



# Geotechnical Engineering Report

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**Proposed Daycare Building  
Southeast of Pine Lane and Twenty Mile Road  
Parker, Colorado**

August 24, 2020 (Revised September 23, 2020)  
Terracon Project No. 25205205

**Prepared for:**  
NLD Parker, LLC  
Minneapolis, Minnesota

**Prepared by:**  
Terracon Consultants, Inc.  
Wheat Ridge, Colorado



August 24, 2020 (Revised September 23, 2020)

NLD Parker, LLC  
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Attn: Mr. Mike Fraser  
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Re: Geotechnical Engineering Report  
Proposed Daycare Building  
Southeast of Pine Lane and Twenty Mile Road  
Parker, Colorado  
Terracon Project No. 25205205

Mr. Fraser:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P25205205 dated June 22, 2020. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

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

Sincerely,  
**Terracon Consultants, Inc.**

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Environmental



Facilities



Geotechnical



Materials

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

**ATTACHMENTS**

- EXPLORATION AND TESTING PROCEDURES**
- SITE LOCATION AND EXPLORATION PLANS**
- EXPLORATION RESULTS**
- SUPPORTING INFORMATION**

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

## **REPORT SUMMARY**

A geotechnical engineering exploration has been performed for the proposed daycare building to be located southeast of Pine Lane and Twenty Mile Road in Parker, Colorado. Based on the information obtained from this subsurface exploration and the laboratory testing completed, the site appears suitable for the proposed construction; however, the following geotechnical conditions will need to be considered:

- Up to about 9 feet of fill materials were encountered in the borings drilled for this exploration. We do not possess any information regarding whether the fill was placed under the observation of a geotechnical engineer. It is our opinion the existing fill should not be used to support foundation, interior slab, pavement, or exterior slab construction without complete removal and modification. Support of pavement construction and exterior slab construction on the existing fill materials can be considered, provided a portion of the existing fill materials are overexcavated, processed, moisture conditioned and recompacted and some movement can be tolerated.
- Based on the results of the laboratory testing and our experience in the area, the clay fill materials and native clay soils have low to moderate expansive potential, while the sand fill materials and native sand soils are considered to have nil to low expansive potential. Based on our experience, the claystone in the area has low to very high expansive potential.
- Test boring data indicate that loose soils may be locally present. Consequently, loose soils could be encountered below foundations or other improvements and these conditions will likely require some corrective work. Corrective work could involve removal and re compaction or replacement, in-place soil densification, or deepening footing excavations to suitable bearing materials.
- Based on the geotechnical engineering analyses, the proposed daycare building may be constructed on a shallow spread footing foundation systems bottomed on a zone of new engineered fill, provided the owner is willing to accept the associated risk of movement.
- Based on the properties of the subsurface materials, the floor system for the proposed parking garage may consist of a slab-on-grade constructed on a zone of new engineered fill, provided the owner is willing to accept the risk of movement.
- Based on the 2015 International Building Code (IBC) Section 1613.3.2, and the subsurface conditions encountered in the borings, the seismic site classification for this site is D.

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- Existing fill and expansive soils may be encountered at exterior flatwork and pavement construction elevation. Construction of exterior flatwork and pavements on a zone of new engineered fill is recommended to improve performance.
- The amount of movement associated with foundations, floor slabs, slabs-on-grade, etc. will be related to the wetting of the underlying soils and bedrock. Therefore, it is imperative the recommendations outlined in the **Grading and Drainage** subsection of **Earthwork** be followed to reduce potential movement. Moisture conditioning and/or replacement of the on-site fill materials and/or native soils and bedrock should follow the recommendations outlined in **Earthwork**.

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

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## INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed daycare building to be located southeast of Pine Lane and Twenty Mile Road in Parker, Colorado.

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

- Subsurface soil conditions
- Groundwater levels
- Earthwork
- Drainage
- Lateral earth pressures
- Seismic site classification
- Foundation design and construction
- Floor slab design and construction
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of six test borings (designated as Boring Nos. 1 to 4 and P1 to P2) to depths ranging from approximately 10 to 50 feet below existing site grades. Plans showing the site and boring locations are shown in the **Site Location and Exploration Plans** section. The results of the laboratory testing performed on soil and bedrock samples obtained from the site during the field exploration are included on the boring logs and as separate graphs in the **Exploration Results** section.

## SITE CONDITIONS

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

Item	Description
<b>Parcel Information</b>	The project is located southeast of the intersection of Pine Lane and Twenty Mile Road in Parker, Colorado. Approximate coordinates: 39.5435° N, -104.7746°W See <b>Site Location</b>

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Item	Description
<b>Existing Improvements</b>	The subject site consists of a vacant lot. Based on historical imagery of the site, the lot was previously developed with a residential structure that has since been demolished and appears to have been graded to accommodate the adjacent roadways.
<b>Current Ground Cover</b>	Ground cover at the subject site consists of grass, weeds, and barren land.
<b>Existing Topography</b>	The site slopes gently down to the west
<b>Geology</b>	Based on our review of the Geologic Maps <sup>1</sup> , the site is underlain by Broadway Alluvium (Qb) and Post-Piney Creek Alluvium (Qpp). The Broadway Alluvium is considered to be Pleistocene in age (2.6 million years ago to 14 thousand years ago) and generally consists of fine to coarse grained sands with interbedded lenses of clay. The Post-Piney Creek Alluvium is Holocene in age (14 thousand years ago to present) and generally consists of sand, silt, and clay with interbedded humic bog clay deposits.

## PROJECT DESCRIPTION

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

Item	Description
<b>Information Provided</b>	NLD Parker provided the following PDF documents: <ul style="list-style-type: none"><li>■ Lot 6 Option 3A</li></ul>
<b>Project Description</b>	We understand the project consists of the construction of a new single story, 12,723 square-foot daycare building with adjacent yard area and parking lot. We anticipate no below-grade areas are planned.
<b>Building Construction</b>	We anticipate the proposed building will be constructed of light gauge metal or wood framing with cast-in-place concrete foundations
<b>Finished Floor Elevation</b>	Unknown at this time but assumed to be within 2 to 3 feet of existing site grades.
<b>Maximum Loads</b>	<ul style="list-style-type: none"><li>■ Columns: 50 to 100 kips</li><li>■ Walls: 3 to 5 kips per linear foot (klf)</li><li>■ Slabs: 100 to 150 pounds per square foot (psf)</li></ul>
<b>Grading/Slopes</b>	We anticipate cuts and fills on the order of 3 feet (+/-) max
<b>Pavements</b>	New pavements will likely consist of flexible asphalt and rigid concrete pavements.

## GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface soil, bedrock, and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The following sections provide our geotechnical characterization.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options, and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

### Typical Profile

Based on the results of the borings for this exploration, subsurface conditions on the site can be generalized as follows:

Material Description	Approximate Depth to Bottom of Stratum below Existing Site Grade	Consistency/ Relative Density/ Hardness
Existing fill consisting of lean clay with varying amounts of sand and sand with varying amounts of clay	About 4 to 9 feet	Variable
Native soil consisting of lean to fat clay with varying amounts of sand, and sand with varying amounts of silt, clay, and gravel	About 38 to 39 feet, Maximum depth explored in Boring Nos. 2, 4 and P1, and P2	Clay: stiff to very stiff Sand: loose to dense
Bedrock consisting of claystone	About 45 to 50 feet, Maximum depth explored in remaining borings	Hard to very hard

Stratification boundaries on the boring logs represent the approximate location of changes in soil and material types; in situ, the transition between materials may be gradual. Further details of the borings can be found on the boring logs in the **Exploration Results**.

Based on the results of the laboratory testing and our experience in the area, the clay fill materials and native clay soils have low to moderate expansive potential, while the sand fill materials and native sand soils are considered to have nil to low expansive potential. Based on our experience, the claystone in the area has low to very high expansive potential. A summary of laboratory test results is included in the **Exploration Results**.

## Groundwater Conditions

The borings were observed while drilling and upon completion of drilling for the presence and level of groundwater. The water levels encountered in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized below.

Boring No.	Shallowest depth to groundwater encountered while or upon completion of drilling <sup>1</sup>
1	32 feet
2	None encountered
3	32 feet
4	None encountered
P1	None encountered
P2	None encountered

1. Due to safety concerns, borings were backfilled immediately after completion. Therefore, subsequent groundwater measurements were not obtained.

These observations represent groundwater conditions at the time of 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.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. Groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

## 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 outlined in this report are followed. We have identified geotechnical conditions that could impact design and construction of the proposed daycare building, pavement areas, and other site improvements.

### Existing Fill Materials

Up to about 9 feet of fill materials were encountered in portions of the site. It should be noted that fill depths presented in the boring logs are approximate and the depth, lateral extents, and composition of fill should be expected to vary. We do not possess any information regarding whether the fill was placed under the observation of a geotechnical engineer.

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Based upon the results of our field exploration and laboratory testing, it is our opinion the existing fill should not be used to support foundations, interior slabs, exterior slabs-on-grade, or pavement construction without complete removal and modification.

If the owner is willing to accept a higher risk of movement for pavements and exterior slabs, consideration could be given to leaving a portion of the existing fill in place and overexcavating a portion of the existing fill materials below these elements, then processing, moisture conditioning and compacting the materials back to subgrade elevation.

It should be noted that there exists the potential for construction debris and/or domestic trash to be encountered within the fill on some portions of the site. Based on the materials encountered in our borings, the potential for encountering construction debris and/or domestic trash is considered to be low. The fill materials should be observed for the presence of trash and debris during site grading and construction.

The existing fill can be reused as engineered fill below foundations, slabs-on-grade, and pavements, provided the material meets the requirements of imported soils in the **Material Types** subsection in **Earthwork**, any deleterious materials are removed, and some movement can be tolerated. Some removal and replacement may be required if unsuitable or soft materials are exposed.

### Expansive Soils and Bedrock

Based on the results of the laboratory testing and our experience in the area, the clay fill materials and native clay soils have low to moderate expansive potential, while the sand fill materials and native sand soils are considered to have nil to low expansive potential. Based on our experience, the claystone in the area has low to very high expansive potential.

This report provides recommendations to help mitigate the effects of soil and bedrock shrinkage and expansion. However, even if these procedures are followed, some movement and cracking in the buildings, pavements, and flatwork should be anticipated. The severity of cracking and other damage such as uneven floor slabs will probably increase if any modification of the site results in excessive wetting or drying of the expansive soils and bedrock. Eliminating the risk of movement and distress is generally not feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. It is imperative the recommendations outlined in the **Grading and Drainage** subsection of **Earthwork** in this report be followed to reduce movement.

### Loose Soils

Test boring data indicate that loose soils may be locally present. Consequently, loose soils could be encountered below foundations or other improvements and these conditions will likely require some corrective work. Corrective work could involve removal and re-compaction or replacement, in-place soil densification, or deepening footing excavations to suitable bearing materials. In any

event, Terracon should be contacted to observe foundation excavations to evaluate bearing conditions and to provide guidance concerning corrective work (if needed).

## **EARTHWORK**

The following presents recommendations for site preparation, excavation, subgrade preparation, and placement of engineered fills on the project. All earthwork on the project should be observed and evaluated by Terracon.

### **Site Preparation**

Strip and remove existing vegetation, organics, and other deleterious materials from proposed building and pavement areas. All exposed surfaces should be free of mounds and depressions that could prevent uniform compaction.

Stripped materials consisting of vegetation, unsuitable fills, and organic materials should be wasted from the site or used to revegetate landscaped areas or exposed slopes after completion of grading operations.

Where possible, the site should be initially graded to create a relatively level surface to receive fill and to provide for a relatively uniform thickness of fill beneath the proposed building and improvement areas. All exposed areas that will receive fill, once properly cleared, should be scarified to a minimum depth of 12 inches, conditioned to near optimum moisture content, and compacted. It is imperative the moisture content of prepared materials be protected from moisture loss.

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

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment.

Depending upon seasonal conditions, surface water may infiltrate into the excavations on the site. Water seeping into excavations at this site could most likely be controlled by shallow trenches leading to a sump pit where the water could be removed by pumping.

The stability of subgrade soils may be affected by precipitation, repetitive construction traffic, or other factors. If unstable conditions are encountered or develop during construction, workability may be improved by overexcavation of wet zones and mixing these soils with crushed gravel. Use of geotextiles could also be considered as a stabilization technique. Lightweight excavation equipment may be required to reduce subgrade pumping.

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## Material Types

Fill for this project should consist of engineered fill. Engineered fill is fill that meets the criteria presented in this report and has been properly documented.

Engineered fill should meet the following material property requirements:

Fill Type <sup>1,2</sup>	USCS Classification	Acceptable location for placement
On-site clay soils	CL, CH	On-site clay soils are considered suitable for reuse as compacted fill below foundation, slab, and pavement areas, and as general fill for this project.
On-site sand soils mixed with clay soils <sup>3,4</sup>	SM, SC, SP	On-site sand soils mixed with clay soils are considered suitable for reuse as compacted fill below foundation, slab, and pavement areas and as general fill for this project.
Imported soils	Varies	Imported soils meeting the gradation outlined herein can be considered acceptable for use as engineered fill beneath slabs and pavements.

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.
2. Care should be taken during the fill placement process to avoid zones of dis-similar fill. Improvements constructed over varying fill types are at a higher risk of differential movement compared to improvements over a uniform fill zone.
3. On-site sand soils should be mixed with on-site clay soils to meet the gradation requirements outlined below for imported soils.
4. Granular soils should not be used in the overexcavation zone below the building, slabs, or pavement areas.

Imported soils and on-site materials for engineered fill (if required) should meet the following material property requirements:

Gradation	Percent finer by weight (ASTM C136)
3"	100
1"	90-100
3/4"	50-100
No. 4 Sieve	50-100
No. 200 Sieve	>50

- Liquid Limit ..... 30 (max)
- Plasticity Index ..... 15 (max)
- Maximum Expansive Potential (%) ..... 1.0\*

\*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at optimum water content. The sample is confined under a 200-psf surcharge and submerged.

## 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
<b>Fill lift thickness</b>	8-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, plate compactor) is used
<b>Compaction requirements <sup>1,2</sup></b>	Minimum of 95% of the material's standard Proctor maximum dry density (ASTM D698)
<b>Moisture content cohesive soils (clay soils) <sup>3</sup></b>	+1 to +4% of the optimum moisture content, with an average daily moisture content of at least +2% 0 to +2% of the optimum moisture content in pavement areas

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

## Excavation

Excavations into the subsurface soils will encounter a variety of conditions. The individual contractor(s) is 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 Occupational Safety and Health Administration (OSHA) excavation and trench safety standards.

Soils penetrated by the proposed excavations may vary significantly across the site. The soil classifications are based solely on the materials encountered in the exploratory 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.

## Grading and Drainage

All grades must be adjusted to provide positive drainage away from the building during construction and maintained throughout the life of the proposed project. Infiltration of water into

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utility or foundation excavations must be prevented during construction. Landscaped irrigation adjacent to the foundation systems should be minimized or eliminated. Water permitted to pond near or adjacent to the perimeter of the structure (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.

Permanent grades should be sloped at a minimum of 10 percent grade for at least 10 feet beyond the perimeter of the building. Asphalt pavement or concrete flatwork should be sloped at a minimum of 2 percent beyond the building perimeters for the life of the building. Where Americans with Disabilities Act (ADA) or other requirements or existing site features limit the gradient, slopes on the order of ½ to 1 percent minimum may be necessary to comply with the ADA, but do increase the risk of unanticipated movement. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be compacted in accordance with recommendations in this report and free of all construction debris to reduce the possibility of water infiltration. After building construction and prior to project completion, we recommend that verification of final grading be performed to document that positive drainage, as described above, has been achieved.

Where paving or flatwork abuts the structure, care should be taken that joints are properly sealed and maintained to prevent the infiltration of surface water.

Landscape or xeriscape areas within 10 feet of the foundation systems shall not be hindered by landscape edging, grade variations, or vegetation. In addition, consideration should be given to snow removal practices that will minimize the stockpiling of snow in planter and landscaped areas adjacent to structural improvements.

Planters located adjacent to the structure should be watertight. Sprinkler mains and spray heads should be located a minimum of 10 feet away from the building lines. Where drip line irrigation is located near the building, we recommend that drip line irrigation systems be located at least 5 feet from the outside edge of the foundations. Roof drains should discharge on pavements or be extended away from the structure a minimum of 10 feet through the use of splash blocks or downspout extensions.

Trees or other vegetation whose root systems have the ability to remove excessive moisture from the subgrade and foundation soils should not be planted next to the building. Trees and shrubbery should be kept away from the exterior edges of foundations, a distance at least equal to their expected mature height.

## Earthwork Construction Considerations

Upon completion of grading operations, care should be taken to maintain the moisture content of the subgrade prior to construction of slabs-on-grade, pavements, etc. Construction traffic over prepared subgrade should be minimized and avoided to the extent practical. Construction traffic over processed clay subgrade will eventually reduce the moisture content and increase the

density of the subgrade. Subsequent wetting of these materials will result in undesirable movement.

The site should also be graded to prevent ponding of surface water on prepared subgrade or in excavations. In areas where water is allowed to pond over a period of time, the affected area should be removed and allowed to dry out; however, allowing the clay soils to dry out below the optimum moisture content is not recommended. If constraints do not allow for moisture conditioning of affected clays as recommended in this report, the affected area should be overexcavated and replaced with engineered fill. As an alternative, geotextiles could also be considered as a stabilization technique.

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during overexcavation operations, excavations, subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade, and just prior to construction of building floor slabs.

## FOUNDATION RECOMMENDATIONS

Based on the geotechnical engineering analyses, the proposed daycare building may be constructed on a shallow spread footing foundation systems bottomed on a zone of new engineered fill, provided the owner is willing to accept the associated risk of movement.

### Spread Footing Foundation Recommendations

Design recommendations for spread footing foundation systems are presented in the following table and paragraphs.

Description	Value
<b>Thickness of Zone Of New Engineered Fill</b>	Minimum of 7 feet below bottom of lowest foundation element and all existing fill materials must be removed to native soils and replaced with new engineered fill
<b>Lateral Extent of Zone Of New Engineered Fill</b>	10 feet outside building footprint
<b>Supporting Stratum</b>	New engineered fill
<b>Maximum Allowable Bearing Pressure</b> <sup>1,2</sup>	2,500 psf
<b>Minimum Dead Load Pressure</b> <sup>3</sup>	500 psf or what is practical
<b>Void Thickness, If Needed</b>	4 inches
<b>Coefficient of Friction (Sliding)</b>	0.3
<b>Minimum Footing Dimensions</b> <sup>4</sup>	Isolated footings: 24 inches Continuous footings: 16 inches

Description	Value
<b>Minimum Embedment Below Finished Grade for Frost Protection</b> <sup>4</sup>	3 feet
<b>Approximate Total Movement</b> <sup>5</sup>	About 1 inch
<b>Estimated Differential Movement</b> <sup>5,6</sup>	About ½ to ¾ inch

1. The recommended maximum allowable bearing pressure assumes that any existing fill or lower strength soils, if encountered, will be excavated and replaced with engineered fill.
2. The maximum allowable soil bearing pressure can be increased by 1/3 for transient loading conditions.
3. Not applicable for mat foundations or stiffened structural slab-on-grade.
4. For perimeter footings, footings beneath unheated areas, and footings that will be exposed to freezing conditions during construction. Interior footings may bottom at a minimum depth of 12 inches below finished grade in heated areas.
5. Foundation movement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of engineered fill, and the quality of the earthwork operations and footing construction.
6. Footings should be proportioned on the basis of equal total dead load pressure to reduce differential movement between adjacent footings.

Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction and throughout the life of the structure. Failure to maintain the proper drainage as recommended in the **Grading and Drainage** section of **Earthwork** will nullify the movement estimates provided above.

Unstable subgrade conditions should be observed by the geotechnical engineer to assess the subgrade and provide suitable alternatives for stabilization. Stabilized areas should be proofrolled prior to continuing construction to assess the stability of the subgrade.

The base of all foundation excavations should be free of water and loose soil prior to concrete placement. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Should the soils at bearing level become excessively dry, disturbed or saturated, or frozen, the affected soil should be removed prior to placing concrete.

Footings, foundations, and masonry walls should be detailed and reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings or other discontinuities in masonry walls is recommended.

## SEISMIC CONSIDERATIONS

Based on our subsurface exploration and laboratory testing, it is our opinion that the soils have a low risk of liquefaction. The following table presents the seismic site classification based on the 2015 International Building Code (IBC), and the subsurface conditions encountered within the borings:

Code Used	Site Classification
2015 International Building Code (IBC) <sup>1,2</sup>	D

1. In general accordance with the 2015 International Building Code, Section 1613.3.2.
2. The 2015 International Building Code (IBC) requires a site subsurface profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100-foot subsurface profile determination. The deepest borings of this exploration extended to a maximum depth of about 50 feet and this seismic site class definition considers that similar subsurface conditions exist below the maximum depth of the subsurface exploration.

## FLOOR SLABS

### Interior Floors

Slab-on-grade floors may be utilized for the interior floor systems, provided slabs-on-grade are constructed on a zone of 7 feet of new engineered fill, and provided some slab movement can be tolerated. We estimate this alternative will reduce movement to about 1 inch. If very little movement can be tolerated, structural floors, supported independent of the subgrade materials, are recommended.

The following design and construction recommendations apply to conventional slab-on-grade construction. If the owner cannot accept the risk of slab movement, a structural floor should be used. If the owner is willing to accept the risk associated with movement of a slab-on-grade floor system, slabs-on-grade should be constructed on a zone of engineered fill, as recommended above. New fill materials beneath slabs-on-grade should be placed and compacted as outlined in the **Earthwork** section of this report.

For structural design of concrete slabs-on-grade, a modulus of subgrade reaction of 100 pounds per cubic inch (pci) may be used for point or limited area loads for floors supported on an engineered fill.

Additional floor slab design and construction recommendations are as follows:

- Positive separations and/or isolation joints should be provided between slabs and all foundations, columns, or utility lines to allow independent movement.
- Control joints should be provided in slabs to control the location and extent of cracking.
- A minimum 3-inch void space should be constructed above or below non-bearing partition walls placed on the floor slab. Special framing details should be provided at doorjambes and frames within partition walls to avoid potential distortion. Partition walls should be isolated from suspended ceilings.
- Interior trench backfill placed beneath slabs should be compacted in accordance with recommended specifications described previously.
- The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet, or other moisture sensitive or impervious coverings,

or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 for procedures and cautions regarding the use and placement of a vapor retarder.

- Floor slabs should not be constructed on frozen subgrade.
- Other design and construction considerations, as outlined in Section 302.1R of the ACI Design Manual, are recommended.

Movements of slab-on-grades using the above outlined technique will likely be reduced and tend to be more uniform. The estimates outlined previously assume that the other recommendations in this report are followed. Additional movement could occur should the subsurface soils become wetted to significant depths, which could result in potential excessive movement causing uneven floor slabs and severe cracking. This could be due to over watering of landscaping, poor drainage, improperly functioning drain systems, and/or broken utility lines. Therefore, it is imperative that the recommendations outlined in this section and in the **Grading and Drainage** subsection of **Earthwork** be followed.

## **EXTERIOR FLATWORK**

Exterior slabs-on-grade and flatwork constructed on the on-site expansive fill materials will have a moderate risk of movement. The risk of movement can be slightly reduced if the exterior slabs-on-grade are overexcavated to a depth of at least 2 feet, moisture conditioned, and recompacted to grade. New fill materials beneath slabs-on-grade should be placed and compacted as outlined in the **Earthwork** section of this report.

For structural design of exterior concrete slabs-on-grade, a modulus of subgrade reaction of 100 pci may be used for point or limited area loads for exterior slabs-on-grade at this site.

Additional slab design and construction recommendations are as follows:

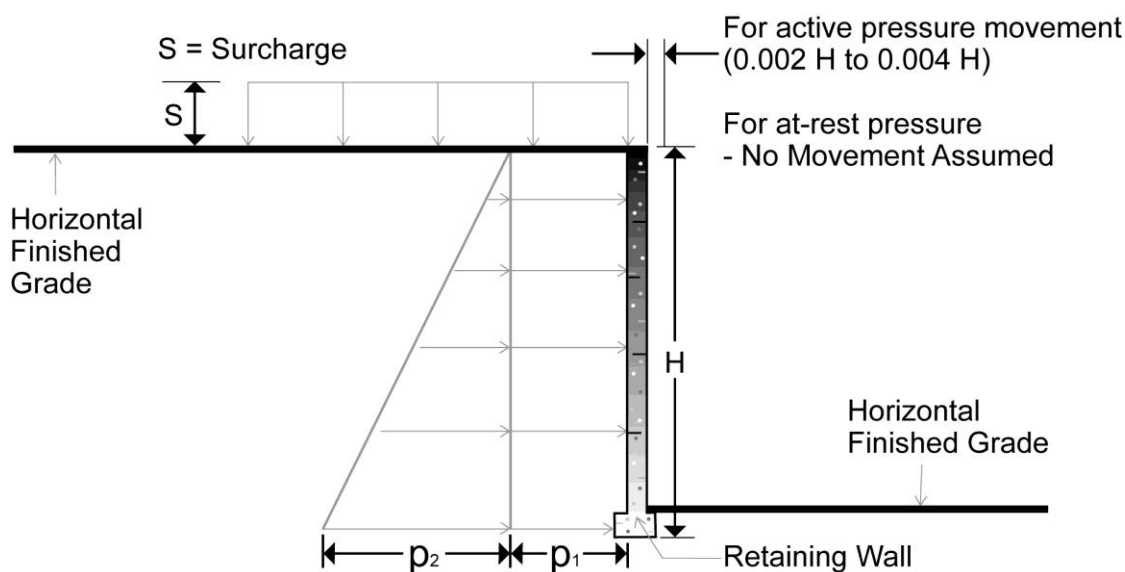
- Minimizing moisture increases in the backfill.
- Controlling moisture-density during placement of backfill.
- Positive separations and/or isolation joints should be provided between exterior slabs and the building to allow independent movement.
- Control joints should be provided in slabs to control the location and extent of cracking.
- Exterior slabs should not be constructed on frozen subgrade
- Other design and construction considerations, as outlined in Section 302.1R of the ACI Design Manual, are recommended.

Movements of exterior slabs-on-grade using the above technique will likely be reduced and tend to be more uniform. Additional movement could occur should the subsurface soils and bedrock become wetted to significant depths, which could result in potential excessive movement causing uneven exterior slabs and severe cracking. This could be due to over watering of landscaping,

poor drainage, and/or broken utility lines. Therefore, it is imperative that the recommendations outlined in the **Grading and Drainage** subsection of **Earthwork** be followed.

## LATERAL EARTH PRESSURES

Below-grade walls or free-standing retaining walls are not anticipated for this project; however, we have included lateral earth pressures recommendations in case plans should change. Reinforced concrete 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 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 Conditions	Lateral Earth Pressure Coefficient	Equivalent Fluid Density (pcf)	Surcharge Pressure, $p_1$ (psf)	Earth Pressure, $p_2$ (psf)
Active ( $K_a$ )	0.47	60	$(0.47)S$	$(60)H$
At-Rest ( $K_o$ )	0.64	80	$(0.64)S$	$(80)H$
Passive ( $K_p$ )	2.1	250	---	---

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 120 pcf
- Horizontal backfill, compacted to at least 95 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 in soil parameters

We recommend that a drain be installed behind retaining walls. The above pressures do not include the influence of surcharge, equipment, or floor loading, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided.

The preceding data are applicable only to cast-in-place concrete or modular block walls up to 5 feet in height. **If taller single walls, tiered walls, or Mechanically Stabilized Earth (MSE) walls will be included in the proposed development, additional site-specific studies and laboratory testing will be required.** In addition, the wall designer should perform standard wall design practices including analysis for overturning, sliding, bearing capacity, and global stability, and results of these analyses should be provided for our review. Additional sampling, laboratory testing and document review associated with retaining walls is beyond the original scope of work but can be performed as a separate scope, for a separate fee.

## **PAVEMENTS**

Design of privately maintained pavements for the project has been based on the procedures outlined by the Asphalt Institute (AI) and the American Concrete Institute (ACI).

Pavements and flatwork constructed on the existing expansive fill materials will have a moderate risk of movement. The risk of movement can be slightly reduced by overexcavating the materials to a depth of 2 feet and properly moisture conditioning and compacting the materials to grade.

### **Design Traffic**

We assumed the following design parameters for Asphalt Institute flexible pavement thickness design:

- Automobile Parking Areas

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- Parking stalls and parking lots for cars and pick-up trucks, up to 50 stalls
- Main Traffic Corridors
  - Parking lots with a maximum of 5 trucks per day
- Subgrade Soil Characteristics
  - USCS Classification – CL to SC (poor to medium subgrade)

We assumed the following design parameters for ACI rigid pavement thickness design based upon the average daily truck traffic (ADTT):

- Automobile Parking Areas
  - ACI Category A-1: Automobile parking with an ADTT of 1 over 20 years
- Main Traffic Corridors
  - ACI Category B: Commercial entrance and service lanes with an ADTT of 25 over 20 years
- Subgrade Soil Characteristics
  - USCS Classification – CL to SC (low to medium support)
- Concrete modulus of rupture value of 500 psi

We should be contacted to confirm and/or modify the recommendations contained herein if actual traffic volumes differ from the assumed values shown above.

### Subgrade Soils

Based on subgrade soil Unified Soil Classifications of CL to SC, AI classifies the subgrade soil as poor to medium, while ACI classifies the subgrade soil as low to medium support. Existing expansive clay fill materials will be encountered below the proposed pavement areas. We recommend overexcavating to a depth of at least 2 feet, moisture conditioning, and recompacting the material to grade to improve performance.

### Recommended Minimum Pavement Sections and Materials

Recommended alternatives for flexible and rigid pavements are summarized for each traffic area as follows:

Traffic Area	Alternative	Preliminary Pavement Thickness (Inches)			
		Asphalt Concrete Surface	Aggregate Base Course	Portland Cement Concrete	Total
Automobile Parking (AI Class I and ACI Category A)	A	6	--	--	6
	B	4	8	--	12
	C <sup>1</sup>	--	--	5	5

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Traffic Area	Alternative	Preliminary Pavement Thickness (Inches)			
		Asphalt Concrete Surface	Aggregate Base Course	Portland Cement Concrete	Total
Main Traffic Corridors (AI Class III and ACI Category B)	A	7	--	--	7
	B	4½	10	--	14½
	C <sup>1</sup>	--	--	6	6

1. The minimum pavement section thickness per ACI

Each alternative should be investigated with respect to current material availability and economic conditions. A minimum 7-inch thickness of rigid reinforced concrete pavement is recommended at the location of dumpsters where trash trucks park and load, and in areas of tight turning radius.

Concrete pavement joint spacing and reinforcement should be in accordance with specifications in ACI 330R-08.

For analysis of pavement costs, the following specifications should be considered for each pavement component:

Pavement Component	Colorado Department of Transportation Criteria
Asphalt Concrete Surface	Grading S or SX
Aggregate Base Course	Class 5 or 6
Portland Cement Concrete	Class P

### Drainage Adjacent to Pavements

Clay subgrade materials will expand and/or lose stability with increases in moisture content. To reduce pavement distress due to wetting of the subgrade in areas of water intensive landscaping or other nearby water sources (or if aggregate base course is used) located adjacent to pavements, edge drains should be considered.

### Pavement Maintenance

Future performance of pavements constructed at this site will be dependent upon several factors, including:

- Maintaining stable moisture content of the subgrade soils both before and after pavement construction.
- Providing for a planned program of preventative maintenance.

The performance of all pavements can be enhanced by minimizing excess moisture, which can reach the subgrade soils. The following recommendations should be implemented:

- Site grading at a minimum 2 percent grade onto or away from the pavements.
- Water should not be allowed to pond behind curbs.
- Compaction of any utility trenches for landscaped areas to the same criteria as the pavement subgrade.
- Sealing all landscaped areas in or adjacent to pavements, or providing drains to reduce the risk of moisture migration to subgrade soils.
- Placing compacted backfill against the exterior side of curb and gutter.
- Placing curb, gutter, and/or sidewalk directly on subgrade soils without the use of base course materials.

Preventative maintenance should be planned and provided for an ongoing pavement management program in order to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration.

Preventative maintenance consists of both localized maintenance (e.g. crack sealing and patching) and global maintenance (e.g. surface sealing). Preventative maintenance is usually the first priority when implementing a planned pavement maintenance program.

## **Pavement Construction Considerations**

Site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, or rainfall. As a result, the pavement subgrade may not be suitable for pavement construction and corrective action will be required. The subgrade should be carefully evaluated at the time of pavement construction for signs of disturbance or excessive rutting. If disturbance has occurred, pavement subgrade areas should be reworked, moisture conditioned, and properly compacted to the recommendations in this report immediately prior to paving.

We recommend the pavement areas be rough graded and then thoroughly proofrolled with a loaded tandem axle dump truck prior to final grading and paving. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills. All pavement areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to paving.

The placement of a partial pavement thickness for use during construction is not recommended without a detailed pavement analysis incorporating construction traffic. In addition, if the actual traffic varies from the assumptions outlined above, we should be contacted to confirm and/or modify the pavement thickness recommendations outlined above.

## CORROSIVITY

The following table lists the results of laboratory water-soluble sulfate testing performed on samples obtained during our field exploration. These values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Boring No.	Sample Depth (feet)	Water-Soluble Sulfate <sup>1</sup> (%)
3	0 – 5	<0.10

1. Results of water-soluble sulfate testing indicate that sample of the on-site soils has an exposure class of S0 when classified in accordance with Table 19.3.1.1 of the American Concrete Institute (ACI) Design Manual. The results of the testing indicate ASTM Type I Portland Cement is suitable for project concrete in contact with on-site soils. However, if there is no (or minimal) cost differential, use of ASTM Type II Portland Cement is recommended for additional sulfate resistance of construction concrete. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 19.

## 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.

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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

## EXPLORATION AND TESTING PROCEDURES

### Field Exploration

**Boring Layout and Elevations:** The locations of the borings are presented in the **Site Location and Exploration Plans**. The borings were located in the field by overlaying the site plan on Google Earth, recording the latitude and longitude coordinates, and staking the borings using a handheld, recreational-grade GPS unit. The accuracy of the latitude and longitude values is typically about +/- 25 feet when obtaining the values using this method. Elevations at the borings were obtained using a level and using the rim of a sewer manhole along Twenty Mile Road west of the site (approximately 39.5434° N, -104.7753° W) as a temporary benchmark with an assigned elevation of 100.0 feet. The accuracy of the boring locations and elevations should only be assumed to the level implied by the methods used.

**Subsurface Exploration Procedures:** The borings were drilled with a CME-55 truck-mounted rotary drill rig with solid-stem augers. During the drilling operations, lithologic logs of the borings were recorded by the field engineer. Relatively undisturbed samples were obtained at selected intervals utilizing a 2½-inch outside diameter modified California barrel sampler. Bulk samples were obtained from auger cuttings. Penetration resistance values were recorded in a manner similar to the standard penetration test (SPT). This test consists of driving the sampler into the ground with a 140-pound hammer free falling through a distance of 30 inches. The number of blows required to advance the barrel sampler 12 inches (18 inches for standard split-spoon samplers, final 12 inches are recorded) or the interval indicated is recorded and can be correlated to the standard penetration resistance value (N-value). The blow count values are indicated on the boring logs at the respective sample depths, barrel sampler blow counts are not considered N-values.

An automatic hammer was used to advance the samplers in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The standard penetration test provides a reasonable indication of the in-place density of sandy type materials, but only provides an indication of the relative stiffness of cohesive materials since the blow count in these soils may be affected by the soils moisture content. In addition, considerable care should be exercised in interpreting the N-values in gravelly soils, particularly where the size of the gravel particle exceeds the inside diameter of the sampler.

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Groundwater measurements were obtained in the borings at the time of drilling. Due to safety concerns, the borings were backfilled with after drilling. Some settlement of the backfill may occur and should be repaired as soon as possible.

### Laboratory Testing

Samples retrieved during the field exploration were returned to the laboratory for observation by the project geotechnical engineer, and were classified in general accordance with the Unified Soil Classification System presented in the **Supporting Information**.

At this time, an applicable laboratory-testing program was formulated to determine engineering properties of the subsurface materials. Following the completion of the laboratory testing, the field descriptions were confirmed or modified as necessary, and the boring logs were prepared. The boring logs are included in the **Exploration Results**.

Laboratory test results are included in the **Exploration Results**. These results were used for the geotechnical engineering analyses and the development of foundation, earthwork, and pavement recommendations. All laboratory tests were performed in general accordance with the applicable local or other accepted standards.

Selected soil samples were tested for the following engineering properties:

- Water content
- Dry density
- Grain size distribution
- Water-soluble sulfate content
- Atterberg limits
- Swell/consolidation

## **SITE LOCATION AND EXPLORATION PLANS**

### **Contents:**

Site Location Plan  
Exploration Plan with Aerial  
Exploration Plan with Overlay

Note: All attachments are one page unless noted above.

**SITE LOCATION**

Proposed Daycare Building ■ Parker, Colorado  
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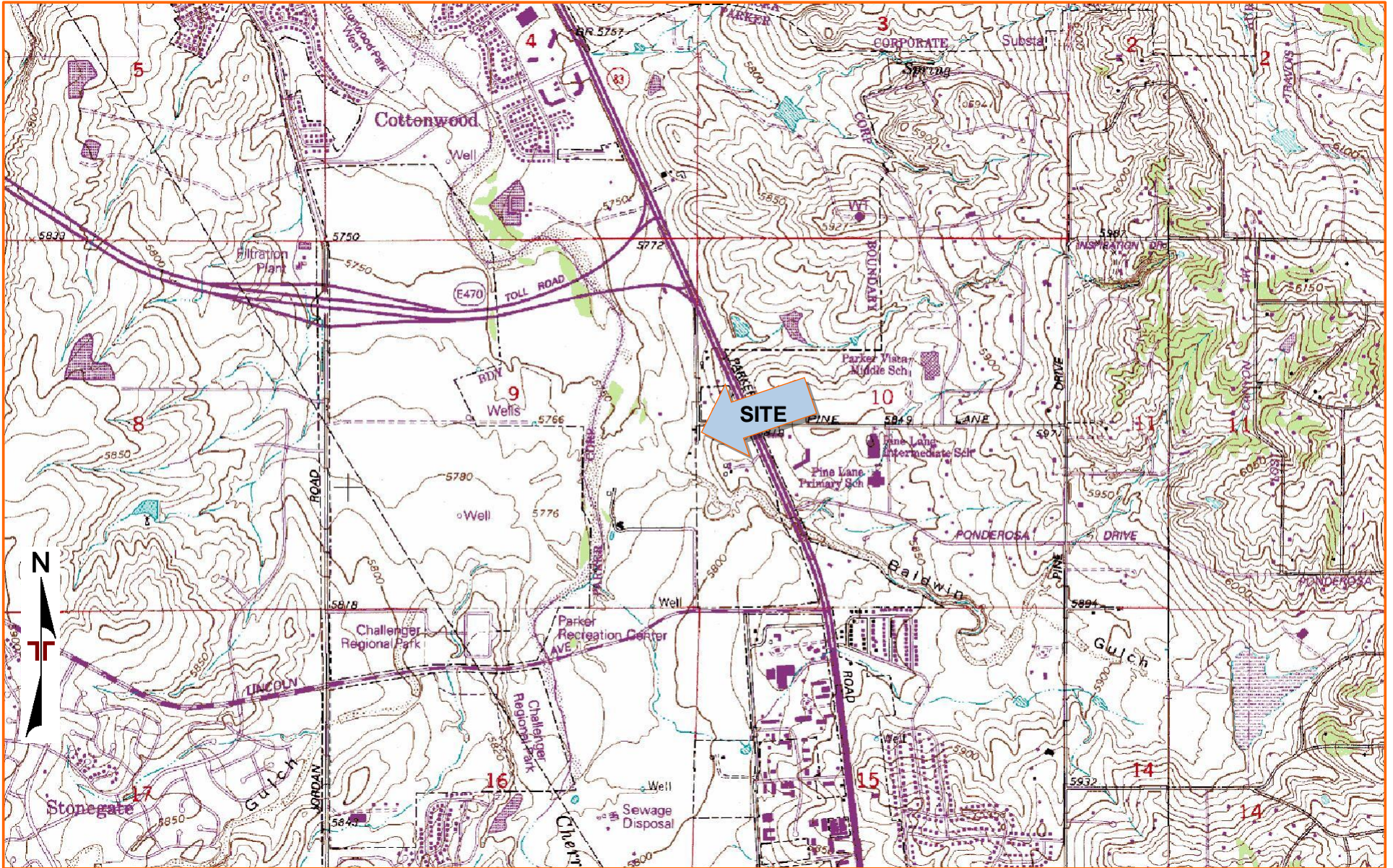


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY  
QUADRANGLES INCLUDE: PARKER, CO (1/1/1994) and PINEY CREEK, CO (1/1/1994).

**EXPLORATION PLAN**

Proposed Daycare Building ■ Parker, Colorado

August 24, 2020 (Revised September 23, 2020) ■ Terracon Project No. 25205205

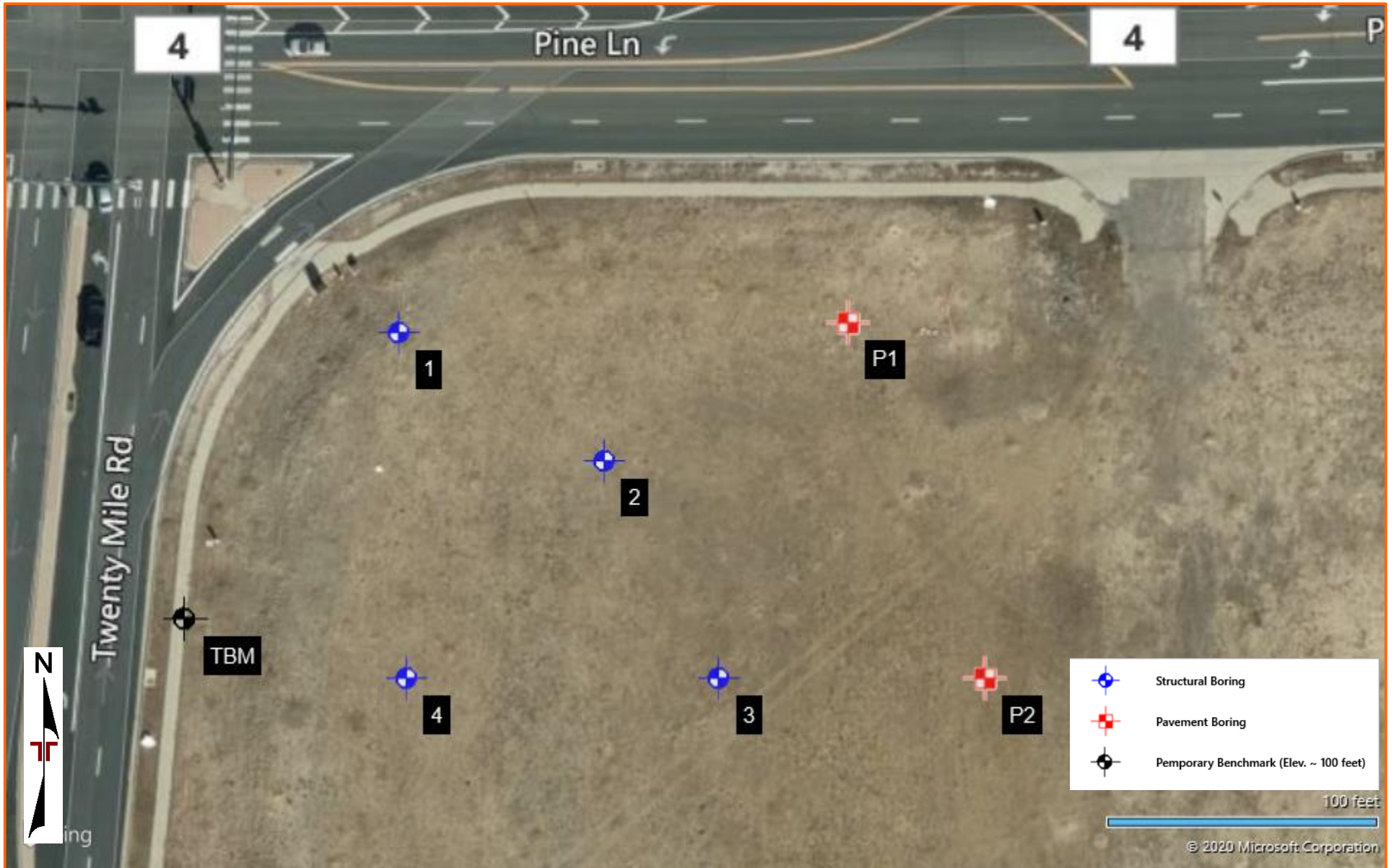


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

## EXPLORATION PLAN WITH OVERLAY

Proposed Daycare Building ■ Parker, Colorado

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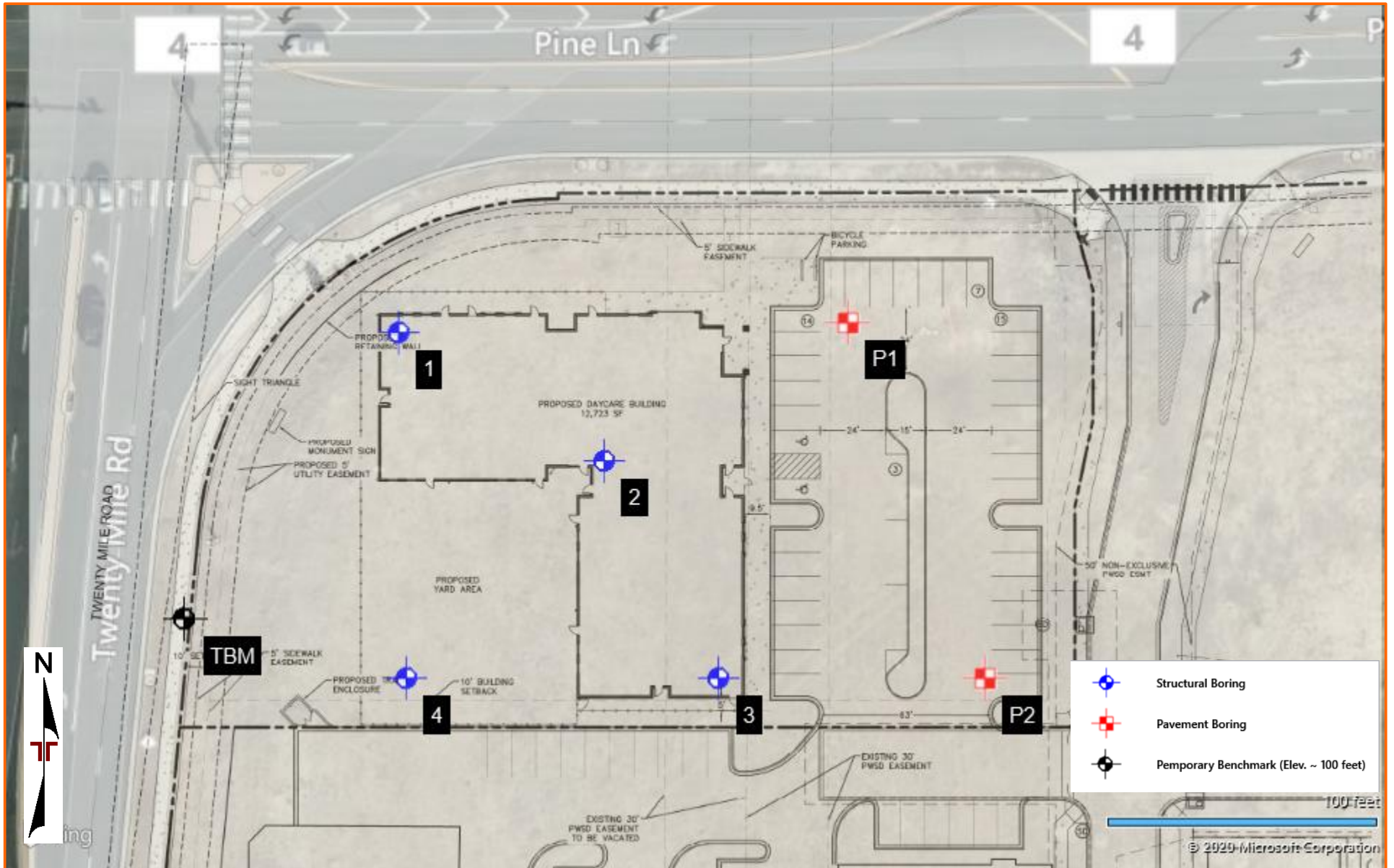


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

## **EXPLORATION RESULTS**

### **Contents:**

Boring Logs (Boring Nos. 1 to 4 and P1 to P2)

Swell Consolidation Test (4 pages)

Grain Size Distribution (3 pages)

Summary of Laboratory Test Results

Note: All attachments are one page unless noted above.

# BORING LOG NO. 1

**PROJECT: Proposed Daycare Building**

**CLIENT: NLD Parker, LLC**

**SITE: Pine Lane and Twenty Mile Road  
Parker, Colorado**

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL\_25205205 PROPOSED DAYCARE.GPJ TERRACON.DATATEMPLATE.GDT 8/24/20

GRAPHIC LOG	LOCATION See <a href="#">Exploration Plan</a> Latitude: 39.5437° Longitude: -104.775°  Surface Elev.: 105.5 (Ft.) ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SWELL (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
									LL-PL-PI	PERCENT FINES
9.0	<b>FILL - SANDY LEAN CLAY (CL)</b> , brown mottled with orange, stiff to very stiff	96.5		10-10					39-20-19	66
14.0	<b>LEAN CLAY (CL)</b> , dark brown, stiff	91.5		5-6			11.4	111		
19.0	<b>CLAYEY SAND (SC)</b> , fine to medium grained, light brown, loose	86.5		4-4						
24.0	<b>FAT CLAY (CH)</b> , light brown to gray, stiff	81.5		7-9			32.0	89		
29.0	<b>SILTY SAND (SM)</b> , fine to coarse grained, light brown to tan, medium dense	76.5		11-12			4.0	94	NP	24
38.0	<b>POORLY GRADED SAND (SP)</b> , fine to coarse grained, light brown to tan, medium dense	67.5	▽	10-9						
45.0	<b>CLAYSTONE</b> , gray, hard	60.5		12-20						
45.0	<b>Boring Terminated at 45 Feet</b>	45		50/9"			17.1	112		
45.0		45		50/9"						

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

Hammer Type: Automatic

Advancement Method:  
4-inch diameter continuous flight power auger

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Elevations recorded using a level and the rim of a sewer manhole at approximate coordinates of 39.5434° N, -104.7753° W.

Abandonment Method:  
Borings backfilled with soil cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

- ▽ 32' while drilling
- ▽ 32' at completion of drilling



Boring Started: 07-21-2020

Boring Completed: 07-21-2020

Drill Rig: CME-55

Driller: Terracon

Project No.: 25205205

# BORING LOG NO. 2

**PROJECT:** Proposed Daycare Building

**CLIENT:** NLD Parker, LLC

**SITE:** Pine Lane and Twenty Mile Road  
Parker, Colorado

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL\_25205205 PROPOSED DAYCARE.GPJ TERRACON.DATATEMPLATE.GDT\_8/24/20

GRAPHIC LOG	LOCATION See <a href="#">Exploration Plan</a> Latitude: 39.5436° Longitude: -104.7748°  Surface Elev.: 105.7 (Ft.) DEPTH ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SWELL (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
									LL-PL-PI	PERCENT FINES
	<b>FILL - SANDY LEAN CLAY (CL)</b> , light brown to brown, very stiff	7.0		10-16					42-18-24	65
	<b>CLAYEY SAND (SC)</b> , fine to coarse grained, brown to dark brown, loose to medium dense	15.0		6-8			18.9	108		
	<b>SILTY SAND (SM)</b> , fine to coarse grained, light brown to tan, loose to medium dense	24.0		6-8			16.0	112	44-18-26	50
	<b>SANDY FAT CLAY (CH)</b> , brown mottled with gray, stiff	25.0		6-8			9.4	121		
	<b>Boring Terminated at 25 Feet</b>	25.0		6-10			3.1	89	NP	15

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

Hammer Type: Automatic

Advancement Method:  
4-inch diameter continuous flight power auger

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Elevations recorded using a level and the rim of a sewer manhole at approximate coordinates of 39.5434° N, -104.7753° W.

Abandonment Method:  
Borings backfilled with soil cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**  
*Groundwater not encountered*



Boring Started: 07-21-2020

Boring Completed: 07-21-2020

Drill Rig: CME-55

Driller: Terracon

Project No.: 25205205

# BORING LOG NO. 3

**PROJECT:** Proposed Daycare Building

**CLIENT:** NLD Parker, LLC

**SITE:** Pine Lane and Twenty Mile Road  
Parker, Colorado

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL\_25205205 PROPOSED DAYCARE.GPJ TERRACON.DATATEMPLATE.GDT 8/24/20

GRAPHIC LOG	LOCATION	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SWELL (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
	See <a href="#">Exploration Plan</a> Latitude: 39.5433° Longitude: -104.7746°  Surface Elev.: 105.2 (Ft.)										LL-PL-PI		
FILL	<b>FILL - SANDY LEAN CLAY (CL)</b> , brown to orange, stiff												
		9.0	96	5			8-8	+3.2 @ 500	12.6	116	46-18-28	66	
							8-10						
SANDY FAT CLAY	<b>SANDY FAT CLAY (CH)</b> , dark brown, stiff			10			6-10		23.8	98	53-19-34	64	
CLAYEY SAND	<b>CLAYEY SAND (SC)</b> , fine to medium grained, light brown to orange, loose	14.0	91	15			3-4		9.9	93			
SANDY LEAN CLAY	<b>SANDY LEAN CLAY (CL)</b> , brown mottled with orange, very stiff	24.0	81	20			5-7						
SANDY LEAN CLAY	<b>SANDY LEAN CLAY (CL)</b> , brown mottled with orange, very stiff	29.0	76	25			11-17		15.7	111			
POORLY GRADED SAND	<b>POORLY GRADED SAND (SP)</b> , fine to coarse grained, light brown to tan, dense	34.0	71	30	▽		50/11"				NP	4	
CLAYEY SAND	<b>CLAYEY SAND (SC)</b> , fine to medium grained, brown to orange, loose	39.0	66	35			5-7		20.5	104			
CLAYSTONE	<b>CLAYSTONE</b> , gray, hard to very hard			40			50/6"		14.7	120			
				45			50/5"		16.6	117			
				50			50/2"		17.4				
<b>Boring Terminated at 50 Feet</b>													

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

Hammer Type: Automatic

Advancement Method:  
4-inch diameter continuous flight power auger

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Elevations recorded using a level and the rim of a sewer manhole at approximate coordinates of 39.5434° N, -104.7753° W.

Abandonment Method:  
Borings backfilled with soil cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

- ▽ 32' while drilling
- ▽ 32' at completion of drilling



Boring Started: 07-21-2020

Boring Completed: 07-21-2020

Drill Rig: CME-55

Driller: Terracon

Project No.: 25205205

# BORING LOG NO. 4

**PROJECT:** Proposed Daycare Building

**CLIENT:** NLD Parker, LLC

**SITE:** Pine Lane and Twenty Mile Road  
Parker, Colorado

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL\_25205205 PROPOSED DAYCARE.GPJ TERRACON.DATATEMPLATE.GDT 8/24/20

GRAPHIC LOG	LOCATION	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SWELL (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
	See <a href="#">Exploration Plan</a> Latitude: 39.5433° Longitude: -104.775° Surface Elev.: 105.5 (Ft.)										LL-PL-PI		
9.0	<b>SANDY LEAN CLAY (CL)</b> , dark brown to orange, stiff to very stiff		96.5	5			11-14	+2.8 @ 500	14.0	117	43-19-24	65	
						9-10							
14.0	<b>SANDY LEAN CLAY (CL)</b> , dark brown to orange, stiff		91.5	10			9-9		12.7	107	46-15-31	64	
18.0	<b>POORLY GRADED SAND (SP)</b> , fine to coarse grained, light brown to tan, medium dense		87.5	15			13-13		2.7	116			
24.0	<b>FAT CLAY (CH)</b> , with sand, brown to orange, very stiff		81.5	20			11-10		21.7	102	51-19-32	87	
29.0	<b>CLAYEY SAND (SC)</b> , fine to medium grained, brown, medium dense		76.5	25			8-8		10.8	109			
30.0	<b>POORLY GRADED SAND (SP)</b> , fine to coarse grained, light brown to tan, medium dense		75.5	30			19-17						
	<b>Boring Terminated at 30 Feet</b>												

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

Hammer Type: Automatic

**Advancement Method:**  
4-inch diameter continuous flight power auger

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

**Notes:**

Elevations recorded using a level and the rim of a sewer manhole at approximate coordinates of 39.5434° N, -104.7753° W.

**Abandonment Method:**  
Borings backfilled with soil cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

Groundwater not encountered



Boring Started: 07-21-2020

Boring Completed: 07-21-2020

Drill Rig: CME-55

Driller: Terracon

Project No.: 25205205

# BORING LOG NO. P1

**PROJECT:** Proposed Daycare Building

**CLIENT:** NLD Parker, LLC

**SITE:** Pine Lane and Twenty Mile Road  
Parker, Colorado

GRAPHIC LOG	LOCATION <small>See <a href="#">Exploration Plan</a></small>	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SWELL (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
	DEPTH ELEVATION (Ft.)								LL-PL-PI	
	Latitude: 39.5437° Longitude: -104.7744°  Surface Elev.: 108.9 (Ft.)									
9.0	100									
10.0	99									
9.0	100	5		8-9					35-21-14	37
		6		6-12			12.1	116		
		10		15-18			6.8	118		
	<b>FILL - CLAYEY SAND (SC)</b> , fine to coarse grained, reddish brown to brown, medium dense  <b>SILTY SAND (SM)</b> , fine to medium grained, light brown, medium dense <b>Boring Terminated at 10 Feet</b>									

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

Hammer Type: Automatic

Advancement Method:  
4-inch diameter continuous flight power auger

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Elevations recorded using a level and the rim of a sewer manhole at approximate coordinates of 39.5434° N, -104.7753° W.

Abandonment Method:  
Borings backfilled with soil cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

*Groundwater not encountered*



Boring Started: 07-21-2020

Boring Completed: 07-21-2020

Drill Rig: CME-55

Driller: Terracon

Project No.: 25205205

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL\_25205205 PROPOSED DAYCARE.GPJ TERRACON\_DATATEMPLATE.GDT 8/24/20

# BORING LOG NO. P2

**PROJECT:** Proposed Daycare Building

**CLIENT:** NLD Parker, LLC

**SITE:** Pine Lane and Twenty Mile Road  
Parker, Colorado

GRAPHIC LOG	LOCATION See <a href="#">Exploration Plan</a> Latitude: 39.5433° Longitude: -104.7743°  Surface Elev.: 108.9 (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SWELL (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
									LL-PL-PI	PERCENT FINES
DEPTH	ELEVATION (Ft.)									
4.0	105			13-15		+3.1 @ 500	11.4	120		
5				6-8			6.4	106		
10.0	99	10		5-7			7.3	113		
<b>Boring Terminated at 10 Feet</b>										

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

Hammer Type: Automatic

Advancement Method:  
4-inch diameter continuous flight power auger

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Elevations recorded using a level and the rim of a sewer manhole at approximate coordinates of 39.5434° N, -104.7753° W.

Abandonment Method:  
Borings backfilled with soil cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

*Groundwater not encountered*



Boring Started: 07-21-2020

Boring Completed: 07-21-2020

Drill Rig: CME-55

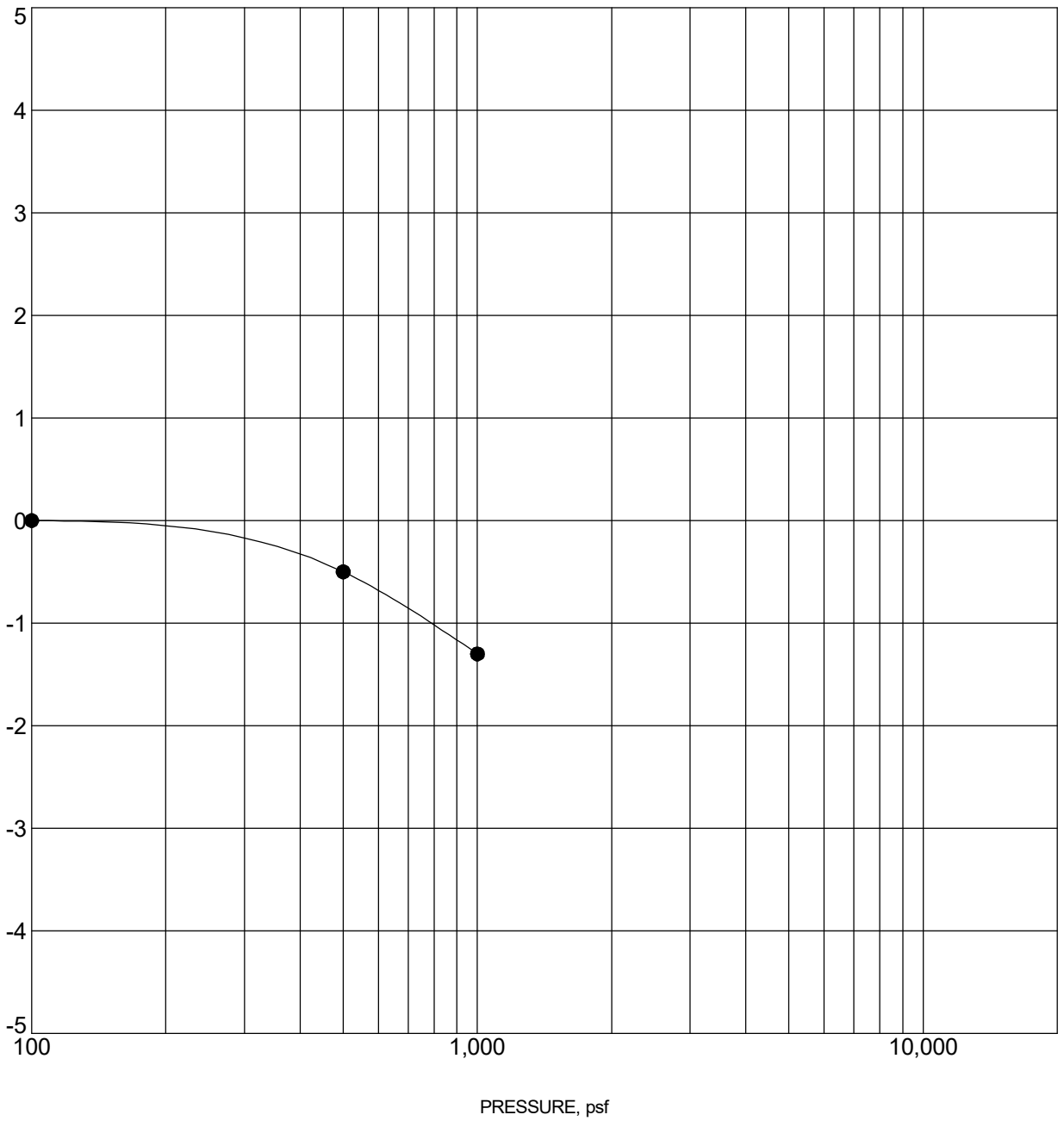
Driller: Terracon

Project No.: 25205205

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL\_25205205 PROPOSED DAYCARE.GPJ TERRACON\_DATATEMPLATE.GDT 8/24/20

# SWELL CONSOLIDATION TEST

AXIAL STRAIN, %



Specimen Identification		Classification	$\gamma_d$ , pcf	WC, %
●	1      9 - 10 ft	LEAN CLAY (CL)	108	18.0

NOTES: Water was added at 500 psf.

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. TC\_CONSOL\_STRAIN-USCS-NO ASTM 25205205 PROPOSED DAYCARE .GPJ TERRACON\_DATATEMPLATE.GDT 8/18/20

PROJECT: Proposed Daycare Building

SITE: Pine Lane and Twenty Mile Road  
Parker, Colorado

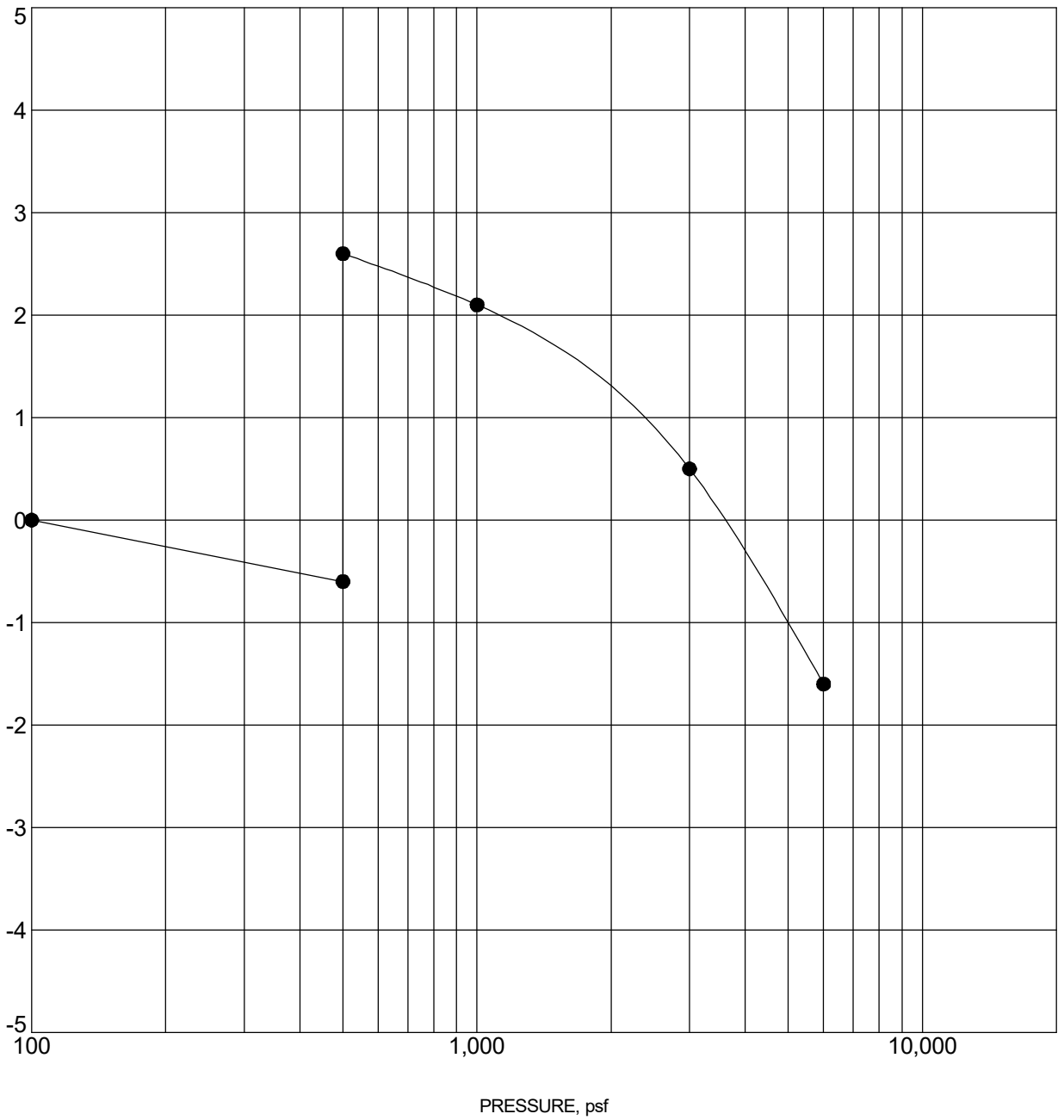


PROJECT NUMBER: 25205205

CLIENT: NLD Parker, LLC

# SWELL CONSOLIDATION TEST

AXIAL STRAIN, %



Specimen Identification		Classification	$\gamma_d$ , pcf	WC, %
●	3      4 - 5 ft	SANDY LEAN CLAY (CL)	116	12.6

NOTES: Water was added at 500 psf.

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. TC\_CONSOL\_STRAIN-USCS-NO ASTM 25205205 PROPOSED DAYCARE.GPJ TERRACON\_DATATEMPLATE.GDT 8/18/20

PROJECT: Proposed Daycare Building

SITE: Pine Lane and Twenty Mile Road  
Parker, Colorado

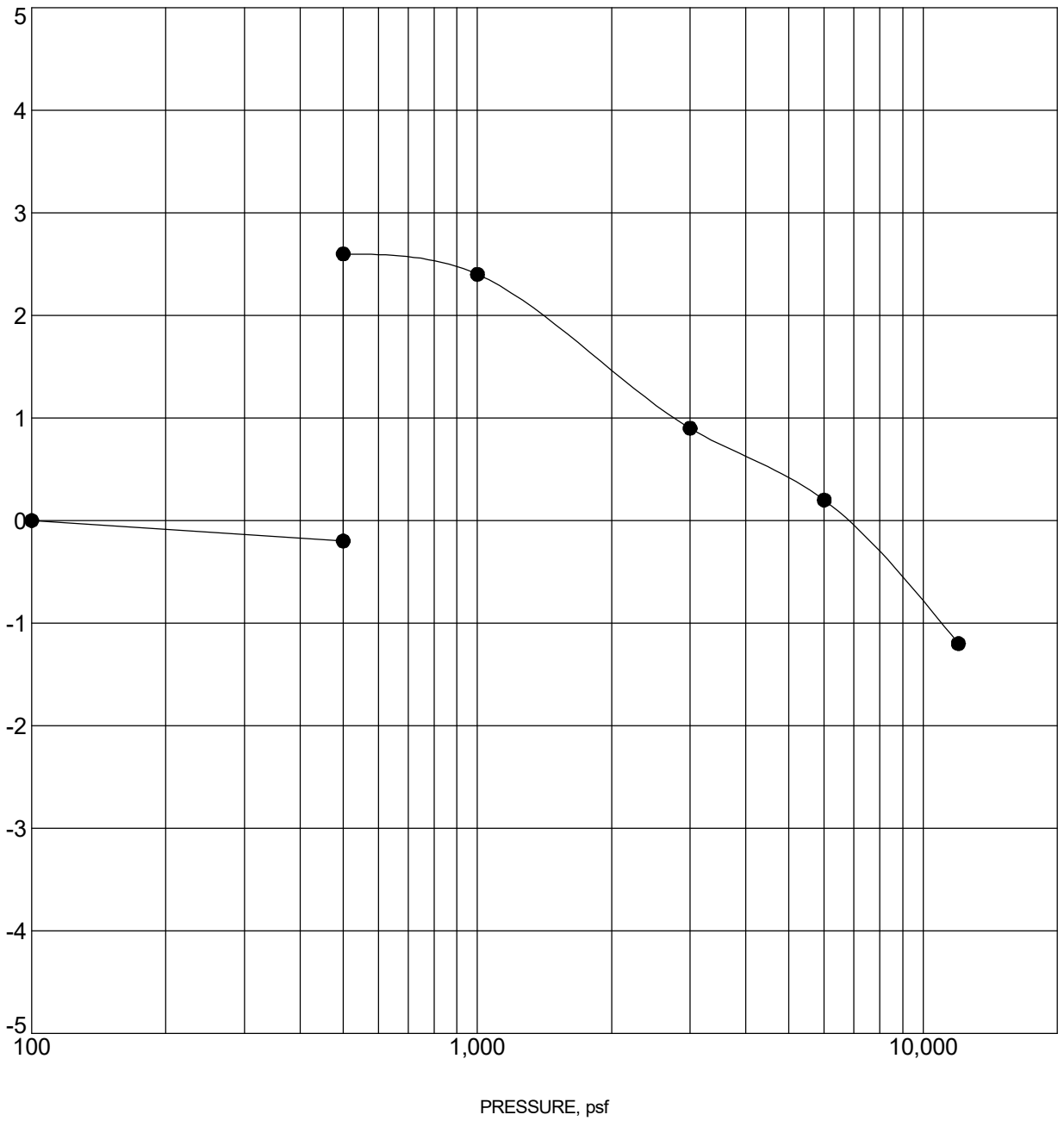


PROJECT NUMBER: 25205205

CLIENT: NLD Parker, LLC

# SWELL CONSOLIDATION TEST

AXIAL STRAIN, %



Specimen Identification		Classification	$\gamma_d$ , pcf	WC, %
●	4      4 - 5 ft	SANDY LEAN CLAY (CL)	117	14.0

NOTES: Water was added at 500 psf.

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. TC\_CONSOL\_STRAIN-USCS-NO ASTM 25205205 PROPOSED DAYCARE.GPJ TERRACON\_DATATEMPLATE.GDT 8/18/20

PROJECT: Proposed Daycare Building

SITE: Pine Lane and Twenty Mile Road  
Parker, Colorado

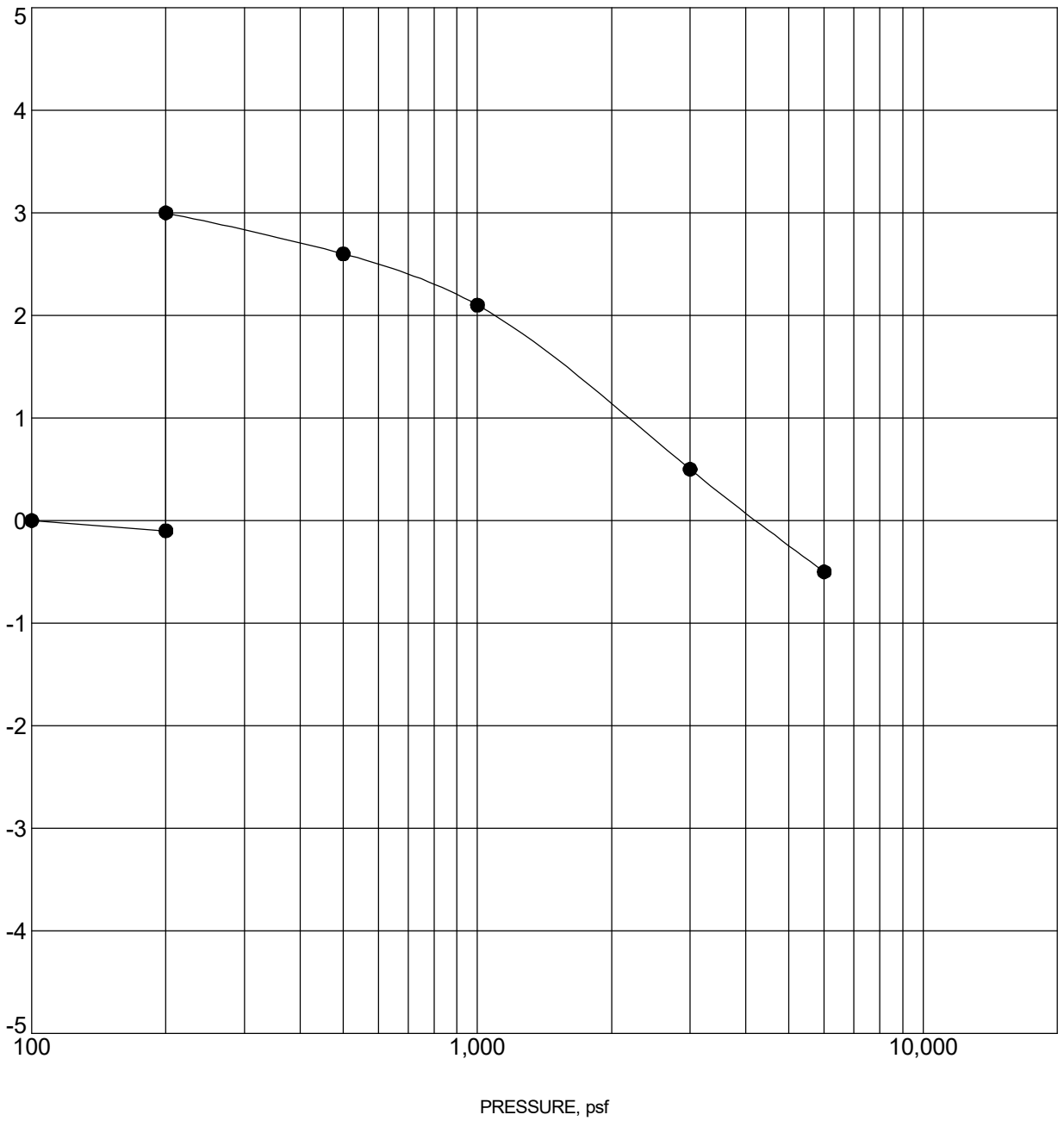


PROJECT NUMBER: 25205205

CLIENT: NLD Parker, LLC

# SWELL CONSOLIDATION TEST

AXIAL STRAIN, %



Specimen Identification		Classification	$\gamma_d$ , pcf	WC, %
●	P2 2 - 3 ft	SANDY LEAN CLAY (CL)	120	11.4

NOTES: Water was added at 200 psf.

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. TC\_CONSOL\_STRAIN-USCS-NO ASTM 25205205 PROPOSED DAYCARE.GPJ TERRACON\_DATATEMPLATE.GDT 8/18/20

PROJECT: Proposed Daycare Building

SITE: Pine Lane and Twenty Mile Road  
Parker, Colorado



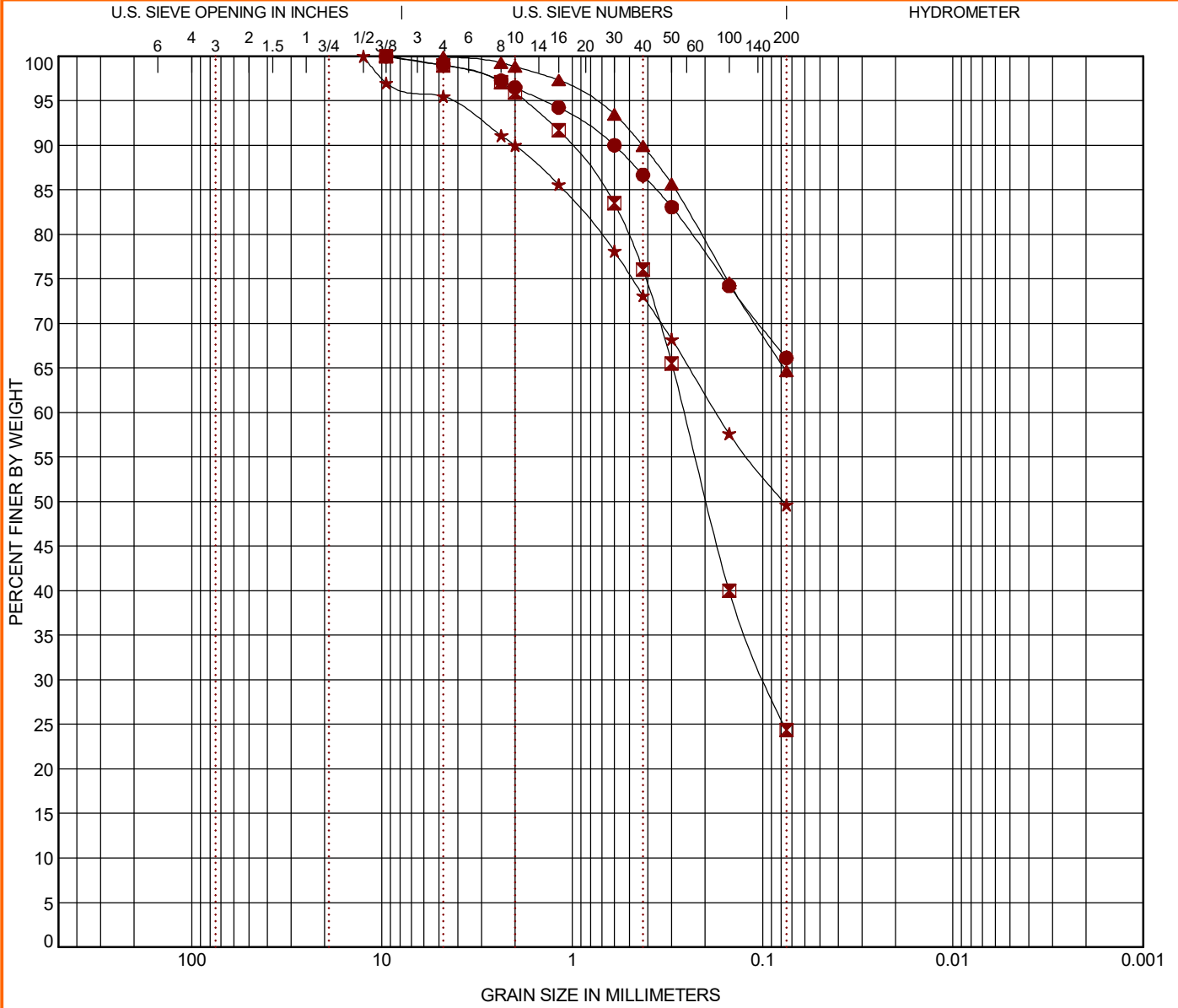
PROJECT NUMBER: 25205205

CLIENT: NLD Parker, LLC

# GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS & AASHTO DESC COMBINED 25205205 PROPOSED DAYCARE .GPJ TERRACON\_DATATEMPLATE.GDT 8/19/20



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification	AASHTO Classification	WC (%)	LL	PL	PI	Cc	Cu
● 1	0 - 5	SANDY LEAN CLAY (CL)	A-6 (11)		39	20	19		
☒ 1	24 - 25	SILTY SAND (SM)	A-2-4 (0)	4.0	NP	NP	NP		
▲ 2	0 - 5	SANDY LEAN CLAY (CL)	A-7-6 (13)		42	18	24		
★ 2	7 - 8	CLAYEY SAND (SC)	A-7-6 (9)	16.0	44	18	26		

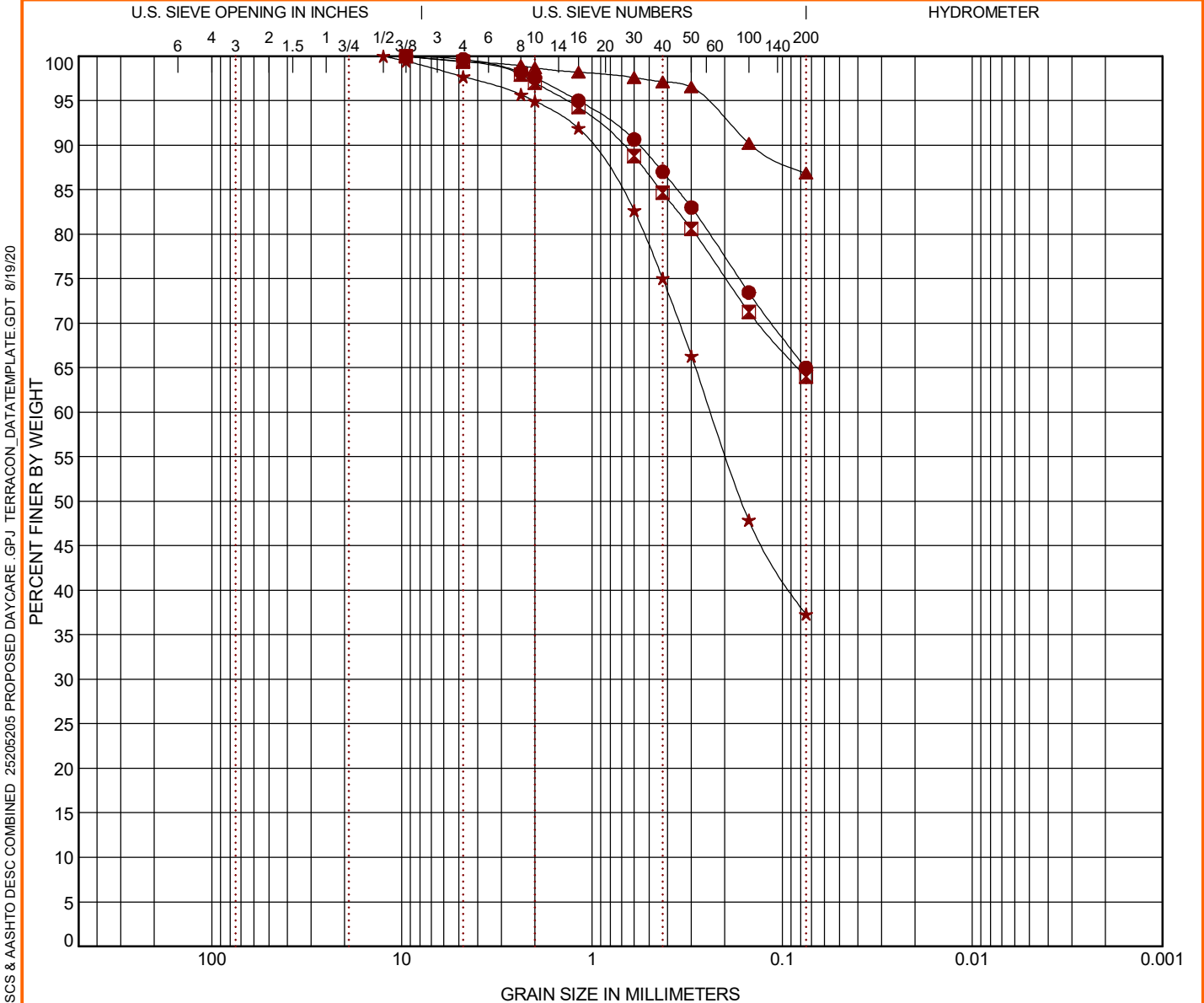
Boring ID	Depth	D <sub>100</sub>	D <sub>60</sub>	D <sub>30</sub>	D <sub>10</sub>	%Gravel	%Sand	%Silt	%Fines	%Clay
● 1	0 - 5	9.5				1.0	32.9		66.1	
☒ 1	24 - 25	9.5	0.258	0.096		1.0	74.6		24.4	
▲ 2	0 - 5	9.5				0.1	35.2		64.7	
★ 2	7 - 8	12.5	0.175			4.5	45.9		49.6	

PROJECT: Proposed Daycare Building	 10625 W I70 Frontage Rd N Ste 3 Wheat Ridge, CO	PROJECT NUMBER: 25205205
SITE: Pine Lane and Twenty Mile Road Parker, Colorado		CLIENT: NLD Parker, LLC



# GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification	AASHTO Classification	WC (%)	LL	PL	PI	Cc	Cu
● 4	0 - 5	SANDY LEAN CLAY (CL)	A-7-6 (13)		43	19	24		
☒ 4	9 - 10	SANDY LEAN CLAY (CL)	A-7-6 (17)	12.7	46	15	31		
▲ 4	19 - 20	FAT CLAY (CH)	A-7-6 (29)	21.7	51	19	32		
★ P1	0 - 5	CLAYEY SAND (SC)	A-6 (1)		35	21	14		

Boring ID	Depth	D <sub>100</sub>	D <sub>60</sub>	D <sub>30</sub>	D <sub>10</sub>	%Gravel	%Sand	%Silt	%Fines	%Clay
● 4	0 - 5	9.5				0.3	34.7		65.0	
☒ 4	9 - 10	9.5				0.6	35.4		64.0	
▲ 4	19 - 20	9.5				0.6	12.5		86.9	
★ P1	0 - 5	12.5	0.237			2.3	60.4		37.3	

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS & AASHTO DESC COMBINED 25205205 PROPOSED DAYCARE .GPJ TERRACON\_DATATEMPLATE.GDT 8/19/20

PROJECT: Proposed Daycare Building

SITE: Pine Lane and Twenty Mile Road  
Parker, Colorado



PROJECT NUMBER: 25205205

CLIENT: NLD Parker, LLC

## SUMMARY OF LABORATORY TEST RESULTS

Proposed Daycare Building - Parker, Colorado

Terracon Project No. 25205205

Boring No.	Depth (ft.)	USCS Class.	Initial Water Content (%)	Initial Dry Density (pcf)	Swell/Consolidation		Particle Size Distribution, Percent Passing by Weight					Atterberg Limits		Water Soluble Sulfates (%)	Remarks
					Surcharge (ksf)	Swell (%)	1/2"	#4	#10	#40	#200	LL	PI		
1	0 - 5	CL					100	99	97	87	66	39	20		
1	4	CL	11.4	111											4
1	9	CL	18.0	108	0.5	+0.0									3,4
1	19	CH	32.0	89											4
1	24	SM	4.0	94			100	99	96	76	24	NV	NP		4
1	39		17.1	112											4
2	0 - 5	CL					100	100	99	89	65	42	18		
2	4	CL	18.9	108											4
2	7	CL	16	112			100	95	90	73	50	44	18		4
2	9	SC	9.4	121											4
2	14	SM	3.1	89			100	96	88	51	15	NP	NV		4
3	0 - 5	CL					100	100	99	91	66	46	18	<0.10	4
3	4	CL	12.6	116	0.5	+3.2									3, 4
3	9	CH	23.8	98			100	98	96	83	64	53	19		
3	14	SC	9.9	93											4
3	24	CL	15.7	111											4
3	29	SP					100	95	61	25	4	NV	NP		4
3	34	SC	20.5	104											4
3	39		14.7	120											4

**Notes:**

Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.  
 \* = Partially disturbed sample  
 - = Compression/settlement  
 NV = no value  
 NP = non-plastic

**Remarks:**

- 1 Remolded Compacted density (about 95% of ASTM D698 maximum density near optimum moisture content)
- 2 Remolded Compacted density (about 95% of ASTM D1557 maximum density near optimum moisture content)
- 3 Water added to sample
- 4 Dry density and/or moisture content determined from one ring of a multi-ring sample
- 5 Minus #200 Only
- 6 Moisture-Density Relationship Test Method ASTM D698/AASHTO T99
- 7 Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180

## SUMMARY OF LABORATORY TEST RESULTS

Proposed Daycare Building - Parker, Colorado

Terracon Project No. 25205205

Boring No.	Depth (ft.)	USCS Class.	Initial Water Content (%)	Initial Dry Density (pcf)	Swell/Consolidation		Particle Size Distribution, Percent Passing by Weight					Atterberg Limits		Water Soluble Sulfates (%)	Remarks
					Surcharge (ksf)	Swell (%)	1/2"	#4	#10	#40	#200	LL	PI		
3	44		16.6	117											4
3	49		17.4												
4	0 - 5	CL					100	100	98	87	65	43	19		4
4	4	CL	14	117	0.5	+2.8									3, 4
4	9	CL	12.7	107			100	99	97	85	64	46	15		4
4	14	SP	2.7	116											4
4	19	CH	21.7	102			100	99	99	97	87	51	19		4
4	24	SC	10.8	109											4
P1	0 - 5	SC					100	98	95	75	37	35	21		4
P1	4	SC	12.1	116											4
P1	9	SM	6.8	118											4
P2	2	CL	11.4	120	0.5	+3.1									3,4
P2	4	SC	6.4	106											4
P2	9	SC	7.3	113											4

**Notes:**

Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.  
 \* = Partially disturbed sample  
 - = Compression/settlement  
 NV = no value  
 NP = non-plastic

**Remarks:**

- 1 Remolded Compacted density (about 95% of ASTM D698 maximum density near optimum moisture content)
- 2 Remolded Compacted density (about 95% of ASTM D1557 maximum density near optimum moisture content)
- 3 Water added to sample
- 4 Dry density and/or moisture content determined from one ring of a multi-ring sample
- 5 Minus #200 Only
- 6 Moisture-Density Relationship Test Method ASTM D698/AASHTO T99
- 7 Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180

## **SUPPORTING INFORMATION**

### **Contents:**













General Notes

Unified Soil Classification System

Note: All attachments are one page unless noted above.

# GENERAL NOTES

## DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

<b>SAMPLING</b>				<b>WATER LEVEL</b>		Water Initially Encountered	<b>FIELD TESTS</b>	(HP) Hand Penetrometer
						Water Level After a Specified Period of Time		(T) Torvane
						Water Level After a Specified Period of Time		(b/f) Standard Penetration Test (blows per foot)
					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.			(OVA) Organic Vapor Analyzer

## DESCRIPTIVE SOIL CLASSIFICATION

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

## LOCATION AND ELEVATION NOTES

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

STRENGTH TERMS	RELATIVE DENSITY OF COARSE-GRAINED SOILS <small>(More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.</small>			CONSISTENCY OF FINE-GRAINED SOILS <small>(50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance</small>			BEDROCK		
	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.	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency)
	Very Loose	0 - 3	0 - 5	Very Soft	less than 500	0 - 1	< 3	< 24	< 20
Loose	4 - 9	6 - 14	Soft	500 to 1,000	2 - 4	3 - 5	24 - 35	20 - 29	Firm
Medium Dense	10 - 29	15 - 46	Medium-Stiff	1,000 to 2,000	4 - 8	6 - 10	36 - 60	30 - 49	Medium Hard
Dense	30 - 50	47 - 79	Stiff	2,000 to 4,000	8 - 15	11 - 18	61 - 96	50 - 79	Hard
Very Dense	> 50	≥ 80	Very Stiff	4,000 to 8,000	15 - 30	19 - 36	> 96	>79	Very Hard
			Hard	> 8,000	> 30	> 36			

## RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

## GRAIN SIZE TERMINOLOGY

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

## RELATIVE PROPORTIONS OF FINES

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

## PLASTICITY DESCRIPTION

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

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

<sup>A</sup> Based on the material passing the 3-inch (75-mm) sieve.

<sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

<sup>C</sup> 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.

<sup>D</sup> 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.

<sup>E</sup>  $Cu = D_{60}/D_{10}$      $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

<sup>F</sup> If soil contains  $\geq 15\%$  sand, add "with sand" to group name.

<sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

<sup>H</sup> If fines are organic, add "with organic fines" to group name.

<sup>I</sup> If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.

<sup>J</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

<sup>K</sup> If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

<sup>L</sup> If soil contains  $\geq 30\%$  plus No. 200 predominantly sand, add "sandy" to group name.

<sup>M</sup> If soil contains  $\geq 30\%$  plus No. 200, predominantly gravel, add "gravelly" to group name.

<sup>N</sup>  $PI \geq 4$  and plots on or above "A" line.

<sup>O</sup>  $PI < 4$  or plots below "A" line.

<sup>P</sup>  $PI$  plots on or above "A" line.

<sup>Q</sup>  $PI$  plots below "A" line.

