REPORT OF GEOTECHNICAL EXPLORATION

KUM & GO #2323

AURORA, CO

PREPARED FOR
ENTITLEMENT AND ENGINEERING SOLUTIONS, INC.

COLORADO LICENSED
LINDSAY A. TIPA
54411
05-21-2021
PROFESSIONAL ENGINEER

October 21, 2020
Revised May 21, 2021
Olsson Project No. 020-2814

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Kum & Go Fact Sheet

Store #	**2323**		
Project address:	**E. 6th Pkwy & E-470 Frontage Rd Aurora, CO**	Date:	**Last Revised 05/21/2021**
Engineer:	**Lindsay Tita, P.E.**	Phone #:	**303-237-2072**

SITE PREPARATION

Is building demolition necessary (Y/N):	**No**	
Are below grade structures known to exist (basements, crawlspaces, UST's) (Y/N/U):	**No**	
Above or below ground utility demolition/relocation (Y/N/U):	**Unknown**	
Is shoring anticipated during construction (Y/N):	**Yes**	**See Report**
Old fill encountered that will require rework (Y/N):	**No**	
Estimated topsoil stripping depth (in):	**6**	
Scarification thickness (in):	**12**	
Proofrolling (Y/N): Where feasible. Not recommended in areas of fuel lines or UST installation	**Yes**	**See Report**
Maximum recorded groundwater elevation (ft):	**Not Encountered**	
Minimum recorded groundwater elevation (ft):	**Not Encountered**	
Unsuitable or unstable soil identified during exploration (Y/N):	**Yes**	**See Report**
Exterior pavement subgrade preparation thickness (in):	**12" Scarify**	
Pavement underslab drainage system recommended (Y/N):	**No**	
Additional pavement subgrade recommendations necessary (Y/N):	**No**	
Do available reports indicate the site was utilized by others prior to Kum & Go (Y/N):	**No**	

Additional Comments: Onsite soils appear suitable for reuse as structural fill. Structural fill will be required below shallow foundations, floor slabs, canopy, exterior slabs, retaining wall foundations, and sidewalks. Shoring of foundation, utility, and UST excavations may be required to prevent cave-in of sandy soils. Overexcavation of the building area to an elevation of 5530 to address a soft clay soil layer will be necessary either during mass grading of the project site or building construction. See report for details.

STRUCTURAL FILL

On site soils suitable for reuse? (Y/N):	**Yes**	**See Report**
Import Fill Soils Maximum Liquid Limit (%):	**45**	
Import Fill Soils Maximum Plastic Limit (%):	**20**	
Maximum Swell Potential (%):	**1% at Surcharge of 500 psf**	
Maximum Particle Size (in):	**2**	
Recommended lift thickness (in):	**4 to 8**	

FOUNDATION DESIGN/FLOOR SLAB

Recommended Building Foundation Type:	**Shallow Spread or Trench Type Foundations**	
Finish Floor Elevation (ft):	**5538.9**	
Recommended Frost Depth (in):	**36**	
Are overexcavation and structural fill recommended below shallow foundations? (Y/N):	**Yes / No**	**See Report**
Is surcharge or preload necessary to prepare the building pad (Y/N):	**No**	
Net allowable soil bearing pressure (psf):	**2,500**	
Minimum column footing width dimensions (in):	**24**	
Minimum continuous footing width dimensions (in):	**18**	
Are perimeter foundation drains recommended for the building (Y/N)	**No**	
Floor slab subgrade preparation thickness (in):	**24**	**12" Struct. Fill 12" Scarify**

****This Fact Sheet only provides a limited overview of the report and is subject to any and all clarifications, conditions, contingencies, limitations and/or qualifications that may exist in the body of the report. The information contained in this Fact Sheet is provided pursuant to Client's request and is provided solely for the convenience of Client and neither Client nor any other party can rely solely on this Fact Sheet. Client and any other party using this report must review the entire report and interpret the information contained in this Fact Sheet in conjunction with the remainder of the report.**

Created by: Lindsay Tita, P.E.

1. PROJECT UNDERSTANDING

1.1. GEOTECHNICAL SCOPE

This Report of Geotechnical Exploration was requested and authorized by Ms. Mary Kasal of Entitlement and Engineering Solutions, Inc. (EES) for the purpose of evaluating existing subsurface conditions and providing geotechnical design recommendations for the new Kum & Go #2323 building, signs, and pavements.

The scope of this geotechnical exploration included the following:

- Site reconnaissance and review of soil and geologic subsurface information from USDA Natural Resource Conservation Services (NRCS) and published geologic mapping.
- Review of the existing contours and overlot grading plan provided by Ware Malcomb, the Civil Engineer for the property owner at the time of our investigation, GB Capital, LLC. Plans were provided by Amanda Casteel via email dated September 21, 2020.
- Review of the Conceptual Site Plan "Aurora, CO, E-470 & E. 6th Parkway" prepared by Entitlement and Engineering Solutions, Inc. dated 09-16-2020.
- Review of the Grading Plan "2323 – Aurora, CO – NWC of 6th Pkwy and E-470 Site Development Plan" prepared by Entitlement and Engineering Solutions, Inc. dated April 28, 2021.
- Drilling and sampling of thirteen (13) soil test borings extending to approximate depths of 10 to 25.5 feet below existing grades.
- Laboratory testing (as noted in the appendices) of soil samples obtained during the field operations.
- Completion of a geotechnical engineering evaluation using information obtained from our field observations, soil test borings, and laboratory testing program.
- Preparation of this Report of Geotechnical Exploration presenting the soil test borings, laboratory test results, and a summary of our engineering evaluations and recommendations.

1.2. SITE LOCATION AND DESCRIPTION

Olsson understands that EES is assisting Kum & Go, L.C. with the redevelopment of an approximately 2.06-acre parcel located in the northwest quadrant of East 6th Parkway and the east E-470 Frontage Road in Aurora, Colorado for the new Kum & Go #2323 facility. The intersection is also noted as East Stephen D. Hogan Parkway and North Valdai Street. Based on review of the project contours and grading plan at the time of our exploration, the overall site is relatively level, with localized slopes along the project perimeter. Along the east side of site, the site slopes west from an elevation of 5340 feet along the existing Frontage Road to an elevation of approximately 5535 feet at the east project boundary. Maximum elevations of 5356 and 5357 feet are noted at the northwest and southeast corners, respectively. Minimum elevations of 5354 feet are noted across the center of site, from the northeast to the southwest corners.

Olsson understands, based on the provided site grading plan and discussions with EES, Inc., that the project developer intends to place between 1 and 5 feet of fill across the site to bring the site up to an elevation of approximately 5542 feet along the east site perimeter sloping down to 5534 along the west site perimeter prior to construction of the Kum & Go project. A finished floor elevation (FFE) of 5538.9 feet has been established by the design team for the new Kum & Go building at the time of this report. Based on this FFE and the site grading plan provided, maximum cuts on the order of 3 feet and fills on the order of 5 feet are estimated for the project site, with the larger fill depths indicated in the northwest project corner and larger cut depths along the east site perimeter. Cuts and fills on the order of 2 feet are anticipated as more typical depths across the site. A Site Location Plan and Boring Location Map are presented in *Appendix A*.

The site is located in the southeast portion of a currently undeveloped lot, bounded to the east by E-470 Frontage Road and the south by East 6th Parkway. The open lot extends to the north and west beyond the limits of the project site. A review of historic aerial photographs available through Google Earth dating back to 1993 indicates the site has been previously used as open space or agricultural farmland since before that time up to the time of our investigation. At some time between June 1993 and September 1999, the commercial facility and associated parking to the south, as well as E-470, Valdai Street, Frontage Road, and East 6th Parkway in the vicinity of the project area were constructed. Between June 2018 and September 2019, East 6th Parkway was extended to the west to its current alignment south of the project site and Valdai Street (Frontage Road) was expanded to add an eastbound turn lane onto East 6th Parkway. Other than some regrading associated with the 2018/2019 road construction activities, the project site has remained relatively unchanged since prior to 1993.

1.3. PROJECT INFORMATION

The proposed Kum & Go #2323 facility will include a 5,620 square foot (approximate), single-story building utilizing light gauge steel framework and cast stone veneer with concrete slab-on-grade. The building will be located in the east-center portion of the site, facing west. The trash enclosure will be located near the northeast corner of the new building. Eight (8) new fuel pump islands and an overhead canopy (49' x 123') will be located west of the new building. Two (2) new diesel fuel pump islands and an overhead canopy (24' x 42') will be located north of the new building. The new underground fuel storage tanks supplying pumps at both fuel canopies are to be located in drive and landscaping areas east of the diesel canopy. Access to the facility will be provided by one new entrance/exit at the northwest corner of the property and one new entrance/exit at the southwest corner. Future monument signs will be positioned at the southwest and northeast corners of the property. A future development sign will be positioned at the southeast corner of the property.

Prior to the field exploration, EES informed ***Olsson*** that the building and main canopy may be rotated in later stages of design following discussions with the City of Aurora. The final site layout described above reflects this rotation. Additional geotechnical borings were performed based on the layout at the time of drilling, and geotechnical borings may not align exactly with the most current site layout; however, borings were completed near enough to the site features to provide reasonable consideration of the subsurface conditions across the site.

Based on our experience with the Kum & Go building design and information provided by the client, ***Olsson*** understands maximum live and dead loads for the new building will be on the order of 41 kips each for isolated columns, 1.5 klf for continuous walls, and 125 psf for floor slabs.

Olsson understands that the type and design of canopy support foundations will be determined by the Canopy Manufacturer/Installer based on their review of the contents of this geotechnical report and the soil conditions encountered at the time of foundation installation. ***Olsson*** will provide recommendations for canopy foundation design, subgrade improvements, or stabilization of canopy foundation subgrades if requested by Kum & Go.

2. Exploratory and Test Procedures

2.1. Field Exploration

A truck-mounted CME-55 drill rig utilizing continuous flight, solid-stem augers was used to complete thirteen (13) soil test borings (B-1 to B-13) for this project. Preliminary soil boring depths and locations were selected by ***Olsson*** and reviewed by Mary Kasal with EES, Inc. during the proposal phase of this project. The soil boring locations and depths were modified or shifted in the field only if necessary to avoid known underground or overhead utilities, existing structures, site features, public right-of-way, or areas of limited access. Refer to the *Boring Location Map* in *Appendix A* and the *Boring Logs* in *Appendix B* for the final locations and depths of each boring.

Relatively undisturbed and split-barrel soil samples were obtained at 2.5- to 5-foot depth intervals during the drilling process and returned to the laboratory for additional testing. Soil samples designated as “SS” were obtained in general accordance with ASTM D-1586 (Penetration Test and Split-Barrel Sampling of Soils). Soil samples designated as "MC" on the boring logs were obtained in general accordance with ASTM D-3550 (Thick Wall, Ring-Lined, Split-Barrel, Drive Sampling of Soils) with a Modified California Barrel Sampler. The “MC” sampler was driven to a 12-inch depth, as it can only sample a maximum 16-inches of soil. Recovered samples were sealed in plastic containers or sampling tubes, labeled, and protected for transportation to the laboratory for testing.

2.2. Laboratory Testing

Per the laboratory scope and sample conditions, tests were completed to evaluate the engineering properties of recovered soil samples. Moisture content and density tests were completed to determine the existing moisture state and unit weight of subsurface soils. Percent passing the #200 sieve tests and soil gradations were completed to determine the amount of fines (clay and silt) in the soil. Atterberg Limits were completed to help classify cohesive samples and determine the plasticity of the soil. Chemical and resistivity tests were performed on selected samples to determine corrosivity potential. A Standard Proctor Test and R-Value test were completed on a bulk sample collected in pavement area to determine compaction and strength parameters for pavement design. Laboratory tests were conducted in general accordance with current ASTM test procedures. A summary of the laboratory test results is presented in *Appendix C*.

3. Subsurface Conditions

3.1. Area Geology

Based on the U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) soil survey data, the project site is mapped primarily in Nunn-Bresser-Ascalon complex (0 to 3 percent slopes). The unit composition is broken down as 40-percent Nunn, 25-percent Bresser, 20-percent Ascalon, and 15-percent minor components. A typical Nunn profile consists of loam, clay loam/clay, over sandy clay loam/fine sandy loam/sandy loam. The three major soil units report bedrock below the upper 80 inches of its typical soil profile. This Nunn soil unit is categorized into hydrologic group C and the Bresser and Ascalon as group B. The three soil units report the depth to the water table to be greater than 80 inches.

Based on a review of USGS Geologic Mapping by Trimble and Machette (1979), the project site is most likely underlain by Windblown Sand consisting of fine to medium sand derived mainly from alluvium of major streams and distributed east and southeast by wind. Nearby bedrock outcrops are mapped as the Denver Formation which consists of claystone, siltstone, sandstone, and conglomerate composed primarily of altered andesitic (volcanic) debris. The subsurface conditions encountered during ***Olsson's*** exploration are generally consistent with the unit descriptions and thicknesses of the windblown deposits described.

Review of Potentially Swelling Soil and Rock in the Front Range Urban Corridor mapping by Hart (1972), the project site is situated in an area described as windblown sand or silt which generally has low swell potential although, the upper six to twelve inches may locally have moderate swell potential. These materials may also be subject to severe settlement of hydrocompaction when soils become saturated. A discussion of expansion and settlement potentials based on ***Olsson's*** laboratory testing is included in *Section 3.6.*

3.2. Test Borings and Laboratory Summary

Soil stratification, as shown on the boring logs, represents soil conditions at the specific boring locations; however, variations may occur between or beyond the borings. The stratification lines represent the approximate boundary between soil types, but the actual transition between soil layers may be gradual. Bedrock or practical auger refusal were not encountered within the depths explored at any boring location.

Borings B-3, B-7, and B-12 (in and around the proposed building footprints), generally encountered a thin surficial root zone overlying 14 to 19 feet of lean clay with varying sand content interbedded with sand with varying clay and silt content, overlying poorly graded sands with trace to no clay. Boring B-12 encountered a layer of sand from 9.5 to 14.5 feet before transitioning back to lean clay from 14.5 to 19 feet. Boring B-13, located near the proposed building footprint and the proposed northeast monument sign, encountered 3.5 feet of sandy lean clay underlying the root zone and overlying silty sand which extended to a depth of 14.5 feet. All four borings terminated in these poorly graded sands. Fine grained, cohesive soils were generally moist and varied from soft to very stiff, with stiffness typically increasing with depth and the softest soils encountered at approximately 4 feet below existing grade at the time of our exploration. Granular soils were generally moist and loose to medium dense. One of the borings drilled within the proposed building footprint (B-3) encountered a layer of soft sandy clay from approximately 3.5 to 6 feet with a blow count of N=3.

Borings B-1, B-2, and B-6, located near the standard pump station and canopy area, generally encountered a thin surficial root zone overlying sands with varying but significant silt and clay content or lean clays with significant sand contents extending to a depth of approximately 14 feet. At this depth, borings B-1 and B-2 encountered poorly graded sands with little to no clay. In boring B-6 between 14 and 19 feet, lean clay with significant sand content was encountered, overlying the poorly graded sands with little to no clay. The poorly graded sands continued to the termination depth of all 3 borings. Fine grained, cohesive soils were generally moist and varied from firm to very stiff, while granular soils were generally moist and medium dense to dense.

Boring B-5, near the proposed stand-alone diesel canopy and UST excavation, encountered a thin surficial root zone overlying lean clay with varying sand contents extending to a depth of approximately 19 feet. From 9.5 to 14.5 feet, sand with varying silt and clay content was observed. At 19 feet, soils transitioned to a sand with varying silt content, which extended to the termination depth of the boring, with fines content decreasing with depth. Fine grained, cohesive soils were generally moist and varied from firm to very stiff, while granular soils were generally moist and medium dense.

Boring B-4, near the originally proposed trash enclosure but now near an area of general site fill and pavements, encountered a thin root zone layer overlying interbedded medium dense sands with varying silt and clay content and firm to stiff lean clay with varying sand contents, which extended to the 10-foot depth explored.

Boring B-8, originally within a proposed UST excavation but now in an area of landscaping and pavement, encountered minimal surficial root zone materials over 6 feet of medium dense to loose sands with varying silt and clay contents. Below these sands, stiff lean clay with varying sand contents extended to a depth of approximately 14.5 feet overlying medium dense to dense poorly graded sand, which extended to the termination depth of 25 feet.

Boring B-9, near the proposed development pole sign location, encountered a minimal layer of root zone materials overlying 6 feet of silty sand, which was overlying stiff to very stiff lean clay with varying sand content extending to the depth explored.

Borings B-11, near the proposed southwest pole sign location, encountered a minimal layer of root zone materials overlying approximately 9.5 feet of soft to firm lean clay with varying sand contents. Sands with varying silt content were encountered underlying the upper clays, which were typically medium dense and moist, which extended to the termination depths of the borings, with fines typically decreasing with depth.

Boring B-10, located near the pavement of the northeast site entrance, encountered approximately 3 inches of surficial organic-rich materials over dense to medium dense sand with varying silt content extending to a depth of 9 feet. Underlying the sands, hard lean clay with varying sand content was encountered extending to the termination depth of the boring at 10 feet.

3.3. Soil Properties

Table 1: Summary of Soil Properties

Sandy Clay – sandy, soft to hard, brown and light brown and yellow brown with some white lensing, moist					
USCS Classification	**Dry Density (pcf)**	**Moisture Content (%)**	**LL / PI (%)**	**P-200 (%)**	**SPT "N" Values (bpf)**
CL	109.2 – 125.2	4.2 – 25.7	27 – 30 / 13 – 17	53.5 – 54.9	3 - 51

Silty and Clayey Sand – fine to coarse grained, with no to trace gravel, loose to very dense, brown and whitish brown and yellowish brown, moist					
USCS Classification	**Dry Density (pcf)**	**Moisture Content (%)**	**LL / PI (%)**	**P-200 (%)**	**SPT "N" Values (bpf)**
SC, SM	99.6 – 114.1	5.5 – 21.3	NP / NP	17.4 – 31.3	8 - 20

Poorly Graded Sand – fine to coarse grained, with no to trace gravel, medium dense to dense, whitish brown and brown and yellowish brown, moist					
USCS Classification	**Dry Density (pcf)**	**Moisture Content (%)**	**LL / PI (%)**	**P-200 (%)**	**SPT "N" Values (bpf)**
SP	105.1 – 112.5	3.2 – 6.2	NT / NT	1.0	20 - 43

N/T indicates no tests performed, N/P indicates Non-Plastic

3.4. Groundwater Summary

Free water was not encountered in any of the borings completed during this exploration. Free or perched groundwater is not expected to adversely impact site grading, earthwork, shallow building construction, UST installation, utilities, or drilled shaft installation.

It should be noted that groundwater levels (perched or otherwise) typically fluctuate with seasonal variations in precipitation, runoff, snowmelt, irrigation demands, or other factors that may differ from those at the time of the drilling operations. *Section 4.4* of this report addresses general groundwater or drainage concerns as applicable to the site design and earthwork as we now understand them.

Table 2: Groundwater Summary

Boring No.	Boring Depth (feet, bgs)	Water Depth During Drilling (feet, bgs)	Water Depth Immediately After Drilling (feet, bgs)	Approximate Surface Elevation (per provided overlot elevations)
B-1	25.0	Not Encountered	Not Encountered	5535.0

Boring No.	Boring Depth (feet, bgs)	Water Depth During Drilling (feet, bgs)	Water Depth Immediately After Drilling (feet, bgs)	Approximate Surface Elevation (per provided overlot elevations)
B-2	25.5	Not Encountered	Not Encountered	5535.0
B-3	25.0	Not Encountered	Not Encountered	5534.0
B-4	10.5	Not Encountered	Not Encountered	5536.0
B-5	25.5	Not Encountered	Not Encountered	5534.0
B-6	25.5	Not Encountered	Not Encountered	5534.5
B-7	25.5	Not Encountered	Not Encountered	5534.0
B-8	25.0	Not Encountered	Not Encountered	5536.0
B-9	20.0	Not Encountered	Not Encountered	5537.0
B-10	10.5	Not Encountered	Not Encountered	5535.0
B-11	15.5	Not Encountered	Not Encountered	5534.0
B-12	25.0	Not Encountered	Not Encountered	5534.0
B-13	20.0	Not Encountered	Not Encountered	5534.0

3.5. CORROSIVITY OF SOILS

The results of the water-soluble sulfate, pH, chloride, and resistivity testing are summarized as follows:

TABLE 3: SOIL CORROSION TESTING SUMMARY

Test/Sample Location	Sulfate (% by mass)	Relative Degree of Sulfate Attack	Chloride (mg/L)	pH	Soil resistivity (ohms-cm)
B-3, 1-3 ft	0.03	Negligible	36	6.72	856

The resistivity value indicates that the lean clay soils are corrosive to buried metal. A mechanical/electrical designer, experienced with local building code requirements and local practice, should review the laboratory test results presented above and determine if corrosion protection of buried utility lines is required and how it is to be implemented.

Laboratory results indicate a negligible risk of sulfate attack for concrete exposed to the lean clay soils on this site. Type I cement may be appropriate for the site as no specific type of cement is required per ACI 201.2R, based on the sulfate levels less than 0.1 percent by mass. Refer to *Appendix C, Summary of Laboratory Test Results* for additional information. An experienced designer should review these results and evaluate suitability of proposed designs based on the corrosivity test results.

3.6. EVALUATION OF ON-SITE SOILS

Based on the encountered soil conditions, conventional shallow spread footings and on-grade concrete floor slabs can be used to support the proposed structure, if constructed in accordance with the recommendations presented in this report. The pole signs can be supported on a drilled pier foundation as recommended in this report. Laboratory test results show that the onsite clay soils have relatively low expansion and collapse potential, as shown in the table below. Based on these laboratory results, limited overexcavation will be required as described in the following sections.

The soils observed on site are typically moisture sensitive and, if moisture contents significantly change, may cause post-construction movement of foundations and/or pavement; therefore, proper drainage around the building, as recommended in *Section 4.4*, should be included in the final design.

TABLE 4: SWELL TESTING RESULTS

Test/Sample Location	Material	In-situ moisture (%)	In-situ dry density (pcf)	Inundation pressure (psf)	Percent swell (%)*	Swell pressure (psf)
B-1 @ 1.0’	Sandy Clay	8.5	121.8	200	1.5	2,000
B-2 @ 9.0’	Sandy Clay	16.0	109.2	1,000	0.6	2,200
B-5 @ 3.5’	Sandy Clay	4.2	116.3	500	-1.3*	N/A

*Negative values indicate sample collapsed upon inundation.

The magnitude of volume change of the soil depends on various factors including soil composition, in-situ moisture content, in-situ density, and the change in moisture content. Low swelling soils with low to moderate swelling pressures, as well as slightly collapsible soils, were observed in our investigation at shallower depths, indicating low risk for total and differential movement of slab elements due to expansive/collapsible soils. Based on the low expansion/collapse potential and the general stiff in situ consistency and medium dense to dense relative densities of the materials across a majority of the site, significant overexcavations will not be necessary. Targeted overexcavations to address soft soil layers encountered will be required underlying shallow foundations within the building area. To provide a consistent bearing surface, we recommend at least 12 inches of the subsurface below interior and exterior building foundations, retaining wall foundations, and trash enclosure wall foundations be scarified, moisture conditioned, and compacted as recommended in *Section 4.2* of this report.

Borings B-3 and B-11 encountered isolated layers of soft material, and boring B-12 encountered soft to firm soils at a depth of 3.5 to 5 feet (N = 5). Soft soils, if encountered during excavation, should be removed, moisture conditioned and compacted as recommended in *Section 4.2*. Underlying the building area, overexcavation to a depth of 4 feet below existing grade at the time of our exploration (an approximate elevation of 5530 feet), preparation of the exposed subgrade as recommended in *Sections 4.1* and *4.2*, and replacement with controlled structural fill will be necessary to address these soft soils.

The surficial soils exhibited the most significant swell percent with a swell pressure of 2,000 psf. To address potential movement due to swelling of the slabs-on-grade, we recommend the building interior and trash enclosure slabs be supported by a minimum 1 foot of structural fill, accomplished by overexcavation and replacement or by raising the site grade. The structural fill may consist of engineer approved imported materials or properly compacted and moisture treated native soils. Structural fill should be founded on at least 12-inches of subgrade prepared by scarifying, moisture conditioning, and compacting as recommended in *Section 4.2* of this report. In order to address potential differential movement and to provide a uniform and stable bearing surface, we recommend that the upper 12-inches below new pavements be scarified, moisture conditioned as necessary, and compacted as discussed in *Section 4.2*.

It should be noted that the on-site granular soils with minimal cohesive binder may not stand unsupported during the excavation and construction of conventional trench or grade beam foundations. This may require the use of shallow spread foundations/stem walls and proper backfilling procedures inside and outside the building.

Based on laboratory testing results from areas sampled during this exploration, the onsite clays and sandy soils are suitable for reuse as structural fill provided they are properly moisture conditioned and compacted as recommended in *Section 4.2*. If higher plasticity soils are encountered, they should be blended with a lower plasticity on-site or imported material in order to reduce the plasticity index to 20 percent or less prior to placement as structural fill. An ***Olsson*** representative should be present during building foundation excavation and overexcavation to document the soil conditions encountered are consistent with those identified during this exploration.

Groundwater was not encountered during our field exploration, however groundwater may fluctuate seasonally or with precipitation events. If groundwater is encountered during earthwork and/or construction activities the excavations will need to be adequately dewatered during these operations. The design, operation, and maintenance of the dewatering system during construction is the responsibility of the contractor.

4. SITE PREPARATION

4.1. GENERAL SITE PREPARATION

The proposed site is currently an open lot with surface covering consisting of grasses and shrubs. All topsoil, vegetation, major root systems, organic soils, and any loose, soft or otherwise unsuitable or deleterious material encountered within the construction area should be stripped and removed and should be carefully separated to avoid incorporation into soils otherwise suitable for reuse as structural fill. Site clearing, demolition, grubbing, and stripping should be completed during periods of dry weather. Operating heavy equipment on the site during periods of wet weather could result in excessive pumping and rutting of the subgrade soils. The base of new construction excavations should be observed and documented by ***Olsson*** prior to the placement of new fill soils.

Based on the low expansion/collapse potential and the general stiff in situ consistency and medium dense to dense relative densities of the materials encountered near the foundation bearing depth, overexcavation below the foundation elements will not be necessary. However, to address shallow soils with slight differential movement potential, 1 foot of new structural fill is recommended below slabs-on-grade. These foundation designs are further discussed in *Section 5.1*. The slab-on-grade overexcavation limits should extend at least 10-feet around the building on all sides to encompass sidewalks and adjacent site features. Overexcavations and subgrade preparation should extend laterally at least 1 foot on each side of shallow footings for every 1 foot of depth.

After grubbing, stripping, site grading, and required overexcavations but prior to placement of structural fill, foundations, floor slabs, pavements, or fill in areas below design grade, the exposed subgrade should be prepared by scarifying, moisture conditioning and compacting the upper 12 inches as recommended in *Section 4.2*. Borings B-3, B-11, and B-12 encountered shallow isolated layers of relatively soft material. Soft soils, if encountered during excavation, should be removed, moisture conditioned and compacted as recommended in *Section 4.2*. Underlying the building area, overexcavation to a depth of 4 feet below existing grade at the time of our exploration (i.e. overexcavation to an approximate elevation of 5530 feet), preparation of the exposed subgrade by scarifying to a depth of 12 inches, moisture conditioning, and compaction as recommended in *Section 4.2*, and replacement with controlled structural fill will be necessary to address these soft soils. If this overexcavation is completed by the developer prior to Kum & Go's construction earthwork, fill placement records should be provided for ***Olsson***'s review.

After scarifying, moisture conditioning, and compacting, we recommend the subgrade be proofrolled wherever equipment access is feasible. Proofrolling may be accomplished with a fully loaded, tandem axle dump truck or other equipment with a minimum gross weight of 20 tons. Proofrolling aids in delineating soft or loose areas that may exist below subgrade level. Unsuitable areas identified by visual observation or proofrolling should be improved by compaction in-place or by overexcavation and replacement of the unstable soil with compacted structural fill. We recommend that an ***Olsson*** representative be on-site to observe and document uniform and stable subgrade conditions prior to placing new structural fill, foundations, or pavements.

Construction scheduling often involves grading and paving by separate contractors and can involve a time lapse between the end of grading operations and the commencement of paving. Disturbance, desiccation, or wetting of the subgrade soils between grading and paving can result in deterioration of the previously completed subgrade. Should this occur, we recommend the soils be reworked to provide a stable subgrade for pavements. Unstable or unsuitable soils revealed by proofrolling should be reworked to provide a stable subgrade. More aggressive stabilization measures may be required if instability persists.

If the minimum depths of compacted structural fill, new or improved native soils, below floor slabs or pavements are provided during site grading or earthwork, if approved by ***Olsson***, additional slab-on-grade overexcavation may not be necessary.

4.2. Structural Fill

The on-site clays and sandy soils are suitable for reuse as general fill, structural fill, or utility backfill below the building and new pavements. If higher plasticity soils are encountered during excavation or site grading, the soils should be blended with lower plasticity soils such that their resulting liquid limit is less than 45, plasticity index is less than 20, and swell potential is less than 1%.

Imported fill materials, if required, should be low plasticity, non-expansive, sandy clays or clayey sands with a liquid limit less than 45, a plasticity index less than 20, and having at least 25 percent passing the #200 sieve. If alternate borrow materials are considered, we recommend the contractor provide supplier gradation and/or laboratory plasticity and swell documentation to ***Olsson*** for review and approval prior to site delivery. In addition to maintaining the recommended plasticity criteria, imported and on-site fill soils should be relatively free of organics (less than about 2 percent by weight) or other deleterious material and should not contain particles larger than 2 inches.

Suitable fill materials should be placed in thin lifts. Lift thickness depends on the type of compaction equipment, but in general, lifts of 4 to 8-inch loose measurement are recommended. Soils should be compacted using equipment of appropriate size and type to achieve the requirements of this report. A self-propelled, smooth drum roller is generally recommended for compacting cohesionless (sandy) soils while a self-propelled, vibratory sheepfoot roller is generally recommended for compacting cohesive (clay) soils. A loose lift thickness of 6 inches is suggested for static (no vibration) compaction procedures. Wheel rolling using rubber-tired equipment is not an acceptable method of compaction and is not recommended. Within small excavations, such as in footing trenches, utility trenches, or around manholes, “Wacker-Packers” or “Rammax” compactors for cohesive soils or vibrating plate compactors for granular soils can be used to achieve the specified compaction. Lift thicknesses should be reduced to 4 inches in small fill areas requiring hand-operated equipment.

During grading operations, representative samples of general and structural fill materials should be initially and periodically checked via laboratory testing to document that the previously mentioned soil parameters are maintained. An ***Olsson*** representative should regularly observe and monitor the excavation and grading operations and perform field density tests to document that the specified moisture and compaction requirements are being achieved. Full time field observation and testing is recommended during the overexcavation and replacement operations below and around the building, canopy, trash enclosure, and UST areas.

TABLE 5: FILL/COMPACTION RECOMMENDATIONS

Areas of Fill Placement	Minimum Compaction (ASTM D698 Standard Proctor)	Moisture Content (Percent of Optimum)
Structural Fill – On-site or imported soils placed below and within 10 feet of the building (including entrance slabs entrance exterior slabs), trash enclosure, retaining walls, signs, and pavements	95%	As necessary to obtain density for cohesionless gravelly soil, -2 to +2 percent for cohesionless soils, or -1 to +3 percent for non-expansive cohesive soil
Floor Slab Subgrade – Structural fill placed below the building floor slab or below the granular cushion layer, if utilized.	95%*	
Utility Trenches – Cohesive backfill structural fill soils placed within new utility trenches	95%	
Pavement Subgrade – On-site or imported structural fill soils below areas of new pavement	95%	
Sidewalk Subgrade – Below grade-supported sidewalks	95%	
Non-Structural Fill – Beneath non-loaded landscape/grass areas	92%	
Pavement Base Course – OAggregate base course below pavements (CDOT Class 5 or Class 6)	95%	

*May be substituted with 65% "relative density" in accordance with ASTM D 4253 and D4252

The moisture content for imported and on-site soils at the time of compaction should generally be maintained between the ranges specified above. More stringent moisture limits may be necessary with certain soils, and some adjustments to moisture contents may be necessary to achieve compaction in accordance with project specifications.

4.3. UTILITIES

New underground utilities should be installed in accordance with local building codes. Utility trench backfill should consist of compacted structural fill placed in accordance with *Section 4.2* of this report. Where utilities will penetrate the footprint of the building, it is recommended that a utility trench "plug" be constructed that extends at least 5 feet beyond the building perimeter. The trench plug should consist of non-expansive backfill materials having at least 50 percent passing the #200 sieve, to provide a moisture barrier to the soils within the influence zone of the new building.

Granular pipe bedding for new utilities is acceptable, but the remaining trench should be backfilled and compacted using the on-site soils originally removed from the trench that are qualified as structural fill per *Section 4.2*.

Water should be prevented from entering utility trenches before, during, and after construction. Excavations should not remain open if rain is anticipated. Excavations should be backfilled as soon as possible with approved structural fill to reduce the potential for moisture infiltration or sidewall sloughing. Depending on the amount of clay, the layers of silty clayey sand and silty sand encountered during our drilling operation may potentially be unstable and susceptible to cave in during UST excavations. The excavation and UST installation contractor should be aware of this. The contractor should review this report thoroughly and determine if shoring or benching of the excavation sidewalls are applicable and select their means and methods accordingly.

4.4. Site Drainage and Groundwater Considerations

Groundwater was not encountered during our field exploration in any of the borings completed for this project. Groundwater or saturated soil conditions are not anticipated to impact shallow site grading, earthwork, or building construction; however, groundwater may fluctuate seasonally or with precipitation events and could be encountered near the base of the fuel tank, utility, or drilled shaft excavations, depending on the depths required for installation. If groundwater is encountered during earthwork and/or construction activities the excavations will need to be adequately dewatered during these operations. ***Olsson*** should be notified if groundwater is encountered.

Water should not be allowed to collect near foundations, floor slabs, or in areas of new pavements, either during or after construction. As applicable, provisions should be made to quickly remove accumulating seepage water or storm water runoff from excavations. Undercut or excavated areas should be sloped toward one corner to allow rainwater or surface runoff to be quickly collected and gravity drained or pumped from construction areas. Subgrade soils that are exposed to precipitation or runoff should be evaluated by the geotechnical engineer prior to the placement of new fill, reinforcing steel, or concrete, to determine if corrective action is required.

To minimize concerns related to improper or inadequate drainage away from foundation bearing subgrades or from cohesive backfill materials used in utility or foundation trenches, we provide the following general recommendations:

- Site grading should provide efficient drainage of rainfall or surface runoff away from new structures and pavements.
- Roof drains from the new building and canopy should be collected and discharged directly to the storm sewer or directed to a down gradient location away from structures and pavements.

- External hose connections in unpaved areas should incorporate splash blocks to prevent localized flooding of foundation bearing or backfill soils. External hose connections should have cut-off valves inside the building to prevent accidental or unauthorized use.
- Maintenance personnel should be informed of the potential concerns associated with excessive watering near the building.

4.5. CONSTRUCTION EQUIPMENT MOBILITY

On-site or imported soils may be susceptible to softening under construction equipment traffic during periods of wet weather. Reducing equipment mobility problems and managing soft surface soils will be dependent on the severity of the circumstances, the soil types, the season in which construction is performed, and prevailing weather conditions.

Some general guidelines for reducing equipment mobility problems and addressing potential soft and wet surface soils are as follows:

- Optimize surface water drainage at the site during construction.
- Whenever possible, wait for dry weather conditions to prevail and do not operate construction equipment on the site during wet conditions. Rutting the surface soils will aggravate the condition and accelerate subgrade disturbance.
- Disk or scarify wet surface soils during periods of favorable weather to accelerate drying. Temporarily compact loose subgrade soils if rain is forecast to promote site drainage and reduce moisture infiltration.
- Use construction equipment that is well-suited for the intended job under the existing site conditions. Heavy rubber-tired equipment typically requires better site conditions than light, track-mounted equipment.
- Implement a construction schedule that realistically allows for rain days. Pressure to perform earthwork under a tight schedule is frequently counterproductive.

If requested, ***Olsson*** can help determine a cost-effective approach for stabilizing unsuitable soils at the time of construction.

4.6. TEMPORARY SLOPES AND EXCAVATIONS

Construction site safety is the responsibility of the general contractor. The contractor shall also be solely responsible for the means, methods, techniques, sequencing, and operations during construction. ***Olsson*** is providing the following information solely as a service to EES, Inc. and Kum & Go. Under no circumstances should ***Olsson's*** provision of the following information be construed to mean that we are assuming responsibility for construction site safety or the contractor's activities. Such responsibility is not implied and should not be inferred.

The contractor should be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations, e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced, and if not followed, the owner, the contractor, or earthwork or utility subcontractors could be liable for substantial penalties. The contractor is responsible for reviewing this geotechnical report, determining the appropriate OSHA slope criteria for the soil conditions encountered, and implementing it during construction. Soils encountered in construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in the widely spaced borings. The contractor should verify that similar soil conditions exist throughout the proposed areas of excavation. If different subsurface conditions are encountered at the time of construction, ***Olsson*** recommends that they be contacted to re-evaluate existing site conditions.

Temporary slopes exceeding 5H:1V should be properly benched prior to placement of new fill. As an alternative to flatter and benched temporary slopes, vertical excavations can be temporarily shored. The contractor should be responsible for the design of temporary shoring in accordance with applicable regulatory requirements. Permanent fill and cut slopes at the site should not exceed 3H:1V. Where steeper slopes are planned, additional analysis should be performed once grading plans have been developed.

If excavations, including utility trenches, are extended to depths of more than 20 feet, OSHA requires that the side slopes of such excavations be designed by a professional engineer registered in the state where construction is occurring.

5. BUILDINGS AND STRUCTURES

5.1. SHALLOW FOUNDATION DESIGN

The site appears suitable for supporting the lightly loaded Kum & Go building on conventional shallow spread or trench type foundations. To reduce potential total and differential movement resulting from consolidation of soft clay soils, and to provide a stable bearing surface, we recommend that the building area be overexcavated to an approximate elevation of 5530, the exposed subgrade be scarified, moisture treated and compacted as recommended in *Section 4.1*, and the overexcavation be backfilled with controlled structural fill. Additional soft soils, if encountered during excavation, should be removed, moisture conditioned and compacted as recommended in *Section 4.2*.

Shallow foundations bearing on the recommended thickness of compacted structural fill (estimated to be at least 5 feet in the building area and 2 feet in the fuel canopy areas) may be designed using a net allowable soil bearing pressure of up to 2,500 pounds per square foot (psf). The net allowable bearing capacity can be increased by 1/3 for transient loadings (short term loading such as wind load or seismic load) when used with the alternative basic load combinations of Section 1605.3.2 of IBC 2015. These design recommendations are based on the anticipated maximum structural loads noted in *Section 1.3* of this report. If additional load demands require an increased bearing capacity, ***Olsson*** should be contacted to discuss the desired design criteria.

Building footings should have minimum dimensions in accordance with local building codes. ***Olsson*** recommends minimum dimensions of 18 inches for continuous footings and 24 inches for isolated column footings to minimize the potential for localized bearing failure. Perimeter footings and footings in unheated areas should bear at a minimum depth of 36 inches below the lowest adjacent final ground surface for frost protection per the City of Aurora requirements. Interior footings in heated areas can bear as shallow as necessary below the floor slab however, Olsson recommends a minimum burial of 12 inches.

The use of the recommended design bearing pressure is contingent on having prepared foundation subgrades observed by an ***Olsson*** geotechnical engineer or his/her authorized field representative prior to placing new structural fill, reinforcing steel, or concrete to document that the subgrade soils and conditions are consistent with the bearing subgrade requirements of this report. Additionally, we recommend bearing subgrades be hand probed before placing reinforcing steel or concrete to identify soft, loose, or otherwise unsuitable conditions.

The total post-construction movement for the new Kum & Go building with foundations less than 5 feet wide designed and constructed as recommended above is anticipated to be less than 1-inch with differential movement limited to less than ½-inch over 50 feet or between adjacent columns. To reduce the effects of differential movement, floating floor slabs with expansion joints, independent from wall and column loads, will be important in minimizing the potential cracking that can occur along and around foundation systems. Floor slab control joints should be used to reduce potential damage due to shrinkage cracks. Additionally, exterior veneers should be installed to allow abutting pavements and sidewalks to move independently.

Lateral resistance of the foundations will be achieved through a combination of base shear resistance mobilized at the footing-subgrade interface and passive earth pressure acting on the vertical faces of the footings at right angles to the direction of applied load. A friction coefficient value of 0.35 can be used between the native soil and the foundation concrete for base shear and sliding resistance. Passive earth pressure resistance can be calculated using parameters provided in *Section 5.6*. For foundations subjected to both uplift and lateral forces, the base friction should be neglected in the calculations.

The uplift resistance for the shallow foundation is developed by the dead load at the footing, and the weight of the soil directly above the footing. The weight of the soil can be calculated using a unit weight of 120 pcf and the volume of a prismatic failure block with vertical faces above the footing edges.

After foundation subgrades have been observed and evaluated by an ***Olsson*** representative, concrete should be placed as soon as possible to avoid subjecting the exposed soils to drying, wetting, or freezing conditions. If foundation subgrade soils are subjected to such conditions, the geotechnical engineer should be contacted to reevaluate the foundation bearing materials. It will not be acceptable for the contractor to place lean concrete, flowable fill, or other types of “mud mat” below shallow foundations unless specifically directed by the geotechnical engineer.

5.2. DEEP FOUNDATION DESIGN – POLE SIGN

During our exploration, boring sidewalls remained open while drilling at the B-9 and B-11 boring locations, and caved to a depth of 13.6 feet immediately following drilling at the B-13 boring location. Sloughing of sidewalls extending through sandy layers during drilled shaft construction should be expected. We recommend that the installation contractor review this report, the soils encountered, and select their means and methods for drilled shaft installation accordingly.

If designing lateral capacity of drilled shaft foundations using LPILE (by Ensoft Inc.) or similar programs, the following parameters are applicable for this project site. The design parameters are based on the results of our laboratory testing program and information obtained from borings B-9, B-11, and B-13. Fill placed during mass grading may change the depths of the soil layers indicated below. ***Olsson*** can be contacted to adjust the parameters below based on the structural fill soils placed across site following review of fill placement records in these areas.

TABLE 6.1 DESIGN PARAMETERS FOR POLE SIGNS CONSTRUCTED NEAR B-9

Soil Type	Approximate Formation Depths (ft)	Moist Unit Weight (pcf)	Ultimate Skin Friction (psf) ***	Ultimate End Bearing (psf) ***	Cohesion/ Friction Angle	Soil Modulus K Clay (pci) Sand (lb/in^3)	Strain Factor E50
SM (Frost)**	0 – 3	120	Ignore	Ignore	Ignore	Ignore	Ignore
SM**	3 – 6	125	100	N/R	32 degrees	Static – 25 Cyclic – N/A	N/A
CL*	6 – 15	130	500	N/R	1,000 psf	Static – 100 Cyclic – N/A	0.01
CL*	15 – 20	130	600	16,500	1,200 psf	Static – 500 Cyclic – 200	0.007

* Clay soils with cohesion of more than 1,000 psf should be modeled as "Stiff Clay with Free Water (Reese)".
** Sandy soils should be modeled as "Sand (Reese)".
*** These are ultimate or nominal values and do not include any factor of safety or resistance factors. When using allowable stress design method, we recommend using a minimum factor of safety 3 for end bearing and 2.5 for side friction against axial resistance with 3/4th of the allowable skin friction for uplift resistance.
N/A = Not Applicable
N/R= Not Recommended

TABLE 6.2 DESIGN PARAMETERS FOR POLE SIGNS CONSTRUCTED NEAR B-11

Soil Type	Approximate Formation Depths (ft)	Moist Unit Weight (pcf)	Ultimate Skin Friction (psf) ***	Ultimate End Bearing (psf) ***	Cohesion/ Friction Angle	Soil Modulus K Clay (pci) Sand (lb/in^3)	Strain Factor E50
CL (Frost)*	0 – 3	110	Ignore	Ignore	Ignore	Ignore	Ignore
CL*	3 – 9.5	130	500	N/R	1000 psf	Static – 100 Cyclic – N/A	0.010
SP**	9.5 – 15.5	115	350	36,000	34 degrees	Static – 90 Cyclic – N/A	N/A

* Clay soils with cohesion more than 1,000 psf should be modeled as "Stiff Clay with Free Water (Reese)".
** Sandy soils should be modeled as "Sand (Reese)".
*** These are ultimate or nominal values and do not include any factor of safety or resistance factors. When using allowable stress design method, we recommend using a minimum factor of safety 3 for end bearing and 2.5 for side friction against axial resistance with 3/4th of the allowable skin friction for uplift resistance.
N/A = Not Applicable
N/R= Not Recommended

TABLE 6.3 DESIGN PARAMETERS FOR POLE SIGNS CONSTRUCTED NEAR B-13

Soil Type	Approximate Formation Depths (ft)	Moist Unit Weight (pcf)	Ultimate Skin Friction (psf) ***	Ultimate End Bearing (psf) ***	Cohesion/ Friction Angle	Soil Modulus K Clay (pci) Sand (lb/in^3)	Strain Factor E50
CL (Frost)*	0 – 3	110	Ignore	Ignore	Ignore	Ignore	Ignore
SM**	3 – 9.5	125	150	N/R	30 degrees	Static – 75 Cyclic – N/A	N/A
SM**	9.5 – 14.5	125	225	N/R	32 degrees	Static – 90 Cyclic – N/A	N/A
SP**	14.5 – 20	120	350	36,000	34 degrees	Static – 150 Cyclic – N/A	N/A

* Clay soils with cohesion more than 1,000 psf should be modeled as “Stiff Clay with Free Water (Reese)”.
** Sandy soils should be modeled as “Sand (Reese)”.
*** These are ultimate or nominal values and do not include any factor of safety or resistance factors. When using allowable stress design method, we recommend using a minimum factor of safety 3 for end bearing and 2.5 for side friction against axial resistance with 3/4th of the allowable skin friction for uplift resistance.
N/A = Not Applicable
N/R= Not Recommended

Individual shafts designed per the parameters provided in the above table are anticipated to experience settlements less than 1-inch. This assumes that proper drainage is provided around the foundations to avoid moisture changes in the subgrade soils.

- ***Olsson*** recommends that drilled shaft foundations be a minimum of 18 inches in diameter and be designed in accordance with the soil parameters provided above. It is our opinion that the overturning moment will be the controlling loading condition and as such will govern the total depth of the shaft; however, the shaft should have a minimum length of 15 feet and should be embedded at least 2 feet or 1 diameter into the stiff clay or medium dense to dense sand layers encountered from 15 to 20 feet, whichever is greater, to achieve the ultimate end bearing values as shown in Table 3. The final shaft diameter and tip depth should be provided by the structural engineer or sign manufacturer based on their review of this report and the soil conditions encountered at the time of installation.
- An uplift capacity of 75 percent of the allowable skin friction can be used in combination with the overall pile weight for the design of a steel reinforced pile to resist uplift loads. The structural capacity of the piles should be determined using applicable local building codes.
- Drilled shafts required to resist uplift forces must be reinforced over their entire length. It is common for drilled shaft foundations to be designed with sufficient reinforcing steel to accommodate incidental bending moments and transient lateral loads. Typically, the reinforcing steel area requirement is equal to approximately 1 percent of the pile cross-sectional area. A distance equal to the shaft diameter should be neglected at the base of

the drilled shaft for side friction calculations to account for the side friction and end bearing interaction that occurs at the tip of the shaft.

- The contractor should be prepared for drilling with temporary casings if required. Where temporary casings are used, the casing should be extracted at a slow, uniform rate, with the pull in line with the center of the shaft. Where groundwater is encountered, concrete should be brought up at least to the external level of groundwater before any casing lifting commences to prevent infiltration of water, caving soils, or creation of voids in shaft concrete.
- Construction specifications for drilled shafts should include a concrete mix designed to limit bleeding of installed shafts. The concrete or grout mix, at a minimum, should be designed to achieve a minimum 28-day compressive strength of 4,000 psi.
- It is the pile contractor's responsibility to increase individual or group shaft lengths, the installation of additional shafts to compensate for any soil disturbance created by the contractor's means and methods during construction.
- An ***Olsson*** field technician should be on-site to observe the shaft as it is drilled and during concrete and reinforcing steel placement.
- The base of the drilled shaft boring should be clean and free of debris or loose soil prior to placing concrete or reinforcing steel. Concrete for the drilled shaft foundation should be placed promptly to reduce exposing the subsoil to rain, surface runoff, or drying conditions. If foundation bearing soils are subjected to such conditions, the soils should be reevaluated by ***Olsson*** prior to reinforcing steel or concrete placement.
- We recommend that concrete for drilled shaft foundations have a slump of 5 to 7 inches at the time of placement.
- Free-fall concrete placement is not recommended unless approved by the structural engineer. The use of a bottom dump hopper or tremie pipe could be considered to prevent potential aggregate segregation or sidewall disturbance.

5.3. SEISMIC CLASSIFICATION

Per the International Building Code (IBC), soils within the upper 100 feet determine the seismic structural design criteria for the project site. The soil shear strengths and blow counts (N values) were estimated based on the results of the laboratory testing program, field exploration, and the assumed soil properties on the undocumented soils below the lowest boring. For this project site, we recommend using a Site Class D (stiff soil profile) in accordance with 2015 IBC. This recommendation is based on the soil conditions encountered in the borings during the exploration and our assumption that the encountered soils continue beyond the drilled depth to the full 100 feet. A seismic survey to a depth of 100 feet should be performed to determine if an alternative seismic Site Class is applicable.

5.4. Floor Slab Design

A concrete slab-on-grade floor system appears feasible for the proposed building. Due to the documented swell and collapse potentials of the shallow native soils, we recommend at least 1 foot of structural fill be provided below the slab on grade by overexcavating and replacing the native subgrade below the bottom of the granular leveling and drainage layer as approved structural fill per *Section 4.2*. This may also be accomplished by properly placing structural fill to raise the site grade, as is indicated in the current grading plan. Following any overexcavation but prior to placement of structural fill, the exposed soils should be scarified, moisture conditioned, and recompacted as discussed in *Section 4.1*. Any overexcavation and replacement with structural fill should extend laterally at least 10 feet beyond all edges of the building. Additionally, the floor slab subgrade should be evaluated by proofrolling (if feasible) with an ***Olsson*** representative present, during the site grading or earthwork stages. If unstable soils are encountered which cannot be adequately densified in place, these soils should be removed and replaced with structural fill in accordance with the recommendations of this report.

Lightly loaded interior partition walls (applying less than 0.75 klf) may be supported directly on the slab on grade floor, although, depending on the floor slab design and the specific wall loads, it may be appropriate to increase the floor slab reinforcement or provide a thickened slab cross section below interior walls. For interior walls with loads greater than 0.75 klf, ***Olsson*** recommends that a footing be installed, independent from the floor slab, to properly distribute the wall loads to the underlying soil and reduce the potential for floor slab damage.

If these recommendations are followed and the subgrade soils are prepared and compacted as recommended, the building floor slab may be designed using a subgrade modulus (“k” value) of 150 psi/in.

Based on our experience with other Kum & Go projects, it may be appropriate to provide a sealed polyethylene vapor barrier between the new floor slab and granular drainage materials to reduce moisture infiltration. The decision to place a vapor barrier in direct contact with the slab or beneath the layer of granular fill should be made by the design engineer after considering the moisture sensitivity of new flooring materials or finishes and installed per the current American Concrete Institute standards and recommendations.

5.5. Exterior Slabs and Sidewalks

If the recommendations of this report are followed, exterior slabs and sidewalks within 10 feet around the Kum & Go building will be underlain with imported structural fill or onsite soils that have been prepared as structural fill. These soils could be frost susceptible. If these soils become very moist or saturated and freeze, slab heaving is possible. Positive grading to direct surface drainage away from the building will help limit the potential for moisture infiltration of slab subgrade soils and subsequent heaving. Considering the fairly low swell potential of the soils encountered, the standard Kum & Go “turn-down” design for approach and entrance slabs should be appropriate. Refer to the applicable Kum

& Go detail provided in the project plans for specific information. At a minimum, we recommend regularly scheduled crack and joint sealing between slabs, pavements, and the building to reduce potential moisture infiltration.

Prior to placing concrete, the exposed subgrade should be prepared in accordance with the recommendations presented in *Section 4.1*. Prepared subgrades should extend a minimum of one foot beyond each edge of the sidewalks, where feasible. It is important that the subgrade support be relatively uniform, with no abrupt changes in the degree of support. Improper subgrade preparation such as inadequate vegetation removal, failure to identify soft or unstable areas, and inadequate or improper compaction can also produce non-uniform subgrade support and cause unacceptable post-construction movement. In addition, positive grading to direct surface drainage away from the building will help limit the potential for moisture infiltration of slab subgrade soils and potential heaving.

5.6. LATERAL EARTH PRESSURES

The following soil parameters are provided for use in designing foundation or below grade retaining walls which are subjected to lateral earth pressures. The maximum toe pressure for below grade walls should not exceed the bearing capacity recommended in this report for shallow spread foundations. The parameters are based on the understanding that retained soils will be similar in composition to the on-site soils encountered during this exploration. The effects of lateral earth pressure should be considered during selection of the underground fuel tank.

Walls which are rigidly restrained at the top and are essentially unable to deflect or rotate should be designed for “at rest” earth pressure conditions. Walls that are unrestrained at the top and are free to deflect or rotate slightly may be designed for “active” earth pressure conditions. The “passive” earth pressure condition should be used to evaluate the resistance of soil to lateral loads. Equivalent fluid densities are provided in the table below, which are frequently used for the calculation of lateral earth pressures for the “at rest” and “active” conditions. The equivalent fluid densities below do not include the effects of surcharge loading.

TABLE 7. EARTH PRESSURE PARAMETERS

Condition	Soil Type	Equivalent Fluid Density*	
		Drained Condition	Undrained Condition
Active (K_a)	Low plasticity cohesive soil	45 pcf	90 pcf
	Cohesionless sand soil	40 pcf	80 pcf
At Rest (K_0)	Low plasticity cohesive soil	65 pcf	100 pcf
	Cohesionless sand soil	60 pcf	90 pcf
Passive (K_p)	Low plasticity cohesive soil	350 pcf	250 pcf
	Cohesionless sand soil	390 pcf	270 pcf

* Assumed level backfill.

These design recommendations are based on the following assumptions:

- For active earth pressure, the wall must rotate about its base, with top lateral movements 0.002 Z to 0.004 Z (granular) or 0.010 Z to 0.020 Z (clays), where Z is wall height. This is necessary to allow the active condition to develop.
- For passive earth pressure, the wall must rotate about its base, with top lateral movements 0.020 Z to 0.060 Z (granular) or 0.020 Z to 0.040 Z (clays), where Z is wall height. This is necessary to allow the passive condition to develop.
- Drained condition requires the walls have a permanent drainage system behind the wall that will prevent hydrostatic pressure from developing. Moisture collected in the drain system should be collected in a sump pit and pumped away from the structure or daylight to a location that will gravity drain. If permanent drainage is not provided, undrained condition should be used for design.
- The soil parameters provided above assume the backfill is level with the top of the wall. If a sloping backfill is utilized, the parameters will need to be reevaluated. In addition to a sloping backfill, the walls should be designed to resist surcharge loads, including nearby shallow foundations or other concentrated load components and traffic loads. Passive pressures are typically lower if the ground surface slopes downward away from the face of the wall.
- Passive resistance against horizontal movement within frost zone should be ignored.
- Backfill soils placed within the height of the retained wall should consist of well compacted selected granular soils or low-plasticity non-expansive cohesive soils. The cohesive soils should be tested to verify these soils can achieve a minimum friction angle of 28 degrees and a unit weight of 125 pcf. Backfilled granular materials should have a minimum friction angle of 32 degrees and a unit weight of 120 pcf. For the values to be valid, the backfill must extend out from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.
- Uniform surcharge, heavy equipment and other concentrated load components are not included.
- Factor of safety is not included. The designer should use appropriate factors of safety for design.
- To calculate the resistance to sliding on native soil, a coefficient of friction value of 0.35 should be used where the footing is supported by engineer-approved bearing soil consisting of clay soils or similar structural fill. A factor of safety of at least 1.5 should be applied to sliding calculations for the overall wall design.

5.7. UNDERGROUND FUEL TANKS

If soft or unstable soil conditions are encountered at the base of the UST excavation, the installation contractor could consider deepening the excavation to suitable bearing soils and replacing these soil as compacted structural fill, backfilling with compacted crushed stone, or using controlled low strength material (CLSM) or flowable fill up to the design base of excavation. If CLSM or flowable fill is selected, a compressive strength of 200 to 300 psi could be considered to allow future removal or excavation if desired.

The use of approved backfill materials is critical for long term tank performance. Do not mix approved backfill materials with sand or native soils.

- Excavated native soils should be replaced with approved backfill of proper size and gradation.
- Backfill suppliers should provide sieve analysis documentation that the materials meet these requirements.
- Backfill materials should be kept dry and free of ice or snow in freezing conditions.

Typical backfill material for new fuel tank installation consists of free-draining naturally rounded aggregates (pea gravel) with a maximum ¾-inch particle size and no more than 5 percent passing a #8 sieve. Crushed and washed stone with a maximum angular particle size of ½ inches and no more than 5 percent passing the #8 sieve can also be used. If material which meets these typical specifications is not locally available, the tank manufacturer should be contacted for information or approval of alternate materials and installation instructions.

Tank backfill materials should be compacted carefully to prevent tank damage; however, if new pavements will cover the backfill materials, adequate compactive effort must be applied to prevent future settlement and pavement damage. If new pavements will be placed over the new underground fuel tanks, we recommend that the backfill be compacted to a minimum 95 percent of the materials Standard Proctor (ASTM D-698) maximum dry density.

These backfill recommendations are provided as a general guideline for underground fuel tank applications. They are not intended to supersede the material recommendations or installation requirements of a specific tank manufacturer. We recommend that the manufacturer's recommendations be reviewed and followed, as appropriate, for the surface covering proposed, the tank type selected, and the site conditions anticipated by the installation contractor. In addition, since the UST is close to an overhead canopy, the excavations for the UST may affect the canopy and vice versa; therefore, the UST installation contractor and the canopy contractor should coordinate their excavation and construction activities. It is also worthwhile to note that the proposed UST is located next to an existing roadway, where shoring may be needed to protect the roads from disturbance or loss of support during the UST excavation and installation.

Groundwater was not encountered during our subsurface exploration and is not anticipated to impact the fuel tank excavations. However, groundwater may fluctuate seasonally and with precipitation events. If free water is encountered during the tank excavation and subgrade preparation, the contractor should follow an applicable local and state dewatering plan. The installation contractors are responsible for the design of shoring or benching of excavation sidewalls as applicable for their selected means and methods. Depending on the amount of clay binder, the sandy layers encountered during our drilling operation may potentially be unstable and may cave in during UST excavation or installation. The applicable contractors should review this report thoroughly and determine if shoring or benching of the excavation sidewalls are applicable and select their means and methods accordingly.

6. Pavements

6.1. Pavement Subgrade Preparation

It is important that pavement subgrade support be relatively uniform, with no abrupt changes in the degree of support. Non-uniform pavement support can occur at the transition from cut to fill areas, as a result of varying soil moisture contents or soil types, or where improperly placed utility backfill has been placed across or through areas to be paved. Improper subgrade preparation such as inadequate vegetation removal, failure to identify soft or unstable areas by proofrolling, and inadequate or improper compaction can also produce non-uniform subgrade support.

Olsson understands that the developer will be placing fill across the site during future mass grading activities. Fill placement during mass grading should be completed using the recommendations discussed in *Sections 4.1* and *4.2*.

To reduce potential for movement of pavements and to provide a stable bearing surface, soils underlying the pavements should be scarified to a minimum depth of 12 inches, moisture conditioned, and compacted as discussed in *Sections 4.1* and *4.2* at the time of pavement construction. The final pavement subgrade should be tested for compaction and proofrolled immediately prior to pavement placement to detect localized areas of instability. Unsuitable or unstable areas should be reworked as necessary to provide a uniform, moisture conditioned, and compacted subgrade.

If soft areas are identified during the subgrade preparation or if the subgrade soils have been exposed to adverse weather conditions, frost, excessive construction traffic, standing water, or similar conditions, the geotechnical engineer or his authorized field representative should be consulted to determine if corrective action is necessary. Proofrolling operations are not recommended in areas of new underground fuel tanks, fuel delivery lines, or underground utilities. Granular subgrade soils lacking adequate cohesive binder may rut or roll under construction equipment traffic. In these areas, the geotechnical engineer may elect to eliminate the proofrolling requirement.

It is recommended the prepared subgrades extend a minimum of 2 feet outside the pavements, where feasible. A representative of the geotechnical engineer should be present during subgrade preparation to observe, document, and test compaction of the materials at the time of placement or rework. As recommended for all prepared soil subgrades, ***Olsson*** recommends that heavy, repetitive construction traffic be controlled, especially during periods of wet weather, to minimize disturbance.

The final grades across this site should account for some post construction movement of exterior pavements due to moisture related shrink/swell or freeze/thaw cycles. To minimize this movement, it is recommended that the paved areas be designed with the maximum grades practical to further reduce the potential for ponding water. Our estimation of total movement is dependent on the grading plan incorporating positive drainage to reduce surface water infiltration of pavement subgrades. To increase pavement life and reduce the potential for heaving, a pavement maintenance program is recommended to regularly clean out and seal control joints and cracks that may develop.

The near surface fine grained materials are susceptible to frost heave. To help reduce distress related frost heave and to prolong the pavement life expectancy we recommend that aggregate base course be installed below the pavement surface materials.

6.2. PAVEMENT DESIGN

For Kum & Go stores, the daily traffic is relatively consistent and predictable, and primarily consists of passenger cars, beverage, food, and fuel delivery trucks, and trash trucks. Based on the information provided by Kum & Go, the traffic volume for the standard duty pavement section consists of 1,250 passenger cars and pickups per day, four (4) 3-axle, single-unit, delivery trucks per day, one (1) 3-axle, single-unit, trash truck every 2 days, and two (2) 5-axle, single trailer, fuel tanker per day. Based on this traffic volume and an annual traffic growth rate of 1.0 percent, an 18-kip Equivalent Single Axle Load ($ESAL_{18}$) value of approximately 122,500 is estimated for the pavement design life of 20 years for rigid pavements.

The concept plan for this store includes a stand-alone diesel canopy on the north side of the site. Based on the information provided by Kum & Go, the traffic volume associated with the increased heavy traffic for this heavy duty pavement section consists of eighteen (18) 3-axle, single-unit, semi diesel trucks per day in addition to the standard duty pavement loadings discussed above. Based on this traffic volume, an 18-kip Equivalent Single Axle Load ($ESAL_{18}$) value of approximately 700,000 is estimated for the pavement design life of 20 years for rigid pavements.

The pavement sections recommended in Tables 10 and 11 have been developed according to the AASHTO Guide for Design of Pavement Structures (1993) guidelines and is based on the $ESAL_{18}$ value indicated above and an estimated modulus of subgrade reaction (k) of 114 pci based on a tested R-value of 16 correlating to a resilient modulus (M_R) value of 4,334 psi. Other design parameters include reliability of 85 percent, combined standard deviation of 0.35 for concrete, initial serviceability index of 4.2, and terminal serviceability index of 2.5. In addition, we assumed a drainage factor of 0.9 and load transfer factor of 2.7 assuming plain/unreinforced jointed concrete pavement with less than one million ESALs.

Olsson recommends that rigid concrete pavement be used in areas designated for heavily loaded trucks, lanes or concentrated lanes of repetitive traffic, or in non-designated areas that could experience turning truck traffic. For this project site, the following Portland cement pavement section is recommended. If the recommendations in this report are followed, a design life of 20 years should be anticipated.

TABLE 8.1 STANDARD-DUTY CONCRETE PAVEMENT

Depth (in)	Material Designation	Material Specification
6.0		Concrete: CDOT Section 412 Portland Cement Concrete Pavement
4.0		Aggregate Base: CDOT Class 6 specification compacted to a minimum 95% of maximum dry density as determined by Standard Proctor (ASTM D-698)
12.0		Minimum prepared subgrade thickness: Scarify and recompact native soils in accordance with *Section 4.1* of this report

TABLE 8.2 HEAVY-DUTY CONCRETE PAVEMENT

Depth (in)	Material Designation	Material Specification
7.0		Concrete: CDOT Section 412 Portland Cement Concrete Pavement
4.0		Aggregate Base: CDOT Class 6 specification compacted to a minimum 95% of maximum dry density as determined by Standard Proctor (ASTM D-698)
12.0		Minimum prepared subgrade thickness: Scarify and recompact native soils in accordance with *Section 4.1* of this report

Curbs should be backfilled as soon as possible after pavement construction. Backfill should be properly compacted and sloped to prevent water from ponding and/or infiltrating pavement subgrades. Pavement joints should be caulked, and cracks should be quickly patched or sealed as they occur to prevent moisture from infiltrating and softening the subgrade soils.

7. LIMITATIONS

The conclusions and recommendations presented in this report are based on the information available regarding the proposed construction, the results obtained from our soil test borings and sampling procedures, the results of the laboratory testing program, and our experience with similar projects. The soil test borings represent a very small statistical sampling of subsurface soils, and it is possible that conditions may be encountered during construction that are substantially different from those indicated by the soil test borings. In these instances, adjustments to design and construction may be necessary. This geotechnical report is based on the site plan and information provided to ***Olsson*** and our understanding of the project as noted in this report. Changes in the location or design of new structures and/or pavements could significantly affect the conclusions and recommendations presented in this geotechnical report. ***Olsson*** should be contacted in the event of such changes to determine if the recommendations of this report remain appropriate for the revised site design.

This report was prepared under the direction and supervision of a Professional Engineer registered in the State of Colorado employed by ***Olsson***. The conclusions and recommendations contained herein are based on generally accepted, professional geotechnical engineering practices at the time of this report, within this geographic area. No warranty, express or implied, is intended or made. This report has been prepared for the exclusive use of Entitlement and Engineering Solutions Inc., Kum & Go L.C., and their authorized representatives for specific application to the proposed project. ***Olsson*** appreciates the opportunity to provide our services on this project and look forward to working with you during construction. Should you have any questions, please do not hesitate to contact us.

Respectfully submitted,
Olsson, Inc.

Lindsay Tita, P.E.
Project Engineer

Edward Schnackenberg, P.E.
Senior Geotechnical Engineer

APPENDIX A

Site Location Plan
Boring Location Map

Site Location Plan

Scale: nts	**Kum & Go Store #2323** **E. 6th Parkway & Frontage Road** **Aurora, Colorado**
Project: 020-2814	
Approved by: LAT	
Date: 9/16/2020	

Boring	Depth (ft)	Approximate Coordinates	
B-1	25.0	39°43'12.33"N	104°43'31.24"W
B-2	25.5	39°43'12.76"N	104°43'30.72"W
B-3	25.0	39°43'12.44"N	104°43'30.01"W
B-4	10.5	39°43'13.23"N	104°43'31.88"W
B-5	25.5	39°43'13.59"N	104°43'29.49"W
B-6	25.5	39°43'11.27"N	104°43'31.11"W
B-7	25.5	39°43'11.50"N	104°43'29.94"W
B-8	25.0	39°43'10.82"N	104°43'30.27"W
B-9	20.0	39°43'10.77"N	104°43'29.17"W
B-10	10.5	39°43'13.17"N	104°43'27.93"W
B-11	15.5	39°43'10.56"N	104°43'31.46"W
B-12	25.0	39°43'12.09"N	104°43'29.31"W
B-13	20.0	39°43'12.97"N	104°43'28.56"W

Boring Location Plan

Scale: nts
Project: 020-2814
Approved by: LAT
Date: 5/21/2021

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Kum & Go Store #2323
E. 6th Parkway & Frontage Road
Aurora, Colorado

APPENDIX B

Symbols and Nomenclature
Boring Logs

SYMBOLS AND NOMENCLATURE

DRILLING NOTES

DRILLING AND SAMPLING SYMBOLS

SS:	Split-Spoon Sample (1.375" ID, 2.0" OD)	HSA:	Hollow Stem Auger	NE:	Not Encountered
U:	Thin-Walled Tube Sample (3.0" OD)	CFA:	Continuous Flight Auger	NP:	Not Performed
CS:	Continuous Sample	HA:	Hand Auger	NA:	Not Applicable
BS:	Bulk Sample	CPT:	Cone Penetration Test	% Rec:	Percent of Recovery
MC:	Modified California Sampler	WB:	Wash Bore	WD:	While Drilling
GB:	Grab Sample	FT:	Fish Tail Bit	IAD:	Immediately After Drilling
SPT:	Standard Penetration Test Blows per 6.0"	RB:	Rock Bit	AD:	After Drilling
		PP:	Pocket Penetrometer	CI:	Cave-In

DRILLING PROCEDURES

Soil samples designated as "U" samples on the boring logs were obtained in using Thin-Walled Tube Sampling techniques. Soil samples designated as "SS" samples were obtained during Penetration Test using a Split-Spoon Barrel sampler. The standard penetration resistance 'N' value is the number of blows of a 140 pound hammer falling 30 inches to drive the Split-Spoon sampler one foot. Soil samples designated as "MC" were obtained in using Thick-Walled, Ring-Lined, Split-Barrel Drive sampling techniques. Recovered samples were sealed in containers, labeled, and protected for transportation to the laboratory for testing.

WATER LEVEL MEASUREMENTS

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In relatively high permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels is not possible with only short-term observations.

SOIL PROPERTIES & DESCRIPTIONS

Descriptions of the soils encountered in the soil test borings were prepared using Visual-Manual Procedures for Descriptions and Identification of Soils.

PARTICLE SIZE

Boulders	12 in. +	Coarse Sand	4.75mm-2.0mm	Silt	0.075mm-0.005mm
Cobbles	12 in.-3 in.	Medium Sand	2.0mm-0.425mm	Clay	<0.005mm
Gravel	3 in.-4.75mm	Fine Sand	0.425mm-0.075mm		

COHESIVE SOILS

Consistency	Unconfined Compressive Strength (Qu) (tsf)
Very Soft	<0.25
Soft	0.25 – 0.5
Firm	0.5 – 1.0
Stiff	1.0 – 2.0
Very Stiff	2.0 – 4.0
Hard	> 4.0

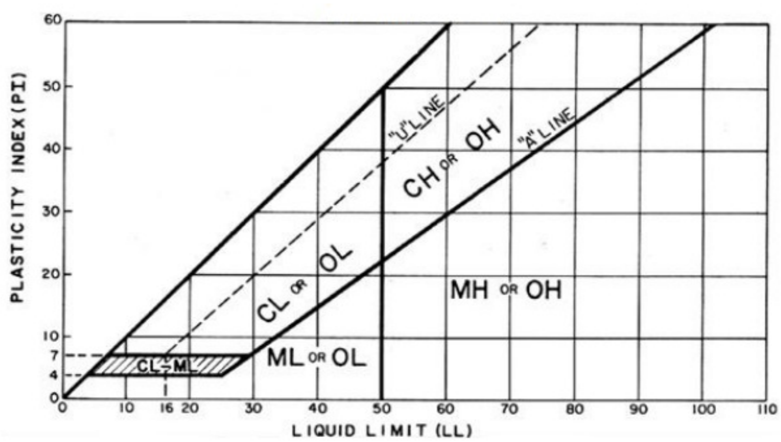
COHESIONLESS SOILS

Relative Density	'N' Value
Very Loose	0 – 3
Loose	4 – 9
Medium Dense	10 – 29
Dense	30 – 49
Very Dense	≥ 50

COMPONENT %

Description	Percent (%)
Trace	<5
Few	5 - 10
Little	15 - 25
Some	30 - 45
Mostly	50 - 100

PLASTICITY CHART



ROCK QUALITY DESIGNATION (RQD)

Description	RQD (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

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SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

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BOREHOLE REPORT NO. B-1

PROJECT NAME	CLIENT
Kum & Go Store #2323	Entitlement and Engineering Solutions
PROJECT NUMBER	LOCATION
020-2814	Aurora, Colorado

Modified California Sampler; Split Spoon

ELEVATION (ft)	MATERIAL DESCRIPTION : X: 3217910 Y: 1688102	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
5535	**APPROX. SURFACE ELEV. (ft):** 5535.0		0								
	ROOT ZONE *0.2'*										
	SANDY CLAY *very stiff, light brown, moist (CL)*			MC 1		11-14		8.5	121.8		Swell (200 psf surcharge): 1.5%
	3.5'										
5530	***CLAYEY SAND*** *fine to coarse sand, loose, yellow brown, moist (SC)*		5	SS 2		6-4-4 N=8					
	grades to medium dense			MC 3		9-14		21.3			
	9.0'										
5525	***SANDY CLAY*** *fine sand, stiff, yellow brown with white silt lensing, moist (CL)*		10	SS 4		4-6-7 N=13					
	14.0'										
5520	***POORLY GRADED SAND*** *with trace clay, fine to medium grained sand particles, dense, yellow brown, moist (SP)*		15	MC 5		11-23		6.2	112.5		
5515	*grades to with trace gravel, medium dense*		20	SS 6		8-9-10 N=19					
5510	*25.0'*		25	MC 7		11-17					

BASE OF BORING AT 25.0 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-2

Sheet 1 of 1

PROJECT NAME	CLIENT
Kum & Go Store #2323	Entitlement and Engineering Solutions
PROJECT NUMBER: 020-2814	LOCATION: Aurora, Colorado

Split Spoon — Modified California Sampler

MATERIAL DESCRIPTION
: **X**: 3217950 **Y**: 1688146

APPROX. SURFACE ELEV. (ft): 5535.0

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
5535		0								
	ROOT ZONE (0.2')									
	SILTY CLAYEY SAND *loose, yellow brown, moist (SC/SM)*		SS 1		6-5-4 N=9					
	grades to medium dense		MC 2		7-9		5.5	99.6		
5530	(6.0')	5								
	SANDY CLAY *lean clay, fine grained sand, very stiff, yellow brown, moist (CL)*		SS 3		9-11-14 N=25					
5525		10	MC 4		9-13		16.0	109.2		Swell (1000 psf surcharge): 0.6%
5520	(14.5') ***POORLY GRADED SAND*** *fine to coarse grained, medium dense, whitish brown, moist (SP)*	15	SS 5		8-7-4 N=11					
5515		20	MC 6		14-15		4.4			
5510	(25.5')	25	SS 7		9-7-11 N=18					

BASE OF BORING AT 25.5 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-3

PROJECT NAME: **Kum & Go Store #2323**

CLIENT: **Entitlement and Engineering Solutions**

PROJECT NUMBER: **020-2814**

LOCATION: **Aurora, Colorado**

Legend: Grab Sample; Split Spoon; Modified California Sampler

MATERIAL DESCRIPTION

: **X**: 3218005 **Y**: 1688114

APPROX. SURFACE ELEV. (ft): 5534.0

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE ***0.2'***		0	GB							
	SANDY CLAY *lean clay, fine to medium grained sand, very stiff, brown with gray lensing, moist (CL)*			MC 1		7-10					
5530	*grades to soft*		5	SS 2		3-2-1 N=3		11.8		30/17	
	grades to stiff			MC 3		4-6					
5525	*grades to increased fine grained sand content, yellow brown*		10	SS 4		4-5-5 N=10					
5520	*grades to very stiff*		15	MC 5		8-12		11.3	116.9		
5515	***19.0'***										
	POORLY GRADED SAND *fine to coarse grained sand particles, medium dense, yellowish brown, moist (SP)*		20	SS 6		10-10-10 N=20					
5510	*grades to dense* ***25.0'***		25	MC 7		16-20					

BASE OF BORING AT 25.0 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

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BOREHOLE REPORT NO. B-4

PROJECT NAME: **Kum & Go Store #2323**	CLIENT: **Entitlement and Engineering Solutions**
PROJECT NUMBER: **020-2814**	LOCATION: **Aurora, Colorado**

Legend: Modified California Sampler; Split Spoon

MATERIAL DESCRIPTION
: **X**: 3217859 **Y**: 1688193

APPROX. SURFACE ELEV. (ft): 5536.0

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE **0.2'**	0								
5535	***SILTY CLAYEY SAND*** *medium dense, yellow brown, moist (SC/SM)* **3.5'**		MC 1		10-7		10.0	114.1		
	SANDY CLAY *lean clay, fine sand, stiff, brown, moist (CL)* **6.0'**	5	SS 2		2-2-3 N=5		10.9			
5530	***CLAYEY SAND*** *fine to medium grained sand particles, medium dense, yellow brown, moist (SC)* **9.0'**		MC 3		9-9					
	SANDY CLAY *lean clay, fine sand, stiff, yellow brown with white silt lensing, moist (CL)* **10.5'**	10	SS 4		9-7-6 N=13		19.0			

BASE OF BORING AT 10.5 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-5

PROJECT NAME	CLIENT
Kum & Go Store #2323	Entitlement and Engineering Solutions
PROJECT NUMBER	**LOCATION**
020-2814	Aurora, Colorado

Legend: Split Spoon (SS); Modified California Sampler (MC)

MATERIAL DESCRIPTION
: **X**: 3218045 **Y**: 1688231

APPROX. SURFACE ELEV. (ft): 5534.0

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE — 0.2'	0								
	SANDY CLAY lean clay, fine to medium sand, firm, brown, moist (CL)		SS 1		4-2-4 N=6					
5530	grades to very stiff, varies to clayey sand	5	MC 2		9-16		4.2	116.3		Swell (500 psf surcharge): -1.3%
	grades to firm, with white lensing		SS 3		3-4-2 N=6					
5525	9.5'									
	SILTY CLAYEY SAND fine to coarse grained sand particles, medium dense, whitish brown, moist (SC/SM)	10	MC 4		6-13					
5520	grades to loose — 14.5'	15	SS 5		9-3-4 N=7					
	SANDY CLAY lean clay, fine grained sand, firm, yellow brown, moist (CL)									
5515	19.0'									
	SILTY SAND with trace clay, medium dense, yellowish brown, moist (SM)	20	MC 6		10-10		6.0			P-200 = 31.3%
5510	Driller's Note: Cave-in to 22.6 feet immediately following drilling — 24.0'									
	POORLY GRADED SAND fine to coarse grained sand particles, medium dense, whitish brown, moist (SP) — 25.5'	25	SS 7		12-12-14 N=26					

BASE OF BORING AT 25.5 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-6

PROJECT NAME	CLIENT
Kum & Go Store #2323	Entitlement and Engineering Solutions
PROJECT NUMBER	LOCATION
020-2814	Aurora, Colorado

Legend: Split Spoon (SS); Modified California Sampler (MC)

MATERIAL DESCRIPTION
: **X**: 3217921 **Y**: 1687995

APPROX. SURFACE ELEV. (ft): 5534.5

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		0								
	ROOT ZONE (0.2')									
	SILTY CLAYEY SAND *fine grained sand particles, medium dense, yellowish brown, moist (SC/SM)*		SS 1		6-7-7 N=14		6.6			
5530	(4.5')		MC 2		6-9					
	SANDY CLAY *lean clay, fine grained sand, stiff, light brown with white lensing, moist (CL)* (6.0')	5								
	SILTY CLAYEY SAND *fine to medium grained sand particles, medium dense, yellow brown, moist (SC/SM)*		SS 3		8-9-8 N=17					
5525	*grades to dense*	10	MC 4		14-17					
	(14.0')									
5520	***SANDY CLAY*** *lean clay, fine grained sand, stiff, yellow brown, moist (CL)*	15	SS 5		9-6-9 N=15		7.9			
	(19.0')									
5515	***POORLY GRADED SAND*** *with trace clay, fine to medium grained sand particles, medium dense, yellowish brown, moist (SP)*	20	MC 6		11-16					
5510	*Driller's Note: Cave-in to 23.4 feet immediately following drilling* (25.5')	25	SS 7		12-12-17 N=29					

BASE OF BORING AT 25.5 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

olsson	BOREHOLE REPORT NO. B-7	Sheet 1 of 1

PROJECT NAME **Kum & Go Store #2323**	CLIENT **Entitlement and Engineering Solutions**
PROJECT NUMBER **020-2814**	LOCATION **Aurora, Colorado**

Split Spoon | Modified California Sampler

MATERIAL DESCRIPTION
: **X**: 3218012 **Y**: 1688019

APPROX. SURFACE ELEV. (ft): 5534.0

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
			0								
	ROOT ZONE 0.2'										
	SANDY CLAY										
	lean clay, fine to medium grained sand, stiff, brown, moist (CL)			SS 1		9-7-5 N=12					
5530	*grades to very stiff*			MC 2		12-14	4.9	8.2	125.2		
			5								
	grades to fine grained sand, firm			SS 3		3-3-4 N=7					
5525	*grades to very stiff*		10	MC 4		5-11		14.4			
5520	*grades to stiff*		15	SS 5		4-6-7 N=13		11.0		28/13	
5515	19.0'										
	POORLY GRADED SAND		20	MC 6		12-15					
	with trace clay, fine to coarse grained sand particles, medium dense, yellowish brown, moist (SP)										
5510	*Driller's Note: Cave-in to 23.3 feet immediately following drilling*										
	grades to dense 25.5'		25	SS 7		12-13-17 N=30		3.2			

BASE OF BORING AT 25.5 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-8

Sheet 1 of 1

PROJECT NAME	CLIENT
Kum & Go Store #2323	Entitlement and Engineering Solutions
PROJECT NUMBER: 020-2814	LOCATION: Aurora, Colorado

Legend: Modified California Sampler; Split Spoon

MATERIAL DESCRIPTION
: X: 3217987 Y: 1687950

APPROX. SURFACE ELEV. (ft): 5536.0

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		0								
5535	*ROOT ZONE* (0.2')									
	SILTY CLAYEY SAND									
	fine grained sand, medium dense, yellow brown, moist (SC/SM)		MC 1		10-5		9.7	102.4		
	grades to loose	5	SS 2		2-3-3 N=6		7.5			P-200 = 23.1%
5530	(6.0')									
	SANDY CLAY		MC 3		6-11	4.3	13.6	115.9		
	lean clay, fine grained sand, very stiff, yellowish brown, moist (CL)									
	grades to stiff	10	SS 4		4-5-7 N=12					
5525										
	grades to very stiff (14.5')	15	MC 5		7-12					
5520	*POORLY GRADED SAND*									
	fine to coarse grained with trace clay, medium dense, whitish brown, moist (SP)									
		20	SS 6		6-7-8 N=15					
5515										
	grades to dense									
	Driller's Note: Cave-in to 24.1 feet immediately following drilling (25.0')	25	MC 7		17-24		4.4	105.1		

BASE OF BORING AT 25.0 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-9

PROJECT NAME	CLIENT
Kum & Go Store #2323	Entitlement and Engineering Solutions
PROJECT NUMBER: 020-2814	LOCATION: Aurora, Colorado

Legend: Split Spoon; Modified California Sampler

MATERIAL DESCRIPTION
: **X**: 3218059 **Y**: 1687945

APPROX. SURFACE ELEV. (ft): 5537.0

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE (0.2')	0								
	SILTY SAND									
5535	*fine grained sand, medium dense, yellowish brown, moist (SM)*		SS 1		6-6-5 N=11				NP/NP	
	grades to firm		MC 2		4-4					
	(6.0')	5								
5530	***SANDY CLAY*** *lean clay, fine grained sand, sitff, yellow brown, moist (CL)*		SS 3		4-4-6 N=10					
	grades to very stiff	10	MC 4		7-9		15.5	113.5		
5525										
	grades to stiff	15	SS 5		4-5-7 N=12		18.6			P-200 = 53.5%
5520										
	(20.0')	20	MC 6		7-8					

BASE OF BORING AT 20.0 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-10

PROJECT NAME	CLIENT
Kum & Go Store #2323	Entitlement and Engineering Solutions
PROJECT NUMBER	LOCATION
020-2814	Aurora, Colorado

Legend: Modified California Sampler; Split Spoon

MATERIAL DESCRIPTION
: **X**: 3218167 **Y**: 1688189

APPROX. SURFACE ELEV. (ft): 5535.0

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
5535		0								
	ROOT ZONE — 0.2'									
	SILTY SAND									
	dense, light brown, moist (SM)		MC 1		14-17		3.8			P-200 = 17.4%
5530	*grades to medium dense, yellow brown with white lensing, moist*	5	SS 2		9-7-5 N=12		3.7			
			MC 3		10-11					
	9.0'									
5525	***SANDY CLAY*** *lean clay, fine grained sand, hard, brown white lensing, moist (CL)* — 10.5'	10	SS 4		16-21-30 N=51					

BASE OF BORING AT 10.5 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-11

PROJECT NAME: **Kum & Go Store #2323**	CLIENT: **Entitlement and Engineering Solutions**
PROJECT NUMBER: **020-2814**	LOCATION: **Aurora, Colorado**

Legend: Split Spoon; Modified California Sampler

MATERIAL DESCRIPTION
: **X**: 3217894 **Y**: 1687923

APPROX. SURFACE ELEV. (ft): 5534.0

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE 0.2'	0								
	SANDY CLAY lean clay, fine grained sand, soft, light brown, moist (CL)		SS 1	CL	2-2-2 N=4		12.5		28/13	P-200 = 54.9%
5530	*grades to very stiff*		MC 2		7-11					
	grades to firm	5	SS 3		4-3-4 N=7		25.7			
5525	9.5'		MC 4		8-9					
	POORLY GRADED SAND with trace clay, fine to coarse grained, medium dense, yellow brown, moist (SP)	10								
5520	15.5'	15	SS 5		9-10-10 N=20					

BASE OF BORING AT 15.5 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-12

PROJECT NAME: **Kum & Go Store #2323**	CLIENT: **Entitlement and Engineering Solutions**
PROJECT NUMBER: **020-2814**	LOCATION: **Aurora, Colorado**

Legend: Modified California Sampler; Split Spoon

MATERIAL DESCRIPTION
: **X**: 3218061 **Y**: 1688079

APPROX. SURFACE ELEV. (ft): 5534.0

ELEVATION (ft)	MATERIAL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE (0.2')	0								
	SANDY CLAY *lean clay, fine grained sand, stiff, brown, moist (CL)*		MC 1		5-9				27/14	
5530	*grades to firm*	5	SS 2		5-3-2 N=5					
	grades to stiff		MC 3		5-9					
5525	(9.5')									
	SILTY CLAYEY SAND *fine to medium grained, medium dense, whitish brown, moist (SC/SM)*	10	SS 4		7-10-11 N=21					
5520	(14.5')									
	SANDY CLAY *lean clay, fine grained sand, very stiff, yellow brown, moist (CL)*	15	MC 5		7-10					
5515	(19.0')									
	POORLY GRADED SAND *with fine to coarse grained sand particles, medium dense, whitish brown, moist (SP)*	20	SS 6		7-10-14 N=24		5.6			P-200 = 1.0%
5510	*Driller's Note: Cave-in to 23.1 feet immediately following drilling*									
	grades to dense (25.0')	25	MC 7		17-26					

BASE OF BORING AT 25.0 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

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BOREHOLE REPORT NO. B-13

PROJECT NAME: Kum & Go Store #2323	CLIENT: Entitlement and Engineering Solutions
PROJECT NUMBER: 020-2814	LOCATION: Aurora, Colorado

Split Spoon — Modified California Sampler

MATERIAL DESCRIPTION
: **X**: 3218118 **Y**: 1688168

APPROX. SURFACE ELEV. (ft): 5534.0

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE **0.2'**		0								
	SANDY CLAY *with trace gray clasts that are oxidized, firm, brown, moist (CL)*			SS 1		5-4-4 N=8		10.4			
	3.5'										
5530	***SILTY SAND*** *medium dense, light brown, moist*			MC 2		6-10					
			5								
				SS 3		6-7-9 N=16					
5525			10	MC 4		7-13		12.2	110.1		
5520	*Driller's Note: Cave-in to 13.6 feet immediately following drilling* **14.5'**										
	POORLY GRADED SAND *fine to medium grained sand, medium dense, yellow brown, moist (SP)*		15	SS 5		9-11-16 N=27					
5515											
	grades to dense **20.0'**		20	MC 6		14-16					

BASE OF BORING AT 20.0 FEET

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
IAD	Not Encountered
AD	Not Performed

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

STARTED:	9/24/20	FINISHED:	9/24/20
DRILL CO.:	VINE LABS	DRILL RIG:	CME 55
DRILLER:	VINE LABS	LOGGED BY:	M. ALMAND
METHOD: CONTINUOUS FLIGHT AUGER			

APPENDIX C

Summary of Laboratory Test Results

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

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SUMMARY OF LABORATORY RESULTS

PROJECT NAME: Kum & Go Store #2323
PROJECT NUMBER: 020-2814
CLIENT: Entitlement and Engineering Solutions
PROJECT LOCATION: Aurora, Colorado

BORING NUMBER	SAMPLE I.D.	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID RATIO	SATURATION (%)	UNCONFINED STRENGTH (tsf)	STRAIN (%)	ATTERBERG LIMITS			P-200	USCS CLASS.
									LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX		
B-1	MC-1	1.0 - 2.0'	8.5	121.8	0.384	59.8							
B-1	MC-3	6.0 - 7.0'	21.3										
B-1	MC-5	14.0 - 15.0'	6.2	112.5	0.498	33.6							
B-2	MC-2	3.5 - 4.5'	5.5	99.6	0.692	21.3							
B-2	MC-4	9.0 - 10.0'	16.0	109.2	0.544	79.5							
B-2	MC-6	19.0 - 20.0'	4.4										
B-3	SS-2	3.5 - 5.0'	11.8						30	13	17		
B-3	MC-5	14.0 - 15.0'	11.3	116.9	0.442	69.1							
B-4	MC-1	1.0 - 2.0'	10.0	114.1	0.477	56.8							
B-4	SS-2	3.5 - 5.0'	10.9										
B-4	SS-4	9.0 - 10.5'	19.0										
B-5	MC-2	3.5 - 4.5'	4.2	116.3	0.449	25.2							
B-5	MC-6	19.0 - 20.0'	6.0									31.3	
B-6	SS-1	1.0 - 2.5'	6.6										
B-6	SS-5	14.0 - 15.5'	7.9										
B-7	MC-2	3.5 - 4.5'	8.2	125.2	0.346	63.5	4.9	5.0					
B-7	MC-4	9.0 - 10.0'	14.4										
B-7	SS-5	14.0 - 15.5'	11.0						28	15	13		
B-7	SS-7	24.0 - 25.5'	3.2										
B-8	MC-1	1.0 - 2.0'	9.7	102.4	0.646	40.7							
B-8	SS-2	3.5 - 5.0'	7.5									23.1	
B-8	MC-3	6.0 - 7.0'	13.6	115.9	0.454	81.0	4.3	7.4					
B-8	MC-7	24.0 - 25.0'	4.4	105.1	0.604	19.6							
B-9	SS-1	1.0 - 2.5'							NP	NP	NP		
B-9	MC-4	9.0 - 10.0'	15.5	113.5	0.485	86.3							
B-9	SS-5	14.0 - 15.5'	18.6									53.5	
B-10	MC-1	1.0 - 2.0'	3.8									17.4	
B-10	SS-2	3.5 - 5.0'	3.7										
B-11	SS-1	1.0 - 2.5'	12.5						28	15	13	54.9	CL
B-11	SS-3	6.0 - 7.5'	25.7										

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

SUMMARY OF LABORATORY RESULTS

PROJECT NAME: Kum & Go Store #2323

PROJECT NUMBER: 020-2814

CLIENT: Entitlement and Engineering Solutions

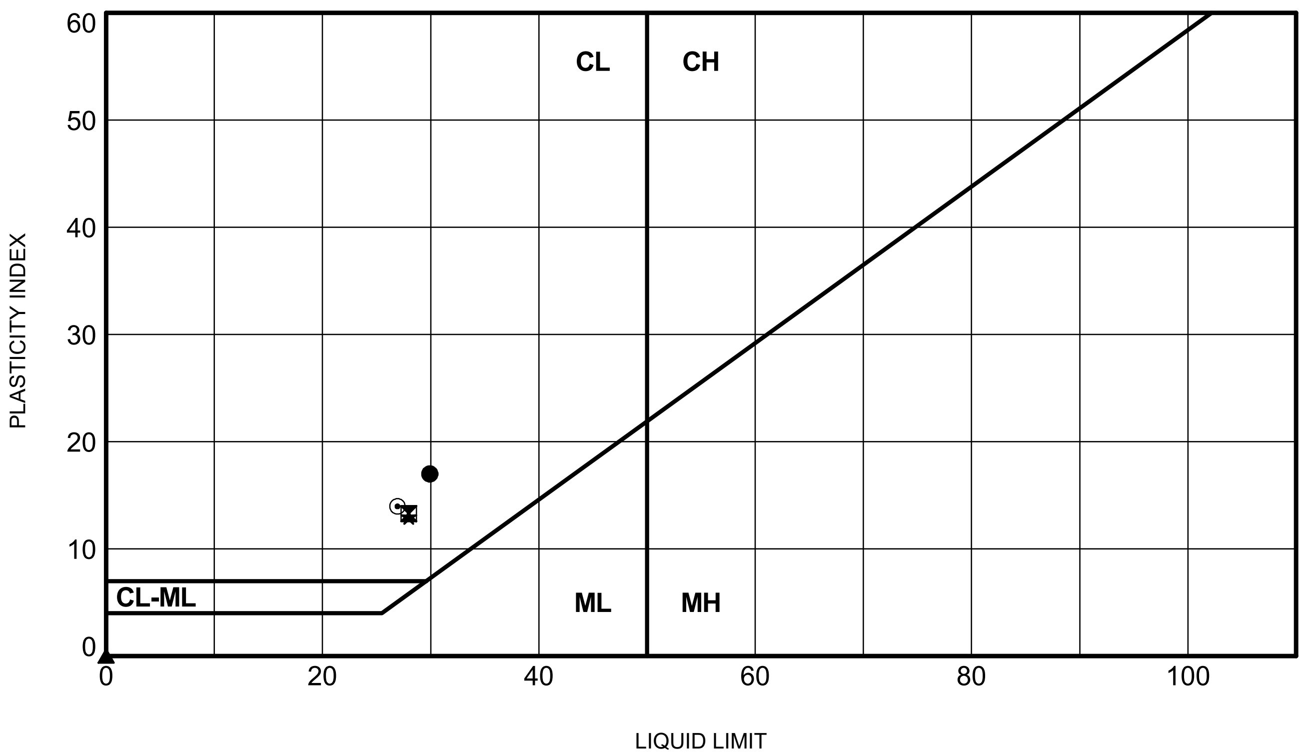
PROJECT LOCATION: Aurora, Colorado

BORING NUMBER	SAMPLE I.D.	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID RATIO	SATURATION (%)	UNCONFINED STRENGTH (tsf)	STRAIN (%)	ATTERBERG LIMITS			P-200	USCS CLASS.
									LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX		
B-12	**MC-1**	1.0 - 2.0'							27	13	14		
B-12	**SS-6**	19.0 - 20.5'	5.6									1.0	
B-13	**SS-1**	1.0 - 2.5'	10.4										
B-13	**MC-4**	9.0 - 10.0'	12.2	110.1	0.531	62.1							

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

ATTERBERG LIMITS RESULTS

PROJECT NAME: Kum & Go Store #2323 **CLIENT:** Entitlement and Engineering Solutions
PROJECT NUMBER: 020-2814 **PROJECT LOCATION:** Aurora, Colorado



	Boring No.	Sample ID	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plastic Index (%)	Fines (%)	Classification (USCS)
●	B-3	SS-2	3.5 - 5	30	13	17		
⧗	B-7	SS-5	14.0 - 15.5	28	15	13		
▲	B-9	SS-1	1.0 - 2.5	NP	NP	NP		
★	B-11	SS-1	1.0 - 2.5	28	15	13	54.9	CL
⊙	B-12	MC-1	1.0 - 2	27	13	14		

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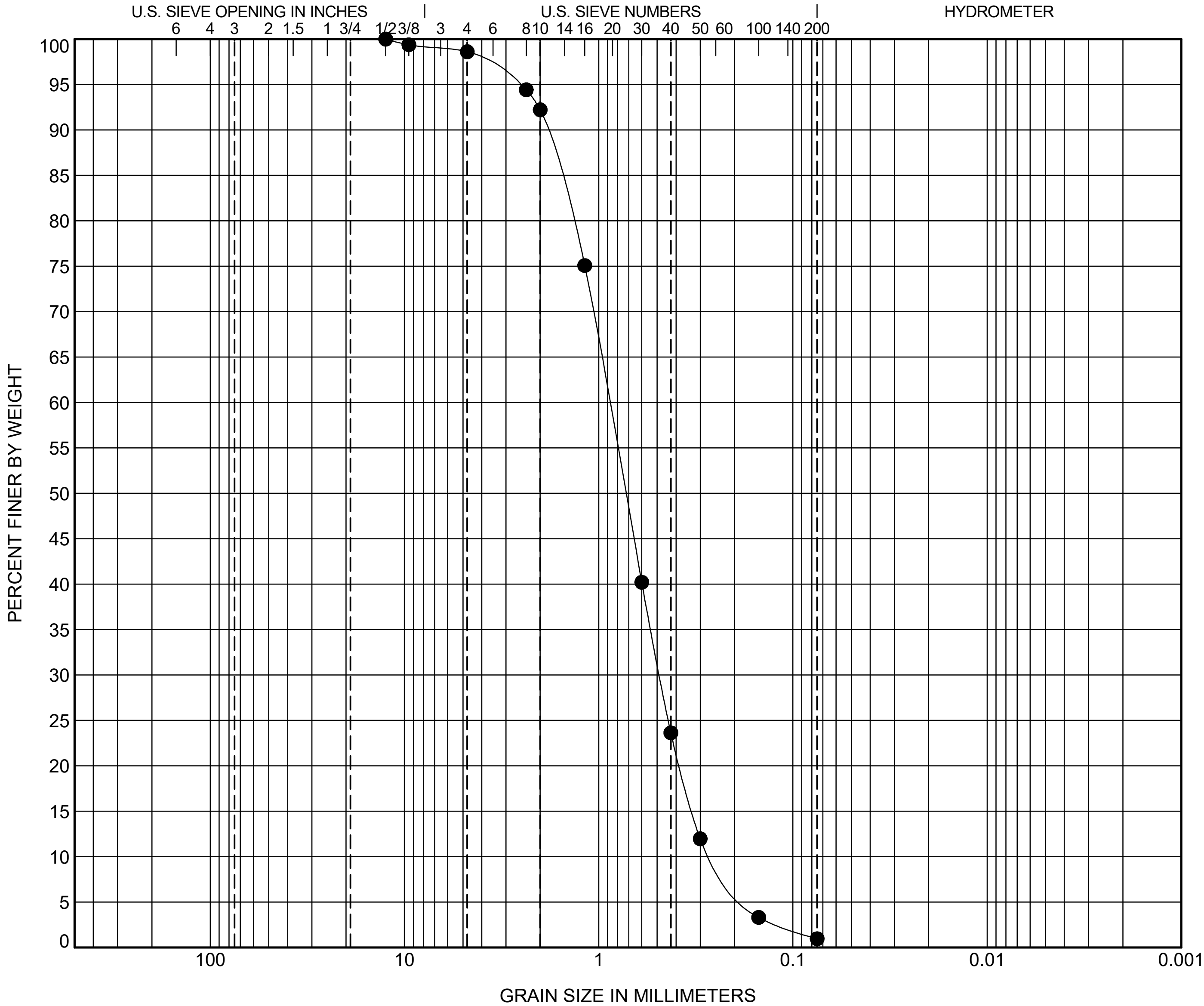
DENVER, COLORADO 80216

GRAIN SIZE DISTRIBUTION

PROJECT NAME: Kum & Go Store #2323 **CLIENT:** Entitlement and Engineering Solutions

PROJECT NUMBER: 020-2814 **PROJECT LOCATION:** Aurora, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Sample ID	Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	**B-12**	**SS-6**	**19.0 - 20.5**	**Poorly graded sand (SP)**				**1.04**	**3.44**

	Boring No.	Sample ID	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-12**	**SS-6**	**12.5**	**0.881**	**0.485**	**0.256**	**1.4**	**97.6**	**1.0**	

OLSSON, INC.
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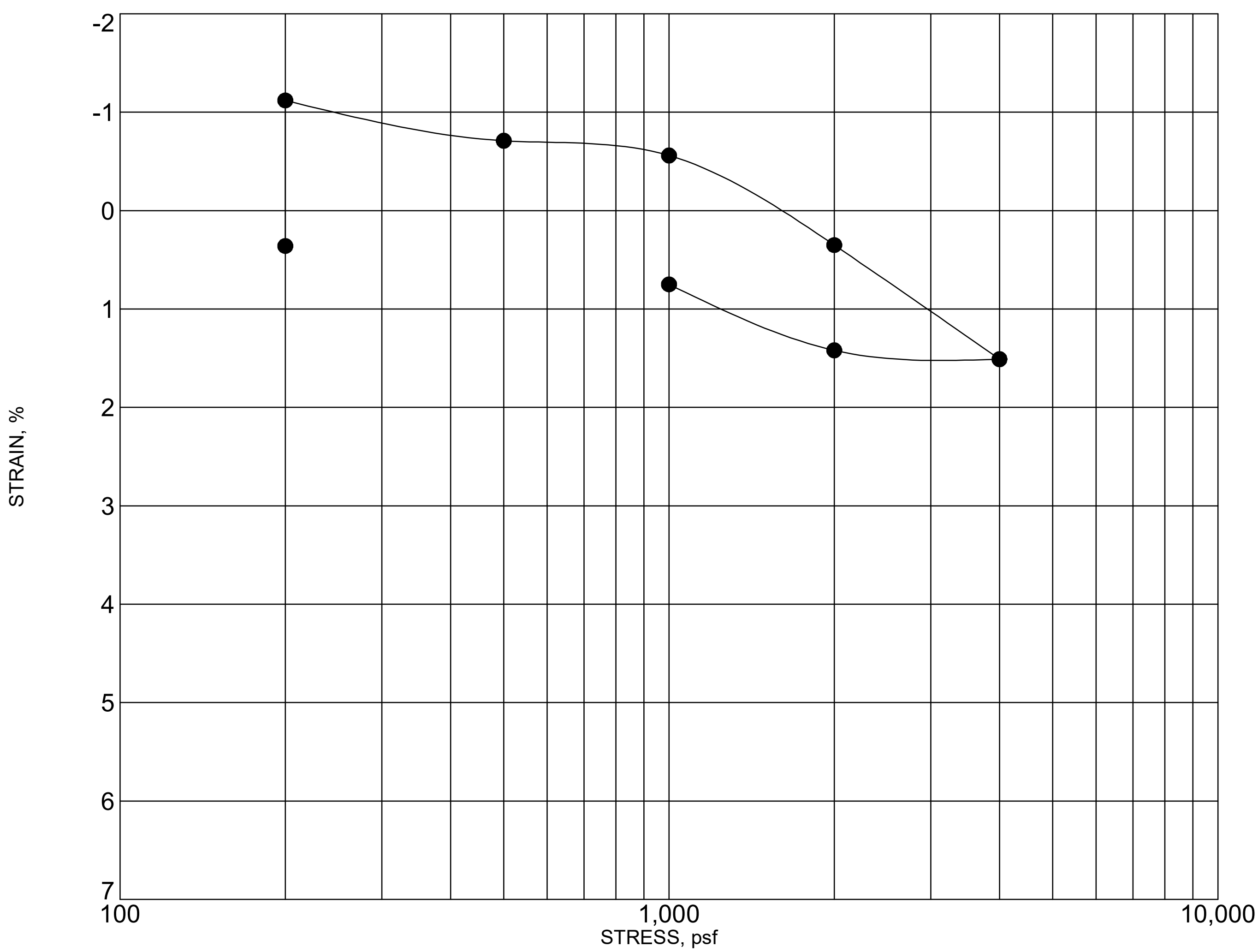
DENVER, COLORADO 80216

SWELL / CONSOLIDATION TEST

PROJECT NAME: Kum & Go Store #2323
CLIENT: Entitlement and Engineering Solutions
PROJECT NUMBER: 020-2814
PROJECT LOCATION: Aurora, Colorado



Boring No: B-1
Sample ID: MC-1
Sample Depth: 1.0 - 2.0'
Start Date: 9/28/2020
Technician: N. RASMUSSEN
Apparatus: DNV Swell A
Specific Gravity: 2.7

Initial Water Content (%): 8.5
Final Water Content (%): 16.5
Initial Dry Density (pcf): 121.8
Initial Void Ratio: 0.383
Final Void Ratio: 0.437
Initial Degree of Saturation (%): 59.6
Final Degree of Saturation (%): 100.0

Est. Preconsolidation Stress (tsf):
Laboratory Water Type: Distilled
Test Procedure Method: C
Interpretation Procedure: NA
Stress at Inundation (psf): 200
Specimen Trimming Method: Ring Sampler

ATTERBERG LIMITS

LL	PL	PI	Classification

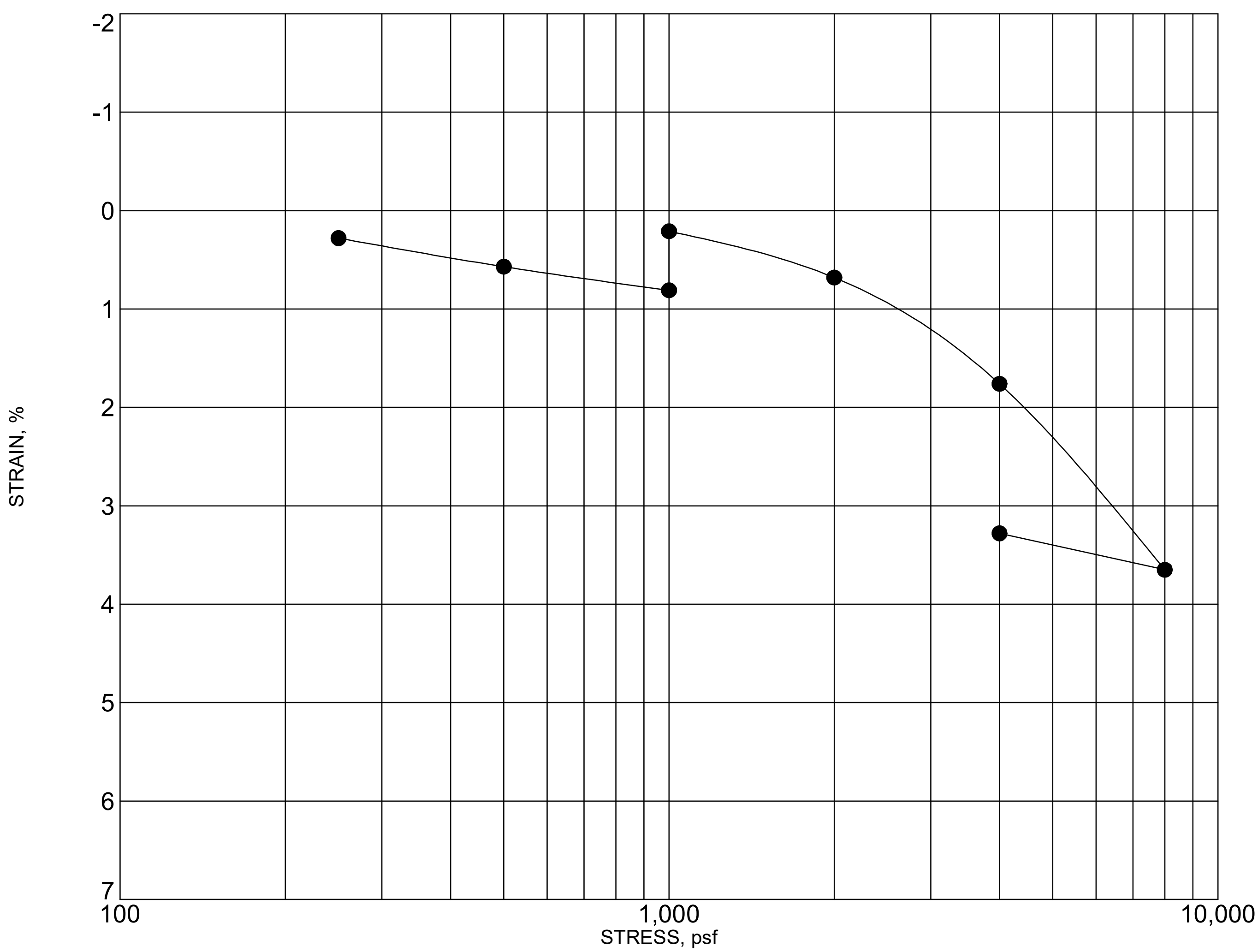
Sample Description: Sandy clay, light brown

Notes: Swell Potential (200 psf surcharge): 1.5%
Swell Pressure: 2,000 psf

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

SWELL / CONSOLIDATION TEST

PROJECT NAME: Kum & Go Store #2323
CLIENT: Entitlement and Engineering Solutions
PROJECT NUMBER: 020-2814
PROJECT LOCATION: Aurora, Colorado



Boring No:	B-2	Initial Water Content (%):	16.0	Est. Preconsolidation Stress (tsf):	
Sample ID:	MC-4	Final Water Content (%):	20.8	Laboratory Water Type:	Distilled
Sample Depth:	9.0 - 10.0'	Initial Dry Density (pcf):	109.2	Test Procedure Method:	C
Start Date:	9/28/2020	Initial Void Ratio:	0.543	Interpretation Procedure:	NA
Technician:	N. RASMUSSEN	Final Void Ratio:	0.523	Stress at Inundation (psf):	1,000
Apparatus:	DNV Swell B	Initial Degree of Saturation (%):	79.5	Specimen Trimming Method:	Ring Sampler
Specific Gravity:	2.7	Final Degree of Saturation (%):	100.0		

ATTERBERG LIMITS

LL	PL	PI	Classification

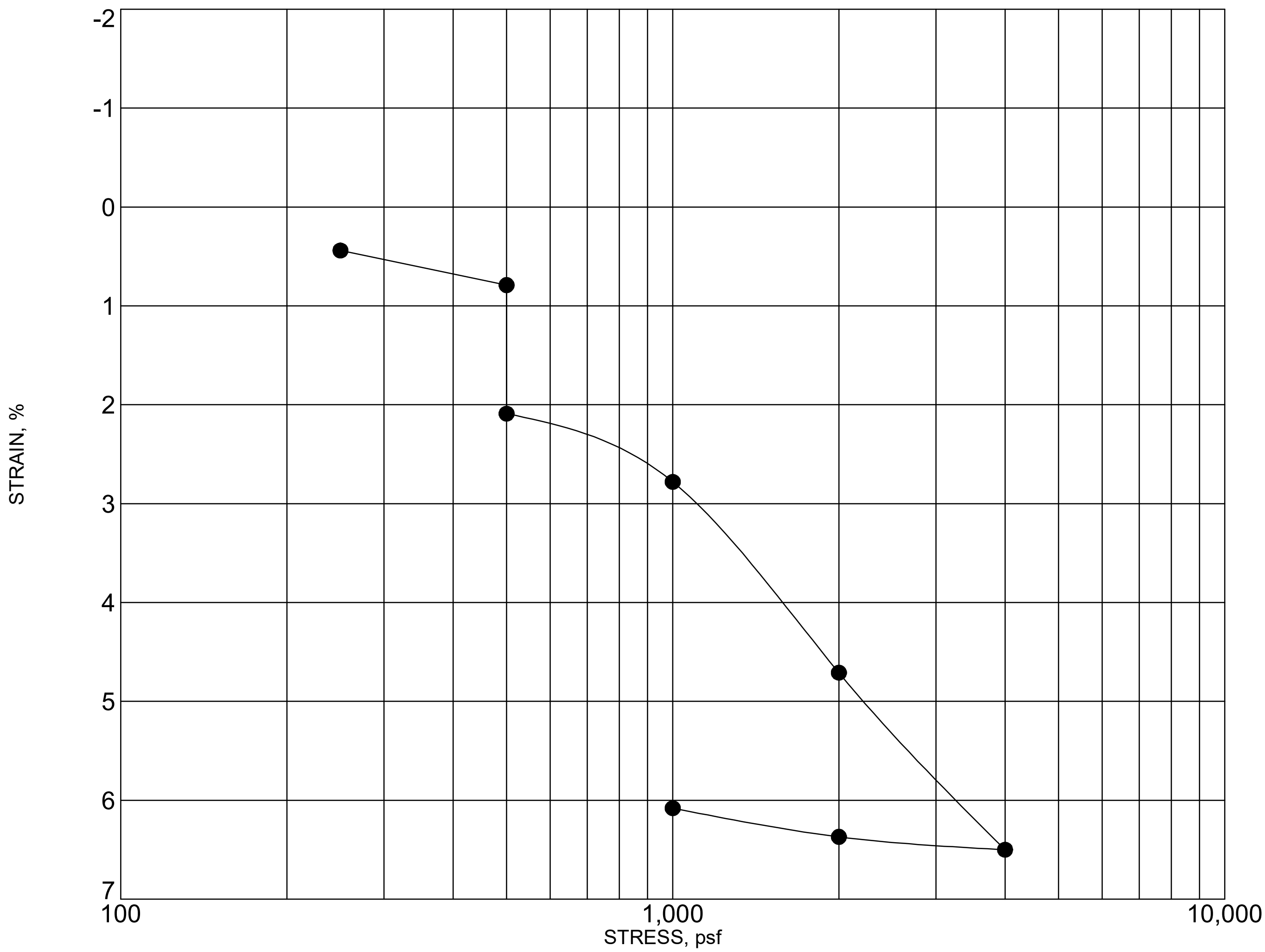
Sample Description: Sandy clay, yellow brown

Notes: Swell Potential (1,000 psf surcharge): 0.6%
Swell Pressure: 2,200 psf

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

SWELL / CONSOLIDATION TEST

PROJECT NAME: Kum & Go Store #2323
CLIENT: Entitlement and Engineering Solutions
PROJECT NUMBER: 020-2814
PROJECT LOCATION: Aurora, Colorado



Boring No: B-5
Initial Water Content (%): 4.2
Est. Preconsolidation Stress (tsf):

Sample ID: MC-2
Final Water Content (%): 17.1
Laboratory Water Type: Distilled

Sample Depth: 3.5 - 4.5'
Initial Dry Density (pcf): 116.3
Test Procedure Method: C

Start Date: 9/28/2020
Initial Void Ratio: 0.449
Interpretation Procedure: NA

Technician: N. RASMUSSEN
Final Void Ratio: 0.481
Stress at Inundation (psf): 500

Apparatus: DNV Swell E
Initial Degree of Saturation (%): 25.1
Specimen Trimming Method: Ring Sampler

Specific Gravity: 2.7
Final Degree of Saturation (%): 96.2

ATTERBERG LIMITS

LL	PL	PI	Classification

Sample Description: Sandy clay, brown

Notes: Swell Potential (500 psf surcharge): -1.3%
Swell Pressure: N/A (collapse upon wetting)

3990 Fox Street
Denver, CO 80216
TEL 303.237.2072
FAX 303.237.2659
www.olsson.com

Soil Corrosion Suite

Project Information	
Project Name:	Kum & Go Store #2323
Project Number:	020-2814
Client Name:	EES, Inc.
Project Location:	Aurora, Colorado
Sample and Test Information	
Sample Location:	B-3, 1-3 feet
Sample Description:	Sandy clay, brown
Laboratory Technician:	N. Rasmussen
Date Tested:	10/7/2020
Test Results	

Water Soluble Sulfate (Colorado Procedure CP-L-2103)

Dilution	Reading	Concentration, mg/L	Concentration, % mass
100:1	3	300	0.03

Water Soluble Chloride (Colorado Procedure CP-L-2104)

Dilution	Concentration, ppm	Concentration, % mass
Second	36	0.004

pH (ASTM G51)

pH Meter Reading
6.72

Electrical Resistivity (ASTM G57, -#10)

Readings (ohm*cm)
918
892
859
856
893

Lowest Resistivity (ohm*cm)
856

Sample portion passing the #10 sieve used in testing. Each reading performed after additional water was added.

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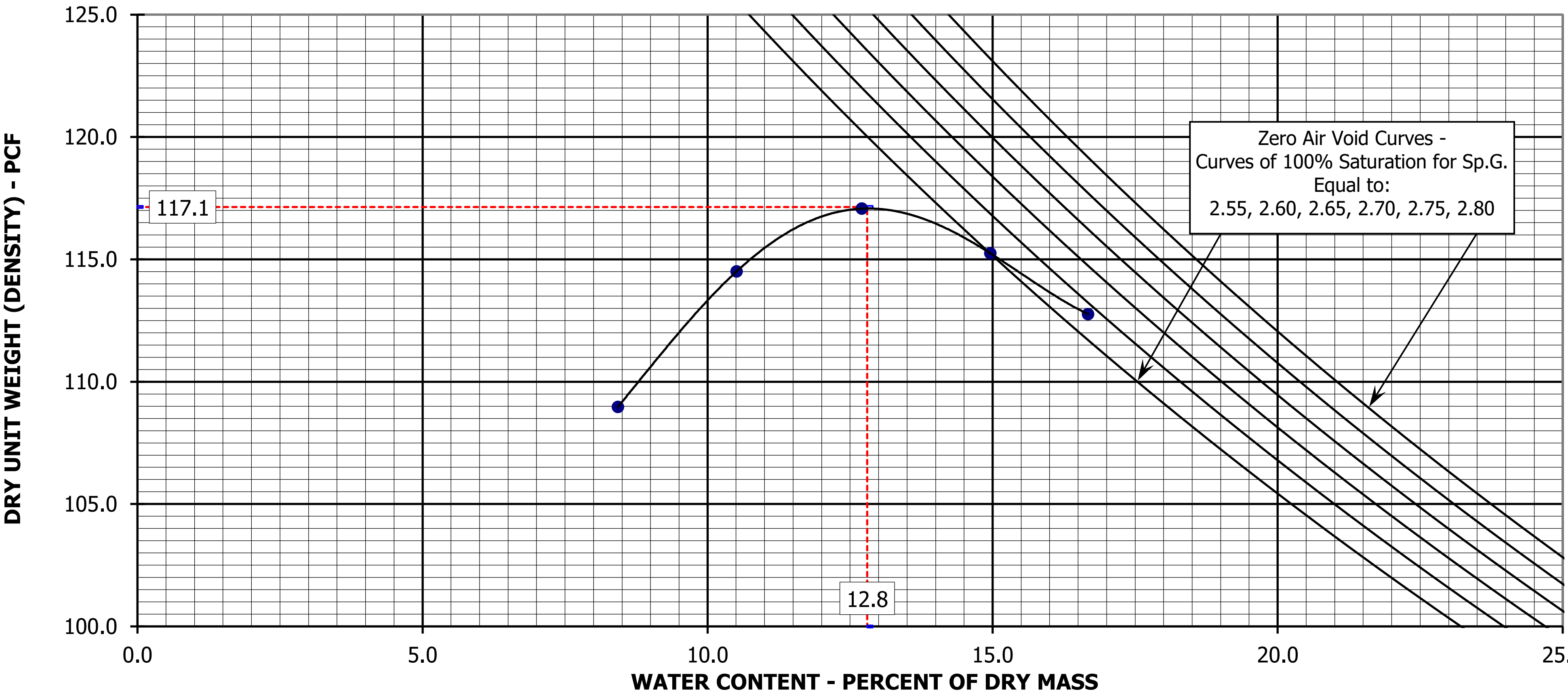
ASTM/AASHTO Compaction Test Procedure Designation:	ASTM D 698 (Standard)
Method:	A
Laboratory Maximum Dry Unit Weight (Density):	**117.1** pcf
Laboratory Optimum Moisture Content (OMC):	**12.8** %



Sample Location	Elev. or Depth, ft	**LL**	PL	**PI**	**-#200, %**	Soil Description & Classification
Composite: B-4 and B-11						Visual: SAND, clayey, brown AASHTO: USCS:

Moisture/Density Relationship (Proctor) Test

Project Number:	20.024, Olsson		
Project Name:	Kum & Go #2323 (Olsson Project No. 020-2814)		
Drawn By:	A. Wright	Tested by:	J. De Los Santos
Checked By:	G. Hoyos	Date:	29-Sep-20
Date:	30-Sep-20	Lab ID Number:	2021110

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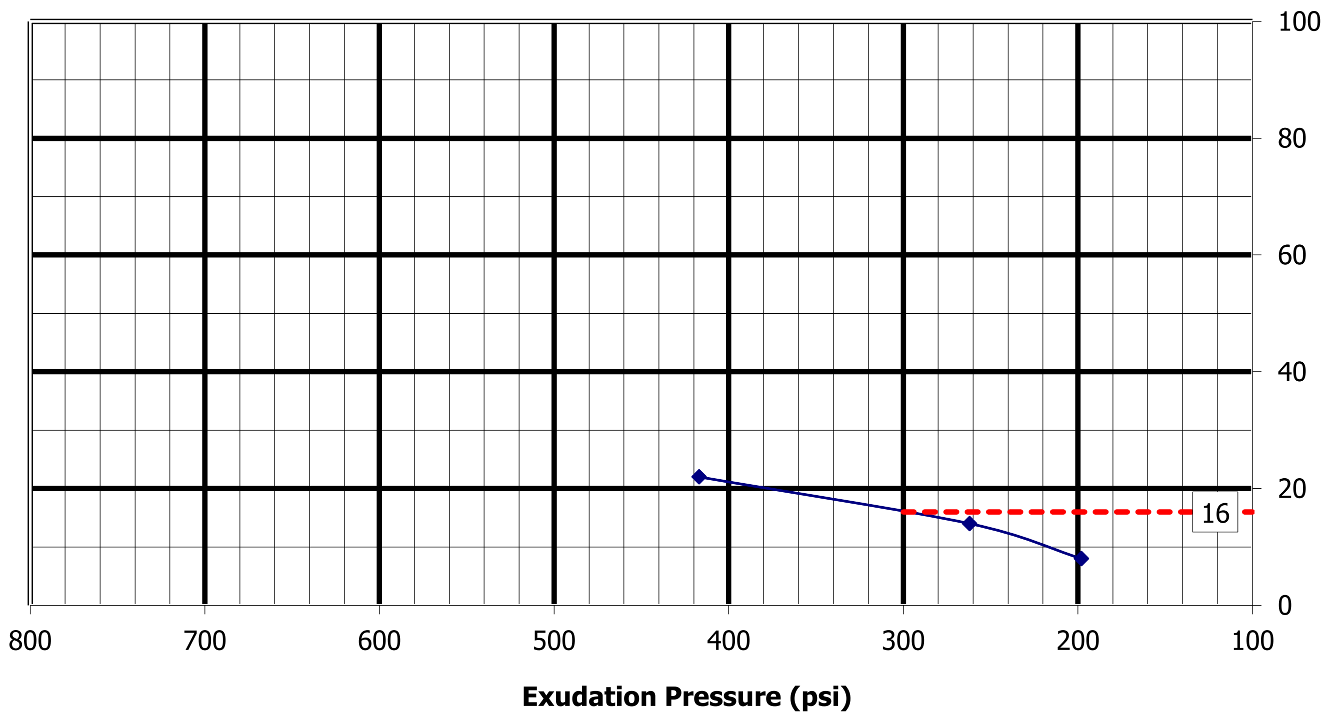
AASHTO ACCREDITED

R-VALUE TEST GRAPH (ASTM D2844)

Project Number:	20.024, Olsson	Date:	29-Sep-20
Project Name:	Kum & Go #2323 (Olsson Project No. 020-2814)	Technician:	J. Weinerth
Lab ID Number:	2021110	Reviewer:	G. Hoyos
Sample Location:	Composite: B-4 and B-11		
Visual Description:	SAND, clayey, brown		



R-Value @ Exudation Pressure 300 psi:	**16**
Specification:	

CDOT Pavement Design Manual, 2011.
Eq. 2.1 & 2.2, page 2-3.

S_1 =[(R-5)/11.29]+3 **S_1= 3.97**

M_R =$10^{[(S_1+18.72)/6.24]}$ **M_R= 4,334**

M_R = Resilient Modulus, psi

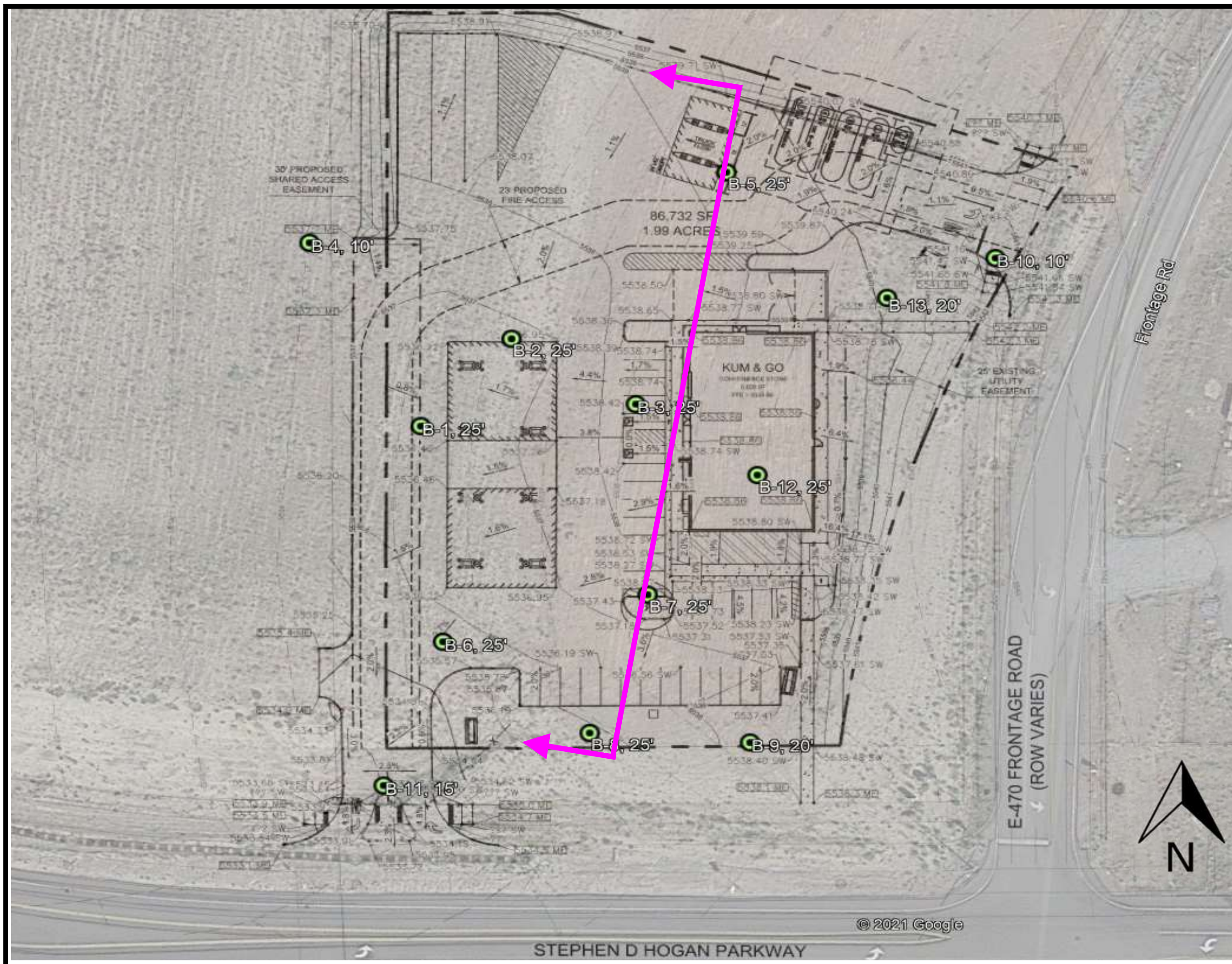
S_1 = the Soil Support Value

R = the R-Value obtained

Test Specimen:	1	2	3
Moisture Content, %:	12.9	13.9	14.7
Expansion Pressure, psi:	0.18	-0.09	-0.27
Dry Density, pcf:	123.2	120.2	117.9
R-Value:	22	14	8
Exudation Pressure, psi:	417	262	198

Note: The R-Value is measured; the M_R is an approximation from correlation formulas.

APPENDIX D
Geologic Cross Section Map
Geologic Profile



Boring	Depth (ft)	Approximate Coordinates	
B-1	25.0	39°43'12.33"N	104°43'31.24"W
B-2	25.5	39°43'12.76"N	104°43'30.72"W
B-3	25.0	39°43'12.44"N	104°43'30.01"W
B-4	10.5	39°43'13.23"N	104°43'31.88"W
B-5	25.5	39°43'13.59"N	104°43'29.49"W
B-6	25.5	39°43'11.27"N	104°43'31.11"W
B-7	25.5	39°43'11.50"N	104°43'29.94"W
B-8	25.0	39°43'10.82"N	104°43'30.27"W
B-9	20.0	39°43'10.77"N	104°43'29.17"W
B-10	10.5	39°43'13.17"N	104°43'27.93"W
B-11	15.5	39°43'10.56"N	104°43'31.46"W
B-12	25.0	39°43'12.09"N	104°43'29.31"W
B-13	20.0	39°43'12.97"N	104°43'28.56"W

Approximate location of geologic cross-section

Geologic Cross Section Location Plan

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Scale: nts
Project: 020-2814
Approved by: LAT
Date: 5/21/2021

Kum & Go Store #2323
E. 6th Parkway & Frontage Road
Aurora, Colorado

OLSSON, INC.
3990 FOX STREET
DENVER, COLORADO 80216

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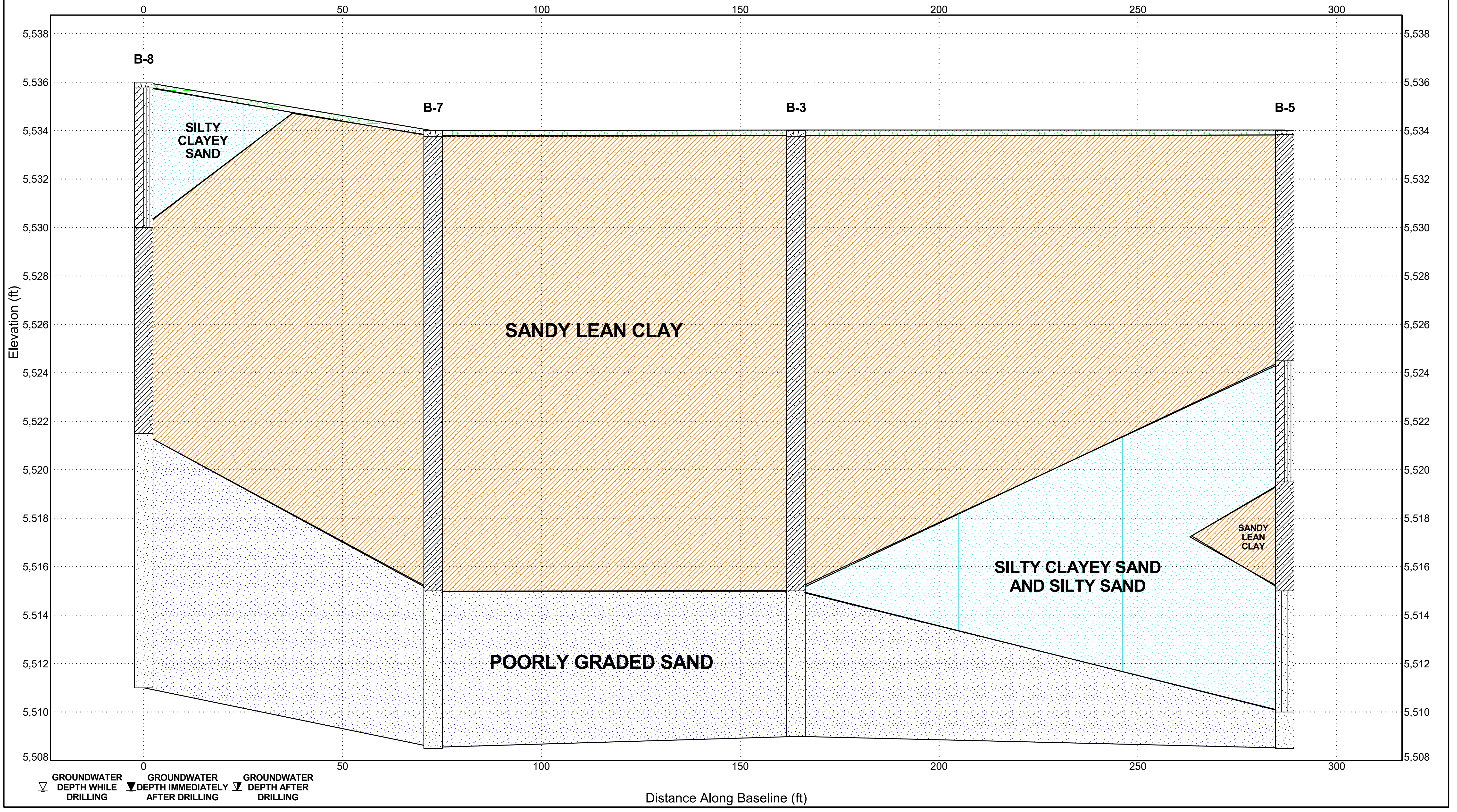
GEOLOGIC PROFILE
Site Cross-Section

Legend: Topsoil; USCS Low Plasticity Sandy Clay; USCS Poorly-graded Sand; USCS Silty, Clayey Sand; USCS Silty Sand

PROJECT NAME Kum & Go Store #2323
PROJECT NUMBER 020-2814
CLIENT Entitlement and Engineering Solutions
PROJECT LOCATION Aurora, Colorado

NOTE: Soil stratification, as shown on the geologic profile, represents soil conditions at the boring locations: however, variations may occur between or around the boring locations.

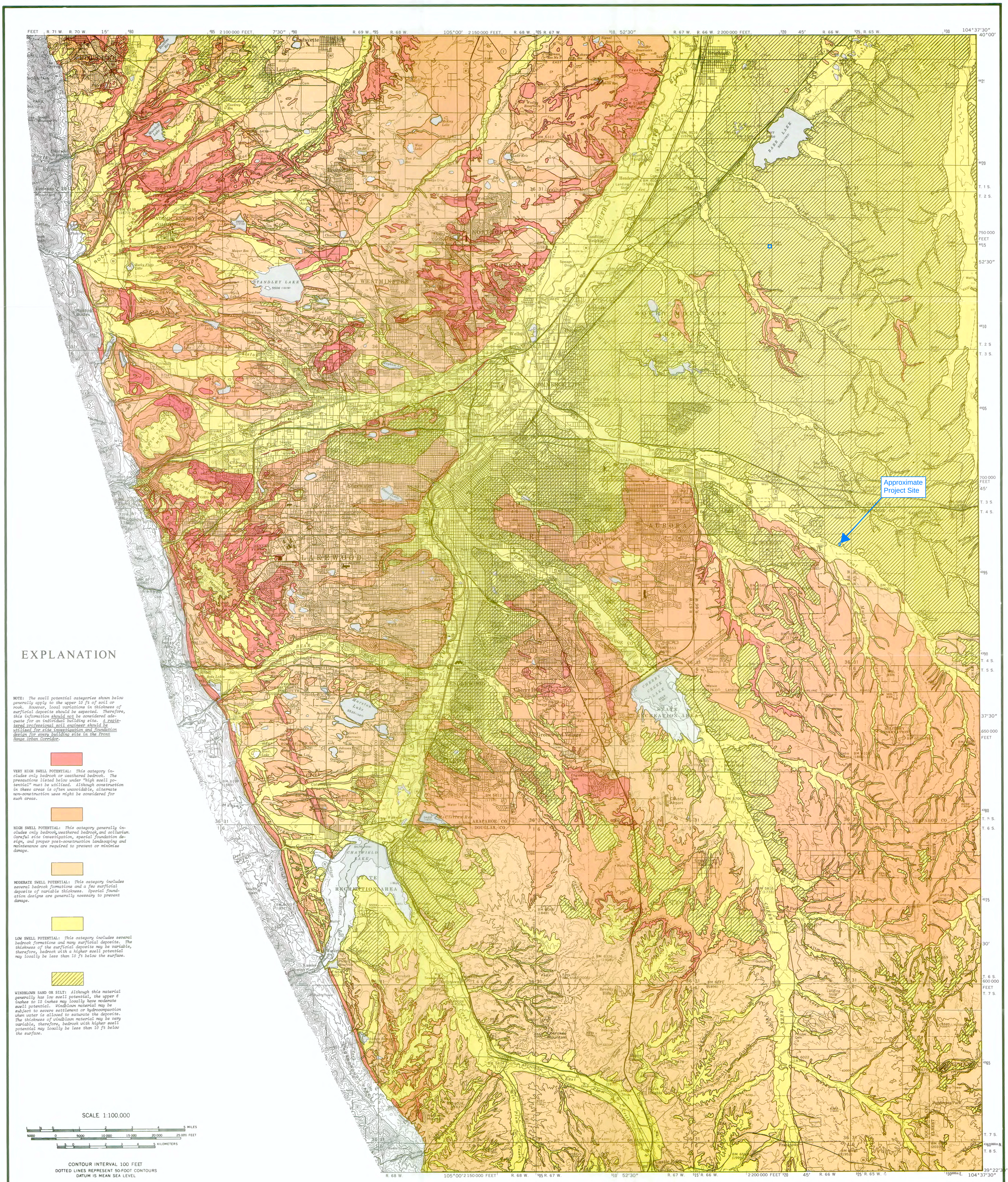


APPENDIX E
Potentially Swelling Soil and Rock Map

DEPARTMENT OF NATURAL RESOURCES
COLORADO GEOLOGICAL SURVEY
JOHN W. ROLD, DIRECTOR

Prepared in cooperation with the
UNITED STATES GEOLOGICAL SURVEY

GREATER DENVER AREA
COLORADO



Map edited and published by the
Colorado Geological Survey, 1973-1974

Base map from U. S. Geological Survey, 1972

CARTOGRAPHICS: JAMES A. BARNES

13°
TRUE NORTH
MAGNETIC NORTH
DECLINATION AT
CENTER OF SHEET

POTENTIALLY SWELLING SOIL AND ROCK IN THE FRONT RANGE URBAN CORRIDOR, COLORADO

BY

Stephen S. Hart

INDEX TO USGS 7.5' QUADRANGLES

FRONT RANGE URBAN CORRIDOR
SHEET 2 OF 4