Geotechnical Engineering Report

Dirksen Elementary School Annex
Chicago, Illinois
November 2, 2018
Terracon Project No. MR185289

Prepared for:
Public Building Commission of Chicago
Chicago, Illinois

Prepared by:
Terracon Consultants, Inc.
Glendale Heights, Illinois

November 2, 2018

Public Building Commission of Chicago
50 West Washington Street, Room 200
Chicago, Illinois 60602

Attn: Mr. Miguel Fernandez
P: 312.744.7861
E: Miguel.Fernandez@cityofchicago.org

Re: Geotechnical Engineering Report
Dirksen Elementary School Annex
8601 West Foster Avenue
Chicago, Illinois
Terracon Project No. MR185289

Dear Mr. Fernandez:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PMR185289 dated September 28, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

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.

Nicholas L. Hussey, P.E. (IA)
Project Engineer

Tony A. Kiefer, P.E.
Senior Engineer

REPORT TOPICS

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Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION
EXPLORATION PLAN
EXPLORATION RESULTS
SUPPORTING INFORMATION

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Description	Three-story addition to the existing school 61,000 square foot structure Max. Column loads: 450 kips, Max. Wall loads: 20 kips per lineal foot Little excavation other than over-excavations for foundation construction Light-duty traffic expected for pavement areas
Geotechnical Characterization	Existing fill up to about 8 feet deep Lean clays and silts to about 50 feet Groundwater encountered in three borings at depths of about 3 to 7 feet
Earthwork	Remove existing fill where encountered below footings Remove a portion of existing fill below slabs and pavements Existing lean clays can be reused for structural fill Clays are sensitive to moisture variation
Shallow Foundations	Shallow foundations may be used at this site Allowable bearing pressure = 4,000 psf Expected settlements: <3/4 inch total Remove and replace existing fill as noted
Deep Foundations	Belled drilled shafts may be used at this site Allowable end bearing resistance of 12,000 psf Skin friction not considered for axial support
Pavements	With subgrade prepared as noted in **Earthwork**. Concrete: ■ 5 inches PCC in passenger vehicle parking areas ■ 6 inches PCC in bus lanes and driveway areas Asphalt: ■ 4 inches ACC over 6 inches granular base in passenger vehicle parking areas ■ 5.5 inches ACC over 6 inches granular base in bus lanes and driveway areas
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report
Dirksen Elementary School Annex
8601 West Foster Avenue
Chicago, Illinois
Terracon Project No. MR185289
November 2, 2018

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed addition to Dirksen Elementary School located at 8601 West Foster Avenue in Chicago, Illinois. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Demolition considerations
- Excavation considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Pavement design and construction
- Frost considerations

The geotechnical engineering scope of services for this project included the advancement of ten test borings to depths ranging from approximately 10 to 50 feet below existing site grade.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and as a separate graph in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available aerial imagery.

Item	Description
Parcel Information	8601 West Foster Avenue in Chicago, Illinois See **Site Location**

Item	Description
Existing Improvements	Existing elementary school building Two mobile classroom buildings to the south of the main school building Paved parking area south of the existing school Subsurface utilities
Current Ground Cover	Asphalt pavement within the planned addition footprint Bare earth/topsoil in part of the planned parking area
Existing Topography	Relatively flat

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our current understanding of the project conditions is as follows:

Item	Description
Proposed Structure	Three-story annex with a planned footprint of about 61,000 square feet. The annex will be connected to the existing school building.
Building Construction	Steel frame or load-bearing masonry walls Slab-on-grade
Finished Floor Elevation	Not provided, but anticipated to match the existing school
Loads (provided by Stearn-Joglekar)	■ Columns: 260 to 450 kips ■ Walls: 10 to 20 kips per linear foot (klf) ■ Slabs: 100 pounds per square foot (psf)
Grading (assumed)	Cuts and fills of less than about 3 feet are anticipated
Below-Grade Structures	None
Pavements	Paved driveway and parking will be constructed. We assume both rigid (concrete) and flexible (asphalt) pavement sections will be considered.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Surficial	Asphalt and topsoil
2	Existing Fill	Mix of sand and sandy lean clay, with occasional zones of lean to fat clay
3	Lean Clay	Lean clay, trace sand and gravel, including lean to fat clay in B-3
4	Silt	Silt and lean to silty clay, trace gravel, with a zone of silty sand in B-3
5	Glacial Soils	Sandy lean clay, trace gravel and occasional sand seams

Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in the **Exploration Results** section.

These water level observations provide an approximate indication of the groundwater conditions existing on the site at the time the observations were made. Free water was not encountered in most borings but shallow perched water (from 3 to 6 feet) was encountered in three borings. This shallow water is indicative of a perched condition where water collects in more granular fill material and becomes trapped above low permeable clay soils. Due to the lower permeability of the soils encountered in the borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Longer-term observations using cased holes or piezometers, sealed from the influence of surface water, would be required for a better evaluation of the groundwater conditions on this site. Also, based on changes in soil color, we estimate the long-term water level at the site could be on the order of 6 feet below grade.

Groundwater level fluctuations 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. Also, trapped or “perched” water could be present within the sand or silt seams within native clay soils and/or in cohesionless soils (fill and native) above lower permeability clay soil layers. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

Existing and possible fill materials were encountered in each of the soil borings performed for the addition. The fill materials extended to depths of about 5 to 8 feet in the borings and could be present to deeper depths in other locations on site. The fill was variable in composition (including wood pieces in boring B-5) and does not appear to have been placed as structural fill. It is our opinion that these materials are not suitable for direct support of new foundations. Medium strength clays may also be encountered below the existing fill in some of the borings.

The loads for the addition are relatively high and may result in relatively large shallow foundation dimension. This report presents alternatives for supporting the addition on either shallow foundations following overexcavation and backfilling of unsuitable materials or on belled drilled shaft foundations extending into stiff to hard native clay soils. These recommendations are provided in the **Shallow Foundations** and **Deep Foundation** sections, respectively.

Provided PBC accepts some risk of poor performance, stable portions of the existing fill could be left in place below slabs and pavements. The **Earthwork** section provides recommendations for establishing a zone of controlled structural fill below slabs and pavements to help reduce the risk of poor performance. Additional recommendations for subgrade preparation are also presented in the **Floor Slabs** and **Pavements** sections.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include foundation excavations and general grading for floor slabs and pavements. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include quality criteria necessary to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

The existing pavement section should be removed prior to any earthwork, and the topsoil/root zone should be removed where present near the existing mobile classrooms and the landscaped area to the south of the current parking lot.

Rough grading to remove a portion of the existing and possible fill materials should be conducted within the annex footprint and the new parking area to a depth necessary to establish the subgrade. After completing these operations, the exposed subgrade should be thoroughly proofrolled (under the observation of Terracon personnel) with a loaded tandem-axle dump truck, or other heavy, rubber-tired construction equipment weighing at least 20 tons, to locate any zones that are soft or unstable. Where excessive rutting or pumping occurs during proofrolling, the exposed subgrade should be removed and replaced or scarified/reworked and recompacted in place to our recommendations for structural fill (see below for details) prior to the placement of new fill.

Existing Fill

As noted in **Geotechnical Characterization**, the borings encountered existing and possible fill to depths ranging from about 5 to 8 feet below existing grades. Based on the variability in the SPT blow counts, material composition, and the moisture contents, it is our opinion that the fill was not placed as structural fill with consistent control of moisture and density. If PBC accepts an increased risk of poor slab/pavement performance in exchange for reduced initial construction costs, stable portions of the existing fill could be left in place below slabs and pavements.

Support of floor slabs and pavements on or above existing fill soils, is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but can be reduced by following the recommendations contained in this report.

Demolition Considerations

It is important that the demolition of the existing mobile classrooms and other improvements be performed with close observation and testing. Any unsuitable fill and lower strength native materials should also be removed at this time. The new parking area will likely be supported on the new fill placed in the demolition excavations. The demolition contractor should be aware of project requirements for backfilling so that removal of these fill materials and replacement under controlled conditions is not necessary upon construction of the new pavements.

Fill Material Types

Earthen materials used for structural fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Locations for Placement
On-site soils	CL, CL/CH, CL/ML, ML, SC, SM	The on-site soils typically appear suitable for reuse as fill.
Low plasticity cohesive [2]	CL-ML, CL, ML	General site grading fill More than 6 inches below finished subgrade
Granular	GW, GP, GM, GC SW, SP, SM, SC	General site grading fill Below foundations
Unsuitable	MH, OL, OH, PT	Green (non-structural) locations

Fill Type [1]	USCS Classification	Acceptable Locations for Placement

1. Structural fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation prior to use on this site.
2. Suitable low plasticity cohesive soil would have a liquid limit less than 45 and a plasticity index of less than 23.

Fill Compaction Requirements

Structural fill should meet the following compaction requirements.

Item	Description
Maximum Fill Lift Thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements [1, 2, 3]	95% below foundations and within 1 foot of finished pavement subgrade 90% above foundations, below floor slabs, and more than 1 foot below finished pavement subgrade
Moisture Content Range [1]	Low plasticity cohesive: -2% to +3% Granular: -3% to +3%

1. As determined by the modified Proctor test (ASTM D 1557).
2. Lean to fat clay and fat clay should not be compacted to more than 100 percent of standard Proctor maximum dry density.
3. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254).

Grading and Drainage

All grades must provide effective drainage away from the addition during and after construction and should be maintained throughout the life of the structure. Water retained next to the addition can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge into a storm sewer, onto pavement or splash blocks at a distance of at least 5 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the addition for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of Terracon. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by Terracon prior to placement of additional lifts. Each lift of fill should be tested for density and water content.

In addition to the documentation of the essential parameters necessary for construction, the continuation of Terracon into the construction phase of the project provides the continuity to maintain Terracon's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

The proposed addition to Dirksen Elementary School Existing could be supported on shallow foundations after an overexcavation and backfill procedure to replace existing/possible fill materials and zones of medium strength native soils. Existing and possible fill was encountered in each of the six borings performed within the planned footprint and extended to depths ranging from about 5 to 8 feet below the existing grades. The fill was variable in composition and does not appear to have been placed as structural fill, and we recommend that all foundations extend through the fill to suitable stiff to hard native clay soils. The foundation excavations should be backfilled with either lean concrete or a compacted granular material such as crushed concrete, or crushed stone graded to IDOT Gradation CA6, or other granular material approved by the geotechnical engineer.

Medium strength native soils were encountered in borings B-1, B-3, and B-5 to depths of about 8 to 11 feet below existing grade, and could be encountered at other locations not directly explored. Additional overexcavation of these lower strength soils is recommended at these locations to establish a suitable bearing subgrade for new foundations.

As an alternative to supporting the addition on shallow foundations following overexcavation and backfill of unsuitable materials, the addition may be supported on a series of belled drilled shafts extending into the underlying stiff to hard native clays. Recommendations for these foundations are provided in the **Deep Foundations** section.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing pressure [1, 2]	4,000 psf
Required Bearing Stratum [3]	Very stiff native clays, or Lean concrete or compacted granular fill extending to suitable native clays
Minimum Foundation Dimensions	Columns: 30 inches Continuous: 18 inches
Ultimate Passive Resistance [4] **(equivalent fluid pressures)**	290 pcf (cohesive backfill) 360 pcf (granular backfill)
Ultimate Coefficient of Sliding Friction [5]	0.30 (native clay) 0.40 (granular material)
Minimum Embedment below Finished Grade for Frost Protection	Exterior footings in heated areas: 42 inches
Estimated Total Settlement from Structural Loads [2]	Less than 3/4 inch
Estimated Differential Settlement [2, 7]	About 1/2 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in the **Earthwork**.

Item	Description
4.	Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
5.	Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.

Construction Adjacent to Existing Building

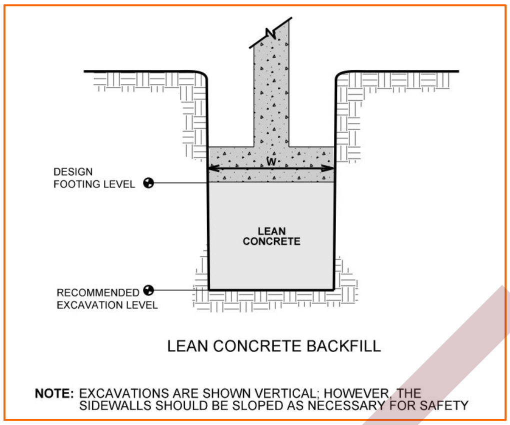
Differential settlement between the addition and the existing building could approach the magnitude of the total settlement of the addition. Underground piping between the two structures should be designed with flexible couplings and utility knockouts in foundation walls should be oversized so minor deflections in alignment do not result in breakage or distress. Care should be taken during excavation adjacent to existing foundations to avoid disturbing existing foundation bearing soils.

New footings should bear at or near the bearing elevation of immediately adjacent existing foundations. Depending upon their locations and current loads on the existing footings, footings for the new addition could cause settlement of adjacent walls. To reduce this concern and risk, clear distances at least equal to the new footing widths should be maintained between the addition's footings and footings supporting the existing building.

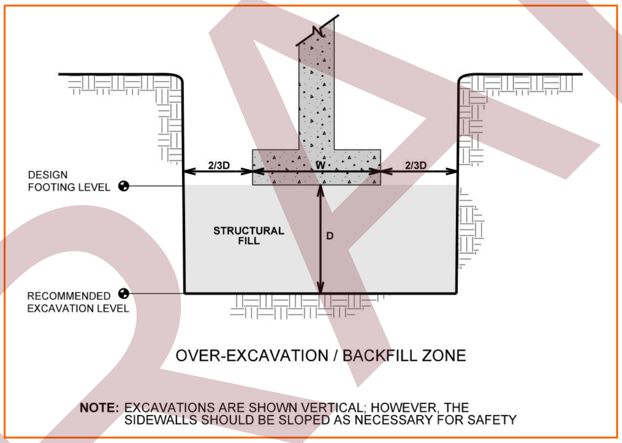
Foundation Construction Considerations

As noted in the **Earthwork** section, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If existing fill or other unsuitable bearing soils (medium strength clays) are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.



Overexcavation for structural fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the design footing level with compacted crushed limestone or other approved granular material placed as recommended in the **Earthwork** section.



DEEP FOUNDATIONS

Drilled Shaft Design Parameters

As mentioned in the **Geotechnical Overview**, belled drilled shaft foundations may be used to support the new addition to Dirksen Elementary School. We estimate that 2.5-foot diameter belled drilled shafts with preliminary bell diameters of about 7 feet may be utilized. Based on the information from the borings, a maximum net allowable end bearing pressure of 12,000 pounds per square foot (psf) can be used for belled shafts bearing on the native very stiff to hard lean clay soils at depths of roughly 12 to 15 feet below existing grade. The maximum net allowable soil bearing pressure is that pressure which may be transmitted to the foundation soils in excess of the minimum surrounding overburden pressure. This pressure may be increased by 1/3 for load combinations including intermittent loads, such as wind.

Tensile reinforcement should extend to the bottom of shafts subjected to uplift loading. Buoyant unit weights of the soil and concrete should be used in the calculations below the highest anticipated groundwater elevation.

A minimum shaft diameter of 30 inches should be used. Concrete may be poured into clean and dry shafts by the free-fall method. Concrete slump for free-fall concrete should be in the range of 5 to 7 inches.

Post-construction settlements of drilled shafts designed and constructed as described in this report are estimated to range from about ½ to ¾ inch. Differential settlement between individual shafts is dependent on the range of loading in adjacent shafts in addition to soil variation. Differential settlement is typically up to ½ the total settlement. These settlement estimates are for soil compression only; elastic settlement of the shaft concrete should be added to this value.

Drilled Shaft Lateral Loading

The following table lists input values for use in LPILE analyses. LPILE estimates values of k_h and E_{50} based on strength; however, non-default values of k_h should be used where provided. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Stratigraphy [1]		L-Pile Soil Model	S_u (psf) [2]	f [2]	g (pcf) [2,3]	ε_{50} [2]	K (pci) [2]
No.	**Material**						**Static**
2	Existing Fill	Soft Clay	100	---	115	0.023	10
3	Lean to Fat Clay	Soft Clay	750	---	130	0.012	135
3	Lean Clay	Stiff Clay w/o Free Water	3,000	---	130	0.005	1030

1. See **Subsurface Profile** in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   - S_u: Undrained shear strength
   - f : Internal friction angle,
   - g: Moist unit weight
   - ε_{50}: Non-default E50 strain
   - K: Horizontal modulus of subgrade reaction
   - q_u: Non-default soil modulus – static. Refer to software guidelines for cyclic loading.
3. Buoyant unit weight values should be used below water table.

The shafts should be spaced at least three shaft diameters apart (center-to-center) if they will be used to resist lateral loads. Pile caps and/or grade beams could be subject to uplift loading due to frost action; thus, perimeter foundation elements beneath unheated areas should extend at least 4 feet below the lowest adjacent finished grade for frost protection.

The load capacities provided herein are based on the stresses induced in the supporting soil strata. The structural capacity of the shafts/piles should be checked to assure they can safely accommodate the combined stresses induced by axial and lateral forces. Lateral deflections of shafts/piles should be evaluated using an appropriate analysis method, and will depend upon the pile's diameter, length, configuration, stiffness and "fixed head" or "free head" condition. We can provide additional analyses and estimates of lateral deflections for specific loading conditions upon request. The load-carrying capacity of shafts/piles may be increased by increasing the diameter and/or length.

Drilled Shaft Construction Considerations

To limit the potential problems with drilled shaft installation, we recommend that an experienced technician with Terracon be on site to make decisions on the belling elevation. To limit problems, caissons should be completed and poured as quickly as possible with concrete waiting on site as the bell is completed. If bell wall instability problems occur, longer casing or the "grout bell" technique may be necessary to complete the bell.

As noted previously, for shafts bearing at a depth of about 12 to 15 feet below existing grade, belling is expected to occur in predominantly stiff to hard clay soils, but occasional zones containing a higher percentage of sandy or silty material could be encountered. Isolated seams of silty or sandy material, if encountered, may contain perched water. To limit the possibility of water infiltration, concrete should be on-site and placed immediately after the bell is completed.

We recommend temporary casing be used when the drilled shafts are installed through the existing fill materials. Temporary casing would need to extend a few feet into the underlying native lean clay to create a seal against soil caving and possible ground water seepage.

If the predominantly clay fill soils are found to stand without caving in an open excavation, the "pour and pull" casing procedure may also be considered. In this method, no permanent corrugated liner is needed. After the concrete is poured in the excavation to a level above the cut-off level, the casing can then be pulled to a point just above the cut-off level. Care must be exercised in this method to ensure the concrete level lowers after the casing is pulled. If the fluid concrete level rises, it is an indication that water or soil intrusion has occurred and the concrete should be mucked out and be re-poured. Concrete slump should be in the range of 7 to 9 inches for a "pour and pull" procedure. Casings must be clean. After the concrete has set for at least 6 hours, the top of the shaft can be backfilled with sand to protect the rebar cage and the casing remaining above the cut-off level can then be pulled from the hole.

We recommend that all belled shaft construction be observed on a full-time basis by a Terracon representative to check that the soils encountered are consistent with the recommended design parameters. The belled shaft contractor should also be required to submit proposed installation procedures, past projects of a similar nature, a resume of their superintendent, and a complete list of equipment that will be used on the job. It is recommended that these procedures and equipment list be submitted to the owner and design team so that they can be reviewed and approved at a pre-bid meeting held in advance of bidding and award of the contract.

Although not encountered in the borings, shallow obstructions may be encountered during construction. The contractor should be prepared to deal with buried concrete, debris, or other types of obstructions while drilling for shafts. Depending on the size, depth, and thickness of obstruction, construction delays can occur and therefore, appropriate contingencies for costs should be planned. Pot-holing at each caisson location in advance of caisson construction is recommended to confirm that the locations are clear of shallow obstructions.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is C**. Subsurface explorations at this site were extended to a maximum depth of 50 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

FLOOR SLABS

As discussed in the **Geotechnical Overview**, existing fill materials are expected to be encountered at the floor slab subgrade level. We recommend that at least 6 inches of controlled structural fill be present at the finished subgrade level below floor slabs where existing fill is left in place.

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	Minimum 6 inches of free-draining (less than 3% passing the U.S. No. 200 sieve) crushed aggregate compacted to at least 90% of ASTM D 1557 [2]
Estimated Modulus of Subgrade Reaction [2]	100 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted, but could be larger than normal and result in some cracking. Mitigation measures noted in **Existing Fill** within the **Earthwork** section are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade within and for at least 10 feet beyond the floor slab should be protected from traffic, rutting, or other disturbances and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site, which has been prepared as recommended in the **Earthwork** section. As discussed in this report, we recommend that at least 12 inches of controlled structural fill be present at the finished subgrade level in pavement areas where truck or bus traffic is expected. At least 6 inches of new fill is recommended in other areas.

Pavement Design Parameters

Traffic load information was not available at the time of this report; therefore, a formal pavement design is not provided. Some typical pavement sections are provided below. Asphaltic cement concrete pavement thicknesses are based on the Illinois Asphalt Pavement Association (IAPA) Parking Lots guide and local design practice. Portland cement concrete thicknesses are based on the American Concrete Institute (ACI) ACI 330R-08 – Guide for the Design and Construction of Concrete Parking Lots. Thickness recommendations for ***Passenger Vehicle Parking*** sections are based on light passenger vehicle (gross weight less than 4 tons) traffic only, and only occasional truck traffic such as snow removal trucks (IAPA light duty – less than 1,500 vehicles per day (vpd) and less than 2% trucks, ACI Traffic Category A). As part of the layout design of the project we recommend the designer use signs and preventive structures to restrict heavy truck traffic from entering these areas. The ***School Bus Lanes, Driveways & Truck Access*** sections are based on less than 25 trucks per day (IAPA moderate duty – up to 3,000 vpd and less than 5% trucks, ACI Traffic Category B).

As a minimum, we suggest the following typical pavement sections be considered.

Traffic Area	Alternative	Recommended Pavement Section Thickness [1] (inches)			
		Asphaltic Cement Concrete [3]	Portland Cement Concrete	Aggregate Base Course	Total
Passenger vehicle parking	PCC	---	5	4 [4]	9
	ACC	4	---	6	10

Traffic Area	Alternative	Recommended Pavement Section Thickness [1] (inches)			
		Asphaltic Cement Concrete [3]	Portland Cement Concrete	Aggregate Base Course	Total
School bus lanes, driveways & truck access [2]	PCC	---	6	4 [4]	10
	ACC	5.5	---	6	11.5

1. All materials should meet the current Illinois Department of Transportation (IDOT) Standard Specifications for Highway and Bridge Construction.
   - Asphaltic Surface/Binder - IDOT Asphaltic Cement Concrete: Section 406
   - Concrete Pavement - IDOT Portland Cement Concrete: Section 420
2. In areas of anticipated heavy traffic, fire trucks, delivery trucks, or concentrated loads (e.g. dumpster pads), and areas with repeated turning or maneuvering of heavy vehicles, a minimum concrete thickness of 7 inches is recommended but should be evaluated further when loading conditions are known.
3. A minimum 1.5-inch surface course should be used on ACC pavements.
4. A 4-inch (or greater) granular base is recommended below PCC pavements to help reduce potential for slab curl, shrinkage cracking, and subgrade “pumping” through joints, unless the subgrades are stabilized with hydrated lime or Class C fly ash.

- California Bearing Ratio: 3 percent
- Modulus of subgrade reaction for compacted soil subgrade: 100 pci;

The above sections represent minimum design thicknesses and, as such, periodic maintenance should be anticipated. The Portland cement concrete pavement should have a minimum 28-day compressive strength of 4,000 psi.

The estimated pavement sections provided in this report are minimums for the assumed design criteria, and as such, periodic maintenance should be expected. Areas for parking of heavy vehicles, concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. Edge restraints (i.e. concrete curbs or aggregate shoulders) should be planned along curves and areas of maneuvering vehicles. A maintenance program that includes surface sealing, joint cleaning and sealing, and timely repair of cracks and deteriorated areas will increase the pavement’s service life. As an option, thicker sections could be constructed to decrease future maintenance.

Terracon has observed dishing in some parking lots surfaced with ACC. Dishing is usually observed in frequently-used parking stalls (such as near the front of buildings), and occurs under the wheel footprint in these stalls. The use of higher-grade asphaltic cement, or surfacing these areas with PCC, should be considered. The dishing is exacerbated by factors such as irrigated islands or planter areas, sheet surface drainage to the front of structures, and placing the ACC directly on a compacted clay subgrade.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Consideration should be given to installing a pavement subdrain system to control subgrade moisture, improve stability, and improve long term pavement performance. If information regarding pavement subdrainage is desired, Terracon can provide further recommendations upon request.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%
- The subgrade and pavement surface should have a minimum 2% slope to promote proper surface drainage
- Install below pavement drainage systems surrounding areas anticipated for frequent wetting
- Install joint sealant and seal cracks immediately
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils
- Place compacted, low permeability backfill against the exterior side of curb and gutter; and

- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials

FROST CONSIDERATIONS

The soils on this site are frost susceptible, and small amounts of water can affect the performance of the slabs on-grade, sidewalks, and pavements. Exterior slabs should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible (NFS) fill or structural slabs (for instance, structural stoops in front of building doors). As an alternative to extending NFS fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS material.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations 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. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services 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.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

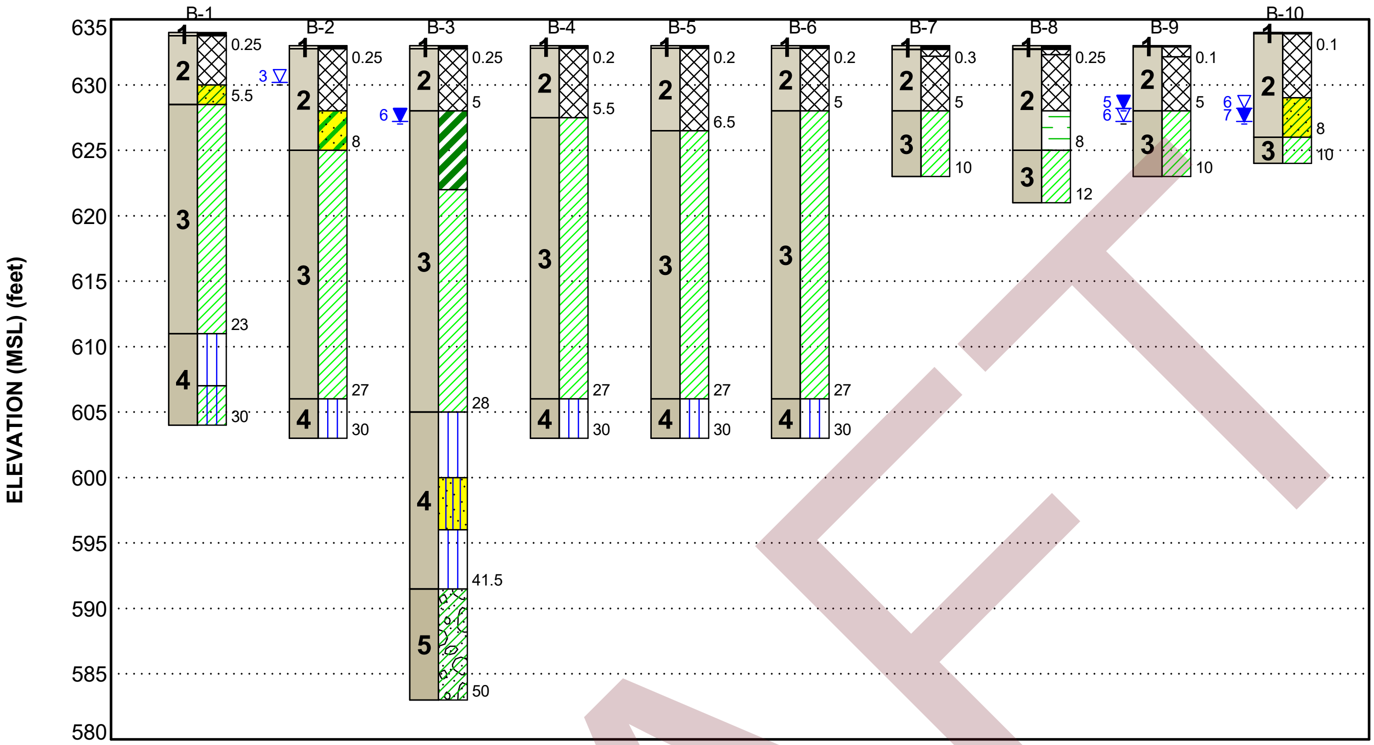
FIGURES

Contents:

GeoModel

GEOMODEL

Dirksen Elementary School Annex ■ Chicago, IL
11/2/2018 ■ Terracon Project No. MR185289



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Surficial**	Asphalt or topsoil
2	**Existing Fill**	Existing and possible fill - mix of sand and sandy lean clay, with occasional zones of lean to fat clay
3	**Lean Clay**	Lean clay, trace sand and gravel (with a zone of fat clay in B-3)
4	**Silt**	Silt and lean to silty clay, trace gravel, with a zone of silty sand in Boring B-3
5	**Glacial Soils**	Sandy lean clay, trace gravel and occasional sand seams

LEGEND

- Asphalt
- Fill
- Sandy Lean Clay
- Lean Clay
- Silt
- Silty Clay
- Clayey Sand
- Fat Clay
- Silty Sand
- Glacial Till
- Organic Lean Clay
- Topsoil

- First Water Observation
- Second Water Observation
- Final Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Location
1	50	Annex area
5	30	
4	10 to 12	Parking area

Boring Layout and Elevations: Terracon used handheld GPS equipment to locate borings with an estimated horizontal accuracy of +/-20 feet. Approximate elevations were obtained using a level and rod referenced to the Chicago City Datum benchmark #489 located on Berwyn Avenue to the east of North Cumberland Avenue (provided elevation = 53.779 feet).

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted rotary drill rig using continuous flight augers. Samples were obtained at 2.5-foot intervals in the upper 15 feet of each boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. The following tests were performed for this project.

- Water content
- Unit dry weight
- Unconfined compressive strength of soil
- Atterberg limits
- Organic content

Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

SITE LOCATION

Dirksen Elementary School Annex ■ Chicago, Illinois
November 2, 2018 ■ Terracon Project No. MR185289

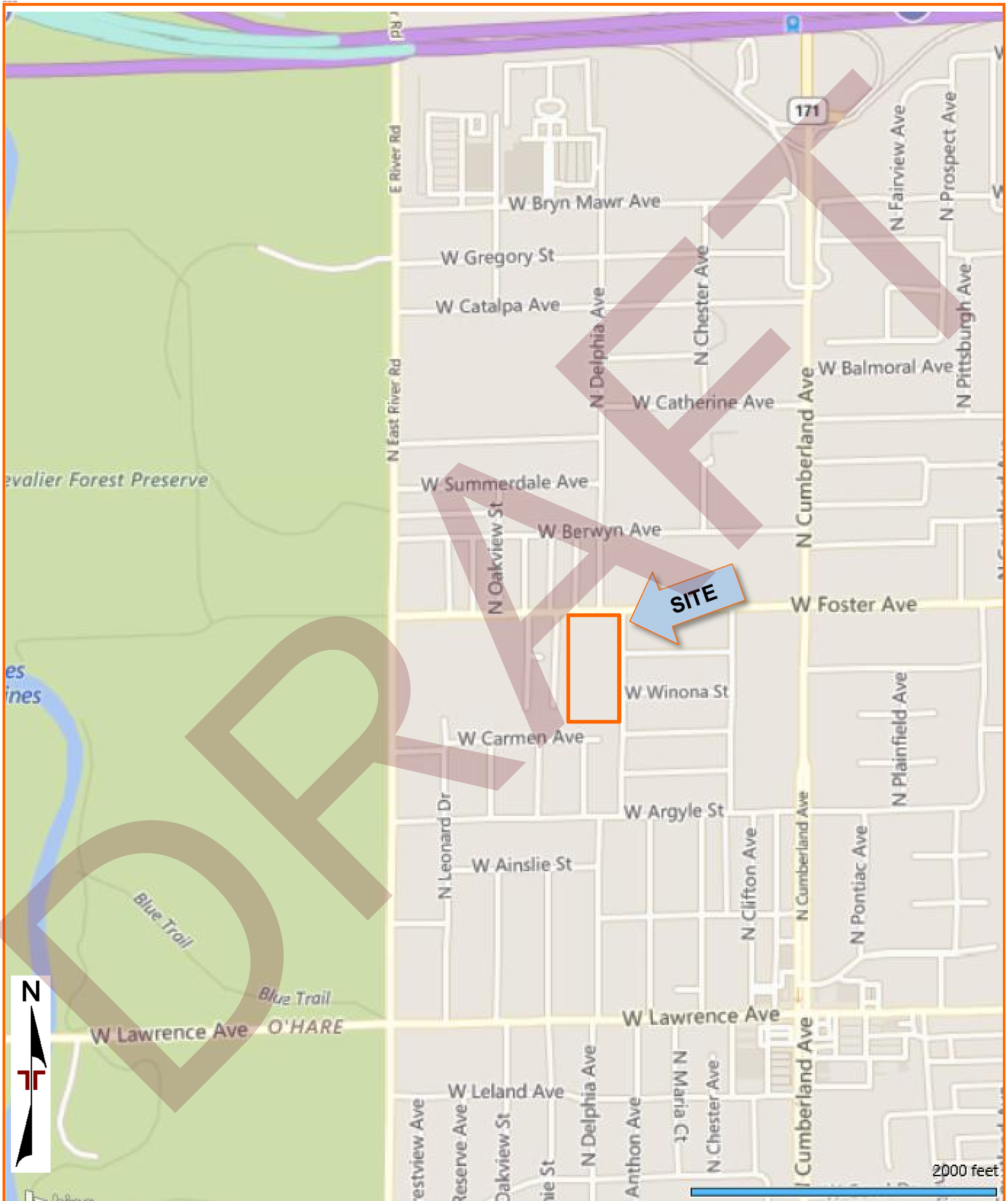


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Dirksen Elementary School Annex ■ Chicago, Illinois

November 2, 2018 ■ Terracon Project No. MR185289

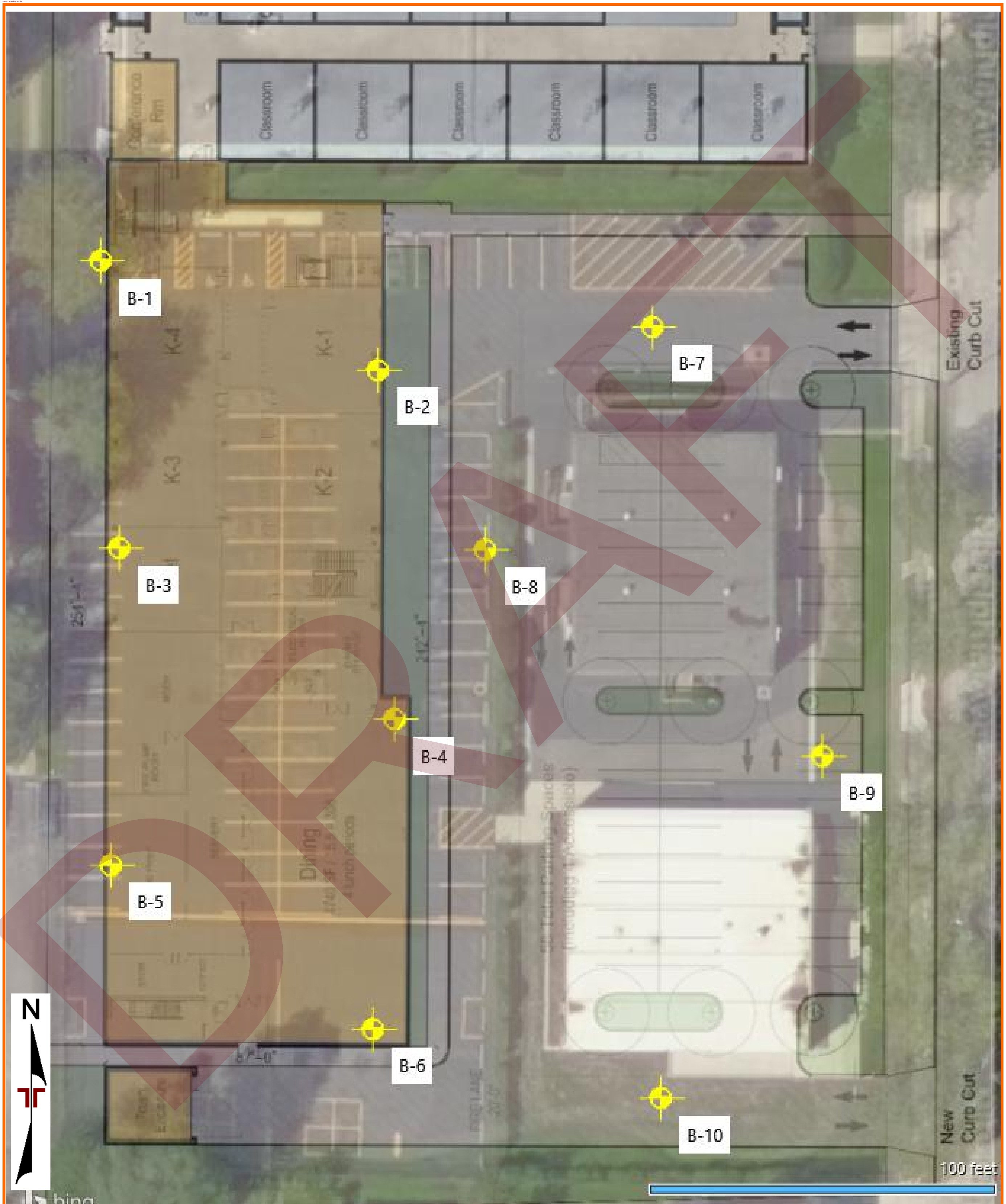


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Logs (B-1 through B-10
Atterberg Limits

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago
Chicago, IL

SITE: 8601 W.Foster Ave.
Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9727° Longitude: -87.842°
Northing: 1933032.99 Easting: 1117861.18

Surface Elev.: 634 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)
1	0.3	**3" Asphalt**	634
2	4.0	**FILL - MIX of SAND, CLAY, and GRAVEL**, dark brown and gray	630
2	5.5	**SANDY LEAN CLAY (CL)**, trace gravel and sand pockets (Possible Fill), brown and grayish brown, stiff	628.5
3	23.0	**LEAN CLAY (CL)**, trace sand and gravel, gray, medium stiff to very stiff	611
4	27.0	**SILT (ML)**, trace gravel, brown, very stiff	607
4	30.0	**LEAN CLAY to SILTY CLAY (CL/ML)**, trace sand and gravel, gray, very stiff to hard	604
		Boring Terminated at 30 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
1.0-2.5		X	8	2-4-7 N=11					15			
3.5-5.0		X	7	2-3-5 N=8	1.5 (HP)				16			
6.0-7.5		X	14	2-2-5 N=7	1.5 (HP)				18			
8.5-10.0		X	18	4-6-10 N=16	3.0 (HP)				19			
11.0-12.5		X	18	5-7-12 N=19	3.5 (HP)				19			
13.5-15.0		X	16	4-8-12 N=20	3.75 (HP)				20			
18.5-20.0		X	18	5-7-10 N=17	4.5 (HP)				24			
23.5-25.0		X	16	6-9-10 N=19	2.5 (HP)				15			
28.5-30.0		X	18	6-12-19 N=31	6.0 (HP)				17			

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not observed during drilling/sampling.

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-25-2018	Boring Completed: 10-25-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-2

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago
Chicago, IL

SITE: 8601 W.Foster Ave.
Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9726° Longitude: -87.8417°
Northing: 1933001.73 Easting: 1117941.69

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
1	0.3	**3" Asphalt**	633												
2		**FILL - SANDY LEAN CLAY**, trace gravel and organics, unusual odors, black and brownish gray				8	3-3-6 N=9					21			
					▽ (3')	8	1-2-3 N=5					19			
	5.0		628	5											
		CLAYEY SAND (SC), trace gravel (Possible Fill), fine to medium grained, brown, loose										24			
	8.0		625												
3		**LEAN CLAY (CL)**, trace sand and gravel, gray, stiff to hard				7	2-5-7 N=12	2.5 (HP)				18			
				10				2.75 (HP)	UC	4.98	9.9	20	112		
						16	5-7-10 N=17	3.0 (HP)				20			
				15											
						10	4-5-9 N=14	2.0 (HP)				22			
				20											
						18	3-5-9 N=14	2.5 (HP)				18			
	27.0		606	25											
4		**SILT (ML)**, trace gravel, gray, hard				18	5-20-40 N=60	4.5 (HP)				15			
	30.0	***Boring Terminated at 30 Feet***	603	30											

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

▽ *3' while drilling*

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-25-2018	Boring Completed: 10-25-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-3

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago
Chicago, IL

SITE: 8601 W.Foster Ave.
Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9725° Longitude: -87.842°
Northing: 1932950.08 Easting: 1117867.03

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)
1	0.3	**3" Asphalt**	633
2	5.0	**FILL - SANDY LEAN CLAY**, with sand and gravel pockets, trace organics, black to gray	628
3	11.0	**FAT CLAY (CH)**, trace sand, gray, medium stiff to soft	622
3	28.0	**LEAN CLAY (CL)**, trace sand and gravel, gray, very stiff	605
4		**SILT (ML)**, trace gravel, gray, hard	

SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
X	7	1-3-7 N=10					19			
X	7	2-3-3 N=6					28			
X	8	0-3-3 N=6	1.0 (HP)				33		54-18-36	
X	7	1-1-2 N=3	0.75 (HP)				32			
X	18	5-7-9 N=16	3.0 (HP)				21			
X	18	3-6-10 N=16	2.75 (HP)				22			
X	16	7-12-10 N=22	3.0 (HP)				16			
X	18	12-24-33 N=57	4.5 (HP)				16			

DEPTH (Ft.): 5, 10, 15, 20, 25, 30

WATER LEVEL OBSERVATIONS: ▽ (at approx. 6 ft)

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not observed during drilling/sampling.

▽ *6' after boring*

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-25-2018	Boring Completed: 10-25-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-3

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago Chicago, IL

SITE: 8601 W.Foster Ave. Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9725° Longitude: -87.842°
Northing: 1932950.08 Easting: 1117867.03

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
4	33.0	**SILTY SAND (SM)**, fine to medium grained, gray, very dense	600	35		X	18	16-34-39 N=73					15			
	37.0	**SILT (ML)**, trace gravel, gray, hard	596	40		X	18	15-24-29 N=53	4.5 (HP)				20			
5	41.5	**SANDY LEAN CLAY (CL)**, trace gravel and occasional sand seams, gray, hard	591.5	45		X	18	10-19-25 N=44	7.5 (HP)				11			
						X	14	10-22-30 N=52	4.5 (HP)				13			
	50.0	***Boring Terminated at 50 Feet***	583	50												

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not observed during drilling/sampling.

6' after boring

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-25-2018

Boring Completed: 10-25-2018

Drill Rig: Truck-mounted

Driller: GeoCON

Project No.: MR185289

BORING LOG NO. B-4

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago Chicago, IL

SITE: 8601 W.Foster Ave. Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9724° Longitude: -87.8417°
Northing: 1932901.23 Easting: 1117947.07

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
1	0.2	**2.5" Asphalt**	633													
2		**FILL - SANDY LEAN CLAY**, with sand and gravel pockets, unusual odors, gray and dark gray				X	12	2-5-6 N=11					18			
	5.5		627.5			X	18	2-3-4 N=7					21			
3		**LEAN CLAY (CL)**, trace sand and gravel, gray, stiff to very stiff							1.0 (HP)	UC	1.34	5.7	14	121		
						X	18	6-6-9 N=15	4.0 (HP)				16			
						X	18	3-6-7 N=13	3.0 (HP)				17			
						X	18	3-5-7 N=12	2.5 (HP)				19			
						X	18	4-7-10 N=17	3.0 (HP)				23			
						X	18	3-5-7 N=12	2.5 (HP)				17			
	27.0		606													
4		**SILT (ML)**, trace gravel, gray, hard				X	18	19-29-30 N=59	4.5 (HP)				14			
	30.0		603	30												
		Boring Terminated at 30 Feet														

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not observed during drilling/sampling

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-25-2018	Boring Completed: 10-25-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-5

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago, Chicago, IL

SITE: 8601 W.Foster Ave. Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9722° Longitude: -87.842°
Northing: 1932858.63 Easting: 1117865.14

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)
1	0.2	**2.5" Asphalt**	633
2	6.5	**FILL - SANDY LEAN CLAY**, with sand and gravel pockets, dark brown; wood pieces in sample at about 4.5 feet	626.5
3	27.0	**LEAN CLAY (CL)**, trace sand and gravel, brownish gray to gray, very stiff to hard; becoming stiff to very stiff in sample at about 23.5 feet	606
4	30.0	**SILT (ML)**, trace gravel, gray, hard	603
		Boring Terminated at 30 Feet	

DEPTH (Ft.) (approx.)	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)
1-2.5	18	4-4-6 N=10		17
3.5-5	14	2-3-3 N=6		20
6-7.5	10	0-0-3 N=3	3.5 (HP)	20
8.5-10	15	3-7-8 N=15	3.75 (HP)	18
11-12.5	16	5-10-13 N=23	4.5 (HP)	19
13.5-15	18	5-9-13 N=22	4.5 (HP)	19
18.5-20	18	4-10-12 N=22	4.5 (HP)	24
23.5-25	18	4-6-8 N=14	2.5 (HP)	16
28.5-30	18	10-20-36 N=56	4.5 (HP)	15

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not observed during drilling/sampling

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-26-2018	Boring Completed: 10-26-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-6

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago
Chicago, IL

SITE: 8601 W.Foster Ave.
Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9721° Longitude: -87.8417°
Northing: 1932811.67 Easting: 1117941.34

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
1	0.2	**2.5" Asphalt**	633													
2		**FILL - SANDY LEAN CLAY**, trace gravel and organics, dark brown and gray				X	10	1-4-5 N=9					23			
	5.0		628			X	13	0-3-3 N=6					21			
3		**LEAN CLAY (CL)**, trace sand and gravel, gray, stiff to hard		5		X	18	3-5-6 N=11	4.5 (HP)				17			
						X	18	4-6-8 N=14	4.5 (HP)				16			
				10		X	18	4-6-10 N=16	3.0 (HP)				18			
						X	18	4-6-10 N=16	4.5 (HP)				21			
				15												
						X	18	5-6-7 N=13	3.0 (HP)				21			
				20												
						X	18	3-5-7 N=12	2.0 (HP)				15			
	27.0		606	25												
4		**SILT (ML)**, trace gravel, gray, hard				X	18	13-25-33 N=58	4.5 (HP)				15			
	30.0		603	30												
		Boring Terminated at 30 Feet														

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not observed during drilling/sampling

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-26-2018	Boring Completed: 10-26-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-7

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago Chicago, IL

SITE: 8601 W.Foster Ave. Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9727° Longitude: -87.8414°
Northing: 1933014.68 Easting: 1118021.04

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
1	0.3	**3.5" Asphalt**	632.5													
2	0.8	**FILL - CRUSHED LIMESTONE**	632													
2		**FILL - SANDY LEAN CLAY**, with sand and gravel pockets, dark brown and brown				X	10	3-3-4 N=7					27			
						X	18	2-2-3 N=5					20			
	5.0		628	5												
3		**LEAN CLAY (CL)**, trace sand and gravel, gray, stiff to hard				X	18	4-4-7 N=11	3.5 (HP)				16			
						X	18	4-6-7 N=13	5.0 (HP)				15			
	10.0		623	10												

Boring Terminated at 10 Feet

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not observed during drilling/sampling.

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-26-2018	Boring Completed: 10-26-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-8

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago Chicago, IL

SITE: 8601 W.Foster Ave. Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9725° Longitude: -87.8416°
Northing: 1932950.18 Easting: 1117973.03

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
1	0.3	**3" Asphalt**	633													
	0.7	**FILL - CRUSHED LIMESTONE**	632.5													
2		**FILL - LEAN CLAY**, trace sand and gravel, moderate plasticity, gray and brown				X	18	2-3-4 N=7					23		49-18-31	
	5.0		628	5		X	0	5-4-4 N=8								
		LEAN CLAY (CL), trace organics (Possible Fill), dark brown, soft to medium stiff				X	18	2-1-1 N=2	0.75 (HP)				25			3.8%
	8.0		625													
3		**LEAN CLAY (CL)**, trace sand and gravel, gray, soft							0.5 (HP)	UC	0.27	15	31	91		
		becoming stiff to hard below about 10 feet		10		X	18	4-5-7 N=12	4.75 (HP)				20			
	12.0		621													

Boring Terminated at 12 Feet

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not observed during drilling/sampling.

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-26-2018	Boring Completed: 10-26-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-9

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago
Chicago, IL

SITE: 8601 W.Foster Ave.
Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9723° Longitude: -87.8412°
Northing: 1932888.36 Easting: 1118062.72

Surface Elev.: 633 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
1	0.1	**1" Topsoil**	633													
2	0.9	**FILL - CRUSHED LIMESTONE**	632													
2		**FILL - MIX of SANDY LEAN CLAY and CLAYEY SAND**, with brick fragments and gravel, dark brown				X	18	4-7-5 N=12					15			
2	5.0		628	5	▽	X	18	2-1-2 N=3					20			
3		**LEAN CLAY (CL)**, trace sand and gravel, gray			▽	X	18	4-4-7 N=11	3.0 (HP)				18			
3	10.0		623	10		X	18	4-6-9 N=15	5.0 (HP)				19			

Boring Terminated at 10 Feet

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

▽ *6' while sampling*

▽ *5' after boring*

Terracon
650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-26-2018	Boring Completed: 10-26-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

BORING LOG NO. B-10

PROJECT: Dirksen Elementary School Annex

CLIENT: Public Building Commission of Chicago Chicago, IL

SITE: 8601 W.Foster Ave. Chicago, IL

LOCATION See Exploration Plan

Latitude: 41.9721° Longitude: -87.8414°
Northing: 1932792.36 Easting: 1118024.74

Surface Elev.: 634 (Ft.)

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)
1	0.1	**1" Topsoil**	634
2	5.0	**FILL - MIX of SAND and SANDY LEAN CLAY**, trace gravel, dark brown	629
2	8.0	**SANDY LEAN CLAY (CL)**, trace gravel (Possible Fill), brownish gray, medium stiff to stiff	626
3	10.0	**LEAN CLAY (CL)**, trace sand and gravel, gray, stiff	624
		Boring Terminated at 10 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	ORGANIC CONTENT (%)
		X	14	4-10-4 N=14					17			
5		X	18	3-3-2 N=5					18			
	▽ ▽	X	18	3-3-3 N=6	2.0 (HP)				16			
10		X	18	3-4-6 N=10	2.0 (HP)				16			

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

Hammer Type: Automatic

Advancement Method:
Power auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation from Google Earth

Notes:

WATER LEVEL OBSERVATIONS

▽ *6' while sampling*

▽ *7' after boring*

650 W Lake St, Ste 420
Chicago, IL

Boring Started: 10-26-2018	Boring Completed: 10-26-2018
Drill Rig: Truck-mounted	Driller: GeoCON
Project No.: MR185289	

SUPPORTING INFORMATION

Contents:

General Notes
Unified Soil Classification System

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Dirksen Elementary School Annex ■ Chicago, IL

November 2, 2018 ■ Terracon Project No. MR185289

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Shelby Tube; Standard Penetration Test	▽ **Water Initially Encountered**	**N** — **Standard Penetration Test Resistance (Blows/Ft.)**
	▽ **Water Level After a Specified Period of Time**	**(HP)** — **Hand Penetrometer**
	▼ **Water Level After a Specified Period of Time**	**(T)** — **Torvane**
	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.	**(DCP)** — **Dynamic Cone Penetrometer**
		UC — **Unconfined Compressive Strength**
		(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		RELATIVE PROPORTIONS OF FINES	
Descriptive Term(s) of other constituents	Percent of Dry Weight	**Descriptive Term(s) of other constituents**	**Percent of Dry Weight**
Trace	<15	Trace	<5
With	15-29	With	5-12
Modifier	>30	Modifier	>12

GRAIN SIZE TERMINOLOGY		PLASTICITY DESCRIPTION	
Major Component of Sample	**Particle Size**	**Term**	**Plasticity Index**
Boulders	Over 12 in. (300 mm)	Non-plastic	0
Cobbles	12 in. to 3 in. (300mm to 75mm)	Low	1 - 10
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)	Medium	11 - 30
Sand	#4 to #200 sieve (4.75mm to 0.075mm	High	> 30
Silt or Clay	Passing #200 sieve (0.075mm)		

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	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 ³ 4 and 1 £ Cc £ 3 [E]	GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [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 ³ 6 and 1 £ Cc £ 3 [E]	SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [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 / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					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 / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					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 ³ 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 ³ 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 ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ³ 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.