Geotechnical Engineering Report

Balsam Park
Greeley, Colorado
January 11, 2021
Terracon Project No. 21205073

Prepared for:
City of Greeley, CO – Public Works
Greeley, Colorado

Prepared by:
Terracon Consultants, Inc.
Greeley, Colorado

January 11, 2021

City of Greeley, CO – Public Works
1001 9th Avenue
Greeley, Colorado 80631

Attn: Mr. Brian Ward, P.E.
P: (970) 350-9881
E: brian.ward@greeleygov.com

Re: Geotechnical Engineering Report
Balsam Park
Southeast of the Intersection of East 24th Street and Balsam Avenue
Greeley, Colorado
Terracon Project No. 21205073

Dear Mr. Ward:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the project referenced above. This study was performed in general accordance with Terracon Proposal No. P21205073 dated December 16, 2020. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, concrete walks, crusher fines paths and retaining walls for the proposed project.

We appreciate the opportunity to be of service to you on this project. Materials testing and construction observation services are provided by Terracon as well. We would be pleased to discuss these services with you. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Abby L. Lennox, E.I.
Field Engineer

COLORADO REGISTERED ERIC D. BERNHARDT 1/11/2021 38829 PROFESSIONAL ENGINEER

Eric D. Bernhardt, P.E.
Geotechnical Department Manager

REPORT TOPICS

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

ATTACHMENTS

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

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Overview	A geotechnical exploration has been performed for the proposed Balsam Park improvements to be constructed southeast of the intersection of East 24th Street and Balsam Avenue. Four (4) borings were performed to depths of approximately 10½ to 20½ feet below existing site grades.
Subsurface Conditions	Subsurface conditions encountered in our exploratory borings generally consisted of about 1½ to 2½ feet of clayey/silty sand over about 6½ to 16½ feet of poorly graded and/or well graded sand with gravel over about 6 feet of poorly graded sand with silt. Boring logs are presented in the **Exploration Results** section of this report.
Groundwater Conditions	The boreholes were observed while drilling and shortly after completion for the presence and level of groundwater. Groundwater was not observed in the borings while drilling, or for the short duration the borings could remain open. These observations represent short-term groundwater conditions at the time of and shortly after the field exploration and may not be indicative of other times or at other locations. Groundwater levels can be expected to fluctuate with varying seasonal and weather conditions, and other factors. However, we do not believe groundwater will significantly impact the project.
Geotechnical Concerns	Comparatively loose sand soils were encountered within the upper approximately 9 feet of the borings completed at this site. These materials present a risk for potential settlement of shallow foundations, concrete flatwork and other surficial improvements. These materials can also be susceptible to disturbance and loss of strength under repeated construction traffic loads and unstable conditions could develop. Stabilization of loose soils may be required at some locations to provide adequate support for construction equipment and proposed structures.
Earthwork	On-site soils typically appear suitable for use as general engineered fill and backfill on the site provided they are placed and compacted as described in this report. Import materials (if needed) should be evaluated and approved by Terracon prior to delivery to the site. Earthwork recommendations are presented in the **Earthwork** section of this report.
Grading and Drainage	As discussed in the **Grading and Drainage** section of this report, surface drainage should be designed, constructed and maintained to provide rapid removal of surface water runoff away from the proposed pavilions and shelters. Water should not be allowed to pond adjacent to foundations or concrete flatwork and conservative irrigation practices should be followed to avoid wetting foundation soils. Excessive wetting of foundations soils can cause movement and distress to foundations and concrete flatwork.
Foundations	We believe the proposed pavilions, shelters, and other ancillary structures can be constructed on a reinforced concrete mat or spread footing foundation system.
Concrete Walks and Crusher Fines Paths	We understand concrete walks and crusher fines paths are to be constructed at the proposed site. Prior to placing landscape fabric, strip and remove existing vegetation, topsoil, and any other deleterious materials from the proposed construction areas. We recommend scarifying the exposed subgrade to a depth of at least 10 inches, moisture conditioning and compacting prior to fill placement or construction of the proposed concrete walks and crusher fines paths.
Seismic Considerations	As presented in the **Seismic Considerations** section of this report, the International Building Code, which refers to Section 20 of ASCE 7, indicates the seismic site classification for this site is D.

Topic [1]	Overview Statement [2]
Construction Observation and Testing	Close monitoring of the construction operations and implementing drainage recommendations discussed herein will be critical in achieving the intended foundation performance. We therefore recommend that Terracon be retained to monitor this portion of the work.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics (bold orange font) above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design making and design purposes. It should be recognized that specific details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein.

Geotechnical Engineering Report

Balsam Park

Southeast of the Intersection of East 24th Street and Balsam Avenue

Greeley, Colorado

Terracon Project No. 21205073

January 11, 2021

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed improvements to Balsam Park located southeast of the intersection of East 24th Street and Balsam Avenue in Greeley, Colorado. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Foundation design and construction
- Seismic considerations
- Excavation considerations

The geotechnical engineering scope of services for this project included the advancement of four (4) test borings to depths ranging from approximately 10½ to 20½ feet below existing site grades.

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

SITE CONDITIONS

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

Item	Description
Parcel Information	The project site is located southeast of the intersection of Balsam Avenue and East 24th Street in Greeley, Colorado. The approximate Latitude/Longitude of the center of the site is 40.39747° N/104.66747° W. See **Site Location**.
Existing Improvements	Balsam Park currently consists of irrigated fields used for recreational sports.
Current Ground Cover	The ground cover consists of maintained grass.
Existing Topography	The site is relatively flat.

PROJECT DESCRIPTION

Our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Communication was made via phone call and email discussing the project scope on December 10, 2020.
Project Description	The project includes improvements to the existing Balsam Park.
Proposed Construction	■ Concrete walks ■ Crusher fines paths ■ Picnic pavilion/shelters ■ Water feature (3/4-inch water line fed flume) ■ Flagstone patios and dry-laid sandstone landscape walls (4-feet max.)
Maximum Loads (assumed)	■ Slabs: 150 pounds per square foot (psf) ■ Pavilion and shelter foundations: 1 to 2 kpf/200psf
Grading/Slopes	Minor cuts are anticipated on the order of 3 feet or less.
Below-grade Structures	We understand no below-grade are planned for this site.

If project information or assumptions vary from what is described above or if location of construction changes, we should be contacted as soon as possible to confirm and/or modify our recommendations accordingly.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

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

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

Model Layer	Layer Name	General Description	Approximate Depth to Bottom of Stratum
1	Clayey Sand	Clayey sand with trace amounts of gravel, dark brown, moist, loose.	About 1½ to 2½ feet below existing site grades.

Model Layer	Layer Name	General Description	Approximate Depth to Bottom of Stratum
2	**Poorly Graded Sand with Gravel**	Poorly graded sand with gravel, orange brown and dark brown, moist, loose to medium dense, FeOx staining.	About 8 to 12 feet below existing site grades.
3	**Well Graded Sand with Gravel**	Well graded sand with gravel, orange brown to brown and light pinkish white, loose to medium dense, FeOx staining.	About 6½ to 16½ feet below existing site grades.
4	**Poorly Graded Sand with Silt/ Silty Sand**	Poorly graded sand with varying amounts of silt and gravel, trace amounts of clay, light brown to dark brown, moist, loose to medium dense.	About 1½ to 6 feet below existing site grades.

As noted in **General Comments,** this characterization is based upon widely spaced exploration points across the site and variations are likely.

Groundwater Conditions

The boreholes were observed while drilling and shortly after completion for the presence and level of groundwater. Groundwater was not observed in the borings while drilling, or for the short duration the borings could remain open. These observations represent short-term groundwater conditions at the time of and shortly after the field exploration and may not be indicative of other times or at other locations. Groundwater levels can be expected to fluctuate with varying seasonal and weather conditions, and other factors. However, we do not believe groundwater will significantly impact the project.

Laboratory Testing

Samples of site soils selected for plasticity testing exhibited low plasticity with liquid limits ranging from non-plastic to 37 and plasticity indices ranging from non-plastic to 26. Laboratory test results are presented in the **Exploration Results** section of this report.

GEOTECHNICAL OVERVIEW

Based on subsurface conditions encountered in the borings, the site appears suitable for the proposed construction from a geotechnical point of view provided certain precautions and design and construction recommendations described in this report are followed. We have identified comparatively loose, low strength sand soils as a geotechnical condition that could impact design, construction and performance of the proposed structures, concrete walks, retaining walls and other site improvements. This condition will require particular attention in project planning, design and during construction and are discussed in greater detail in the following sections.

Low Strength Soils

Comparatively loose sand soils were encountered within the upper approximately 9 feet of the borings completed at this site. These materials present a low risk for potential settlement of shallow foundations, concrete flatwork and other surficial improvements. These materials can also be susceptible to disturbance and loss of strength under repeated construction traffic loads and unstable conditions could develop. Stabilization of loose soils may be required at some locations to provide adequate support for construction equipment and proposed structures. Terracon should be contacted if these conditions are encountered to observe the conditions exposed and to provide guidance regarding stabilization (if needed).

Foundation Recommendations

We believe the proposed pavilions, shelters and other ancillary structures can be constructed on a reinforced concrete mat or spread footings foundation system.

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

EARTHWORK

The following presents recommendations for site preparation, excavation, subgrade preparation, fill materials, compaction requirements, utility trench backfill, grading and drainage and exterior slab design and construction. Earthwork on the project should be observed and evaluated by Terracon. Evaluation of earthwork should include observation and/or testing of over-excavation, subgrade preparation, placement of engineered fills, subgrade stabilization and other geotechnical conditions exposed during the construction of the project.

Site Preparation

Prior to placing any fill, strip and remove existing vegetation, topsoil, and any other deleterious materials from the proposed construction area.

Stripped organic materials should be wasted from the site or used to re-vegetate landscaped areas after completion of grading operations. Prior to the placement of fills, the site should be graded to create a relatively level surface to receive fill, and to provide for a relatively uniform thickness of fill beneath proposed structures.

Excavation

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Excavations into the on-site soils will encounter weak soil conditions with possible caving conditions.

The soils to be excavated can vary significantly across the site as their classifications are based solely on the materials encountered in widely-spaced exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, the actual conditions should be evaluated to determine any excavation modifications necessary to maintain safe conditions.

Although evidence of fills or underground facilities such as grease pits, septic tanks, vaults, and utilities was not observed during the site reconnaissance, such features could be encountered during construction. If unexpected underground facilities are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Any over-excavation that extends below the bottom of foundation elevation should extend laterally beyond all edges of the foundations at least 8 inches per foot of over-excavation depth below the foundation base elevation. The over-excavation should be backfilled to the foundation base elevation in accordance with the recommendations presented in this report.

Depending upon depth of excavation and seasonal conditions, surface water infiltration and/or groundwater may be encountered in excavations on the site. It is anticipated that pumping from sumps may be utilized to control water within excavations.

The subgrade soil conditions should be evaluated during the excavation process and the stability of the soils determined at that time by the contractors' Competent Person. Slope inclinations flatter than the OSHA maximum values may have to be used. The individual contractor(s) should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance from the crest of the slope equal to the slope height. The exposed slope face should be protected against the elements.

Subgrade Preparation

The top 10 inches of the exposed ground surface should be scarified, moisture conditioned, and recompacted to at least 95 percent of the maximum dry unit weight as determined by ASTM D698 before any new fill or foundation or pavement is placed.

After the bottom of the excavation has been compacted, engineered fill can be placed to bring the pavilion and shelter pads and concrete flatwork subgrade (if any) to the desired grade. Engineered fill should be placed in accordance with the recommendations presented in subsequent sections of this report.

The stability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unstable conditions develop, workability may be improved by scarifying and drying. Alternatively, over-excavation of wet zones and replacement with granular materials may be used, or crushed gravel and/or rock can be tracked or "crowded" into the unstable surface soil until a stable working surface is attained. Use of cement or geosynthetics could also be considered as a stabilization technique. Laboratory evaluation is recommended to determine the effect of chemical stabilization on subgrade soils prior to construction. Lightweight excavation equipment may also be used to reduce subgrade pumping.

Fill Materials

The on-site soils or approved granular and low plasticity cohesive imported materials may be used as fill material. The earthwork contractor should expect significant mechanical processing and moisture conditioning of the site soils will be needed to achieve proper compaction

Imported soils (if required) should meet the following material property requirements:

Gradation	Percent finer by weight (ASTM C136)
4"	100
3"	70-100
No. 4 Sieve	50-100
No. 200 Sieve	50 (max.)

Soil Properties	Values
Liquid Limit	35 (max.)
Plasticity Index	15 (max.)

Other import fill materials types may be suitable for use on the site depending upon proposed application and location on the site, and could be tested and approved for use on a case-by-case basis.

Compaction Requirements

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift.

Item	Description
Fill lift thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum compaction requirements	95 percent of the maximum dry unit weight as determined by ASTM D698
Moisture content cohesive soil (clay)	-1 to +3 % of the optimum moisture content
Moisture content cohesionless soil (sand)	-3 to +3 % of the optimum moisture content

1. We recommend engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the fill material pumping when proof rolled.
3. Moisture conditioned clay materials should not be allowed to dry out. A loss of moisture within these materials could result in an increase in the material's expansive potential. Subsequent wetting of these materials could result in undesirable movement.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction.

All underground piping within or near the proposed structures should be designed with flexible couplings, so minor deviations in alignment do not result in breakage or distress. It is imperative that utility trenches be properly backfilled with relatively clean materials. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cohesive fill in non-pavement areas to reduce the infiltration and conveyance of surface water through the trench backfill.

It is strongly recommended that a representative of Terracon provide full-time observation and compaction testing of trench backfill within structure and concrete walkway areas.

Grading and Drainage

Grades must be adjusted to provide effective drainage away from the proposed pavilions and shelters during construction and maintained throughout the life of the proposed project. Infiltration of water into foundation excavations must be prevented during construction. Landscape irrigation adjacent to foundations should be minimized or eliminated. Water permitted to pond near or adjacent to the perimeter of the structures (either during or post-construction) can result in significantly higher soil movements than those discussed in this report. As a result, any estimations of potential movement described in this report cannot be relied upon if positive drainage is not obtained and maintained, and water is allowed to infiltrate the fill and/or subgrade.

Exposed ground (if any) should be sloped at a minimum of 10 percent grade for at least 5 feet beyond the perimeter of the proposed concrete flatwork and pavilions, where possible. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. The use of swales, chases and/or area drains may be required to facilitate drainage in unpaved areas around the perimeter of the pavilions. Backfill against foundations should be properly compacted and free of all construction debris to reduce the possibility of moisture infiltration. After construction of the proposed pavilions and prior to project completion, we recommend verification of final grading be performed to document positive drainage, as described above, has been achieved.

Flatwork will be subject to post-construction movement. Maximum grades practical should be used for flatwork to prevent areas where water can pond. In addition, allowances in final grades should take into consideration post-construction movement of flatwork, particularly if such movement would be critical. Where flatwork abuts the pavilions, care should be taken that joints are properly sealed and maintained to prevent the infiltration of surface water.

Planters located adjacent to shelters and pavilions (if any) should preferably be self-contained. Sprinkler mains and spray heads should be located a minimum of 5 feet away from the structure line(s). Low-volume, drip style landscaped irrigation should be used sparingly near the structure. Roof drains should discharge on to flatwork or be extended away from the shelters and pavilions a minimum of 5 feet through the use of splash blocks or downspout extensions. A preferred alternative is to have the roof drains discharge by solid pipe to storm sewers, a detention pond, or other appropriate outfall.

Exterior Slab Design and Construction

Exterior slabs on-grade, exterior architectural features, and utilities founded on, or in backfill or the site soils will likely experience some movement due to the volume change of the material. Potential movement could be reduced by:

- Minimizing moisture increases in the backfill;
- Controlling moisture-density during placement of the backfill;
- Using designs which allow vertical movement between the exterior features and adjoining structural elements; and
- Placing control joints on relatively close centers.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of Terracon. Monitoring should include documentation of adequate removal of vegetation and topsoil, proof rolling, and mitigation of areas delineated by the proof roll to require mitigation. Each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by Terracon prior to placement of additional lifts.

In areas of foundation excavations, the bearing subgrade and exposed conditions at the base of the recommended over-excavation should be evaluated under the direction of Terracon. In the event that unanticipated conditions are encountered, Terracon should prescribe mitigation options.

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

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Reinforced Mats and Spread Footings - Design Recommendations

Description	Values
Bearing material	Moisture conditioned and recompacted native soils placed in accordance with the **Earthwork** section of this report
Maximum net allowable bearing pressure [1]	1,500 psf
Lateral earth pressure coefficients [2]	Active, K_a = 0.27 Passive, K_p = 3.69 At-rest, K_o = 0.43
Sliding coefficient [2]	μ = 0.5
Moist soil unit weight	γ = 110 pcf
Minimum embedment depth below finished grade [3]	30 inches

Description	Values
Subgrade modulus	k_1 = 35 psi/in $K_{(BxB)} = K_1\left(\frac{B+1}{2B}\right)^2$ (sands) $K_{(BxL)} = \frac{K_{(BxB)}\left(1 + 0.5 * \left(\frac{B}{L}\right)\right)}{1.5}$ Where: k_1 = coefficient of subgrade reaction of foundations measuring 1 ft. x 1ft. $K_{(BxB)}$ = coefficient of subgrade modulus for a square foundation having dimensions BxB. $K_{(BxL)}$ = coefficient of subgrade modulus for a rectangular foundation having dimensions BxL.
Total estimated settlement[4]	Up to 1 inch
Estimated differential settlement	¼ to ½ of total settlement

1. The recommended maximum net allowable bearing pressure assumes any unsuitable fill or soft soils, if encountered, will be over-excavated and replaced with properly compacted engineered fill. The design bearing pressure applies to a dead load plus design live load condition. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions.
2. The lateral earth pressure coefficients and sliding coefficients are ultimate values and do not include a factor of safety. The foundation designer should include the appropriate factors of safety.
3. For frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils. The minimum embedment depth is for perimeter footings beneath unheated areas and is relative to lowest adjacent finished grade, typically exterior grade. Interior column pads in heated areas should bear at least 12 inches below the adjacent grade (or top of the floor slab) for confinement of the bearing materials and to develop the recommended bearing pressure.
4. The estimated movements presented above are based on the assumption that the maximum footing size is 10 feet for column footings and 4 feet for continuous footings.

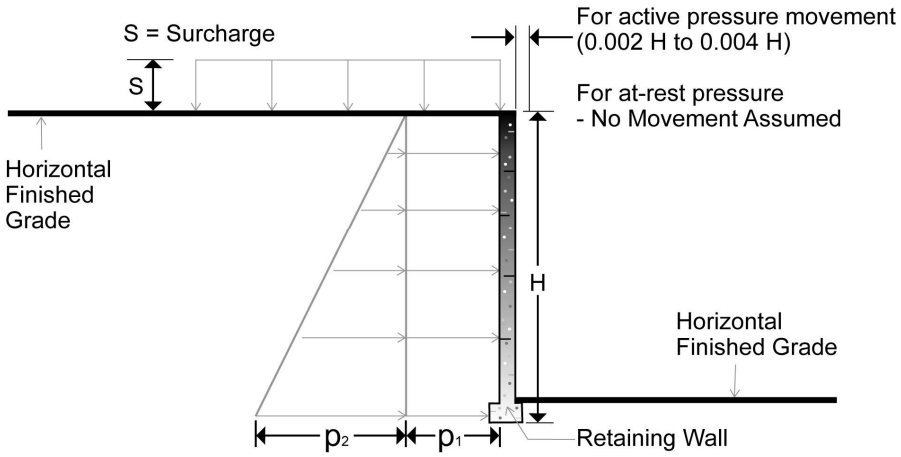
Foundations should be proportioned to reduce differential foundation movement. Proportioning on the basis of equal total settlement is recommended; however, proportioning to relative constant dead-load pressure will also reduce differential movement between adjacent foundations. Foundations should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement.

Foundation excavations should be observed by Terracon. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

RETAINING WALLS

Lateral Earth Pressures

Dry-laid sandstone landscape walls and other site retaining walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls (walls with foundation stones set in earth) and assumes wall movement. The "at-rest" condition assumes no wall movement. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls.



Earth Pressure Coefficients

Earth Pressure Conditions	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)
Active (Ka)	Granular - 0.27	30	(0.27)S	(30)H
At-Rest (Ko)	Granular - 0.43	47	(0.43)S	(47)H
Passive (Kp)	Granular - 3.69	406	---	---

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 **H** to 0.004 **H**, where **H** is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- In-situ soil backfill weight a maximum of 110 pcf

- Horizontal backfill, compacted between 95 and 98 percent of standard Proctor maximum dry density
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No dynamic loading
- No safety factor included
- Ignore passive pressure in frost zone

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up 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. To calculate the resistance to sliding, a value of 0.5 should be used as the ultimate coefficient of friction between the footing and the underlying soil.

CRUSHER FINES PATHS AND CONCRETE WALKS

We understand concrete walks and crusher fines paths are to be constructed at the proposed site. Prior to placing landscape fabric, strip and remove existing vegetation, topsoil, and any other deleterious materials from the proposed construction areas. We recommend scarifying the exposed subgrade to a depth of at least 10 inches, moisture conditioning and compacting prior to fill placement or construction of the proposed concrete walks and crusher fines paths.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 20½ feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

CORROSIVITY

Results of water-soluble sulfate testing indicate Exposure Class S0 according to ACI 318. ASTM Type I or II portland cement should be specified for all project concrete on and below grade.

Foundation concrete should be designed for low sulfate exposure in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

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

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

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

ATTACHMENTS

Contents:

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

EXPLORATION AND TESTING PROCEDURES

Field Exploration

The field exploration program consisted of the following:

Number of Borings	Boring Depth (feet)	Location
2	20 or auger refusal	Planned structure areas
2	10 or auger refusal	Planned sidewalk, path, and patio areas

Boring Layout and Elevations: We used handheld GPS equipment to locate borings with an estimated horizontal accuracy of +/-20 feet. A ground surface elevation at each boring location was obtained by Terracon using handheld GPS equipment.

Subsurface Exploration Procedures: We advanced soil borings with a truck-mounted drill rig using continuous-flight, solid-stem augers. Three samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Soil sampling was performed using, modified California barrel and standard split-barrel sampling procedures. For the standard split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. For the modified California barrel sampling procedure, a 2½-inch outer diameter split-barrel sampling spoon is used for sampling. Modified California barrel sampling procedures are similar to standard split-barrel sampling procedures; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. The samples were placed in appropriate containers, taken to our soil laboratory for testing, and classified by a geotechnical engineer.

In addition, we observed and recorded groundwater levels during drilling observations.

Our exploration team prepared field boring logs as part of standard drilling operations including sampling depths, penetration distances, and other relevant sampling information. Field logs included visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Final boring logs, prepared from field logs, represent the geotechnical engineer's interpretation, and include modifications based on observations and laboratory test results.

Property Disturbance: We backfilled borings with auger cuttings after completion. Our services did not include repair of the site beyond backfilling our boreholes. Excess auger cuttings were

removed from the site. Because backfill material often settles below the surface after a period, we recommend checking boreholes periodically and backfilling, if necessary. We can provide this service for additional fees, at your request.

Laboratory Testing

The project engineer reviewed field data and assigned various laboratory tests to better understand the engineering properties of various soil strata. Laboratory testing was conducted in general accordance with applicable or other locally recognized standards. Procedural standards noted in this report are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgement. Testing was performed under the direction of a geotechnical engineer and included the following:

- Visual classification
- Dry density
- Grain-size analysis
- Moisture content
- Atterberg limits
- Water-soluble sulfates

Our laboratory testing program includes examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified soil samples in accordance with the Unified Soil Classification System (USCS). Soil samples obtained during our field work will be disposed of after laboratory testing is complete unless a specific request is made to temporarily store the samples for a longer period of time.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Balsam Park ■ Greeley, Colorado
January 11, 2021 ■ Terracon Project No. 21205073

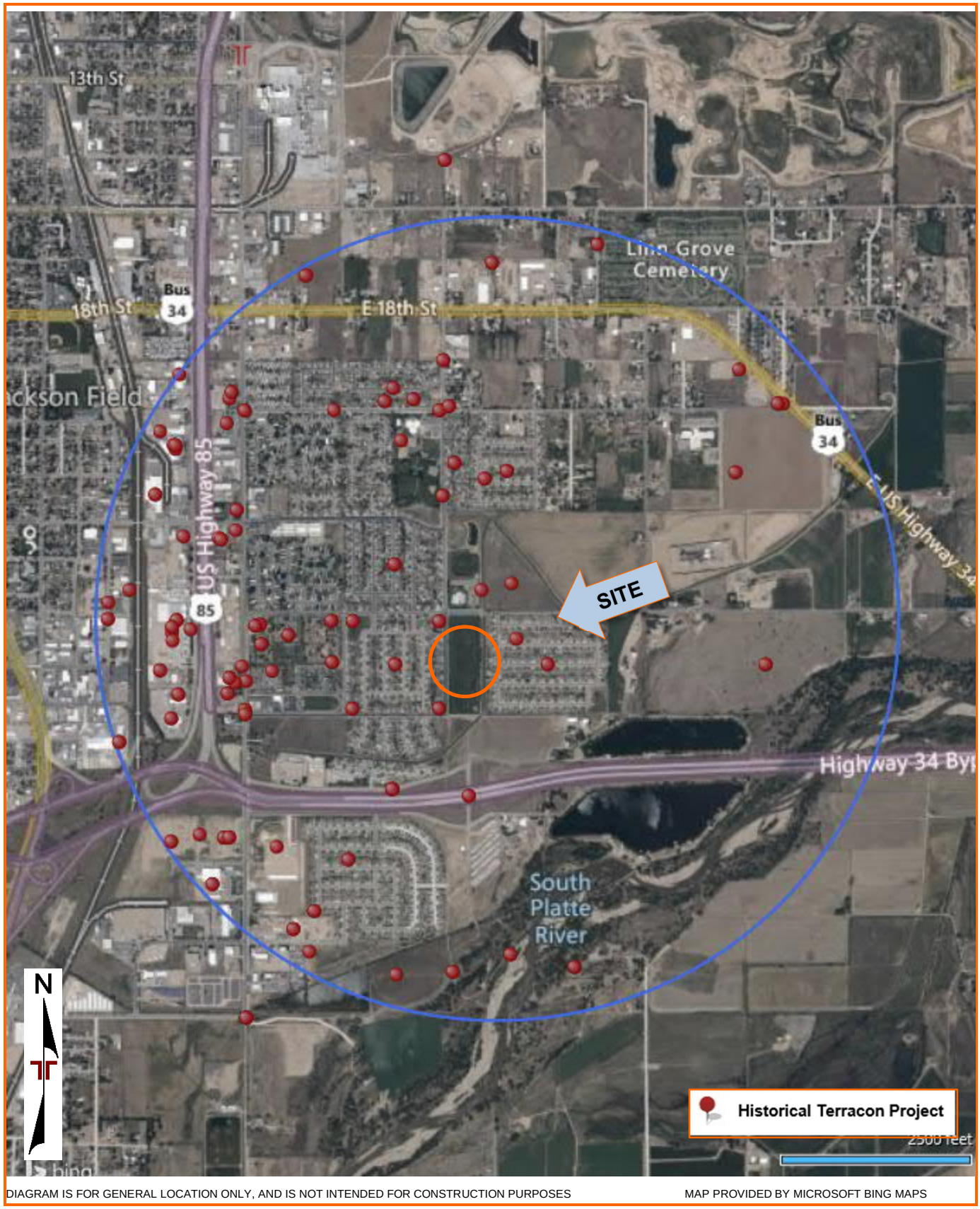


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Balsam Park ■ Greeley, Colorado

January 11, 2021 ■ Terracon Project No. 21205073

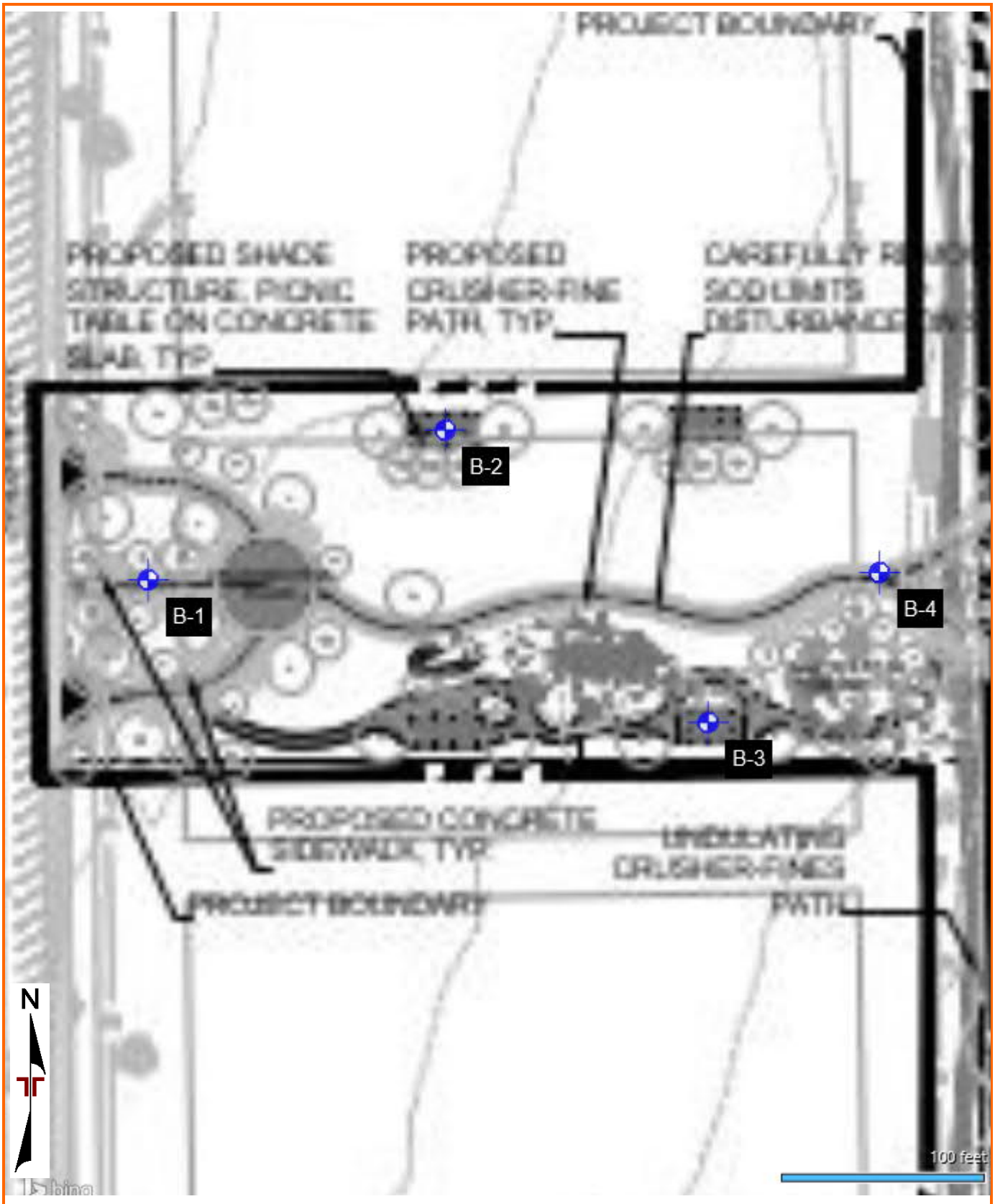


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

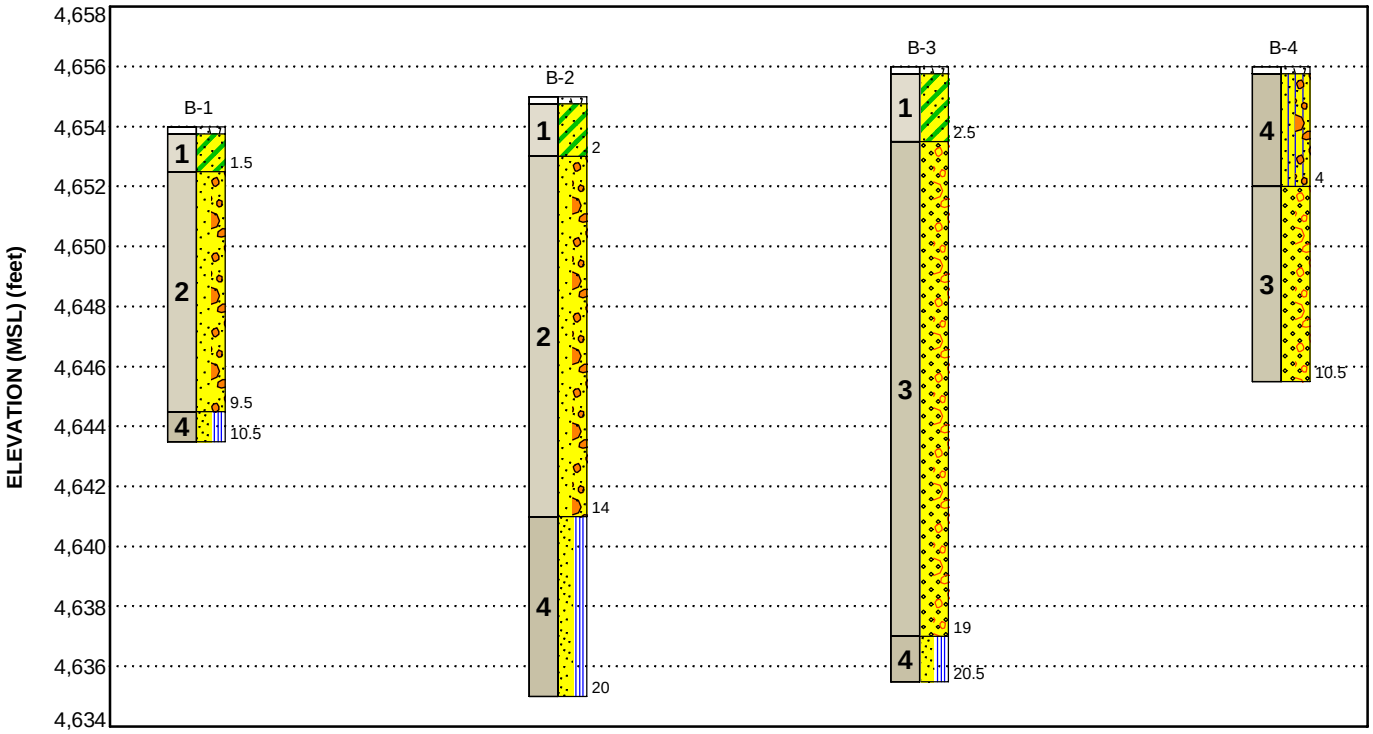
EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

GEOMODEL

Balsam Park ■ Greeley, CO
Terracon Project No. 21205073



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

Model Layer	Layer Name	General Description
1	CLAYEY SAND	Clayey sand with trace amounts of gravel, dark brown, moist, loose.
2	POORLY GRADED SAND WITH GRAVEL	Poorly graded sand with gravel, orange brown and dark brown, moist, loose to medium dense, FeOx staining.
3	WELL GRADED SAND WITH GRAVEL	Well graded sand with gravel, orange brown to brown and light pinkish white, loose to medium dense, FeOx staining.
4	POORLY GRADED SAND WITH SILT/SILTY SAND	Poorly graded sand with varying amounts of silt and gravel, trace amounts of clay, light brown to dark brown, moist, loose to medium dense.

LEGEND

- Vegetative Layer
- Clayey Sand
- Poorly-graded Sand with Gravel
- Poorly-graded Sand with Silt
- Well-graded Sand with Gravel
- Silty Sand with Gravel

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

BORING LOG NO. B-1

PROJECT: Balsam Park

CLIENT: City of Greeley CO
Greeley, CO

SITE: Balsam Avenue and East 24th Street
Greeley, CO

LOCATION See Exploration Plan

Latitude: 40.3975° Longitude: -104.6681°

Approximate Surface Elev.: 4654 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		0.3	4654+/-								
1			**VEGETATIVE LAYER**, about 3 inches thick								
		1.5	4652.5+/-								
2			**POORLY GRADED SAND WITH GRAVEL (SP)**, orange brown, moist, loose, FeOx staining				3-3	2.8	108		
				5			1-2-3 N=5	2.0		NP	3
		9.5	4644.5+/-								
4		10.5	**POORLY GRADED SAND WITH SILT**, fine to medium grained, brown, moist, medium dense, FeOx staining	10			6-5-6 N=11	5.4			
			4643.5+/-								
			Boring Terminated at 10.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Advanced using 4-inch diameter, continuous-flight, soild-stem auger.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using handheld GPS equipment

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
1289 1st Ave
Greeley, CO

Boring Started: 12-22-2020 | Boring Completed: 12-22-2020

Drill Rig: CME 55 | Driller: Sean P.

Project No.: 21205073

BORING LOG NO. B-2

PROJECT: Balsam Park

CLIENT: City of Greeley CO
Greeley, CO

SITE: Balsam Avenue and East 24th Street
Greeley, CO

LOCATION See Exploration Plan

Latitude: 40.3977° Longitude: -104.6676°

Approximate Surface Elev.: 4655 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		0.3	4655+/-								
		VEGETATIVE LAYER, about 3 inches thick									
		CLAYEY SAND, trace gravel, dark brown, moist, loose									
		2.0	4653+/-								
2		**POORLY GRADED SAND WITH GRAVEL**, trace clay, dark brown, moist, loose to medium dense					2-3	4.3	106		
		light pinkish white		5			2-2-3 N=5	2.4			
		orange brown with red, FeOx staining		10			5-5-6 N=11	67.8			
		14.0	4641+/-								
4		**POORLY GRADED SAND WITH SILT (SP-SM)**, light brown, moist, medium dense, FeOx staining		15			5-9-12 N=21	4.5		NP	10
		trace gravel									
		20.0	4635+/-	20			9-15	5.7	102		
		Boring Terminated at 20 Feet									

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

Hammer Type: Automatic

Advancement Method:
Advanced using 4-inch diameter, continuous-flight, soild-stem auger.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using handheld GPS equipment

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
1289 1st Ave
Greeley, CO

Boring Started: 12-22-2020 | Boring Completed: 12-22-2020

Drill Rig: CME 55 | Driller: Sean P.

Project No.: 21205073

BORING LOG NO. B-3

PROJECT: Balsam Park

CLIENT: City of Greeley CO
Greeley, CO

SITE: Balsam Avenue and East 24th Street
Greeley, CO

LOCATION See Exploration Plan

Latitude: 40.3973° Longitude: -104.6672°

Approximate Surface Elev.: 4656 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		0.3	4656+/-								
			VEGETATIVE LAYER, about 3 inches thick								
			CLAYEY SAND (SC), trace gravel, dark brown, moist, loose								
		2.5	4653.5+/-								
3			**WELL GRADED SAND WITH GRAVEL (SW)**, light pinkish white and orange brown, moist, loose to medium dense, FeOx staining				2-3-4 N=7	10.0		37-11-26	40
				5			2-3-3 N=6	1.9			
				10			4-5-6 N=11	1.5		NP	3
				15			6-7	1.8	123		
4		19.0	4637+/-								
			POORLY GRADED SAND WITH SILT, light brown, moist, medium dense	20			6-9-9 N=18	4.1			
		20.5	4635.5+/-								
			Boring Terminated at 20.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Advanced using 4-inch diameter, continuous-flight, soild-stem auger.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using handheld GPS equipment

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
1289 1st Ave
Greeley, CO

Boring Started: 12-22-2020 | Boring Completed: 12-22-2020

Drill Rig: CME 55 | Driller: Sean P.

Project No.: 21205073

BORING LOG NO. B-4

PROJECT: Balsam Park

CLIENT: City of Greeley CO
Greeley, CO

SITE: Balsam Avenue and East 24th Street
Greeley, CO

LOCATION See Exploration Plan

Latitude: 40.3975° Longitude: -104.6669°

Approximate Surface Elev.: 4656 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
4		0.3	4656+/-								
			VEGETATIVE LAYER, about 3 inches thick								
			SILTY SAND WITH GRAVEL, trace clay, dark brown, moist, loose			X	2-3-3 N=6	6.0		NP	15
		4.0	4652+/-								
3			**WELL GRADED SAND WITH GRAVEL**, light pinkish white to brown, moist, loose to medium dense	5		X	4-4-4 N=8	1.4			
				10		X	4-5-7 N=12	1.9			
		10.5	4645.5+/-								
			Boring Terminated at 10.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Advanced using 4-inch diameter, continuous-flight, soild-stem auger.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using handheld GPS equipment

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
1289 1st Ave
Greeley, CO

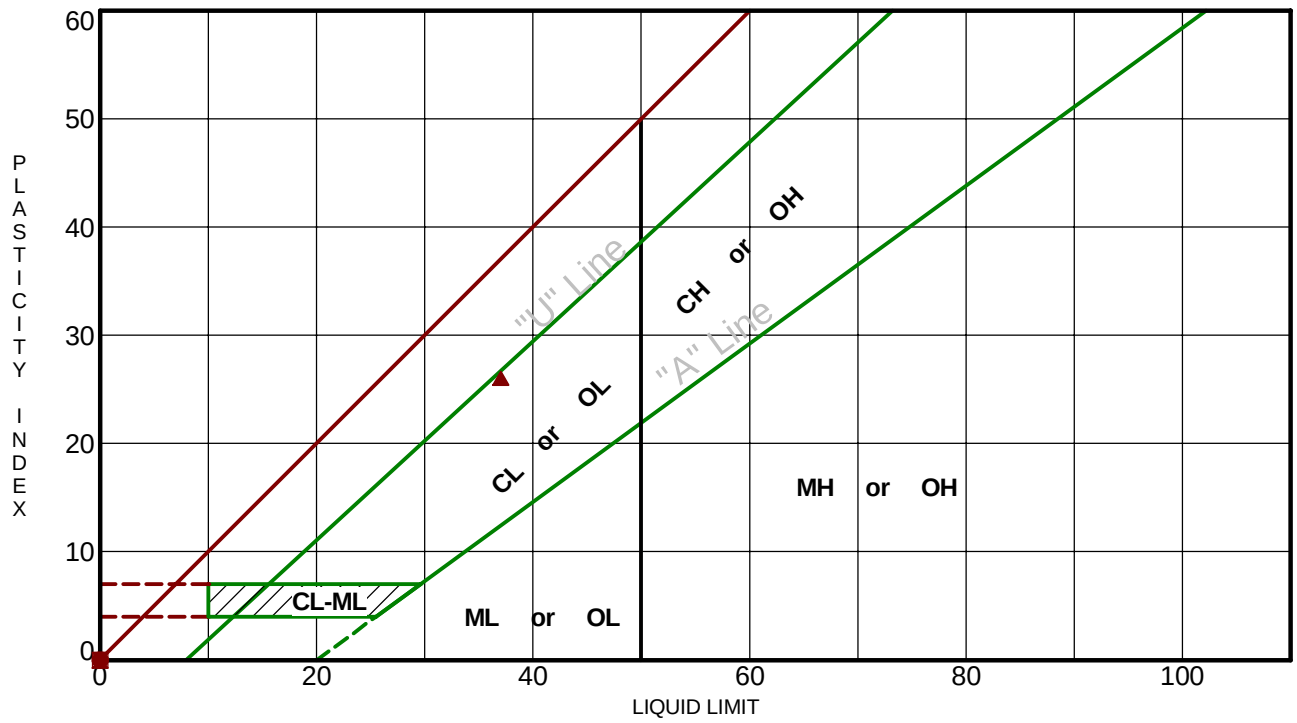
Boring Started: 12-22-2020 | Boring Completed: 12-22-2020

Drill Rig: CME 55 | Driller: Sean P.

Project No.: 21205073

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID		Depth	LL	PL	PI	Fines	USCS	Description
●	B-1	4 - 5.5	NP	NP	NP	2.6	SP	POORLY GRADED SAND with GRAVEL
⊠	B-2	14 - 15.5	NP	NP	NP	9.5	SP-SM	POORLY GRADED SAND with SILT
▲	B-3	2 - 3.5	37	11	26	40.4	SC	CLAYEY SAND
★	B-3	9 - 10.5	NP	NP	NP	2.8	SW	WELL-GRADED SAND with GRAVEL
⊙	B-4	2 - 3.5	NP	NP	NP	15.0	SM	SILTY SAND with GRAVEL

PROJECT: Balsam Park

PROJECT NUMBER: 21205073

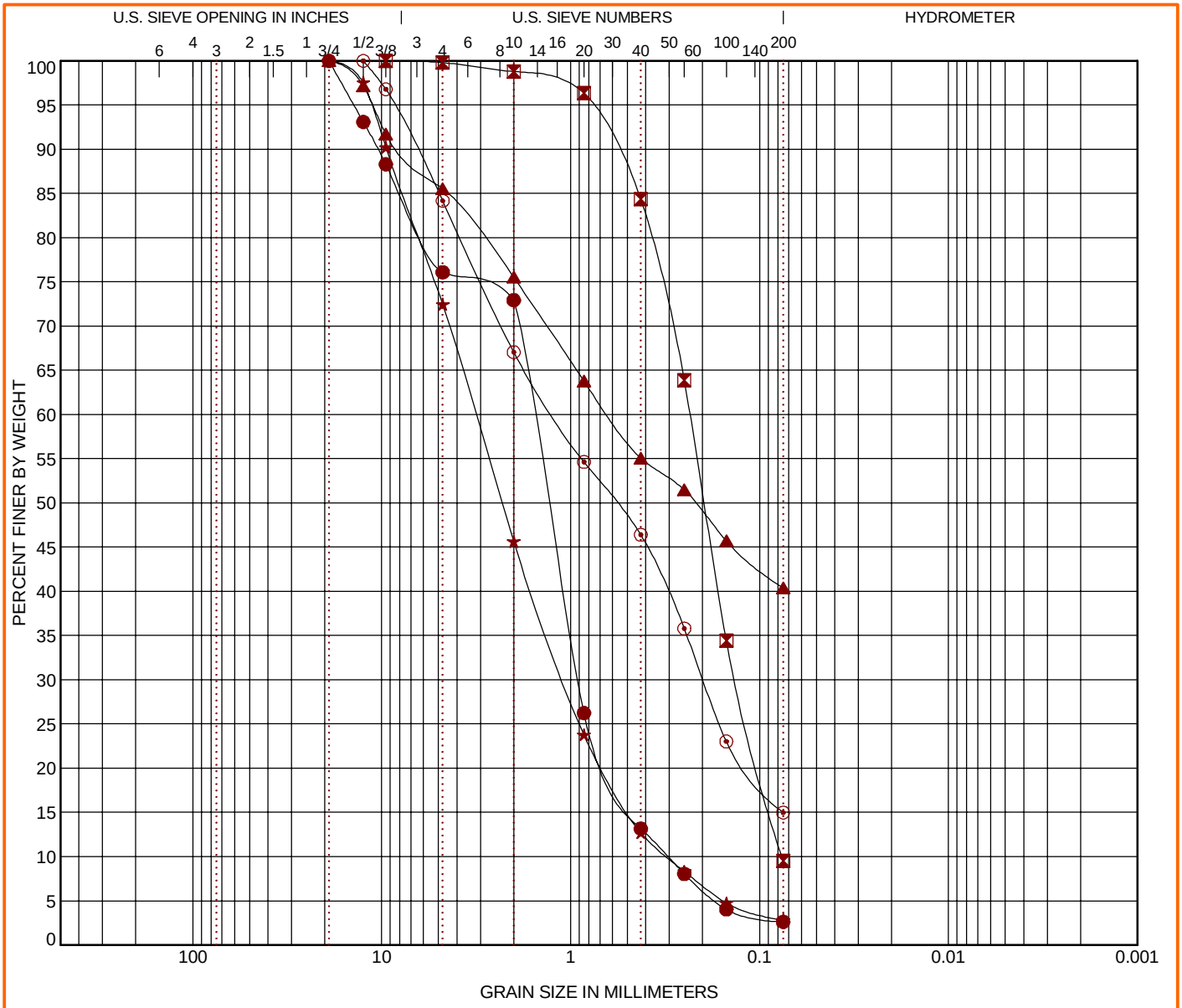
SITE: Balsam Avenue and East 24th Street
Greeley, CO

Terracon
1289 1st Ave
Greeley, CO

CLIENT: City Of Greeley CO
Greeley, CO

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-1	4 - 5.5	POORLY GRADED SAND with GRAVEL (SP)	2.0	NP	NP	NP	1.72	5.15
⊠	B-2	14 - 15.5	POORLY GRADED SAND with SILT (SP-SM)	4.5	NP	NP	NP	0.99	3.08
▲	B-3	2 - 3.5	CLAYEY SAND (SC)	10.0	37	11	26		
★	B-3	9 - 10.5	WELL-GRADED SAND with GRAVEL (SW)	1.5	NP	NP	NP	1.21	10.36
⊙	B-4	2 - 3.5	SILTY SAND with GRAVEL (SM)	6.0	NP	NP	NP		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-1	4 - 5.5	19	1.578	0.911	0.306	0.0	23.9	73.5		2.6	
⊠	B-2	14 - 15.5	9.5	0.234	0.133	0.076	0.0	0.2	90.3		9.5	
▲	B-3	2 - 3.5	19	0.629			0.0	14.4	45.2		40.4	
★	B-3	9 - 10.5	19	3.177	1.084	0.307	0.0	27.5	69.7		2.8	
⊙	B-4	2 - 3.5	12.5	1.23	0.198		0.0	15.8	69.2		15.0	

PROJECT: Balsam Park

PROJECT NUMBER: 21205073

SITE: Balsam Avenue and East 24th Street
Greeley, CO

Terracon
1289 1st Ave
Greeley, CO

CLIENT: City Of Greeley CO
Greeley, CO

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Client
City Of Greeley CO
Greeley, CO

Project
Balsam Park

Sample Submitted By: Terracon (21) **Date Received:** 12/31/2020 **Lab No.: 21-0018**

Results of Corrosion Analysis

Sample Number	--
Sample Location	B-1
Sample Depth (ft.)	2.0-3.0
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	171

Analyzed By: Trisha Campo
Chemist

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS
Balsam Park ■ Greeley, CO
Terracon Project No. 21205073

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

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	> 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]		GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]		SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A"		CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K, L, M]
			PI plots below "A" line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[Q] PI plots below "A" line.