation bedrock been determined? Check method used: 9 laboratory shear tests $\boxed{9}$ other List Other items:	Unconfined Compression Strength of Bedrock

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Spread Footings				
$\boxed{Y}$ N	4		Are there spread footings on the project?	
			If no, go to Question **11**	
$\boxed{Y}$ N X	5		Has the recommended bottom of footing elevation and reason for this recommendation been provided?	On Bedrock
Y N $\boxed{X}$		a	Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?	
	6		Were representative sections analyzed for the entire length of the structure for the following:	
$\boxed{Y}$ N X		a	bearing capacity?	
Y $\boxed{N}$ X		b	sliding?	To be performed by PB
Y $\boxed{N}$ X		c	Overturning?	To be performed by PB
$\boxed{Y}$ N X		d	settlement?	
Y $\boxed{N}$ X	7		Has the need for a shear key been evaluated?	To be performed by PB
Y N X		a	If needed, have the details been included in the plans?	
Y N $\boxed{X}$	8		If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?	
$\boxed{Y}$ N X	9		Has the recommended allowable soil or rock bearing pressure been provided?	
Y N $\boxed{X}$	10		If weak soil is present at the proposed foundation level, has the removal / treatment of this soil been developed and included in the plans?	
Y N X		a	Have the procedure and quantities related to this removal / treatment been included in the plans?	

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Pile Structures - Bridge			
Y $\boxed{N}$	11	Are there piles on the project? If no, go to Question **17**	
Y N	12	Has an appropriate pile type been selected? Check the type selected: 9 H-pile (driven) 9 H-pile (drilled) 9 Cast In-place Concrete 9 other List Other items:	
Y N X	13	Have the estimated pile length or tip elevation and section (diameter) been specified? Check method used: 9 SPILE, DRIVEN, PICAP3 or equivalent software 9 hand calculations	
	14	If required for design, have sufficient soil parameters been provided and calculations performed to evaluate the:	
Y N X		a Lateral load capacity and maximum deflection of the piles?	
Y N X		b Vertical load capacity and maximum settlement of the piles?	
Y N X		c Negative skin friction on piles driven through new embankment or soft foundation layers?	
Y N X		d Potential for and impact of lateral squeeze from soft foundation soils?	
Y N X	15	If piles are to be driven to bedrock, have "pile points" been recommended to assure secure contact with the rock surface, as per BDM 202.2.3.2.a?	
Y N X	16	If subsurface obstacles exist, has preboring been recommended to avoid these obstructions?	

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Drilled Shafts			
Y $\boxed{N}$	17	Are there drilled shafts on the project? If no, go to the next checklist.	
Y N X	18	Have the drilled shaft diameter and embedment length been specified?	
Y N X	19	Have the recommended drilled shaft diameter and embedment been developed based on side friction and end bearing for vertical loading situations?	
	20	For shafts undergoing lateral loading, have the following been determined:	
Y N X		a. maximum lateral shear	
Y N X		b. maximum bending moment	
Y N X		c. maximum deflection	
Y N X		d. reinforcement design	
Y N X	21	Generally, bedrock sockets are 6" smaller in diameter than the soil embedment section of the drilled shaft. Has this factor been accounted for in the drilled shaft design?	
Y N X	22	If a bedrock socket is required below soil embedment, have separate quantities been estimated based on shaft diameters and materials to be excavated?	
Y N X	23	Has the site been assessed for groundwater influence?	
Y N X		a If yes, if artesian flow is a potential concern, does the design address control of groundwater flow during construction?	
Y N X	24	If special construction features (e.g., slurry, casing, load tests) are required, have all the proper items been included in the plans?	

Notes:

Stage 1

:

LABORATORY TEST STANDARDS

STANDARD	REFERENCE NUMBER
I. Soil/Rock Testing	
Description and Identification of Soils (Visual-Manual Procedures)	ASTM D 2488
Classification of Soils for Engineering Purposes (USCS).	ASTM D 2487
Laboratory Determination of Water (Moisture) Content of Soil and Rock	ASTM D 2216
Classification for Sizes of Aggregate for Road and Bridge Construction	ASTM D 488
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D 4318
Shrinkage Factors of Soils by Mercury Method	ASTM D 427
Moisture, Ash, and Organic Matter of Peat and Other Organic Soils	ASTM D 2974
Specific gravity of Soils	ASTM D 854
Direct Shear Test of Soils under Consolidated Drained Conditions	ASTM D 3080
Particle-Size Analysis of Soils	ASTM D 422
Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166
Compressive Strength of Intact Rock Core Specimens	ASTM D 7012
Slake Durability Index of Shale/Similar Weak Rock Test	ASTM D 4644
Point Load Test of Rock Core Specimens	ISRM* / ASTM D5731
CBR (California Bearing Ration) of Laboratory-Compacted Soils	ASTM D 1883
Laboratory Compaction Characteristics of Soil using Standard Effort	ASTM D 698
Laboratory Compaction Characteristics of Soil using Modified Effort	ASTM D 1557
One-Dimensional Consolidation Properties of Soils	ASTM D 2435
One-Dimensional Swell or Settlement Potential of Cohesive Soils	ASTM D 4546
Ph of Soil	ASTM D 4972

*ISRM – International Society for Rock Mechanics

II. Concrete Testing

Compressive Strength for Cylindrical Concrete Specimens	ASTM C-39
Acid-Soluble Chloride in Mortar and Concrete	ASTM C 1152

CLASSIFICATION OF SOILS

Ohio Department of Transportation

(The classification of a soil is found by proceeding from top to bottom of the chart. The first classification that the test data fits is the correct classification.)

SYMBOL	DESCRIPTION	Classifcation AASHTO	Classifcation OHIO	LL_O/LL x 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
	Gravel and/or Stone Fragments with Sand	A-1-b			50 Max.	25 Max.		6 Max.	0	
F S	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC		0	
	Coarse and Fine Sand	--	A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
	Gravel and/or Stone Fragments with Sand and Silt	A-2-4				35 Max.	40 Max.	10 Max.	0	
		A-2-5					41 Min.			
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6				35 Max.	40 Max.	11 Min.	4	
		A-2-7					41 Min.			
	Sandy Silt	A-4	A-4a	76 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	76 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		76 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	76 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	76 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		76 Min.		36 Min.	41 Min.	≤LL-30	20	
	Clay	A-7-6		76 Min.		36 Min.	41 Min.	>LL-30	20	
	Organic Silt	A-8	A-8a	75 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	75 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6

MATERIAL CLASSIFIED BY VISUAL INSPECTION

- Sod and Topsoil
- Pavement or Base
- Uncontrolled Fill (Describe)
- Bouldery Zone
- Peat, S-Sedimentary W-Woody F-Fibrous L-Loamy & etc

* Only perform the oven-dried liquid limit test and this calculation if organic material is present in the sample.

APPENDIX A.1 - ODOT Quick Reference for Visual Description of Soils

1) STRENGTH OF SOIL:

Non-Cohesive (granular) Soils - Compactness

Description	Blows Per Ft.
Very Loose	≤ 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	> 50

Cohesive (fine grained) Soils - Consistency

Description	Qu (TSF)	Blows Per Ft.	Hand Manipulation
Very Soft	<0.25	<2	Easily penetrates 2" by fist
Soft	0.25-0.5	2 - 4	Easily penetrates 2" by thumb
Medium Stiff	0.5-1.0	5 - 8	Penetrates by thumb with moderate effort
Stiff	1.0-2.0	9 - 15	Readily indents by thumb, but not penetrate
Very Stiff	2.0-4.0	16 - 30	Readily indents by thumbnail
Hard	>4.0	>30	Indent with difficulty by thumbnail

2) COLOR :

If a color is a uniform color throughout, the term is single, modified by an adjective such as light or dark. If the predominate color is shaded by a secondary color, the secondary color procedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled"

3) PRIMARY COMPONENT

Use **DESCRIPTION** from ODOT Soil Classification Chart on Back

4) COMPONENT MODIFIERS:

Description	Percentage By Weight
Trace	0% - 10%
Little	10% - 20%
Some	20% - 35%
"And"	35% -50%

5) Soil Organic Content

Description	% by Weight
Slightly Organic	2% - 4%
Moderately Organic	4% - 10%
Highly Organic	> 10%

6) Relative Visual Moisture

Description	Criteria	
	Cohesive Soil	**Non-cohesive Soils**
Dry	Powdery; Cannot be rolled; Water content well below the plastic limit	No moisture present
Damp	Leaves very little moisture when pressed between fingers; Crumbles at or before rolled to $^1/_8$"; Water content below plastic limit	Internal moisture, but no to little surface moisture
Moist	Leaves small amounts of moisture when pressed between fingers; Rolled to $^1/_8$" or smaller before crumbling; Water content above plastic limit to -3% of the liquid limit	Free water on surface, moist (shiny) appearance
Wet	Very mushy; Rolled multiple times to $^1/_8$" or smaller before crumbles; Near or above the liquid limit	Voids filled with free water, can be poured from split spoon.

APPENDIX A.2 - ODOT Quick Reference Guide for Rock Description

1) **ROCK TYPE:** Common rock types are: Claystone; Coal; Dolomite; Limestone; Sandstone; Siltstone; & Shale.

2) **COLOR:** To be determined when rock is wet. When using the GSA Color charts use only Name, not code.

3) **WEATHERING**

Description	Field Parameter
Unweathered	No evidence of any chemical or mechanical alternation of the rock mass. Mineral crystals have a bright appearance with no discoloration. Fractures show little or no staining on surfaces.
Slightly weathered	Slight discoloration of the rock surface with minor alterations along discontinuities. Less than 10% of the rock volume presents alteration.
Moderately weathered	Portions of the rock mass are discolored as evident by a dull appearance. Surfaces may have a pitted appearance with weathering "halos" evident. Isolated zones of varying rock strengths due to alteration may be present. 10 to 15% of the rock volume presents alterations.
Highly weathered	Entire rock mass appears discolored and dull. Some pockets of slightly to moderately weathered rock may be present and some areas of severely weathered materials may be present.
Severely weathered	Majority of the rock mass reduced to a soil-like state with relic rock structure discernable. Zones of more resistant rock may be present, but the material can generally be molded and crumbled by hand pressures.

4) **RELATIVE STRENGTH**

Description	Field Parameter
Very Weak	Core can be carved with a knife and scratched by fingernail. Can be excavated readily with a point of a pick. Pieces 1 inch or more in thickness can be broken by finger pressure.
Weak	Core can be grooved or gouged readily by a knife or pick. Can be excavated in small fragments by moderate blows of a pick point. Small, thin pieces can be broken by finger pressure.
Slightly Strong	Core can be grooved or gouged 0.05 inch deep by firm pressure of a knife or pick point. Can be excavated in small chips to pieces about 1-inch maximum size by hard blows of the point of a geologist's pick.
Moderately Strong	Core can be scratched with a knife or pick. Grooves or gouges to ¼" deep can be excavated by hand blows of a geologist's pick. Requires moderate hammer blows to detach hand specimen.
Strong	Core can be scratched with a knife or pick only with difficulty. Requires hard hammer blows to detach hand specimen. Sharp and resistant edges are present on hand specimen.
Very Strong	Core cannot be scratched by a knife or sharp pick. Breaking of hand specimens requires hard repeated blows of the geologist hammer.
Extremely strong	Core cannot be scratched by a knife or sharp pick. Chipping of hand specimens requires hard repeated blows of the geologist hammer.

5) **TEXTURE**

Component		Grain Diameter
Boulder		>12"
Cobble		3"-12"
Gravel		0.08"-3"
Sand	**Coarse**	0.02"-0.08"
	Medium	0.01"-0.02"
	Fine	0.005"-0.01"
	Very fine	0.003"-0.005"

6) **BEDDING**

Description	Thickness
Very Thick	>36"
Thick	18" – 36"
Medium	10" – 18"
Thin	2" – 10"
Very Thin	0.4" – 2"
Laminated	0.1" – 0.4"
Thinly Laminated	<0.1"

7) DESCRIPTORS

Arenaceous – sandy	Argillaceous - clayey	Brecciated – contains angular to subangular gravel
Calcareous - contains calcium carbonate	Carbonaceous - contains carbon	Cherty- contains chert fragments
Conglomeritic - contains rounded to subrounded gravel	Crystalline – contains crystalline structure	Dolomitic- contains calcium/magnesium carbonate
Ferriferous – contains iron	Fissile – thin planner partings	Fossiliferous – contains fossils
Friable – easily broken down	Micaceous – contains mica	Pyritic – contains pyrite
Siliceous – contains silica	Stylolitic – contain stylotites (suture like structure)	Vuggy – contains openings

8) DISCONTINUITIES

a) Discontinuity Types

Type	Parameters
Fault	Fracture which expresses displacement parallel to the surface that does not result in a polished surface.
Joint	Planar fracture that does not express displacement. Generally occurs at regularly spaced intervals.
Shear	Fracture which expresses displacement parallel to the surface that results in polished surfaces or slickensides.
Bedding	A surface produced along a bedding plane.
Contact	A surface produced along a contact plane. (generally not seen in Ohio)

b) Degree of Fracturing

Description	Spacing
Unfractured	> 10 ft
Intact	3 ft. – 10 ft.
Slightly fractured	1 ft – 3 ft
Moderately fractured	4 in. – 12 in.
Fractured	2 in – 4 in.
Highly fractured	< 2 in.

c) Aperture Width

Description	Spacing
Open	> 0.2 in.
Narrow	0.05 in. - 0.2 in.
Tight	<0.05 in.

d) Surface Roughness

Description	Criteria
Very Rough	Near vertical steps and ridges occur on the discontinuity surface.
Slightly Rough	Asperities on the discontinuity surface are distinguishable and can be felt.
Slickensided	Surface has a smooth, glassy finish with visual evidence of striation.

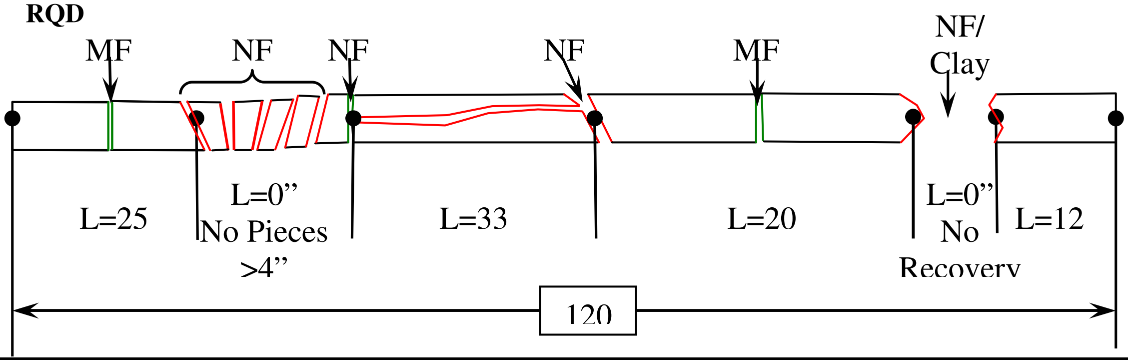
10) LOSS

$$Run\ Loss = \left(\frac{L_R - R_R}{L_R}\right) * 100 \quad Unit\ Loss = \left(\frac{L_U - R_U}{L_U}\right) * 100$$

L_R=Run Length R_R=Run Recovery

L_U=Rock Unit Length R_U=Rock Unit Recovery

9) RQD



$$RQD = \left(\frac{\sum Length\ \ of\ \ Pieces > 4inches}{Total\ Length\ of\ Core}\right) * 100$$

$$RQD = \left(\frac{25+33+20+12}{120}\right) * 100 = 75\%$$