7. Preliminary Geotechnical Engineering Report completed by IDE – November 28, 2016

PRELIMINARY
GEOTECHNICAL ENGINEERING REPORT
Proposed Buildings at Seymour Avenue
2250 Seymour Ave., Cincinnati, OH

November 28, 2016

Prepared for

Ms. Julie M. Banner
Port of Greater Cincinnati
Development Authority
3 East Fourth Street, Suite 300,
Cincinnati, Ohio 45202

STATE OF OHIO
MOHAMED MOUSTAFA ELGENDY
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REGISTERED PROFESSIONAL ENGINEER

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IDE Project 16045A-41

November 28, 2016

Ms. Julie M. Banner
Development Associate
Port of Greater Cincinnati
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23 East Fourth Street, Suite 300,
Cincinnati, Ohio 45202

RE: IDE Project No. 16045A-41
PRELIMINARY Geotechnical Engineering Report
Proposed Buildings at Seymour Avenue
2250 Seymour Ave, Cincinnati, OH 45212

Dear Ms. Julie M. Banner:

Infrastructure & Development Engineering, Inc. (IDE) is pleased to submit the attached "Preliminary Geotechnical Engineering Report," conducted in connection with the above-referenced project site.

IDE conducted a preliminary geotechnical exploration at the project site to provide preliminary recommendations for general site development for three different buildings. The subsurface exploration program included the completion of six (6) soil borings at the site, two (2) borings at each building location, laboratory testing of the recovered subsurface material samples, and a preliminary report.

The preliminary report outlines the exploration procedures used, describes the subsurface conditions encountered, and presents recommendations relative to geotechnical design, site preparation and drainage and anticipated construction concerns and precautions.

The following lists the major findings and conclusions of this preliminary exploration. **This summary should not be used as a separate document or in lieu of reading the entire preliminary geotechnical engineering report, including the appendices.**

Building #1 South of Langdon Farm Road, Cincinnati, OH 45212

Based on the results of the two (2) soil test borings (B-1 and B-2) completed at the Building #1 site, the following general soil conditions were encountered.

- **Pavement Structure** was encountered at the ground surface across the site to depths of up to approximately six (6) inches.
- **Lean CLAY** with variable amounts of sand was encountered below the pavement structure in boring B-1 to approximate depth of thirteen (13) below the existing ground surface. This material is suitable for structural support four feet below the existing ground elevation.
- **Clayey SAND** was encountered below the pavement structure in boring B-2 to approximate depths of thirteen (13) below the existing ground surface. This material is suitable for structural support four feet below the existing ground elevation .
- **Lean CLAYS** was encountered from thirteen (13) feet to the end of the boring at twenty (20) feet below the ground elevation. This material is suitable for structural support.

Building #2 West of Seymour Avenue, Cincinnati, OH 45212

Based on the results of the two (2) soil test borings (B-3 and B-4) completed at the Building #2 site, the following general soil conditions were encountered.

- **Pavement Structure** was encountered at the ground surface across the site to depths of up to approximately twelve (12) inches.
- **Lean CLAY** with variable amounts of sand and limestone fragments were encountered below the pavement structure in both borings to approximate depth of thirteen (13) below the existing ground elevation. This material was soft in boring B-4 at approximate depth of (3.5-5.0) feet, the soft material encountered in boring B-4 is not suitable for bearing structural building loads. This soft materials can cause excessive settlement under structural loading. The existence and the vertical extent of these soft materials under any future building shall be carefully verified in a site specific geotechnical investigation for the selection of the appropriate foundation system. This material is suitable for structural support below the soft layer or if soft soils are replaced with suitable structural fill.
- **Lean CLAY** was encountered from approximately thirteen to twenty (13.0- 20.0) feet deep. This material is suitable for structural support.

Detailed recommendations on the suitable foundation types or options will be provided in a geotechnical engineering report for the final geotechnical investigations once the final design details of the proposed structure have been developed. Additional construction costs associated with the presence of the soft clays may likely be incurred at the project site.

Building #3 at 2250 Seymour Ave Cincinnati, OH 45212

Based on the results of the two (2) soil test borings (B-5 and B-6) completed at the Building #3 site, the following general soil conditions were encountered.

- **Pavement Structure** was encountered at the ground surface across the site to depths of up to approximately six (6) inches.
- **Lean CLAY (Fill)** was encountered to a depth of eight (8) feet in boring B-5 and five and one-half (5.5) feet in boring B-6.
- **LIMESTONE cobbles** was encountered with some brown silty clay in boring B-5 from five and one-half (5.5) feet to the end of boring at twenty feet from the existing ground elevation.
- **FAT CLAY** was encountered in boring B-6 below the fill material to the end of boring at twenty feet from the existing ground elevation.

The materials encountered in both borings may not be representative of the soils under the existing building foundations due to the cut and fill operations during the construction of the existing building. Also, due to the large footprint of the building, it is recommended that a detailed geotechnical investigation be performed based on specific design details and building layouts to provide structure-specific recommendations including bearing capacity for this building. **No generalized shallow foundation bearing capacity recommendations can be provided in this preliminary geotechnical investigation at Building #3 site.**

The results of IDE's preliminary investigation are intended for general site development, and not suitable for specific construction activities. Once final design details of the proposed structures for the parcels have been developed, IDE should be retained by the Client to complete a final geotechnical engineering investigation, including building-specific and pavement design soil test borings, to provide structure-specific recommendations and analysis.

IDE appreciates the opportunity to provide preliminary design and construction recommendations for this project site. Should you have any questions concerning the preliminary exploration or if IDE can be of further assistance, please contact us at your convenience.

Respectfully submitted,

Infrastructure & Development Engineering, Inc.

Mohamed Elgendy, MSCE, PE
Senior Geotechnical Engineer

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1.0 INTRODUCTION

1.1 Authorization

This report describes the performance and results of a preliminary geotechnical exploration and engineering evaluation conducted in connection with the subsoil conditions which exist at the subject site. The site location is indicated on the Site Vicinity Map, included as Plate 1 in Appendix A.

Infrastructure & Development Engineering, Inc. (IDE) was retained by Port of Greater Cincinnati Development Authority to conduct a preliminary geotechnical exploration at the project site and to provide preliminary recommendations, as appropriate for the subsurface conditions encountered. The exploration study was undertaken in accordance with IDE's "Professional Services Agreement," and IDE Proposal No. P16097-41 dated October 4, 2016.

1.2 Scope

The geotechnical engineering investigation conducted at the subject site included a subsurface exploration program, laboratory testing program, and the generation of this preliminary geotechnical engineering report. The subsurface exploration program included the completion of six (6) soil borings at the site and laboratory testing of the recovered subsurface material samples. Field and laboratory data were then utilized by IDE's engineering staff in the development of geotechnical recommendations and in the preparation of this engineering report. This report presents an overall assessment of the subsurface conditions encountered at the site, topsoil thickness, and preliminary recommendations and considerations for site development, which only includes generalized bearing capacity and seismic classification recommendations for the subsoil conditions.

The results of this investigation are to be considered preliminary, and not suitable for construction. Once final design details of the proposed structures for the parcels have been developed, IDE should be retained to complete a final geotechnical engineering investigation, including building-specific and pavement design soil test borings, to provide structure-specific recommendations and analysis for the Client.

1.3 Project Description

We understand that the project involves the design and construction of the proposed development of three separate buildings as follows:

Building #1 (Bldg1), this future development building is located to the south of Langdon Farm Road and west of Seymour Avenue in the existing abandoned parking lot. The building is anticipated to be approximately 46,500 square feet.

Building #2 (Bldg2), this building is a future development and is located to the west of Seymour Avenue, Cincinnati, OH 45212 in the existing abandoned parking lot to the south of Bldg1 development location. Bldg2 is anticipated to be approximately 59,300 square feet.

Building #3 (Bldg3) is located at 2250 Seymour Ave Cincinnati, OH 45212. Bldg3 will be constructed in the existing Cincinnati Gardens building location after the demolition of the existing building. The new development is anticipated to be approximately 116,300 square feet.

The future development locations and the approximate anticipated dimensions are shown on Plate 2 Appendix A. The three buildings are expected to consist of commercial buildings with parking areas and driveways. Topographically, the site is sloped at each building location. No specific buildings layout, building design loading information, and/or traffic data was provided to us at the time of this preliminary report preparation.

2.0 SUBSURFACE EXPLORATION

2.1 Soil Boring Program

The soil boring program included the completion of Six (6) soil test borings, two borings were located at each building site indicated by the Client. All Soil test borings were drilled to final depth of twenty (20) feet from the existing ground elevation. Borings were located and staked in the field by IDE technician prior to drilling. The approximate test boring locations are indicated on the Boring Location Plan, included as Plate 2 in Appendix A.

The borings were completed by Central Star Drilling on November 3rd and 4th, 2016. The borings were advanced by means of a track-mounted All Terrain Vehicle (ATV) drill rig equipped with 2¼" inner-diameter hollow-stem augers. Representative samples of the subsurface materials were recovered from the soils below the probe head using conventional split-spoon sampling techniques conducted in general accordance with the "Standard Method for Penetration Resistance and Split-Barrel Sampling of Soil" ASTM D1586. Samples were recovered at normal intervals of 2½ feet to a depth of 10 feet and at 5 feet intervals thereafter. The recovered disturbed split-spoon samples were removed from the sampler, visually examined, and described by the driller. Representative portions of each sample were placed in labeled, double bagged zip lock bags and returned to IDE soil testing laboratory for testing. Groundwater levels were checked for in the open boreholes during drilling and upon completion of each hole and the results recorded in the field are shown on the boring logs.

IDE's Geotechnical Engineer was on site to observe the drilling and completion including the topsoil thicknesses and subsurface conditions of the six (6) borings.

2.2 Laboratory Testing Program

The recovered samples were visually and manually classified in IDE's AASHTO-Accredited Soils Laboratory in general accordance with the standard procedures of ASTM D2487, "Classification of Soils for Engineering Purposes."

Twelve (12) representative samples were subjected to moisture content determinations, in accordance with ASTM D2216. The results of these tests are presented on the boring logs included in Appendix B. Wet sieve analyses were conducted on three (3) soil samples to determine the percentage of sample particle size gradation according to ASTM D422. The results of these tests are presented in Table 1.

Table 1 Summary of Sieve Analysis Test Results					
Boring No.	Depth (ft)	Gravel (%)	Sand (%)	Fines (%)	USCS
B-1	3.5-5.0, 6.0-7.5	1	42	57	Sandy Lean CLAY
B-2	6.0 – 7.5, 8.5-10	0	66	34	Clayey SAND
B-4	6.0 – 7.5, 8.5-10	5	26	69	Lean CLAY with Sand

Five (5) Atterberg Limits tests were also conducted on representative soil samples, in accordance with ASTM D4318. The test results are summarized in Table 2 and included in Appendix C of this report. All laboratory testing were conducted in general accordance with current applicable ASTM standards.

Table 2 Summary of Atterberg Limits Test Results					
Boring No.	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	USCS (fines)
B-1	3.5-5.0, 6.0-7.5	39	21	18	CL
B-2	3.5-5.0, 6.0-7.5	40	21	19	CL
B-4	6.0-7.5	32	20	12	CL
B-5	6.0-7.5	24	18	6	CL
B-6	6.0-7.5	52	26	26	CH

Logs were then prepared for each of the test borings. Each log includes descriptions of the primary strata encountered, depths of strata changes, sample types and depths, Standard Penetration Test (SPT) resistance values (N), groundwater observation information, and moisture content test results. The boring logs are included in Appendix B.

It should be noted that the stratification lines shown on the soil boring logs do not represent exact geological planes but approximate transitions between soil and rock types. In-situ stratum changes could occur gradually, abruptly or at slightly different depths.

Based on the soil survey of the area in the current National Soil Survey for Hamilton County published by the US Department of Agriculture's Natural Resources Conservation Service (USDA NRCS), the project site lies predominantly in Urban land-Udorthents (UrUXC). (refer to Appendix D for the soil Survey Map).

3.0 SUBSURFACE SOIL CONDITIONS

3.1 General Subsurface Conditions

The soil boring program included the completion of the two soil test borings at each building location in the project site. The soil borings were located across the site as shown on the boring location plan (refer to the attached Boring Location Plan). The soil conditions at each building location are presented below:

Building #1

At the ground surface, the two borings (B-1 and B-2) encountered approximately Six (6) inches to one foot (1) of pavement and stone base material. Below the pavement structure, boring B-1 encountered brown stiff sandy Lean Clay down to thirteen (13) feet deep from the ground elevation. In boring B-2 a brown medium dense to loose clayey **SAND** was encountered to thirteen (13) feet depth from the ground elevation. In the upper thirteen feet in boring B-1 and B-2, the Standard Penetration Test (SPT) N-values in the material ranged from 9 blows per foot (bpf) to 26 bpf, with an average of (SPT) N-value 14 bpf. The fines in this layer were classified as Lean CLAYS (CL) in both borings

In both borings, a hard to very stiff gray sandy lean **CLAY** soil was encountered from thirteen (13) feet to the end of the boring at twenty (20) feet below the ground elevation. The Standard Penetration Test (SPT) N-values in the material ranged from 19 blows per foot (bpf) to 58 bpf, with an average of 34 bpf.

Building #2

Borings B-3 and B-4 encountered approximately one foot of pavement and stone base material. Below the pavement structure, boring B-3 encountered a brown sandy **CLAY** material with different amounts of sand and trace limestone fragments to a depth of thirteen (13) feet. In boring B-3, a brown sandy **CLAY** layer was encountered from approximately one to thirteen (1-13) feet, the Standard Penetration Test (SPT) N-values in the material ranged from 14 blows per foot (bpf) to 23 bpf, with an average of (SPT) N-value 18 bpf. In boring B-4, the soil encountered below the pavement structure was stiff brown silty CLAY with limestone boulders in the upper two feet and become soft with trace sand and trace gravel at approximately five feet from the existing ground elevation. From five to thirteen (5.0-13.0) feet deep, the soils encountered was stiff brown sandy CLAY. The Standard Penetration Test (SPT) N-values in the material was 9 bpf in both tests performed.

From thirteen to twenty (13.0- 20.0) feet deep, a dark gray stiff to very stiff **CLAY** was encountered in both borings B-3 and B-4. The Standard Penetration Test (SPT) N-values in the material ranged from 10 bpf to 18 bpf, with an average of (SPT) N-value 12 bpf.

Building #3

Borings B-5 and B-6 were performed to the north and the east side of the existing Cincinnati Gardens building. A fill consists of silty **CLAY** material was encountered to a depth of eight (8) feet in boring B-5 and five and one-half (5.5) ft in boring B-6. The Standard Penetration Test (SPT) N-values in the material ranged from 2 bpf to 4 bpf and in one test the material was very soft and the split spoon sampler penetrated the soil under the weight of the hammer with zero blows for six (6) inches.

In boring B-5 below the fill material, a layer of **LIMESTONE** cobbles was encountered with some brown silty clay was encountered. The Standard Penetration Test (SPT) N-values in the material ranged from 41 bpf to refusal (50 bpf/ 3 inches penetration).

In boring B-6, medium to very stiff brown sandy **CLAY** soil was encountered below the fill material to the end of boring at twenty feet from the existing ground elevation. The Standard Penetration Test (SPT) N-values in the material ranged from 28 bpf to 29 bpf. This material was classified in the laboratory as **FAT CLAY** with Liquid limit of 52% and a Plasticity Index of 26%.

3.2 Groundwater Conditions

Groundwater was encountered in only Boring B-6 during drilling at an approximate depth of seventeen (17) feet upon completion below the existing ground surface. Groundwater was not encountered in any of the remaining borings completed for this project. The boreholes were backfilled upon completion, so delayed groundwater levels were not measured. It should be noted that groundwater levels are significantly affected by the overall permeability of the soil profile, the time frame of the observations, and by site surface characteristics and seasonal weather conditions. Water levels may vary with time, and may fluctuate significantly in response to local conditions.

3.3 Limitations

Soil and groundwater conditions have been established and evaluated at the specific boring positions at this site. Soil profiles utilized in engineering analysis and development of recommendations have been developed through interpolation between sample depths and boring locations, and are therefore assumed. Variations from the interpolated profile conditions may be present, and may not become known until construction is underway. Should significant variations become evident during construction, IDE should be retained to evaluate the effects of the noted variations and to provide revised recommendations as necessary.

The subsurface conditions set forth on the boring logs represent conditions at the specific boring locations at the time of the field drilling operations. Conditions may change over time due to natural causes or due to the action of man, and exploration; groundwater conditions in the upper soil strata in particular, are likely to fluctuate over time at the site, in response to local site, seasonal and short-term weather conditions. Should a significant time period elapse before construction is undertaken (at most three years), it is recommended that IDE be given the opportunity to review the site conditions to determine if changes have occurred and to evaluate the need for additional exploration.

4.0 PRELIMINARY GEOTECHNICAL DESIGN RECOMMENDATIONS

At this time of report preparation, no specific buildings layout and/or buildings design loading information was provided to IDE. Thus, the following recommendations should be considered **preliminary in nature. Once specific design plans and buildings layouts have been finalized, IDE should be retained to perform a final geotechnical engineering investigation at each building site, including building-specific and pavement design soil test borings, and provide final geotechnical design recommendations.**

The following preliminary conclusions and geotechnical design recommendations are given based on the soil test borings that were completed as part of this preliminary geotechnical investigation randomly selected borings within the project site, the previously discussed project information, observations at the site, analysis of the laboratory results, interpretation of the field data obtained during the exploration, our understanding of the project, and our experiences with similar subsurface and project conditions. Once specific civil design details and building layouts have been finalized, additional, building-specific soil borings should be completed at the site to provide structure-specific recommendations and analysis for the project.

4.1 Bearing Capacity Recommendations

Building #1

The materials encountered predominantly in the twelve (12) feet below the existing pavement in the two borings were classified in the laboratory as sandy LEAN CLAY with an average Standard Penetration Test (SPT) N-value of 14 bpf. **Based on the materials encountered, a generalized shallow foundation net bearing capacity of 1,500 pounds per square foot can be generally used at a depth of four (4) feet from the existing ground elevation.**

Building #2

The materials encountered predominantly in the twelve (12) feet below the existing pavement in boring B-3 were classified as sandy lean CLAY with an average of (SPT) N-value of 18 bpf . In boring B-4, a soft soil was encountered in the split spoon sample collected from 3.5- 5.0 feet deep, this soil is not suitable to support foundation structural loads. The depth and extent of this soft material shall be investigated in a detailed geotechnical investigation and replaced with suitable structural fill. **Based on the materials encountered and after replacing the soft soils with structural fill, a generalized shallow foundation net bearing capacity of 1,500 pounds per square foot can be generally used.**

Building #3

The materials encountered in both borings B-5 and B-6 were predominantly fill in the upper 5.5 to 8.0 feet. **This material may not be representative of the soils under the existing building foundations due to the cut and fill operations during the construction of the existing building. Also, due to the large footprint of the building, it is recommended that a detailed geotechnical investigation be performed based on specific design details and building layouts to provide structure-specific recommendations including bearing capacity for this building. No generalized shallow foundation bearing capacity recommendations can be provided in this preliminary geotechnical investigation at Building #3.**

Groundwater was encountered in only Boring B-6 during drilling at an approximate depth of seventeen (17) feet upon completion below the existing ground surface. We do not anticipate groundwater to be encountered during foundation construction. Any groundwater or surface water that accumulates in the foundation excavations should be lowered by sumps and pumps during excavations. The groundwater will have to be lowered to the bottoms of the foundation excavations.

As stated above, once specific design details and buildings layouts have been finalized, additional, building-specific soil borings should be completed at the site to provide structure-specific recommendations and analysis for the Client.

4.2 Seismic Site Classification

Based on the results of the Standard Penetration Tests (SPT) in the six borings completed for this preliminary investigation, the average N-values range from 4 to 100 blows per foot (bpf) for the subsurface soils encountered within approximately twenty (20) feet of the existing ground surface. Based on the subsurface conditions encountered at the boring locations , it is recommended that a Seismic Site Class "D" be used as the basis of design in accordance with the current Ohio Building Code.

5.0 EARTHWORK & CONSTRUCTION RECOMMENDATIONS

5.1 Site and Subgrade Preparations

Building #1 and Building #2

Stripping of the construction area is recommended to remove all unsuitable surficial material including existing pavement and the soft soils encountered. The soft clay material encountered in boring B-4 or any soft material that may be encountered in a detailed geotechnical investigation or during construction shall be characterized to verify its extent and if needed to be stripped and replaced.

Building # 3

After the demolition of the existing Cincinnati Gardens building including its foundation, an engineered structural fill shall be placed up to the desired elevation. All structural fill materials shall be tested by IDE to determine the suitability of the material and compatibility before the fill operations. Earthwork operations are to be monitored by a representative of IDE under the supervision of the project geotechnical engineer during demolition and the backfilling operations to ensure the engineered backfilling is suitable to support structural foundation loads.

As a general recommendation for all three buildings, surface water should not be allowed to pond in working areas during construction. Temporary barriers or diversion methods may be necessary to intercept surface water along the site perimeter and carry it away from the construction area. All stripped subgrade surfaces should be stable under proofrolling operations conducted with a fully-loaded tandem-axle dump truck or other suitable heavy-wheeled construction equipment. Any area showing rutting, pumping, or any other distress during proofrolling operations is subject to corrective action. Such corrections may involve simple undercutting and replacement procedures, and/or procedures such as lime stabilization may be considered. Where excessively wet (or dry/loose) materials are noted at the surface, it is anticipated that at least the upper twelve (12) to eighteen (18) inches of the subgrade surface should be reworked, including moisture conditioning and recompacting. If proper compaction still cannot be achieved (as described below), the material should be removed and replaced with suitable borrow material.

5.2 Backfill Recommendations

For pavement areas, all backfill materials are to be placed in individual lifts not exceeding eight (8) inches in loose thickness. Moisture contents of each lift are to be maintained within optimum plus/minus two (2) percentage points per Standard Proctor method (ASTM D698). Each lift of material is then to be compacted to a minimum in-place density of ninety-eight (98) percent of the maximum laboratory density as determined in accordance with Standard Proctor method (ASTM D698). Fill materials should be free of all limestone or rock fragments having maximum dimensions greater than four (4) inches.

For backfills within the proposed building footprints, the moisture contents of each lift should be maintained within optimum plus/minus two (2) percentage points per Modified Proctor method (ASTM D1557). Each lift of material is then to be compacted to a minimum in-place density of ninety-five (95) percent of the maximum laboratory density as determined in accordance with Modified Proctor method (ASTM D1557). All fill materials should be free of all limestone or rock fragments having maximum dimensions greater than four (4) inches.

Earthwork operations are to be monitored by a representative of IDE under the supervision of the project geotechnical engineer. Site clearing activities and placement of fill are to be observed. Soil samples should be collected and tested for determination of maximum density and optimum moisture content prior to the start of fill placement. In-place density tests should be performed frequently during construction to confirm the degree of compaction and verify compliance with project specifications.

All excavated soils deemed suitable for backfill by the project geotechnical engineer can be reused, provided that the materials are placed and compacted in a controlled manner, as described above. Moisture conditioning via aeration and drying may be necessary in bringing near-surface soils in line with optimum moisture contents. Lime modification may be considered for use to aid in drying of excessively wet and/or highly plastic fill materials (Stratum 1a, Stratum 1b and Stratum 1c soils). Backfilling is to proceed as outlined in the preceding paragraphs.

If off-site borrow is required, the following criteria should be utilized.

1. Maximum dry density per ASTM D 698: 105 pcf minimum.
2. Cohesive borrow material classification:
    a. CL or CL-ML
    b. Plasticity Index < 20, per ASTM D 2487
    c. Maximum organic content 5% (per LOI method)
3. Granular borrow classification; all classifications except SM (per ASTM D2487)

The granular borrow soil can be used as backfill to facilitate the backfilling and compaction during winter and wet weather. If the granular soil is placed on top of compacted silty and clayey soil or backfill, an underdrain system should be installed to keep water from accumulating in the granular soil. The water could freeze due to the frost penetration. The ice lenses will create heaving problems to building foundations. The water will also weaken the compacted silty and clayey soil beneath the granular soil layer.

Any excavated fat clays are not suitable for reuse as structural backfill. For fat clays to be reused as backfill, the material should be lime-modified to reduce the plasticity characteristics to the above-recommended criteria for cohesive borrow material.

5.3 Foundation Excavation Recommendations

During the foundation excavations, the subsoil conditions as described in this preliminary geotechnical engineering report should be verified in detailed geotechnical investigation. For foundations supported on the natural soils and/or on the compacted backfill, the foundation excavations should be observed to ensure that any soft, loose, or otherwise unsuitable materials are removed, and that the foundations will be supported directly on an acceptable subgrade. Any significant differences should be brought to the attention of the owner's representative along with appropriate recommendations. Please note that the overall performance of the foundations is governed by the soils below the bottoms of the foundations.

The soils beneath the bases of the foundation excavations should be tested with approved bearing strength evaluation equipment and/or a hand penetration device to determine if compressible or wet and soft soils are present underneath the foundation elevation. This is to ensure that the soils immediately below the foundation base are satisfactorily prepared to support the foundations. All soft, wet, and unsuitable soils must be removed (undercut) from the foundation areas and replaced with approved fill materials.

Prior to the placement of fill material, extra care should also be taken to tie-in the new compacted fill with the excavation slopes or existing slopes greater than 5 (horizontal) to 1 (vertical), with benches as necessary. This is to ensure that no pockets of loose or soft materials are left along the excavation slopes or existing slopes below the foundation bearing level. Temporary cut slopes should be maintained in accordance with the current OSHA regulations governing trenching and slope stability at all times.

During construction, exposure to moisture and the environment may cause softening of the subgrade soils; therefore, the foundation excavations should be suitably dewatered (if required): Foundation concrete should be placed the same day, or as soon as practical after, the excavation is inspected and approved. If water intrusion or exposure softens the bearing soils, the softened soils must be removed from the base of the foundation excavation immediately prior to the placement of concrete.

5.4 Groundwater Considerations

Groundwater was encountered in only Boring B-6 during drilling at an approximate depth of seventeen (17) feet and upon completion. Groundwater was not encountered and/or measured in any of the remaining borings completed for this project. On the basis of the groundwater observations made during the field exploration operations, we do not anticipate any construction problems with groundwater at the site.

If excessive groundwater is encountered in localized areas, a sump and pump system should be placed to remove the water. Otherwise, the bottoms of the excavations will be very soft due to ponding of water at the bottoms of the excavations. Additional water problems experienced during construction can be the result of precipitation and/or surface water flows into the excavations. If groundwater problems develop, IDE or a qualified geotechnical engineering and materials testing firm should be contacted to provide additional input or recommendations, as appropriate, as the work progresses. During the backfill of the foundation excavations, any groundwater encountered should be kept at a level below the fill operations during the placement and compaction of the backfill materials.

5.5 Slope Stability Considerations

Based on our visual inspection of the site topography, we do not anticipate slope stability issues at the project site. However, we recommend that final slopes within the clay soils be designed no steeper than three (3) horizontal to one (1) vertical (3H:1V) for clay soils, on-site or borrowed. Permanent surface protection should be provided for all 3H:1V or steeper slopes. Cut-off drains or diversion channels should be installed at the top of all high slopes.

6.0 LIMITATIONS

The preliminary conclusions and recommendations outlined in this report have been based upon subsurface conditions encountered at Six (6) specific boring locations at the time of our field exploration, and the information concerning the proposed project site provided by Port of Greater Cincinnati Development Authority. Subsurface conditions could vary between the boring locations.

This preliminary report is provided for the sole use of Port of Greater Cincinnati Development Authority, the designers, and the contractors on the project for which it was prepared. Use of this report by any unauthorized third parties or for any unrelated project will be at that party's sole risk. IDE disclaims liability for any use of or reliance on this report by third parties.

The preliminary conclusions and recommendations outlined in this report have been formulated by IDE in accordance with the locally accepted standards for the practice of geotechnical engineering at the time of preparation of the report. No other warranties, either expressed or implied, are offered.

IDE should be notified of any revisions to the use of this project so that these revisions may be evaluated against the existing conditions. Should it become necessary to revise the preliminary conclusions and recommendations contained in this report, IDE will submit a written report to address any changes to the conclusions and recommendations. In the event that the proposed construction scheme and use of the project site varies from that described, IDE requests the opportunity to review our recommendations.

The information presented in this report should be considered preliminary and not suitable for specific types of construction. Once more specific design details have been developed, IDE should be retained to complete a final geotechnical engineering investigation at the project site to review the preliminary recommendations presented in this report and determine if any modifications are necessary. Additional, building-specific and pavement design soil test borings and laboratory testing would also be completed at that time.

APPENDIX A

FIGURES

Project Manager:	M. ELGENDY
Drawn By:	T. FOSTER
Scale:	N/A
DATE:	11/8/2016
Project No.:	16045A-41

PLATE 1: SITE VICINTY MAP

2250 Seymour Ave.
Cincinnati, OH 45212

INFRASTRUCTURE DEVELOPMENT ENGINEERING

CINCINNATI OFFICE
2451 CROWNE POINT DRIVE
CINCINNATI, OHIO 45241
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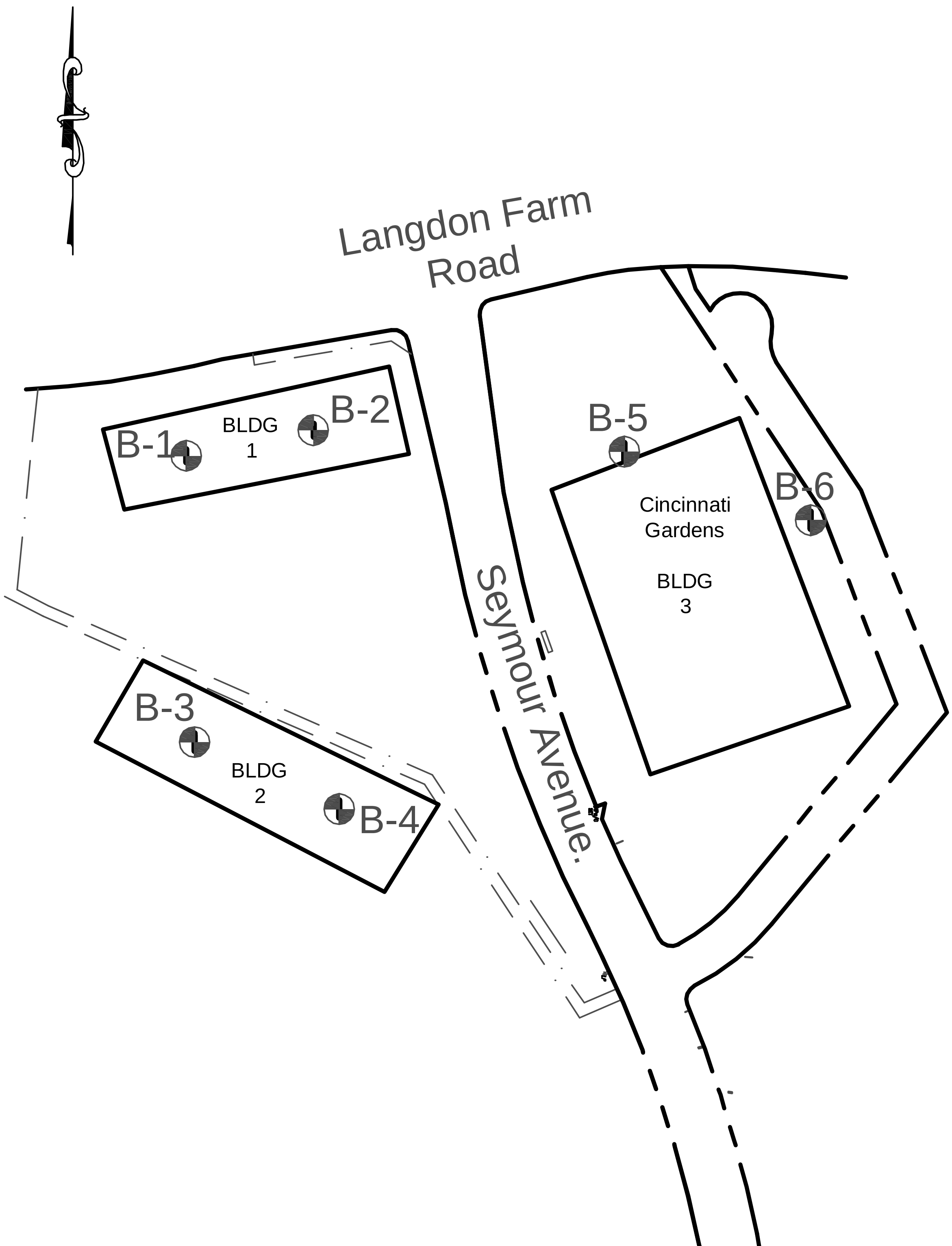


Project Manager: M. ELGENDY

Drawn By: T. FOSTER

Scale: N/A

DATE: 11/8/2016

Project No.: 16045A-41

PLATE 2: BORING PLAN

2250 Seymour Ave.
Cincinnati, OH 45212

Infrastructure Development Engineering

CINCINNATI OFFICE
2451 CROWNE POINT DRIVE
CINCINNATI, OHIO 45241
Tele: (513) 671-8144
Fax: (513) 671-8150

APPENDIX B

SOIL BORING LOGS

Client: Port of Greater Cincinnati Development

Project: Proposed Redevelopment at Seymour Av.

Location: Seymour Av., Cincinnati, OH 45212

Project No: 16045A-41

Log of Borehole B-1

Depth (ft)	Description	Depth / Elev.	Type	Recovery (in)	SPT Value	N-Value	Natural Moisture Content (%)	Pocket Penetrometer (tsf)
0	Ground Surface	0						
0–1	***Pavement*** 1.5" Asphat 4" Stone Base							
1.5–3	***Lean CLAY*** Stiff Brown Sandy Lean CLAY (CL) moist w/variable amounts of sand and trace gravel		SS	18	3-5-6	11		
4–5.5			SS	18	4-6-8	14	21	
6.5–8			SS	18	4-7-8	15	12	
9–10.5			SS	18	4-10-16	26		
13		-13						
13–15	***Lean CLAY*** Hard to Very Stiff Gray dry Sandy CLAY (CL) w/variable amounts of sand, rock fragments at 14.5 ' depth		SS	18	7-13-22	35		
17–18	Become moist at the last sample End of Boring at 20 feet							
18.5–20		-20	SS	6	7-7-12	19		

Standard Penetration Test blows/ft: 10 20 30 40

Drilling Co.: Central Star Drilling

Drill Method: 2 1/4" ID HSA

Drill Date: 11/03/16

IDE, Inc.
2451 Crowne Point Drive
Cincinnati, OH 45241

Explored Depth: 20'

Water Level on Completion: n/a

Hole Caved at: 17'

Client: Port of Greater Cincinnati Development

Project: Proposed Redevelopment at Seymour Av.

Location: Seymour Av., Cincinnati, OH 45212

Project No: 16045A-41

Log of Borehole B-2

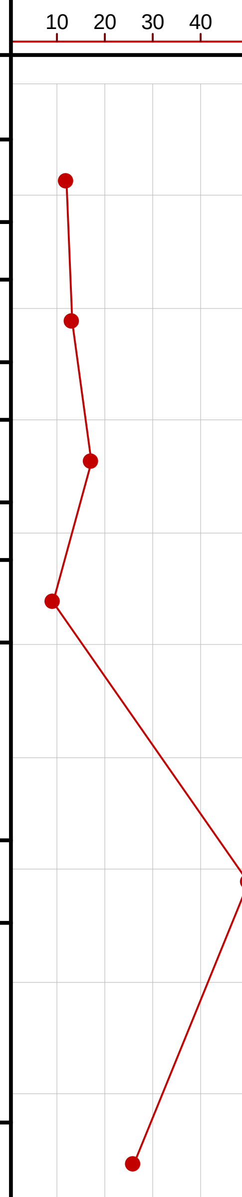
SUBSURFACE PROFILE

Depth (ft)	Description	Depth / Elev.
0	Ground Surface	0
0–1	***ASPHALT***	-1
1–2	***FILL*** CLAY with base stone	
2–13	***Clayey SAND*** Medium dense to loose moist Brown Clayey SAND w/trace gravel	-13
13–20	***Lean CLAY*** Hard to Very Stiff blueish Gray moist Silty CLAY (CL) w/trace to some Limestone Fragments	
20	End of Boring at 20 feet deep	-20

SAMPLE

Depth (ft)	Type	Recovery (in)	SPT Value	N-Value	Natural Moisture Content (%)	Pocket Penetro-meter (tsf)
2	SS	18	3-5-7	12		
4.5	SS	18	5-6-7	13		
7	SS	18	4-8-9	17	17	
9.5	SS	18	4-4-5	9	20	
14	SS	18	7-26-32	58		
19	SS	18	7-10-16	26		

Standard Penetration Test blows/ft



Drilling Co.: Central Star Drilling

Drill Method: 2 1/4" ID HSA

Drill Date: 11/03/16

IDE, Inc.
2451 Crowne Point Drive
Cincinnati, OH 45241

Explored Depth: 20'

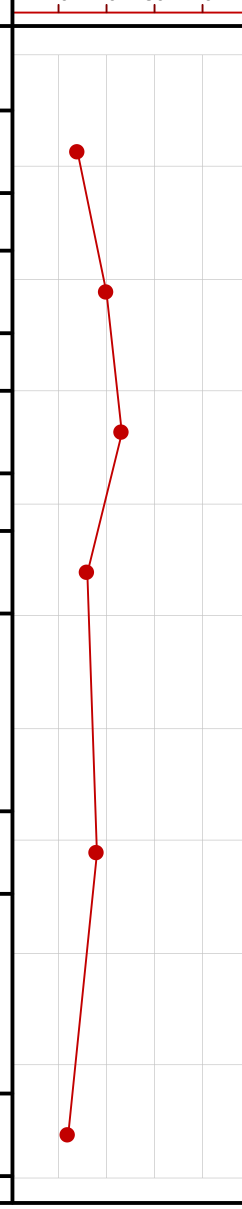
Water Level on Completion: n/a

Hole Caved at: Dry Cave 00'

Sheet: 1 of 1

Client: Port of Greater Cincinnati Development	***Log of Borehole B-3***
Project: Proposed Redevelopment at Seymour Av.	
Location: Seymour Av., Cincinnati, OH 45212	
Project No: 16045A-41	

SUBSURFACE PROFILE					SAMPLE			Standard Penetration Test blows/ft		Natural Moisture Content (%)	Pocket Penetro-meter (tsf)
Depth (ft)	Symbol	Water Level	Description	Depth / Elev.	Type	Recovery (in)	SPT Value	10 20 30 40	N-Value		
0			Ground Surface	0							
0–1			***Stone Base***	-1							
1–13			***Sandy CLAY*** Stiff to Very stiff Brown Sandy CLAY (CL) w/Limestone Fragments		SS	18	4-7-7		14		
					SS	18	6-8-12		20		
					SS	4	7-14-9		23	11	
					SS	18	13-9-7		16		
				-13							
13–20			***Lean CLAY*** Very Stiff to Stiff gray moist CLAY (CL) w/trace limestone Fragments		SS	18	3-13-5		18	13	
			End of Boring at 20 ft deep		SS	18	5-6-6		12		
20				-20							



Drilling Co.: Central Star Drilling	IDE, Inc. 2451 Crowne Point Drive Cincinnati, OH 45241	Explored Depth: 20'
Drill Method: 2 1/4" ID HSA		Water Level on Completion: n/a
Drill Date: 11/03/16	Sheet: 1 of 1	Hole Caved at: 17'

Client: Port of Greater Cincinnati Development

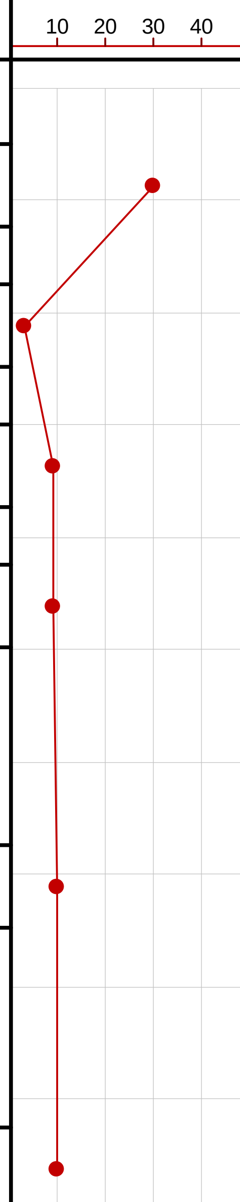
Project: Proposed Redevelopment at Seymour Av.

Location: Seymour Av., Cincinnati, OH 45212

Project No: 16045A-41

Log of Borehole B-4

SUBSURFACE PROFILE				SAMPLE					
Depth (ft)	Description	Depth / Elev.	Type	Recovery (in)	SPT Value	Standard Penetration Test blows/ft	N-Value	Natural Moisture Content (%)	Pocket Penetro-meter (tsf)
0	Ground Surface	0							
0–1	Sand and Gravel base	-1							
1–5	**LEAN CLAY** Stiff to Soft Brown dry SILTY CLAY (CL) w/Limestone boulders		SS	3	10-9-21		30		
	soft in SS sample from 3.5'-5'	-5	SS	12	3-1-2		3		
5–13	**LEAN CLAY** Stiff Brown moist SILTY CLAY (CL) w/somesand and trace gravel		SS	18	3-4-5		9	15	
			SS	18	5-5-4		9	16	
		-13							
13–20	**LEAN CLAY** Stiff Dark Gray moist CLAY (CL) w/some sand		SS	18	3-4-6		10		
	End of Boring at 20 feet deep	-20	SS	18	4-4-6		10		



Drilling Co.: Central Star Drilling

Drill Method: 2 1/4" ID HSA

Drill Date: 11/03/16

IDE, Inc.
2451 Crowne Point Drive
Cincinnati, OH 45241

Explored Depth: 20'

Water Level on Completion: n/a

Hole Caved at: Dry Cave 00'

Sheet: 1 of 1

Client: Port of Greater Cincinnati Development

Project: Proposed Redevelopment at Seymour Av.

Location: Seymour Av., Cincinnati, OH 45212

Project No: 16045A-41

Log of Borehole B-5

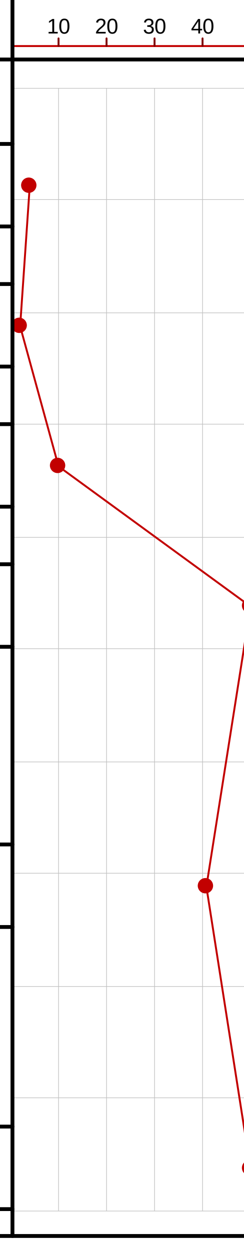
SUBSURFACE PROFILE

Depth (ft)	Symbol	Water Level	Description	Depth / Elev.
0			Ground Surface	0
0–8			***LEAN CLAY (FILL)*** Soft to medium stiff Brown moist SILTY CLAY (CL) w/ little gravel. Become stiff at 6' deep	-8
8–20			***LIMESTONE COBBLES*** LIMESTONE Cobbels w/some Brown Silty Clay. End of Boring at 20 feet deep	-20

SAMPLE

Type	Recovery (in)	SPT Value	N-Value	Natural Moisture Content (%)	Pocket Penetro-meter (tsf)
SS	16	1-2-2	4		
SS	3	1-1-1	2	17	
SS	16	1-3-7	10	20	
SS	6	29-19-39	58		
SS	0	13-19-22	41		
SS	0	23-35-50/	100		

Standard Penetration Test blows/ft



Drilling Co.: Central Star Drilling

Drill Method: 2 1/4" ID HSA

Drill Date: 11/03/16

IDE, Inc.
2451 Crowne Point Drive
Cincinnati, OH 45241

Explored Depth: 20'

Water Level on Completion: n/a

Hole Caved at: 15'

Sheet: 1 of 1

Client: Port of Greater Cincinnati Development

Project: Proposed Redevelopment at Seymour Av.

Location: Seymour Av., Cincinnati, OH 45212

Project No: 16045A-41

Log of Borehole B-6

Depth (ft)	Description (SUBSURFACE PROFILE)	Depth / Elev.	Type (SAMPLE)	Recovery (in)	SPT Value	N-Value	Natural Moisture Content (%)	Pocket Penetro-meter (tsf)
0	Ground Surface	0						
0–0.5	***Pavement*** Concrete 4" Gravel Base 2"							
1.5–2.5	***LEAN CLAY (FILL)*** Stiff to Soft Light Brown SILTY CLAY w/Limestone Fragments		SS	12	1-2-1	3		
4–5			SS	16	1-WOH-4	4	17	
5.5		-5.5						
6.5–7.5	***FAT CLY*** Medium Stiff to Very Stiff Brown Sandy CLAY (CH) w/trace Limestone Fragments		SS	18	4-4-4	8	20	
9–10			SS	18	9-12-16	28	28	
14–15			SS	18	9-13-15	28		
17	End of Boring at 20 ft deep							
19–20		-20	SS	18	10-12-17	29		

Standard Penetration Test blows/ft: 10 20 30 40

Drilling Co.: Central Star Drilling

Drill Method: 2 1/4" ID HSA

Drill Date: 11/03/16

IDE, Inc.
2451 Crowne Point Drive
Cincinnati, OH 45241

Explored Depth: 20'

Water Level on Completion: 17.5'

Hole Caved at: 18.0'

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY		
	Penetration Resistance[1] (blows/foot)	Relative Density
SAND and/or GRAVEL	0 to 4	Very Loose
	5 to 10	Loose
	11 to 30	Medium Dense
	31 to 50	Dense
	Over 50	Very Dense
	Penetration Resistance[1] (blows/foot)	Consistency
SILT and CLAY	0 to 2	Very Soft
	3 to 4	Soft
	5 to 8	Medium Stiff
	9 to 15	Stiff
	16 to 30	Very Stiff
	31 to 50	Hard
	Over 50	Very Hard

Note: [1]ASTM D1586-74

A 2-inch outside-diameter by $1^3/_8$-inch inner-diameter split-spoon barrel sampler is driven eighteen (18) inches with a 140-pound hammer falling thirty (30) inches. The number of blows required for each six (6) inches of penetration is recorded. The sum of the blows required for the final twelve (12) inches of penetration is the Standard Penetration Resistance.

- SPT Value ....Standard hammer blows for three 6-inch intervals
- N Value ....Sum of the blows for the last two 6-inch intervals

RELATIVE PROPORTIONS	
Term	% By Weight
Trace	0 – 10
Little	10 – 20
Some	20 – 35
And	35 – 50

APPENDIX C

LABORATORY TEST RESULTS

INFRASTRUCTURE DEVELOPMENT ENGINEERING

- Civil Engineering
- Land Surveying
- Environmental
- Geotechnical
- Materials Testing
- Construction Inspection

Client: Port of Greater Cincinnati Development Authority
Project: Proposed Development at Seymour Av.
Location: Seymour Avenue Cincinnati, OH
Project No: 16045A-41

Tested by: B.G.
Date: 11/8/2016
Checked by M.E.
Date: 11/9/2016

Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass ASTM D2216

Boring #	B1	B1	B2	B2	B3	B3
Sample #	S-2	S-3	S-3	S-4	S-3	S-5
Depth	3.5'-5'	6'-7.5'	6.0'-7.5'	8.5'-10'	6.0'-7.5'	13.5'-15'
Moisture Can #	f6	g7	d7	h4	b3	i4
Wt. Can + Wet soil	310.45	318.01	331.91	344.26	237.87	315.48
Wt. Can + Dry soil	265.72	279.95	289.47	296.21	219.77	278.22
Wt. Water	44.73	38.06	9.53	48.05	18.1	9.76
Wt. Cup	50.86	50.81	50.6	50.06	50.46	51.08
Wt. of Dry Soil	214.86	229.14	56.23	246.15	169.31	77.36
Water Content %	21	17	17	20	11	13

Boring #	B4	B4	B5	B5	B6	B6
Sample #	S-3	S-4	S-3	S-4	S-3	S-4
Depth	6.0'-7.5'	8.5'-10'	6.0'-7.5'	8.5'-10'	6.0'-7.5'	8.5'-10'
Moisture Can #	b6	h5	g3	a7	e3	e7
Wt. Can + Wet soil	335.98	317.18	314.44	329.06	328.92	330.69
Wt. Can + Dry soil	298.23	281.06	283.42	309.83	275.24	285.11
Wt. Water	37.75	36.12	31.02	19.23	53.68	45.58
Wt. Cup	50.06	50.17	50.38	50.02	50.41	50.45
Wt. of Dry Soil	248.17	230.89	233.04	259.81	224.83	234.66
Water Content %	15	16	13	7	24	19

Approved M.E.

INFRASTRUCTURE & DEVELOPMENT ENGINEERING, INC.

INFRASTRUCTURE DEVELOPMENT ENGINEERING

- Civil Engineering
- Land Surveying
- Environmental
- Geotechnical
- Materials Testing
- Construction Inspection

Client: Port of Greater Cincinnati Development Authority
Project: Proposed Development at Seymour Av.
Location: Seymour Avenue Cincinnati, OH
Project No: 16045A-41

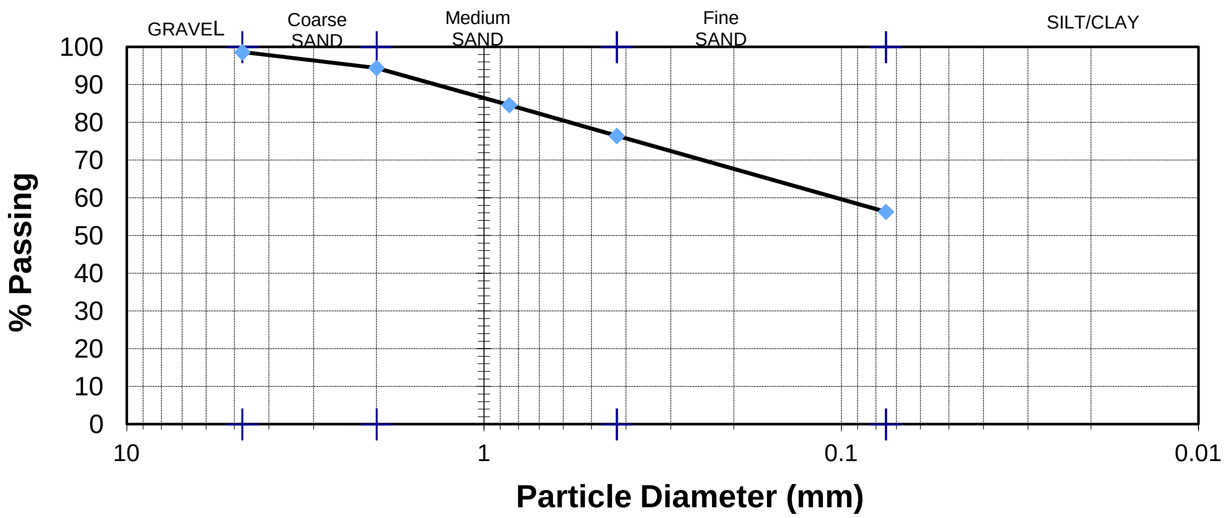
Tested by: M.E.
Date: 11/18/2016
Checked by M.E.
Date: 11/18/2016

Sieve Analysis Data Sheet

ASTM D422

Sample: B1-S2, S3 3.5'-5.0' & 6.0'-7.5'

Sieve Number	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
#4	4.75	462.6	463.64	1.0	1.4	99
#10	2.00	431.8	434.98	3.2	4.2	94
#20	0.85	622.94	630.38	7.4	9.8	85
#40	0.43	552	558.18	6.2	8.2	76
#200	0.075	493.59	508.81	15.2	20.1	56
Pan		470.42		42.6	56.3	0
			TOTAL:	**75.65**	**100.0**	



Grain Size Distribution Curve

% Gravel: 1
% Sand: 42
% Fines: 56
USCS Soil Classification: **Sandy Lean CLAY**

INFRASTRUCTURE & DEVELOPMENT ENGINEERING, INC.

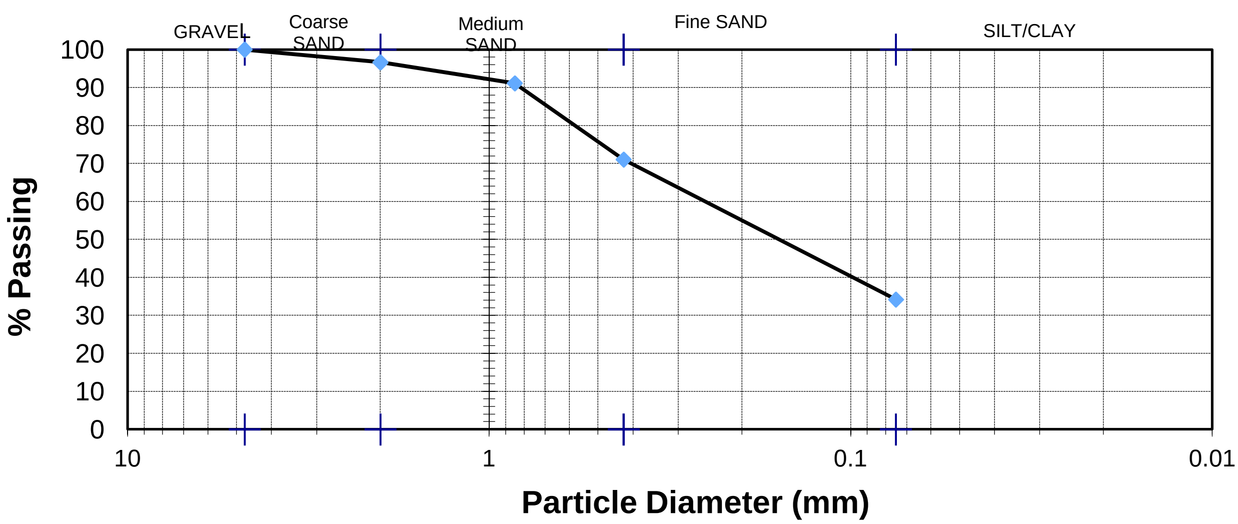
Client: Port of Greater Cincinnati Development Authority
Project: Proposed Development at Seymour Av.
Location: Seymour Avenue Cincinnati, OH
Project No: 16045A-41

Tested by: M.E.
Date: 11/15/2016
Checked by M.E.
Date: 11/15/2016

Sieve Analysis Data Sheet
ASTM D422

Sample: B2-S3,S4 6'-7.5 , 8.5'-10.0'

Sieve Number	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
#4	4.75	462.6	462.6	0.0	0.0	100
#10	2.00	431.8	438.1	6.3	3.3	97
#20	0.85	622.94	633.4	10.5	5.5	91
#40	0.43	552	590.0	38.0	20.1	71
#200	0.075	493.59	563.4	69.8	36.9	34
Pan		470.42		64.70	34.2	0
			TOTAL:	**189.4**	100.0	



Grain Size Distribution Curve

% Gravel: 0
% Sand: 66
% Fines: 34

D_{10}:
D_{30}:
D_{60}:

C_u:
C_c:

USCS Soil Classification: **Clayey SAND**

Client: Port of Greater Cincinnati Development Authority
Project: Proposed Development at Seymour Av.
Location: Seymour Avenue Cincinnati, OH
Project No: 16045A-41

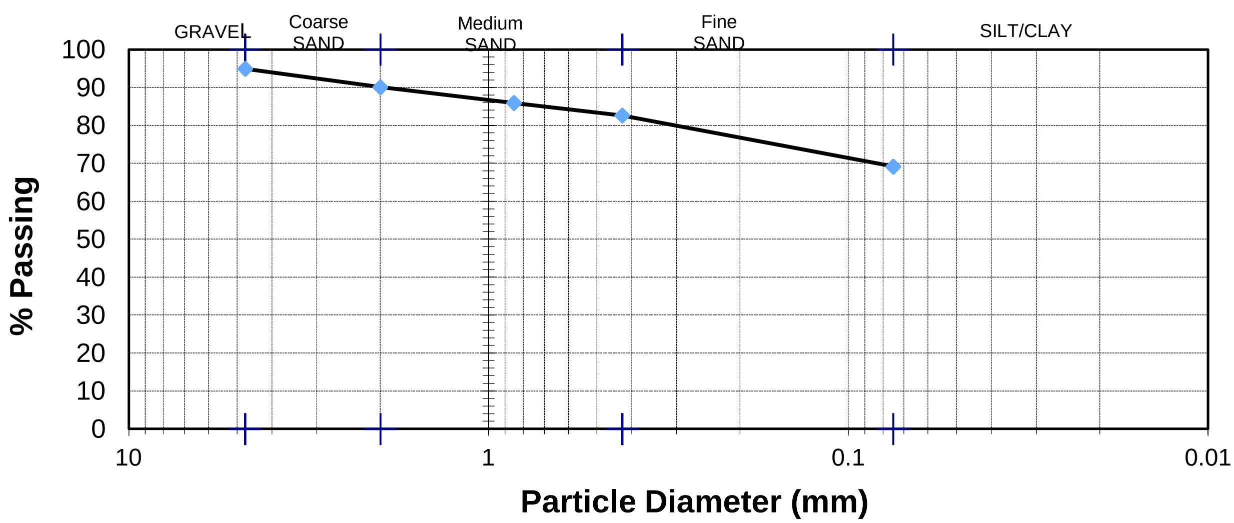
Tested by: M.E.
Date: 11/21/2016
Checked by M.E.
Date: 11/21/2016

Sieve Analysis Data Sheet

ASTM D422

Sample: B4-S3,S4 6'-7.5 , 8.5'-10.0'

Sieve Number	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve & Soil (g)	Soil Retained (g)	Soil Retained (%)	Soil Passing (%)
#4	4.75	462.6	470.84	8.24	5.0	95
#10	2.00	431.8	439.8	7.95	4.9	90
#20	0.85	622.94	629.8	6.82	4.2	86
#40	0.43	552	557.4	5.37	3.3	83
#200	0.075	493.59	515.6	21.99	13.5	69
Pan		470.42		112.88	69.1	0
			TOTAL:	**163.25**	100.0	



Grain Size Distribution Curve

% Gravel:	5	**D_{10}:**		**C_u:**	
% Sand:	26	**D_{30}:**		**C_c:**	
% Fines:	69	**D_{60}:**			

USCS Soil Classification: **Lean Clay with SAND**

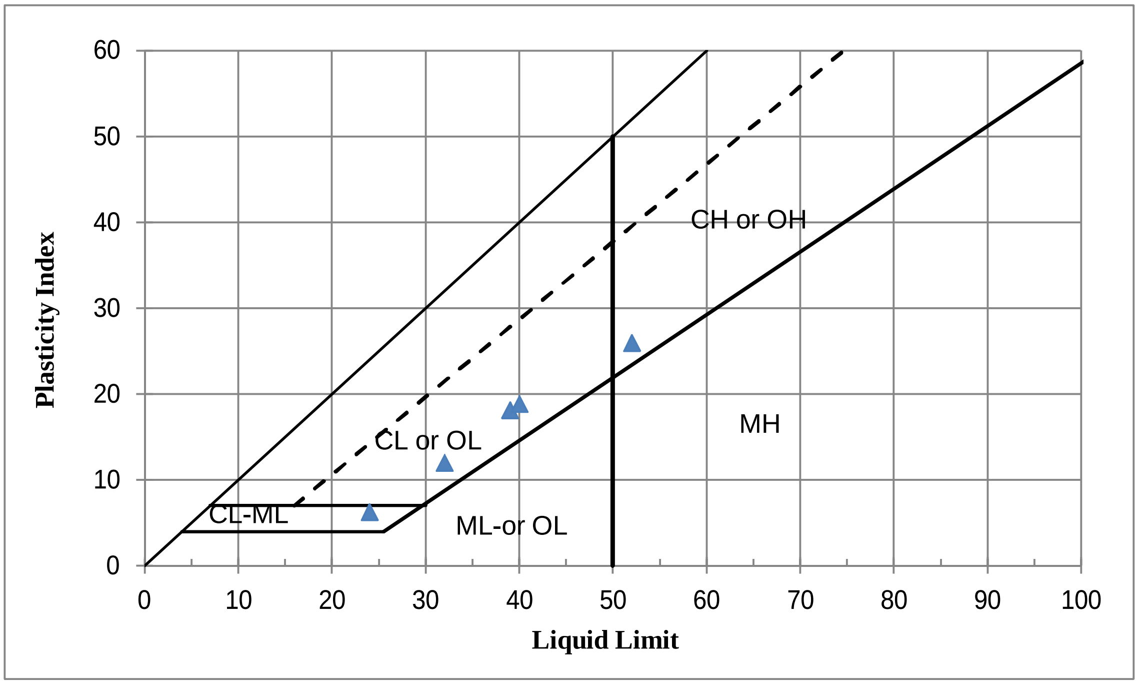
INFRASTRUCTURE DEVELOPMENT ENGINEERING

- Civil Engineering
- Land Surveying
- Environmental
- Geotechnical
- Materials Testing
- Construction Inspection

Client: Port of Greater Cincinnati Development Authority
Project: Proposed Development at Seymour Av.
Location: Seymour Avenue Cincinnati, OH
Project No: 16045A-41

Date: 11/23/2016

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils ASTM D4318



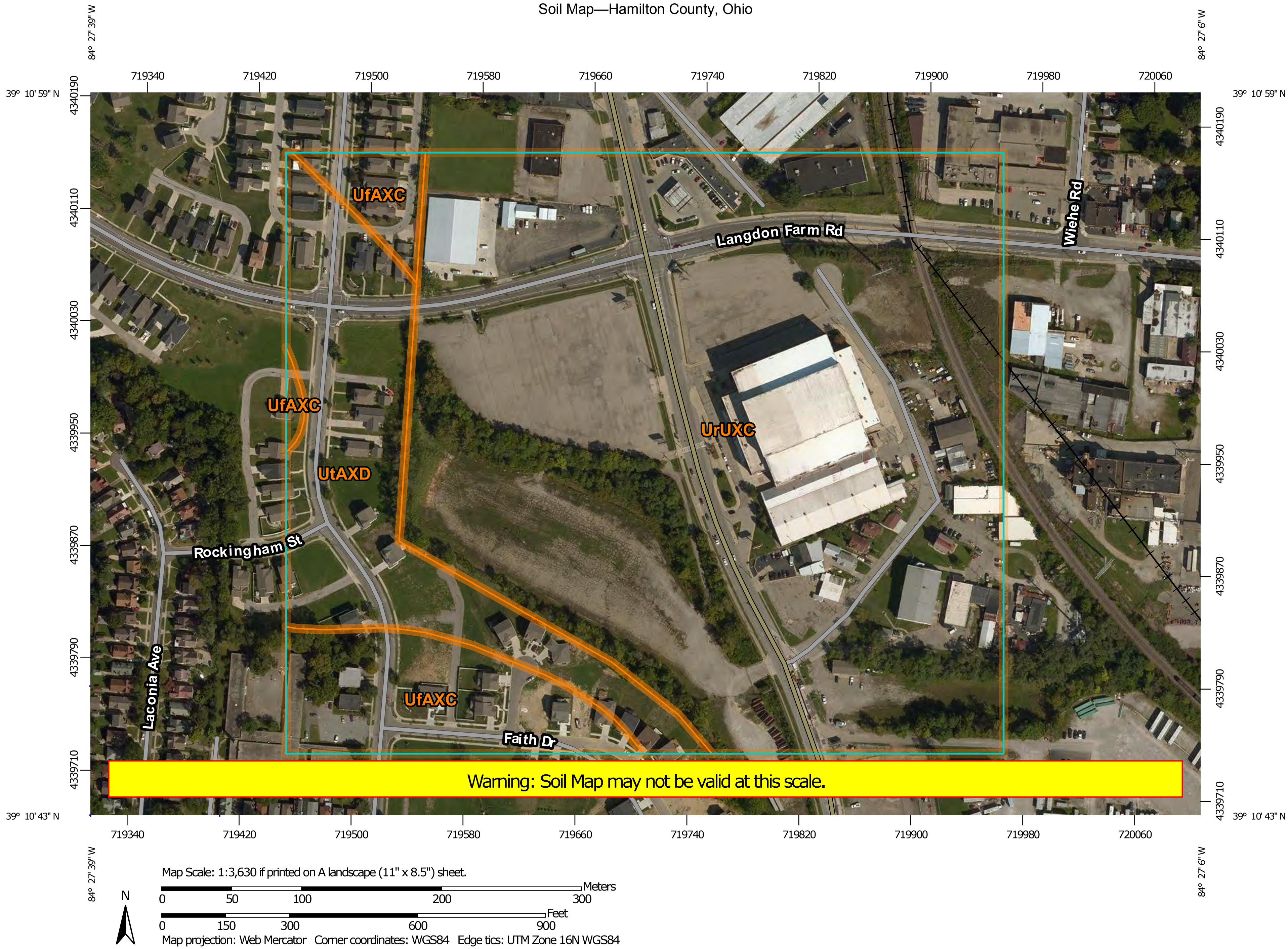
Sample No., depth	Description	LL %	PL %	PI %	% pass. #40	USCS
B-1, S-2, S-3 3.5'-7.5'	BRN Sandy Lean CLAY	39	21	18	-	CL
B-2, S-2, S-3 3.5'-7.5'	BRN Clayey SAND	40	21	19	-	CL
B-4, S-3, 6.0'-7.5'	BRN Sandy CLAY	32	20	12	-	CL
B-5, S-3, 6.0'-7.5'	BRN Lean Clay with SAND	24	18	6	-	CL
B-6, S-3, 6.0'-7.5'	BRN sandy clay	52	26	26	-	CH

Approved M.E.

INFRASTRUCTURE & DEVELOPMENT ENGINEERING, INC.

APPENDIX D

PROJECT AREA SOIL SURVEY RESULTS
(USDA NRCS)


84° 27' 39" W
84° 27' 6" W
39° 10' 59" N
39° 10' 43" N
719340
719420
719500
719580
719660
719740
719820
719900
719980
720060
4340190
4340110
4340030
4339950
4339870
4339790
4339710
UfAXC
UfAXC
UtAXD
UrUXC
UfAXC
Langdon Farm Rd
Wiehe Rd
Rockingham St
Laconia Ave
Faith Dr
Warning: Soil Map may not be valid at this scale.
Map Scale: 1:3,630 if printed on A landscape (11" x 8.5") sheet.
Meters
0 50 100 200 300
Feet
0 150 300 600 900
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Hamilton County, Ohio
Survey Area Data: Version 15, Sep 29, 2015

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

Date(s) aerial images were photographed: Aug 26, 2014—Oct 26, 2014

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

Map Unit Legend

Hamilton County, Ohio (OH061)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
UfAXC	Urban land-Alfic Udarents complex, fragipan substratum over till, 0 to 12 percent slopes	5.5	10.1%
UrUXC	Urban land-Udorthents complex, 0 to 12 percent slopes	40.5	74.4%
UtAXD	Urban land-Alfic Udarents complex, loamy substratum over till, 12 to 25 percent slopes	8.4	15.5%
Totals for Area of Interest		**54.4**	**100.0%**

Engineering Properties

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Report—Engineering Properties

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Hamilton County, Ohio														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
UfAXC—Urban land-Alfic Udarents complex, fragipan substratum over till, 0 to 12 percent slopes														
Alfic udarents	35	D	0-23	Silt loam, loam, silty clay loam	CL	A-6	0- 0- 0	0- 0- 0	97-100-100	94-100-100	87-99-100	80-94-100	30-38-45	15-20-25
			23-39	Silty clay loam, loam, clay loam	CL	A-6	0- 0- 0	0- 0- 0	96-97-99	87-91-97	79-91-97	61-76-89	34-40-50	16-21-29
			39-63	Loam, clay loam	CL	A-7-6	0- 0- 0	0- 0- 0	93-94-99	81-87-97	73-87-97	58-74-89	34-42-50	16-23-29
			63-80	Loam, clay loam	CL	A-7-6	0- 0- 0	0- 0- 0	92-92-97	80-83-94	72-83-94	58-71-87	34-42-50	16-23-29

Engineering Properties–Hamilton County, Ohio														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
UtAXD—Urban land-Alfic Udarents complex, loamy substratum over till, 12 to 25 percent slopes														
Alfic udarents	40	D	0-41	Clay, silty clay, silty clay loam, clay loam	CH	A-7-6	0- 0- 0	0- 0- 0	96-97-100	91-94-100	82-93-100	74-90-100	46-60-70	25-36-44
			41-80	Loam, clay loam	CL	A-7, A-7-6	0- 1- 2	0- 1- 2	97-98-100	87-95-100	73-87-100	54-68-83	31-43-50	13-24-29

Data Source Information

Soil Survey Area: Hamilton County, Ohio
Survey Area Data: Version 15, Sep 29, 2015

Dwellings and Small Commercial Buildings (OH)

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. This table shows the degree and kind of soil limitations that affect dwellings with and without basements and small commercial buildings. The ratings in the table are both verbal and numerical.

Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Dwellings are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of about 7 feet. The ratings for dwellings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Compressibility is inferred from the Unified classification. The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Small commercial buildings are structures that are less than three stories high and do not have basements. The foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. The ratings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (which is inferred from the Unified classification). The properties that affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Report—Dwellings and Small Commercial Buildings (OH)

[Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The table shows only the top five limitations for any given soil. The soil may have additional limitations]

Dwellings and Small Commercial Buildings (OH)–Hamilton County, Ohio							
Map symbol and soil name	Pct. of map unit	Dwellings without basements (OH)		Dwellings with basements (OH)		Small commercial buildings (OH)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
UfAXC—Urban land-Alfic Udarents complex, fragipan substratum over till, 0 to 12 percent slopes							
Urban land	55	Not rated		Not rated		Not rated	
Alfic udarents	35	Somewhat limited		Very limited		Somewhat limited	
		Depth to saturated zone	0.93	Depth to saturated zone	1.00	Depth to saturated zone	0.93
		Shrink-swell	0.50	Shrink-swell	0.50	Slope	0.81
						Shrink-swell	0.50
UrUXC—Urban land-Udorthents complex, 0 to 12 percent slopes							
Urban land	60	Not rated		Not rated		Not rated	
Udorthents	40	Not rated		Not rated		Not rated	
UtAXD—Urban land-Alfic Udarents complex, loamy substratum over till, 12 to 25 percent slopes							
Urban land	55	Not rated		Not rated		Not rated	
Alfic udarents	40	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	1.00	Slope	1.00
		Slope	1.00	Slope	1.00	Shrink-swell	1.00
		Slippage	0.50	Slippage	0.50	Slippage	0.50

Data Source Information

Soil Survey Area: Hamilton County, Ohio
Survey Area Data: Version 15, Sep 29, 2015