Preliminary Geotechnical Engineering Report

Shadyside New K-12 School Facility

Belmont County, Ohio

January 12, 2018

Terracon Project No. N4175317

Prepared for:

Shadyside Local Schools
c/o SHP Leading Design
Columbus, Ohio

Prepared by:

Terracon Consultants, Inc.
Columbus, Ohio

January 12, 2018

Terracon

Shadyside Local Schools
c/o SHP Leading Design
250 Civic Drive, Suite 200
Columbus, Ohio 43215

Attn: Mr. Joshua L. Predovich, AIA, LEED AP
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E: jpredovich@shp.com

Re: Preliminary Geotechnical Engineering Report
Shadyside New K-12 School Facility
Village of Shadyside
Belmont County, Ohio
Terracon Project No. N4175317

Dear Mr. Predovich:

Terracon Consultants, Inc. (Terracon) has completed the preliminary geotechnical engineering services for the above referenced project. This project was performed in general accordance with our proposal number PN4175317 dated November 28, 2017 and authorized via an Agreement for Services with Shadyside Local Schools dated December 6, 2017. This report presents the findings of the subsurface exploration and provides preliminary geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

Additional geotechnical subsurface exploration, laboratory testing, and geotechnical engineering analyses will be necessary as the project proceeds into the final design phase.

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

Sincerely,
Terracon Consultants, Inc.

Abdul Mohammed
Staff Engineer

Kevin M. Ernst, P.E.
Principal

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Preliminary geotechnical engineering services have been completed for the Shadyside New K-12 School facility to be developed on a 15.6- acre site located northeast of the intersection of W. 38th Street and Florence Avenue in Shadyside, Belmont County, Ohio. Four (4) geotechnical test borings were performed for this project to a depth of 30 to 60 feet. This report presents a summary of the subsurface conditions encountered in the borings and provides general geotechnical engineering recommendations related to suitability of the site for development relative to earthwork and the design and construction of foundations, floor slabs and retaining walls for the proposed project.

Based on the information obtained from our subsurface exploration program, the following preliminary geotechnical considerations were identified:

- The project lies within the Appalachian Plateau Province, referred to as the Appalachian Highlands Division and the Allegheny (Kanawha) Plateaus Section. The Unglaciated Appalachian Plateau is a rugged, eroded plain of sedimentary rock, marked by flat-topped highlands and rounded hills as opposed to the sharply defined landscape of the Appalachian Mountain system to the east.

- Based on the provided topographic map, the site can be generally characterized as a north-south trending hilltop ridge nose with hillside slopes along the west, south and east sides of the ridgeline. The side slopes can be generally characterized as steeply to moderately sloping.

- Overall the site has significant relief with ground surface elevations in the be in the range of about 760 to 835 feet (approximately 75 feet of relief). The footprint of the proposed school building is situated along the east facing hillside in a moderately sloping area.

- The site is located above the abandoned works of the BT-077 room and pillar mine. The mine was abandoned in 1927 and the mine elevation was approximately 606 feet within the Pittsburgh No. 8 coal seam. Assuming that the building is situated at approximate elevation 775 feet, the depth to the mine would be about 169 feet.

- Based on the test borings, the subsurface profile at the proposed site can be generalized as surficial layer (topsoil) underlain by native cohesive soil. Beneath the native cohesive soil bedrock was encountered to the depths explored.

- Geotechnical issues related to development of the site primarily concern design and construction on the sloping ground at the site. We would anticipate that significant cut and fill of the site would be needed to develop a terraced site grading scheme to develop relatively level areas for development of the building pad, parking areas and play fields. Depending on the final grading scheme, retaining walls for grade separation may be necessary as part of the overall site grading.

- Development of stable cut and fill slopes will be required, and stability enhancing design features for sidehill fill, such and shear keys and special soil and rock benching will be required to assure satisfactory factors of safety with respect to slope stability. Depending on the desired cut slope angles required for the project, specialty systems such as soil nails might be considered to allow for construction of steepened cut slope angles.

- New buildings and structures within the project site likely can be supported on shallow spread footings bearing within the at least stiff consistency native cohesive soils or bedrock or structural fill extended to native competent soil/bedrock. Spread footings for the building should bear at minimum below the frost depth.

- Based on the depth to the mine and the rock types encountered, our initial assessment of the risk for mine subsidence at the site can be classified as low, however the risk of mine subsidence cannot be completely ruled out and the owner would need to be willing to accept this risk in developing this site. Measures to reduce the risk of mine subsidence include mine void grouting within the angle of draw below building and other critical structures.

- Medium to high plasticity lean clays were encountered in the borings drilled at the site. These soils have the potential for volume change (shrink-swell potential) due to fluctuation in soil moisture conditions. The potential for moisture content variation to create shrink-swell floor slab and pavement soil subgrades should be considered during design and construction of the proposed development.

- Additional geotechnical subsurface exploration, laboratory testing, and engineering analyses will be necessary as the project proceeds into the final design phase. As part of the additional exploration, further evaluation of the mine subsidence risk should be undertaken. This evaluation could include geo-referencing the mine map to the current site plan and performing additional test borings and rock coring to provide further information concerning the characteristics of the mine workings and roof rock. This mine subsidence evaluation could include geophysical evaluation methods that employ down-the-borehole LiDAR and sonar imaging methods.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT
SHADYSIDE NEW K-12 SCHOOL FACILITY
BELMONT COUNTY, OHIO

Terracon Project No. N4175317
January 12, 2018

1.0 INTRODUCTION

This report presents the results of our preliminary geotechnical engineering services performed for the proposed development of a New K-12 School facility at the intersection of W. 38th Street and Florence Avenue in Shadyside, Belmont County, Ohio.

Our geotechnical engineering exploration for this project included the advancement of four (4) geotechnical test borings. The test borings were advanced to an approximate depth of 30 to 60 feet below existing surface grades. Boring logs of the recently completed test borings and a Boring Location Plan (Exhibit A-2) are included in Appendix A. Descriptions of the field exploration are also included in Appendix A.

The purpose of these services is to provide information and preliminary geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- pavement design and construction
- foundation design and construction
- floor slab design and construction
- seismic considerations

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-2: Boring Location Plan. A preliminary location of a K-12 school building that was provided to us by SHP is shown on Exhibit A-2.
Proposed development	Due the preliminary nature of the project, other than the location of the school building, a conceptual layout of the overall proposed K-12 school facility was not available at the time this report was prepared. However, we anticipate that the proposed facility will include two-story building with slab-on-grade ground floor. Additional information concerning the building structure was not provided. We have assumed that the build structure would consist of masonry block

Item	Description
	walls and steel/wood framing. Locations drives, parking areas, play fields, and other ancillary structures of the overall school facility were not available due to the preliminary planning nature or the project.
Proposed grading	A site grading plan was not provided. Based on the topography of the site we have assumed that relatively significant earthwork will be required to terrace the site to develop relatively level areas for development of proposed buildings, parking lots and playfield areas. We have assumed that cut and fill up to about 20 to 30 feet will be required to establish proposed site grades.
Pavements	Pavement design information not provided. We have assumed that the drives and parking lots will consist of asphalt pavement sections with some localized areas of concrete pavements (e.g., drive aprons, etc.)

2.2 Site Location and Description

Item	Description
Location	The project site is an approximate 15.6-acre parcel (Parcel No: 17-60029.000) located northeast of the intersection of W. 38th Street and Florence Avenue in Shadyside, Belmont County, Ohio. The approximate GPS coordinates of the site are 39.976381, -80.750475.
Current ground cover	The site has significant slope and is heavily wooded but contains two to three tiers that are accessible by gravel drives.
Existing topography	See Appendix C, Exhibit C-8: Topographic Map. Based on the provided topographic map, the site can be generally characterized as a north-south trending hilltop ridge nose with hillside slopes along the west, south and east sides of the ridgeline. The side slopes can be generally characterized as steeply to moderately sloping. Overall the site has significant relief with ground surface elevations in the be in the range of about 760 to 835 feet (approximately 75 feet of relief). The footprint of the proposed school building is situated along the east facing hillside in a moderately sloping area with ground surface elevations within the footprint in the range of about 762 to 775 feet (approximately 13 feet of relief).
Underground and surface mines	Review of Ohio Department of Natural Resources (ODNR) information indicates mapped workings of an abandoned room and pillar type underground mine at the project site. The abandoned underground mine is designated as BT-077 by ODNR. The mine was abandoned in 1927 and the mine elevation was approximately 606 feet within the Pittsburg No. 8 coal seam. Entries to the mine were drift and slope type. See Appendix C, Exhibits C-4 and C-5

Item	Description
	for maps of the abandoned underground mine. Review of ODNR information does not indicate mapped surface mines at the site.

3.0 SUBSURFACE CONDITIONS

3.1 Geology

The project lies within the Appalachian Plateau Province, referred to as the Appalachian Highlands Division and the Allegheny (Kanawha) Plateaus Section. The Unglaciated Appalachian Plateau is a rugged, eroded plain of sedimentary rock, marked by flat-topped highlands and rounded hills as opposed to the sharply defined landscape of the Appalachian Mountain system to the east.

The Appalachian Plateau is largely underlain by rocks of Permian and Pennsylvanian age that appear perfectly horizontal in roadcuts and outcrops. The rocks appear horizontal because the dips on the fold limbs are less than 2 or 3 degrees which the human eye cannot discern. Soils in this area are often low in fertility and acidic. The terrain consists of landforms drained by mature-stage streams with well-developed floodplains, and meanders. Hills between major streams generally exhibit erosion-rounded summits and relatively shallow slopes. Elevation relief of the region is on the order of a few hundred feet.

The soils in the unglaciated plateau portion of the project consist of mainly residuum, colluvium, glacial outwash, lacustrine/glaciolacustrine, and alluvium. Some areas also contain a thin veneer of loess deposits.

The Pennsylvanian aged Monongahela Group consists of abundant shale, siltstone, and claystone. It is also noted to contain sandstone, limestone and coal. Claystone, shale, and siltstone vary in color from red, gray, olive, green, yellow, and black. These units are typically argillaceous to sandy, non-bedded to thinly bedded, and locally calcareous. Sandstone is typically brown to gray, fine to conglomeratic, thin to massive to cross bedded, locally calcareous and micaceous. Limestone is typically gray to black, micritic to coarse grained, thin to medium bedded but can also be nodular to irregularly bedded. Coal is black, banded, and bituminous, thin to thickly bedded, and can be locally or regionally distributed.

Subsidence can occur in areas where voids have been created from underground mining of coal and clay. Audits into the mine complexes may include drift entries, slope entries, and vertical air shafts. Structural failures of the mine support system may also create additional hazards from the failure of support pillars and timbers within the mine, pillar punching, and roof beam failure. These hazards may propagate immediately to the surface and be expressed as a catastrophic shear failure or may be expressed as a slow and steady expanding depression or swell. The extent of the surface expressions is dependent on the type and thickness of the overlying soils and rocks. Economic coals in this group are the Pittsburgh (No. 8), Pomeroy (No. 8a), Meigs Creek (No. 9), and Waynesburg (No.11). Shale, claystone, and coal units near the surface can be ripped with some difficulty. Sandstone, limestone, unweathered siltstone, and shale are resistant to ripping and blasting, breaking or cutting is required for excavation.

3.2 Typical Profile

Based on the results of the borings, surface and subsurface conditions on the project site can be generalized as follows:

At the existing ground surface, borings B-1 and B-3 were performed as a part of this investigation were located outside the pavement limits and encountered 12 inches of topsoil. The borings B-2 and B-4 located within the existing pavement and encountered 4 and 12 inches of asphalt at the existing ground surface.

Underlying the surficial materials, material identified as fill was encountered in the boring B-2 and B-4. The fill material extended to depths ranging from 0.3 to 6 feet below existing grades and the recovered samples were noted containing metal flakes and trace organics. The fill materials in borings B-2 and B-4 extended to a depth of 2 and 6 feet beneath the existing ground surface and consisted of silty clay.

Underlying the surficial and existing fill materials, the borings encountered native cohesive soils consisting of lean clay, lean clay with sand, gravelly lean clay, silty clay, sandy silty clay with a medium stiff to hard consistency. Beneath the native cohesive soil bedrock was encountered to the depths explored.

Specific conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs included in Appendix A of this report.

3.3 Bedrock

Bedrock was encountered in each of the borings at depths varying from about 822.5 to 743.5 feet below the existing ground surface. The bedrock generally became less weathered and more competent below the uppermost very severely weathered horizon and consisted of shale, limestone and sandstone, very slightly to completely weathered, very thin to thin bedded, brown and black, soft to hard, poor to excellent RQD.

3.4 Groundwater

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Ground water was not encountered in the borings while drilling to the depth that rock coring was begun. The rock coring process requires introduction of water into the borehole by the driller. Thus, the at completion water level observations likely do not reflect the true groundwater levels. The water levels observed in the boreholes are noted on the attached boring logs, and are summarized below:

Boring Number	Observed Water Depth (feet)[1]	
	While Drilling	After Drilling
B-1	N/E	7.0
B-2	N/E	3.0
B-3	N/E	1.0
B-4	N/E	3.0

[1] Below existing grade

The absence of groundwater in the borings does not specify there is no static water level present at site. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in the cohesive soil present at the site. Fluctuations of groundwater levels may occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs.

4.0 PRELIMINARY DESIGN AND CONSTRUCTION RECOMMENDATIONS

4.1 Geotechnical Considerations

Based on the results of the subsurface exploration, laboratory testing, and our analyses, it is our opinion that the site can be developed as a school facility.

Geotechnical issues related to development of the site primarily concern design and construction on the sloping ground at the site. We would anticipate that significant cut and fill of the site would be needed to develop a terraced site grading scheme to develop relatively level areas for development of the building pad, parking areas and play fields. Depending on the final grading scheme, retaining walls for grade separation may be necessary as part of the overall site grading. The materials exposed in cuts will likely include soil and bedrock, with rock excavation needed. Development of stable cut and fill slopes will be required, and stability enhancing design features for sidehill fill, such and shear keys and special soil and rock benching will be required to assure satisfactory factors of safety with respect to slope stability. Depending on the desired cut slope angles required for the project, specialty systems such as soil nails might be considered to allow for construction of steepened cut slope angles.

New buildings and structures within the project site likely can be supported on shallow spread footings bearing within the at least stiff consistency native cohesive soils or bedrock or structural fill extended to native competent soil/bedrock. Spread footings for the building should bear at minimum below the frost depth. Special foundation design considerations include providing for suitable subgrade material transitions for foundations that will bear on materials having different compressibility characteristics, such as foundations that transition from bearing on bedrock to bearing upon native soils or structural fill. These design provisions are need to reduce the differential settlement response of the foundation system, and include modifications of the immediate bearing materials below footings (e.g. soil transition layers) and appropriate structural design of the building to accommodate differential settlement of the structure.

Medium to high plasticity lean clays were encountered in the borings drilled at the site. These soils have the potential for volume change (shrink-swell potential) due to fluctuation in soil moisture conditions. The potential for moisture content variation to create shrink-swell of floor slab and pavement soil subgrades should be considered during design and construction of the proposed development..

Due to the presence of abandoned underground mine working below the site, the owner would need to be accept the risk of potential mine subsidence. Measures to reduce the risk of mine subsidence include mine void grouting within the angle of draw below building and other critical structures. Addition discussion concerning mine subsidence is provided in the following section.

4.2 Mine Subsidence

Mine subsidence is controlled by many factors, including height of the mined-out area, width of the unsupported mine roof, thickness of overburden, competency (strength) of bedrock, pillar dimensions, hydrogeology, fractures/joints and time.

Literature suggests that "pit" subsidence is associated with roof collapse of mines that have total overburden of less than 165 feet, weak roof rock of shale or mudstone, and a ratio of unconsolidated-material thickness to rock thickness of less than 1.2. Additionally, literature suggests that pit subsidence does not occur where the thickness of the unconsolidated overburden is greater than 90 feet.

Literature describes "sag" subsidence as a gentle, gradual settling of the surface that is associated with pillar crushing or pillar punching of deeper mines (overburden of more than 75 feet) the area of mine subsidence increases proportionally with the increasing width of the unsupported rock roof. The potential area of subsidence is equal to the extraction area plus an area surrounding the extraction measured by an angle up to 35 degrees, called the angle of draw, from the vertical edge of the extraction area.

The site is located above the abandoned works of the BT-077 room and pillar mine. The mine was abandoned in 1927 and the mine elevation was approximately 606 feet within the Pittsburgh No. 8 coal seam. Assuming that the building is situated at approximate elevation 775 feet, the depth to the mine would be about 169 feet.

In the case of the subject site, the ratio of unconsolidated-material thickness to rock thickness suggests that pit subsidence is unlikely to occur. The limestone and sandstone encountered in the test borings is generally considered a "good" roof rock material. Thus, if mine subsidence was to occur, it would likely manifest as a sag type subsidence.

Based on the depth to the mine and the rock types encountered, our initial assessment of the risk for mine subsidence at the site can be classified as low, however the risk of mine subsidence cannot be completely ruled out and the owner would need to be willing to accept this risk in developing this site. Measures to reduce the risk of mine subsidence include mine void grouting within the angle of draw below building and other critical structures. We recommend a detailed mine subsidence evaluation be performed to further evaluate the risk level of subsidence at this site. Based on this evaluation, remediation measures, if any, can be recommended.

4.3 Landslides

Terracon reviewed mapping of the "Landslide and Related features of the Businessburg and Moundsville, Ohio-West Virginia Quadrangle" prepared by United States Geological Survey (USGS) in 1978. This mapping is presented in Appendix C, as Exhibits C-6 and C-7

The site is located on the on the area were soil and rock are susceptible to land sliding. The ridge top area of site is however in the areas least prone to land sliding. Despite low susceptibility to sliding, the USGS notes that modification by excavation and fill may lead to local landslides. The surrounding slopes are classified as soil and rock susceptible to landsliding. According to USGS, these areas consisted of soil and rock that is similar to rock that is similar to that involved in landsliding elsewhere in the map; primarily areas underlain by claystone, mudstone and shale associated with other rock types. Rock in these areas weathers rapidly on exposure forming clayey soil that is highly susceptible to sliding. Included in these areas are U-shaped, shallow valleys containing thick layers of clay soil that are susceptible to sliding due to excavation or overloading via fill placement.

4.4 Preliminary Earthwork and Foundation Design Recommendations

The following preliminary design and recommendations have been developed to assist planners and designers in the conceptual design related to development of the site. The recommendations are based on the provided topographic map, the geologic and mining/landslide mapping previously described, the findings of the test borings, laboratory testing, and our current understanding of the project. Additional geotechnical exploration, laboratory testing and geotechnical engineering analyses will be necessary to develop the required geotechnical engineering analyses for final design and construction.

Description	Preliminary Recommendations
Earthwork	
■ Site grading	■ Existing slopes that are 5H:1V or steeper should be benched horizontally into native soils of at least stiff consistency after removal of surficial unsuitable soils. Unsuitable surficial soils at the site include exiting fill and weak colluvial soils on hillside slope. Soil benches should be wide enough for construction equipment and configured on a 2H:1V bench width to height ratio. This construction measure is recommended to allow all structural fill to be keyed into the sloping ground surface. The finished grades should then be established with quality controlled engineered fill. Special benching requirements will likely be necessary, and would need to be determined by slope stability analyses by the Geotechnical Engineer based on a preliminary site grading plan. ■ Fill slopes less than 10 feet in height can be configured as steep as 3H:1V, provided that the structural fill is placed in accordance with the recommendations provided in this report. A project specific slope stability analysis is recommended for fill embankments in excess of 10 feet in height. We recommend not placing new fill on existing hill slopes, unless a site specific slope stability analyses is performed. We can assist with such analyses upon request. Fill slopes configured steeper

than 3H:1V would need to evaluated by the slope stability analysis by the Geotechnical Engineer. Methods to steepen slope angles include design of soil slopes reinforced with geosynthetic materials such as geogrids. It is recommended that the crest of any fill slope should be at least 20 feet away from the proposed edge of any structure or pavement when slope heights exceed 10 feet. The setback would need to be determined based on the overall height of the fill slope. Drainage provisions are important with respect to design of fill slope. These provisions may include underdrains below the fill as well as surface water controls that limit direct, concentrated flow

- Cut slopes of 3H:1V or flatter in soils and weathered bedrock are recommended to reduce the potential for surface sloughing within the overburden soils. It is recommended that the crest of any cut slope should be at least 20 feet away from the proposed edge of any structure or pavement when slope heights exceed 10 feet. The setback would need to be determined based on the overall height of the cut slope. We recommend that design of cut slopes consider measures to collect surface water run-off, removing sloughed material, and perform general slope maintenance.

- Cut Slopes in competent bedrock should be configured no steeper than 2H:1V for cuts not exceeding 15 feet in height. Additional evaluation of design slope angles and benching in bedrock would need to consider the proposed grading scheme. Depending on the desired cut slope angles required for the project, specialty systems such as soil nails might be considered to allow for construction of steepened cut slope angles.

	■ Excavations for the project are anticipated to encounter soils and bedrock. The soils can likely be excavated using conventional excavation equipment; however, the bedrock is anticipated to take more effort to excavate likely requiring excavation equipment configured to excavate rock. Rock excavation in confined spaces and trenches may require use of percussion tools and drilling. The contractor should be afforded the opportunity to perform rock coring at the site to evaluate rock characteristics related to the proposed excavation and determine means and methods of excavation.
■ Suitability of fill materials types	■ The on-site soils generally appear suitable for use as engineered fill. If on-site soils used as engineered fill do not meet the low plasticity criteria, they should not be utilized within 1.5 feet (CL soils that have Atterberg liquid limit (LL) of between 40 and 50; or 3 feet (CH soils with LL>50) of finished grade beneath building areas. Thorough blending medium to high plasticity lean clay (CL), with lower plasticity soils or chemical additives such as lime or lime kiln dust could be considered as a method to provide for acceptable engineered fill materials. ■ We anticipate that the weathered bedrock (shale, siltstone and sandstone) can be used for structural fill, provided special compaction specifications are developed and implemented during construction. These specifications will include breaking down the materials to a soil-like consistency and moisture conditioning (slaking) the material to allow for placement is compacted lifts. Depending on the durability of the less weathered sandstone and limestone, these material may be suitable for use as rock fill, placed as selected locations within the fill. The suitability of using the onsite sandstone and limestone for fill will require additional

	evaluation by geotechnical laboratory testing to determine rock durability.
Foundations	
■ Allowable bearing capacity – Shallow foundations	■ For bearing in native stiff or better consistency clays, structural fill or bedrock - 3,000 pounds per square foot (psf). Further evaluation of allowable bearing capacity will need to be undertaken bases on proposed loads and bearing elevations Settlement analyses should be performed as part of the final geotechnical study for the project using the actual building loads to ascertain that the foundation settlements will be within tolerable range. ■ Special foundation design considerations include providing for suitable subgrade material transitions for foundations that will bear on materials having different compressibility characteristics, such as foundations that transition from bearing on bedrock to bearing upon native soils or structural fill. These design provisions are need to reduce the differential settlement response of the foundation system, and include modifications of the immediate bearing materials below footings (e.g. soil transition layers) and appropriate structural design of the building to accommodate differential settlement of the structure.
Seismic Considerations	
■ Seismic site class	■ Based on the borings, Site Class C can be used for preliminary design purposes. If necessary, additional geophysical testing could be undertaken to further evaluate the Seismic Site Class.
Floor Slabs	
■ Modulus of subgrade reaction	■ Native lean clay soils (LL<40, PI<20) or low volume change structural fill – 100 psi/in for point loading conditions. A 1.5-foot thick low volume change layer consisting of lean clay material with LL less than 40 and PI of less than 20 percent is recommended beneath the floor slab subgrade.

Pavements	
■ California Bearing Ratio	■ Native lean clay soils (LL<40, PI<20) or low volume change structural fill – CBR value of 3 can be used for preliminary design of the pavements. Additional laboratory testing should be performed to establish the CBR value for final design

Once designs are more thoroughly developed, we recommend supplemental geotechnical exploration be completed to confirm the applicability of these preliminary design parameters.

5.0 ADDITIONAL GEOTECHNICAL STUDY

The information and recommendations presented in this report should be considered preliminary. To develop final geotechnical recommendations for this project, we recommend that additional geotechnical field exploration and laboratory testing be undertaken once preliminary design plans, structural loading and pavement design criteria are available.

The additional geotechnical study should include additional test borings located within the proposed building and pavement areas, with additional borings situated in cut and fill slope areas to provide subsurface information for the slope stability analyses. Additional laboratory testing should include a CBR testing and soil strength parameters to develop design parameters.

Further evaluation of the mine subsidence risk should be undertaken. This evaluation could include geo-referencing the mine map to the current site plan and performing additional test borings and rock coring to provide further information concerning the characteristics of the mine workings and roof rock. This mine subsidence evaluation could include geophysical evaluation methods that employ down-the-borehole LiDAR and sonar imaging methods. Information from this evaluation should include collection of geotechnical data to provide for design of mine remediation, should remediation become an aspect of the overall site development.

6.0 GENERAL COMMENTS

The scope of this geotechnical engineering study was preliminary in nature. As part of the final design of the development, Terracon should be retained to provide additional geotechnical engineering services; and to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: AKM	Project No. N4175317	Terracon Consulting Engineers & Scientists	SITE LOCATION MAP
Drawn by: AKM	Scale: N.T.S.		Shadyside - New K-12 School Facility Belmont County, Ohio
Checked by: KME	File Name: N4175317 SLP	800 Morrison Road Columbus, Ohio 43230	
Approved by: KME	Date: Dec., 2017	PH. (614) 863-3113 FAX. (614) 863-0475	Exhibit A-1

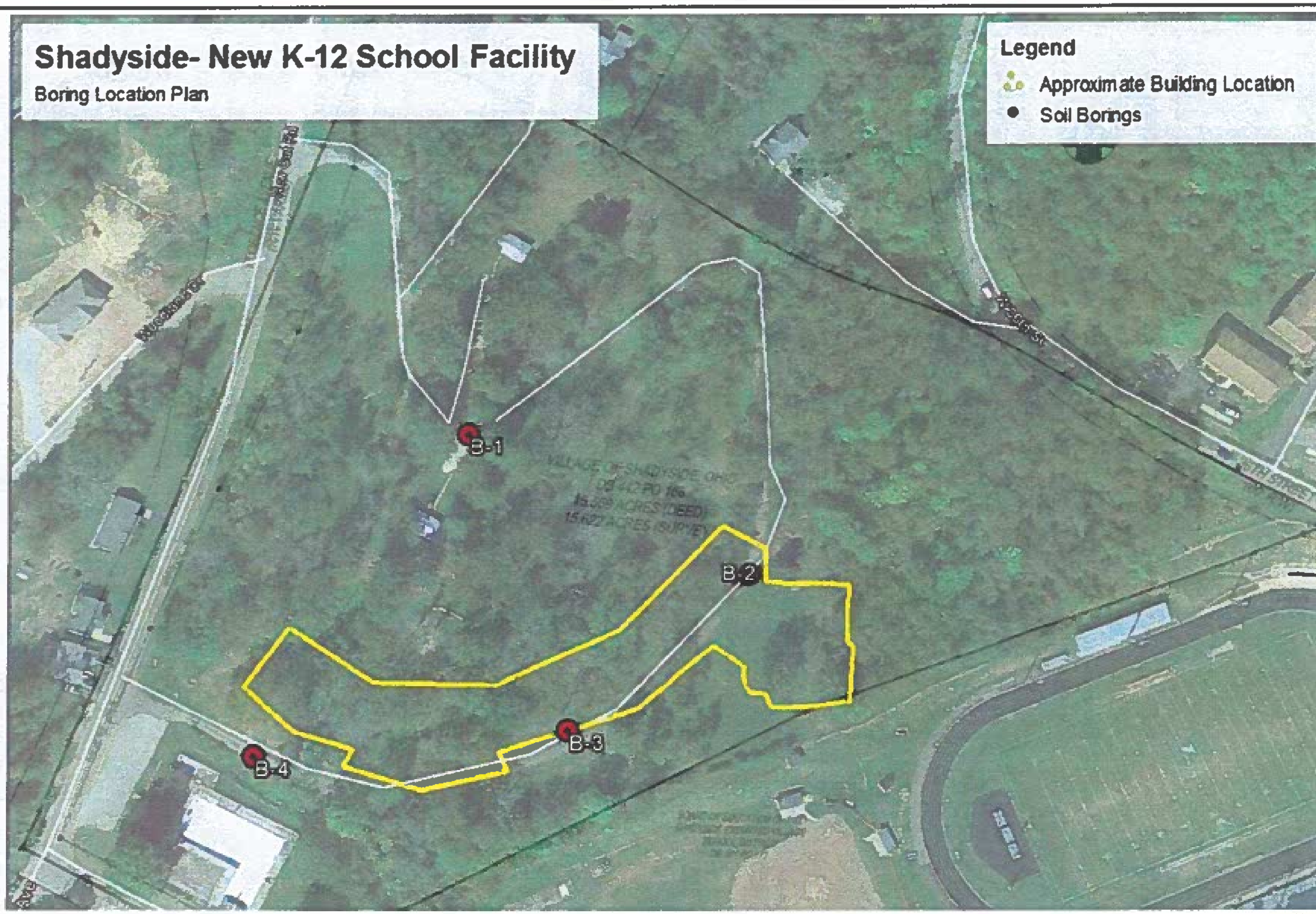


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: AKM	Project No. N4175317	Terracon Consulting Engineers & Scientists	BORING LOCATION PLAN	Exhibit
Drawn by: AKM	Scale: N.T.S.		Shadyside - New K-12 School Facility Belmont County, Ohio	A-2
Checked by: KME	File Name: N4175317 BLP	800 Morrison Road Columbus, Ohio 43230		
Approved by: KME	Date: Dec. 2017	PH. (614) 863-3113 FAX. (614) 863-0475		

Field Exploration Description

The subsurface exploration consisted of drilling and sampling four (4) test borings at the site to approximate depths of 30 to 60 feet below existing grades. The borings were laid out in the field by Terracon personnel based on the approximate building location map provided by Mr. Predovich of SHP. The approximate boring locations are indicated on the boring location plans included in this appendix.

Test borings were drilled with a track-mounted rotary drill rig using hollow stem augers to advance the boreholes. In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound C.M.E. auto-hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ relative density of granular soils and consistency of cohesive soils.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method.

Where competent bedrock was encountered at the boring locations, a changeover to rock coring techniques was made. Rock coring was performed in the borings using an NQ-size core barrel with water as a circulating fluid. Percent recovery and rock quality designation (RQD) were calculated for the core samples and are noted at their depths of occurrence on the boring logs. RQD is the percent of total length cored consisting only of rock pieces at least 4 inches or more in length and is a measure of the integrity of the rock mass in-situ.

The spilt-barrel and hand-excavated samples were sealed in watertight glass jars. Rock cores were placed in protective boxes. All samples were returned to the laboratory for testing and classification.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation of the samples.

BORING LOG NO. B-1

PROJECT: Shadyside - New K-12 School Facility

CLIENT: SHP Leading Design, Columbus, Ohio

SITE: W 38th Steet & Florence Ave., Shadyside, Ohio

LOCATION See Exhibit A-2

Latitude: 39.9763° Longitude: -80.7506°

Approximate Surface Elev: 836 (Ft.) +/-

GRAPHIC LOG	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
	1.0	TOPSOIL (12"), contains gravel	835+/-							
		SANDY SILTY CLAY (CL-ML), trace organics, brown, moist, very stiff				X	12	6-8-9 N=17		3.0 (HP)
						X	18	7-8-10 N=18		2.0 (HP)
					▼	X	18	7-7-7 N=14		2.0 (HP)
	13.5		822.5+/-			X	18	5-6-12 N=18		2.0 (HP)
	18.5	SANDSTONE, completely weathered, brown, very hard	817.5+/-			X	3	50/3"		-
		SHALE, very severely weathered shale, gray, hard				X	8	44-50/3"		-
						X	5	50/5"		-

Depth scale: 5, 10, 15, 20, 25

Stratification lines are approximate. In-situ, the transition may be gradual.

Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
- Began coring at 34' and water was added into the borehole during coring.

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

▼ *Water @ 7.0 feet after completion*

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-12-2017	Boring Completed: 12-12-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-4

BORING LOG NO. B-1

PROJECT: Shadyside - New K-12 School Facility

CLIENT: SHP Leading Design
Columbus, Ohio

SITE: W 38th Steet & Florence Ave.
Shadyside, Ohio

LOCATION See Exhibit A-2

Latitude: 39.9763° Longitude: -80.7506°

Approximate Surface Elev: 836 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
	SHALE, very severely weathered shale, gray, hard *(continued)*					5	50/5"		-
			30						
34.0		802+/-				1			-
	LIMESTONE, moderately to slightly weathered, moderately hard, close joints, thin bedded, fair RQD, moderately open joints, gray		35						
	-clay seams encountered @ 36.0' and 38.7'								
	-high-angle fracture encountered @ 39.4' - 40.3'		40			117		66	
44.0	-high-angle fracture encountered @ 43.3' - 43.7'	792+/-							
	SHALE, moderately to moderately severely weathered, medium to soft, very close to close joints, very thin bedded, poor RQD, slightly open joints		45			114			
48.0		788+/-							
	LIMESTONE, slightly to moderately weathered, moderately hard, close joints, thin bedded, fair RQD, slightly open joints -high-angle fractures encountered @ 48.2' - 48.7' and 50.4' - 51.1'		50					53	

Stratification lines are approximate. In-situ, the transition may be gradual.
Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

Water @ 7.0 feet after completion

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-12-2017	Boring Completed: 12-12-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-4

BORING LOG NO. B-1

PROJECT: Shadyside - New K-12 School Facility

CLIENT: SHP Leading Design Columbus, Ohio

SITE: W 38th Steet & Florence Ave. Shadyside, Ohio

LOCATION See Exhibit A-2

Latitude: 39.9763° Longitude: -80.7506°

Approximate Surface Elev: 836 (Ft.) +/-

GRAPHIC LOG	DEPTH / MATERIAL DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
	LIMESTONE, slightly to moderately weathered, moderately hard, close joints, thin bedded, fair RQD, slightly open joints *(continued)*				114			
	-high-angle fractures encountered @ 54.5' - 55.1', 56.2' - 56.5' and 59.5' - 60.0'	55			72		70	
	60.0 — 776+/-	60						
	Boring Terminated at 60 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

Water @ 7.0 feet after completion

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-12-2017	Boring Completed: 12-12-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-4

BORING LOG NO. B-2

PROJECT: Shadyside - New K-12 School Facility

CLIENT: SHP Leading Design
Columbus, Ohio

SITE: W 38th Steet & Florence Ave.
Shadyside, Ohio

LOCATION Offset 10 feet up hill

Latitude: 39.9759° Longitude: -80.7496°

Approximate Surface Elev: 762 (Ft.) +/-

GRAPHIC LOG	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
	0.3	**ASPHALT(4")**	761.5+/-							
		FILL - SILTY CLAY, trace gravel, trace metal flakes, brown, moist				X	4	3-3-3 N=6		1.0 (HP)
	2.0		760+/-		▼					
		LEAN CLAY (CL), trace gravel, trace sand, brown, moist, medium stiff to stiff				X	16	3-4-9 N=13		1.5 (HP)
				5		X	18	6-6-7 N=13		1.5 (HP)
						X	18	4-5-5 N=10		1.5 (HP)
	13.5		748.5+/-	10						
		LEAN CLAY (CL), brown, moist, very stiff, contains completely weathered shale fragments				X	18	7-8-9 N=17		1.5 (HP)
	18.5		743.5+/-	15						
		SHALE, completely weathered, brown, soft				X	8	39-50/3"		-
	21.0		741+/-	20						
		LIMESTONE, fresh, hard, wide joints, thin bedded, excellent RQD, tight joints, hard				Core	98			
				25						

Stratification lines are approximate. In-situ, the transition may be gradual.
Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
- Boring offset 10.0' (up hill) due to frozen ground.
- Began coring at 21' and water was added into the borehole during coring.

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

▼ *Water @ 3.0 feet after completion*

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-13-2017	Boring Completed: 12-13-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-5

BORING LOG NO. B-2

PROJECT: Shadyside - New K-12 School Facility

CLIENT: SHP Leading Design
Columbus, Ohio

SITE: W 38th Steet & Florence Ave.
Shadyside, Ohio

LOCATION Offset 10 feet up hill

Latitude: 39.9759° Longitude: -80.7496°

Approximate Surface Elev: 762 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
	LIMESTONE, fresh, hard, wide joints, thin bedded, excellent RQD, tight joints, hard *(continued)*					98		100	
	30.0	732+/-	30						
	Boring Terminated at 30 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.
Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

Water @ 3.0 feet after completion

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-13-2017	Boring Completed: 12-13-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-5

BORING LOG NO. B-3

PROJECT: Shadyside - New K-12 School Facility

CLIENT: SHP Leading Design, Columbus, Ohio

SITE: W 38th Steet & Florence Ave. Shadyside, Ohio

LOCATION See Exhibit A-2

Latitude: 39.9755° Longitude: -80.7502°

Approximate Surface Elev: 775 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
1.0	**TOPSOIL (12")**, contains gravel	774+/-		▼					
	SILTY CLAY (CL-ML), trace gravel, trace sand, trace organics, brown, moist, stiff				X	5	4-5-6 N=11		2.0 (HP)
6.0		769+/-	5			20			-
8.5	**LEAN CLAY (CL)**, trace gravel, gray, moist, hard, contains completely weathered shale fragments	766.5+/-			X	8	5-5-7 N=12		-
13.5	**LEAN CLAY WITH SAND (CL)**, brown, moist, hard, contains completely weathered shale fragments	761.5+/-	10		X	18	17-22-28 N=50		4.5 (HP)
	SHALE, very severely weathered, soft, gray				X	4	15-17-21 N=38		-
20.0		755+/-	15			1	50/1"		-
	LIMESTONE, very slightly weathered, hard, close to moderately close joints, thin bedded, good RQD, slighly open joints, gray - shale seam noted @ 22.2' - 22.4'		20			120			
			25						

Stratification lines are approximate. In-situ, the transition may be gradual.
Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
- Began coring at 20' and water was added into the borehole during coring.

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

▼ *Water @ 1.0 feet after completion*

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-13-2017	Boring Completed: 12-13-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-6

BORING LOG NO. B-3

PROJECT: Shadyside - New K-12 School Facility

CLIENT: SHP Leading Design
Columbus, Ohio

SITE: W 38th Steet & Florence Ave.
Shadyside, Ohio

LOCATION See Exhibit A-2

Latitude: 39.9755° Longitude: -80.7502°

Approximate Surface Elev: 775 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
	LIMESTONE, very slightly weathered, hard, close to moderately close joints, thin bedded, good RQD, slighly open joints, gray *(continued)*					120		84	
	30.0	745+/-	30						
	Boring Terminated at 30 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual
Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

Water @ 1.0 feet after completion

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-13-2017	Boring Completed: 12-13-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-6

BORING LOG NO. B-4

PROJECT: Shadyside - New K-12 School Facility

**CLIENT: SHP Leading Design
Columbus, Ohio**

**SITE: W 38th Steet & Florence Ave.
Shadyside, Ohio**

LOCATION See Exhibit A-2

Latitude: 39.9754° Longitude: -80.7514°

Approximate Surface Elev: 764 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
1.0	**ASPHALT (12.0")**	763+/-							
	FILL - SILTY CLAY, trace gravel, trace sand, brown, moist, stiff				X	7	5-6-7 N=13		2.5 (HP)
				▼					
			5		X	18	5-6-8 N=14		2.5 (HP)
6.0		758+/-							
	LEAN CLAY (CL), trace gravel, brown, moist, hard, completely weathered shale fragments				X	18	10-10-25 N=35		4.5 (HP)
			10		X	18	13-12-20 N=32		4.5 (HP)
13.5		750.5+/-							
	SHALE, severely weathered, soft, gray to brown		15		X	8	20-15-17 N=32		-
18.5		745.5+/-				1	50/1"		-
19.0	**LIMESTONE**, very slightly weathered, hard, gray	745+/-							
	LIMESTONE, moderately weathered, hard, close joints, thin bedded, good RQD, slightly open joints, gray		20						
	-high-angle fracture encountered @ 22.2' - 22.8'					113		80	
			25						

Stratification lines are approximate. In-situ, the transition may be gradual.
Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
- Began coring at 19' and water was added into the borehole during coring.

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

▼ *Water @ 3.0 feet after completion*

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-13-2017	Boring Completed: 12-13-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-7

BORING LOG NO. B-4

PROJECT: Shadyside - New K-12 School Facility

CLIENT: SHP Leading Design
Columbus, Ohio

SITE: W 38th Steet & Florence Ave.
Shadyside, Ohio

LOCATION See Exhibit A-2

Latitude: 39.9754° Longitude: -80.7514°

Approximate Surface Elev: 764 (Ft.) +/-

GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	RQD (%)	LABORATORY HP (tsf)
	LIMESTONE, moderately weathered, hard, close joints, thin bedded, good RQD, slightly open joints, gray *(continued)*				113			
					7		0	
	30.0 — 734+/-	30						
	Boring Terminated at 30 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.
Logged by N. Calendine

Hammer Type: Automatic 140 lb, 30 in. drop

Advancement Method:
3.25" HSA; NQ CORE

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No water encountered prior to rock coring

Water @ 3.0 feet after completion

Terracon
800 Morrison Rd
Gahanna, OH

Boring Started: 12-13-2017	Boring Completed: 12-13-2017
Drill Rig: D-90 (rig #763)	Driller: T. Stout
Project No.: N4175317	Exhibit: A-7

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING	Rock Core; Standard Penetration Test	
WATER LEVEL	▽ Water Initially Encountered ▽ Water Level After a Specified Period of Time ▼ Water Level After a Specified Period of Time Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	
FIELD TESTS	N	Standard Penetration Test Resistance (Blows/Ft.)
	(HP)	Hand Penetrometer
	(T)	Torvane
	(DCP)	Dynamic Cone Penetrometer
	(PID)	Photo-Ionization Detector
	(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

UNIFIED SOIL CLASSIFICATION SYSTEM

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

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

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

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

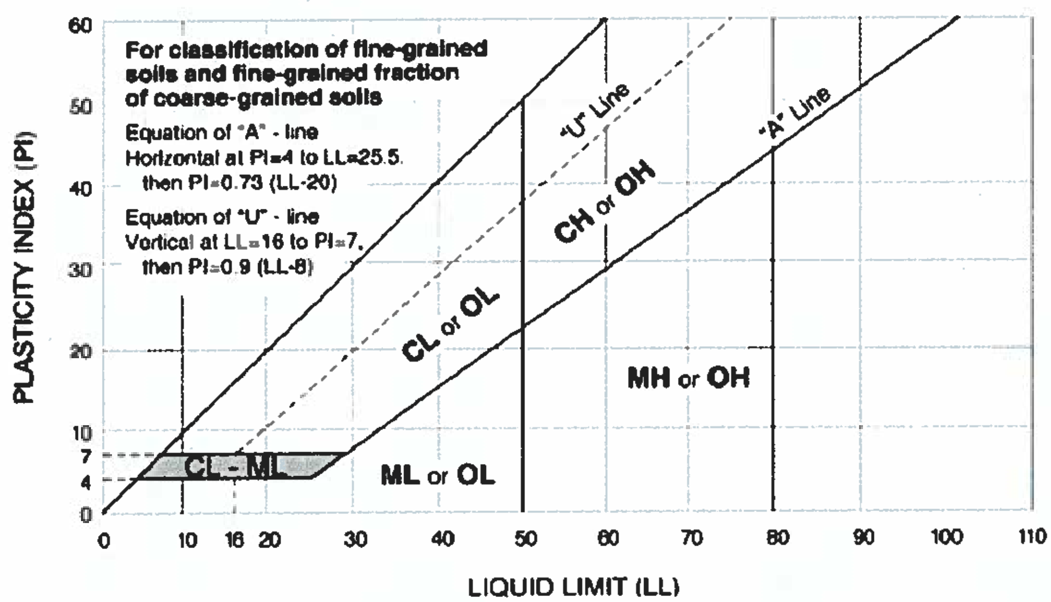
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Exhibit C-2

DESCRIPTION OF ROCK PROPERTIES

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [a]		
Spacing	**Joints**	**Bedding/Foliation**
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) a	
RQD, as a percentage	**Diagnostic description**
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

a. RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

Joint Openness Descriptors	
Openness	**Descriptor**
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

Ohio Mine View Record

December 21, 2017

Current
- Air Shaft
- Drift Entry
- Vertical Mine Shaft
- Slope Entry

Past
- Air Shaft
- Drift Entry
- Vertical Mine Shaft
- Slope Entry
- Locations

Locations - From Geologic Maps
- Abandoned pit
- Abandoned quarry
- Quarry area
- Sand, gravel, or barrow pit
- Locations

Surface Affected Area

N

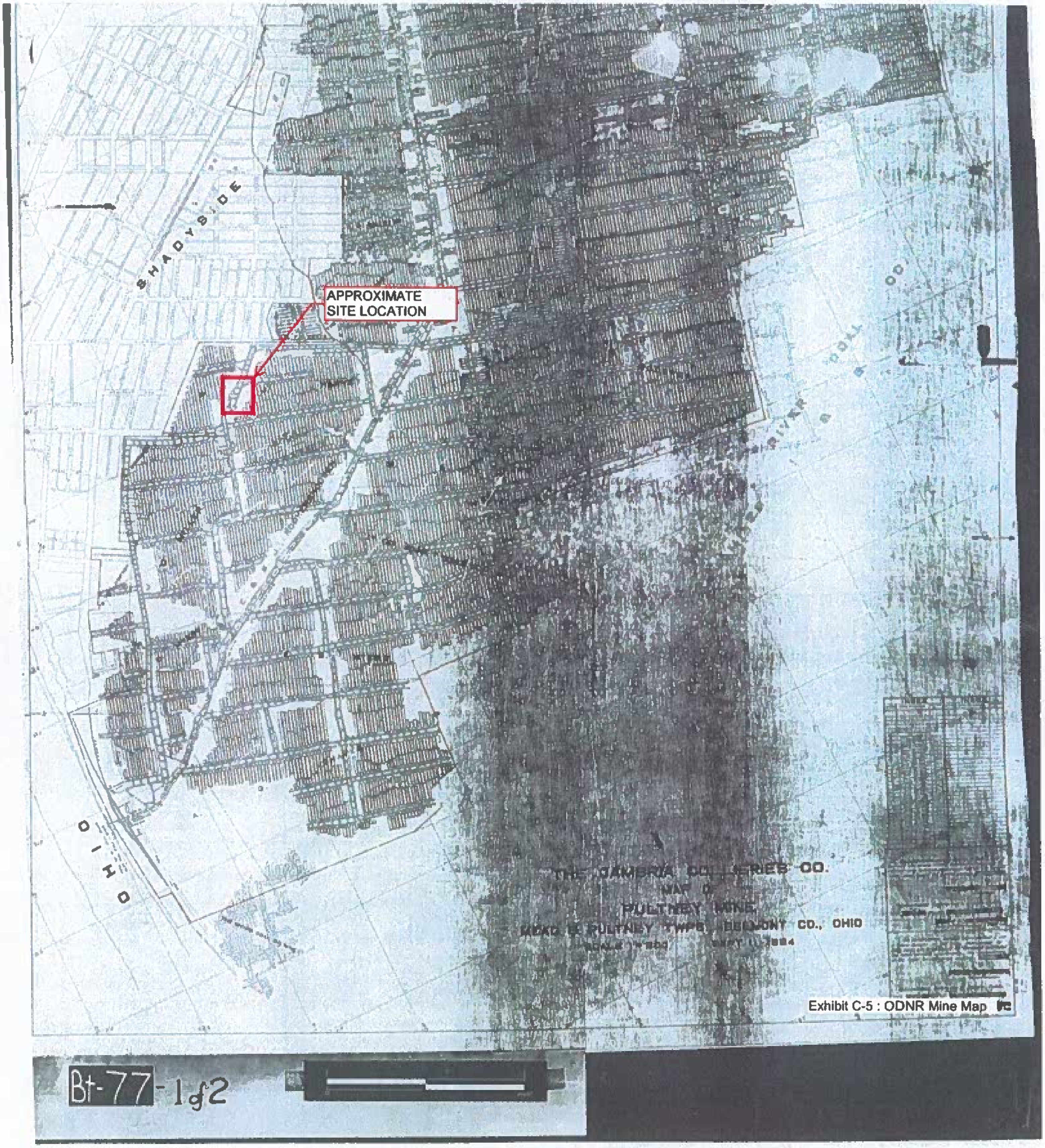
0 0.075 0.15 0.3 mi

0 0.1 0.2 0.4 km

1:9,028

Exhibit C-4 : ODNR Mine Map

Ohio Dept. of Natural Resources


SHADYSIDE
APPROXIMATE
SITE LOCATION
OHIO
PULTNEY MINE
CO., OHIO
Exhibit C-5 : ODNR Mine Map
Bt-77-1 of 2

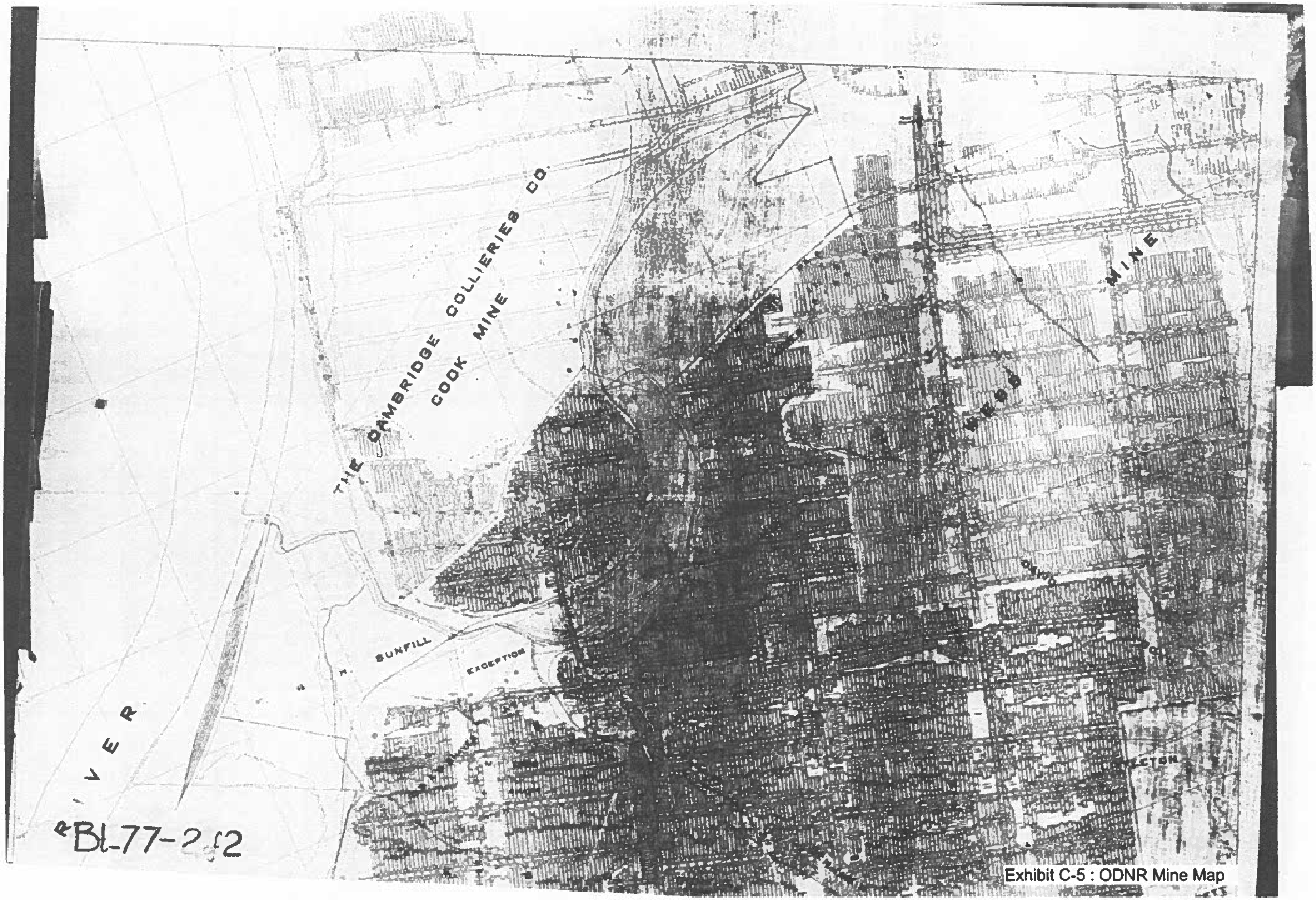


Exhibit C-5 : ODNR Mine Map

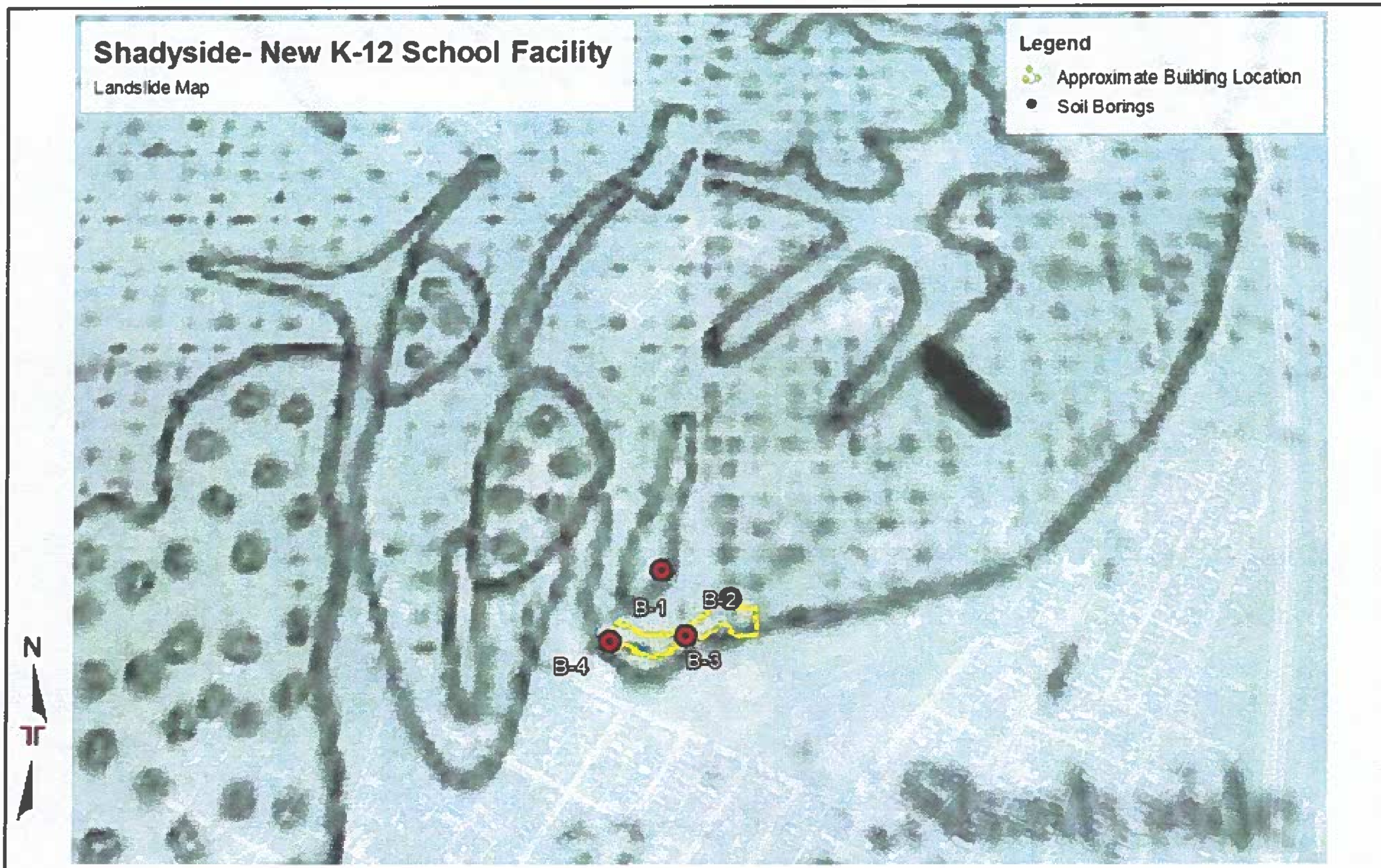


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

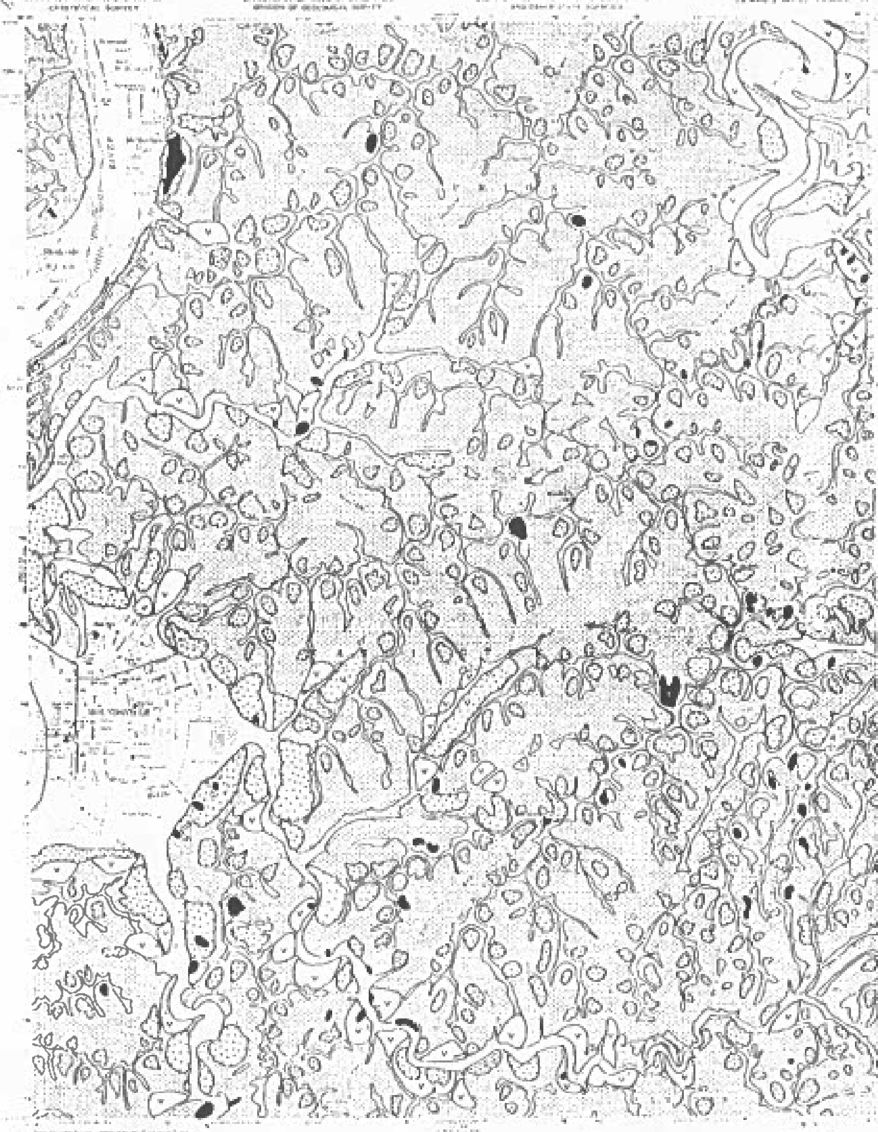
Project Manager: AKM	Project No. N4175317	Terracon Consulting Engineers & Scientists	LANDSLIDE MAP
Drawn by: AKM	Scale: N.T.S.	800 Morrison Road Columbus, Ohio 43230	Shadyside - New K-12 School Facility
Checked by: KME	File Name: N4175317 LS	PH. (614) 863-3113 FAX. (614) 863-0475	Belmont County, Ohio
Approved by: KME	Date: Jan. 2018		Exhibit C-6

LANDSLIDES AND RELATED FEATURES

by

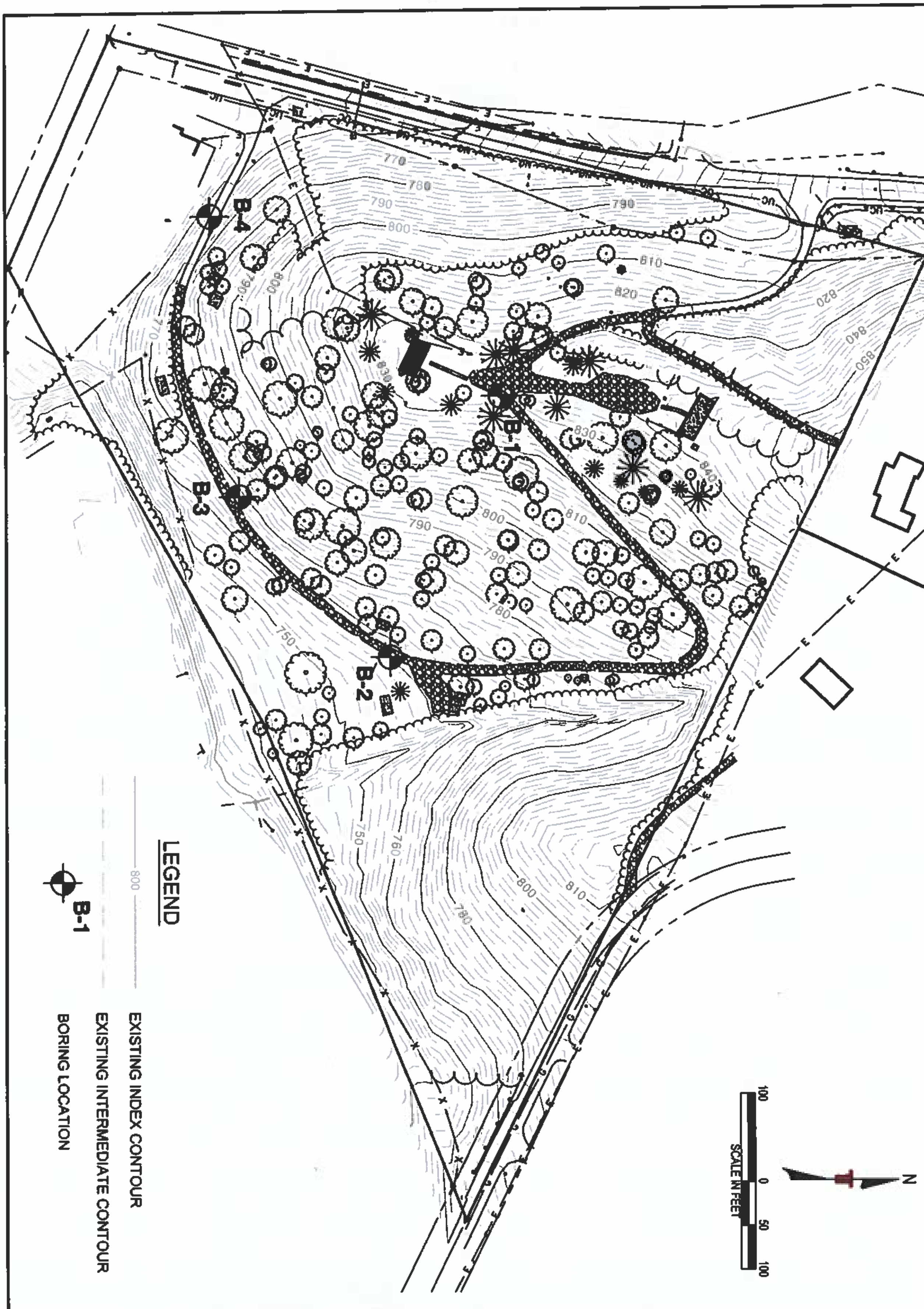
U. S. Geological Survey

Exhibit C-7 : USGS LANDSLIDE MAP BUSSINESSBURG



LANDSLIDES AND RELATED FEATURES

Exhibit C-7 : USGS LANDSLIDE MAP MOUNDSVILLE



REV	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
800 MORRISON ROAD COLUMBUS, OHIO 43230
PH (614) 863-3113 FAX (614) 863-0475

TOPOGRAPHIC MAP

SHADYSIDE LSD
NEW K-12 PRELIMINARY GEOTECHNICAL INVESTIGATION
SHP LEADING DESIGN
W 38TH STEET & FLORENCE AVE.
SHADYSIDE, BELMONT COUNTY OHIO

EXHIBIT C-8

DESIGNED BY	AKM
DRAWN BY	DAB
APPVD BY	KME
SCALE	1"=100'
DATE	1/11/2018
JOB NO	N4175317
ACAD NO	SITE 11-17
SHEET NO	1 OF 1