



Report of Geotechnical Engineering Evaluation

Proposed In-N-Out Burger Restaurant
SWC of East Pine Lane and South Parker Road
Parker, Colorado 80134

Prepared for

In-N-Out Burger
13502 Hamburger Lane
Baldwin Park, California 91706
ATTN: Mr. Aaron Anderson

Prepared by

Professional Service Industries, Inc.
1070 West 124th Avenue
Suite 800
Westminster, Colorado 80234

May 4, 2021

PSI Project No. 05322222

A handwritten signature in blue ink that reads "Hannah C. Tawfik".

Hannah C. Tawfik, P.E.
Project Engineer

A handwritten signature in blue ink that reads "Kyle R. Duitsman".

Kyle R. Duitsman, P.E.
Site Manager



Professional Service Industries, Inc.
1070 West 124th Avenue, Suite 800
Westminster, Colorado 80234
Phone: (303) 424-5578
Fax: (303) 423-5625

Mr. Aaron Anderson
In-N-Out Burger
13502 Hamburger Lane
Baldwin Park, California 91706

**Re: Report of Geotechnical Engineering Evaluation
Proposed In-N-Out Burger Restaurant
SWC of East Pine Lane and South Parker Road
Parker, Colorado 80134**

Dear Mr. Anderson:

Professional Service Industries, Inc (PSI), an Intertek Company, is pleased to transmit our Report of Geotechnical Engineering Evaluation for the Proposed In-N-Out Burger Restaurant to be located in Parker, Colorado; which includes the field exploration and laboratory testing results, as well as site preparation and foundation design recommendations.

If you have questions pertaining to this report, or if we may be of further service, please contact us at your convenience.

PSI thanks you for your business and we look forward to finding ways to grow our partnership, expand our services, and continue Building Better Together.

Professional Service Industries, Inc.

A handwritten signature in blue ink that reads "Kyle R. Duitsman".

Kyle R. Duitsman, P.E.
Site Manager



Hannah C. Tawfik, P.E.
Project Engineer

Reviewed by: Lloyd Lasher, P.E.
Principal Consultant





TABLE OF CONTENTS

1.0 INTRODUCTION	1
2.0 PROJECT INFORMATION	1
3.0 SUBSURFACE INFORMATION	2
3.1 SITE GEOLOGY AND GEOLOGIC HAZARDS.....	3
3.2 SUBSURFACE CONDITIONS	3
<u>3.2.1 Subsurface Profile</u>	4
<u>3.2.2 Swell Potential</u>	4
<u>3.2.3 Groundwater Conditions</u>	5
<u>3.2.4 Laboratory Testing</u>	5
4.0 GEOTECHNICAL EVALUATION	5
5.0 SITE GRADING RECOMMENDATIONS	6
5.1 STRUCTURAL FILL.....	7
5.2 GENERAL FILL PLACEMENT AND TESTING	8
6.0 GEOTECHNICAL RECOMMENDATIONS	8
6.1 FOUNDATIONS	8
6.2 SLABS ON GRADE.....	10
6.3 SEISMIC PARAMETERS.....	11
6.4 PAVEMENT RECOMMENDATIONS	12
<u>6.4.1 Subgrade Preparation Recommendations</u>	12
<u>6.4.2 Pavement Thickness Recommendations</u>	12
<u>6.4.3 Flexible Pavement</u>	13
<u>6.4.4 Aggregate Base Course</u>	14
<u>6.4.5 Rigid Pavement</u>	14
6.5 SOIL CORROSIVITY.....	14
6.6 PERCOLATION TEST	15
7.0 LIMITATIONS	15

ATTACHMENTS

- Site Vicinity Map (Figure 1)
- Boring Location Map (Figure 2)
- Boring Logs (Figures 3 through 8)
- Key to Symbols (Figure 9)
- Appendix A – Laboratory Testing Results





1.0 INTRODUCTION

Professional Service Industries, Inc. (PSI), an Intertek Company, has conducted a geotechnical engineering evaluation for the site of the proposed In-N-Out Burger Restaurant to be located at the southwest corner of East Pine Lane and South Parker Road in Parker, Colorado. The purpose of our study was to characterize the subsurface strata at the subject site and to develop recommendations for site preparation and provide geotechnical parameters for design and construction of the proposed restaurant. Our services on this project were provided in general accordance with PSI Proposal Number 339809 dated April 5, 2021, authorized by Mr. Aaron Anderson on April 6, 2021.

PSI's scope of services for the geotechnical study did not include an assessment of environmental conditions in the soil, bedrock, surface water, groundwater, or air, on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

The report, which follows, presents a brief review of our understanding of the project, a discussion of the site and subsurface conditions encountered, and our recommendations for design and construction of foundations, pavements and slabs.

2.0 PROJECT INFORMATION

PSI understands that In-N-Out (INO) is planning the construction of a new restaurant to be located at the southwest corner of East Pine Lane and South Parker Road in Parker, Colorado. Our project understanding is based on information provided by Mr. Anderson via email which included a Request for Proposal (RFP) dated April 1, 2021. The RFP included project information, site photographs, aerial images, and a drawing titled "Preliminary Site Layout Plan-SP 01" dated 1/27/2021.

Based on this information, PSI understands that the project includes construction of a single-story, wood-frame, slab-on-grade restaurant and associated concrete drive-thru lane and asphalt parking areas. The proposed building is planned to be approximately 3,900 square feet in size, with a 400 square foot trash enclosure to be located to the southwest of the building. A patio area will also be located to the south of the proposed building.

Structural loads were not provided; therefore, PSI is basing this proposal on column loads not exceeding 75 kips, wall loads not exceeding 1.5 kips per linear foot, and slab loads not exceeding 150 psf. Proposed grading information was not provided, therefore, PSI is basing our services on final grades being within 2 feet of existing. Anticipated traffic loading or pavement performance expectations were not provided. Recommended minimum pavement sections have been provided based upon our experience with similar developments and the INO Typical Grading and Paving Standards.



Proposed stormwater retention/detention facilities were not indicated on the plans provided. Therefore, we anticipate stormwater drainage will be diverted to existing offsite ponds or systems and have not included services related to these items. A percolation test was performed near Boring B6 for informational purposes.

The 1.87-acre site is currently vacant, however; the greater site is currently under development. The site is generally level with approximately 2 to 3-feet of slope downward from north to the south. The latitude and longitude of the subject site is approximately 39.5433° North and 104.7737° West. The site is bounded by South Parker Road to the east, East Pine Lane to the north, and parcels under development to the south and west. The site has been previously graded during development of the surrounding area.



Descriptions of the site are based upon observations made during our field exploration program. The geotechnical recommendations presented in this report are based upon the provided project information and the subsurface materials described in this report. If any of the noted information is incorrect, please inform us so that we may amend the recommendations presented in this report, if needed.

3.0 SUBSURFACE INFORMATION

The following sections provide information relating to subsurface conditions encountered at the boring locations and published geologic information in the general vicinity of the project site. The geology section is based upon the “Geological Map of the Greater Denver Area, Front Range Urban Corridor, Colorado” by Donald E. Trimble and Michael N. Machette dated 1979 and information relating to subsurface conditions within the property gathered from our current field study.



3.1 Site Geology and Geologic Hazards

Based on the referenced map by Trimble and Machette 1979, the site lies in an area mapped as Modern Alluvium (Quaternary, Qa) can be described as “includes Piney Creek Alluvium and younger deposits”.

Based upon historical aerial photographs, the site was vacant land until as far back as 1937 (oldest Google Earth image). It appears South Parker Road was first constructed between 1937 and 1955, and further development of the area and construction of East Pine Lane began around 1994. East Pine Lane was completed around 2004, with some partial site grading occurring at that time. The site has been graded multiple times since 2004.

Baldwin Gulch runs along the south side of the development, approximately 1/10th of a mile south of the site.

3.2 Subsurface Conditions

As part of PSI’s evaluation of this site, six (6) exploratory borings were drilled at the approximate locations as indicated on Figure 2, the Boring Location Map, as follows:

Boring Number	Location	Depth
B1	Building	15 feet
B2	Drive-Thru Window	15 feet
B3	Building	15 feet
B4	Trash Enclosure	15 feet
B5	Pavement	10 feet
B6	Pavement	10 feet

The percolation test was performed near Boring B6, which was drilled to a depth of 10 feet.

The borings were advanced using a CME-55 truck mounted drill rig equipped with 4-inch diameter, solid-stem, continuous-flight auger. Soil samples were recovered at selected depths during drilling with the truck-mounted drill rig using a Modified California Sampler (outside diameter- 2.4 inches; inside diameter – 2.0 inches) driven by a 140-lb. weight free falling 30 inches. The number of blows required to drive the sampler 12 inches is designated as the penetration resistance (N-value, blows per foot) and provides an indication of the consistency of cohesive soils and the relative density of granular materials. While the procedure is similar to that employed in the Standard Penetration Test (ASTM D1586) the penetration resistance obtained using the California barrel sampler is generally higher than that obtained using the standard split-spoon sampler. A correction factor of 0.6 for sand and 0.77 for clay is used for N-Values collected using the Modified California sampler. The reported N-values were not corrected.

A representative from our office observed the drilling and prepared borings logs of the conditions encountered. Individual logs of the borings are presented on Figures 3 through 8. It should be



noted that the subsurface conditions presented on the boring logs are representative of the conditions at the specific locations drilled. Variations may occur and should be expected across the site. The soil morphology represents the approximate boundary between subsurface materials and the transitions may be gradual and indistinct. Water level information, if encountered, obtained during our field operations is also shown on the boring logs. Elevations referenced were obtained via Google Earth and should be considered approximations.

3.2.1 Subsurface Profile

At the boring locations, PSI generally encountered varying layers of silty clay and silty, clayey sand overlying bedrock. The silty clay is brown and dark brown, stiff to hard, and moist. The silty, clayey sand soils, which can be described as fine to medium grained sand, moist, brown and light brown, and generally medium dense. Bedrock was encountered at depths of approximately 4 to 11 feet below existing grade, and can be described as moist, brown/gray and yellow-brown with rust and white in places, moist, and hard. Apparent fill was encountered in Boring B5, which was dark brown with rust, stiff and moist.

The Boring Logs illustrated in Figures 3 through 8 should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratifications, penetration resistances, locations of the samples and laboratory test data.

3.2.2 Swell Potential

PSI performed ASTM D4546 Swell Testing on selected samples collected during our field exploration. The following table summarizes the swell test results:

Boring	Sample Depth (feet)	Soil Type	In-situ Moisture Content (%)	Swell Potential (%)	Swell Pressure (psf)
B1	2 ½	Silty, Clayey Sand	12	1.1	2,800
B1	10	Bedrock	16	3.6	12,400
B3	5	Silty Clay	7	1.9	1,700
B3	10	Bedrock	7	1.2	3,400
B4	2 ½	Silty Clay	10	6.1	3,400
B4	5	Silty Clay	14	6.1	11,800
B4	10	Bedrock	17	2.4	6,500

The laboratory swell test results are included in Appendix A and on the individual boring logs (Figures 3 through 8). The test results indicated swell percentages of 0.5 to 3.5 percent when tested under a surcharge pressure of 250, 500, and 1,000 psf. The surcharge values were applied based on the sample depth, with 100 psf surcharge applied for every 1 foot below the ground



surface. Once the samples were hydrated under the surcharge pressure and swelling had stopped, additional pressure was applied until the sample was at or below its initial volume.

Based on the laboratory results, PSI has classified the on-site soils and bedrock as having “low to high” swell potential. Based on this, swell mitigation will be necessary at this site. Care must be taken during construction to prevent drying of the subgrades. Significant wetting and drying of the soils will increase the risk of movement and should be avoided.

3.2.3 Groundwater Conditions

Groundwater was not observed during drilling operations. It should be noted that it is possible for the groundwater table to fluctuate during the year depending upon climatic and rainfall conditions and changes to surface topography and drainage patterns. Discontinuous zones of perched water may also exist, or develop, within the overburden materials subsequent to the construction of the proposed development. The groundwater levels present in this report are the levels that were measured at the time of our field activities. We recommend the contractor determine the groundwater level prior to construction and assess any potential impacts.

3.2.4 Laboratory Testing

A summary of laboratory testing is shown below:

Soil Type	N-Values	Moisture Content (%)	Dry Density (pcf)	Percent Fines (%)
Overburden – Silty Clay & Silty, Clayey Sand	19-50+	6-22	97-123	17-73
Bedrock	50+	7-17	106-115	37

The soil samples obtained during the field exploration were transported to the laboratory and selected soil samples were tested in the laboratory to measure material properties for our geotechnical evaluation. Laboratory testing was accomplished in general accordance with ASTM and other applicable procedures. Laboratory testing was performed on selected samples to evaluate the classification, swell and other engineering characteristics of the subsurface materials. Laboratory test data along with detailed descriptions of the soils can be found on the logs of borings and in Appendix A. The samples that were not altered by laboratory testing will be retained for 90 days from the date of this report and then will be discarded without further notice.

4.0 GEOTECHNICAL EVALUATION

The primary concern at this location are the presence of moderate to high swell potential soils. Mitigation to alleviate the swell potential of the onsite soils is recommended.

To mitigate the swell potential in the onsite soils, PSI recommends the soils be overexcavated no less than 5-feet below bottom of floor slab and replaced with moisture conditioned structural fill,



or no less than 2-feet below bottom of foundations (whichever is greater). We also recommend the pavements bear on no less than 2-feet of moisture conditioned and recompacted structural fill soils. Structural fill may consist of on-site soils.

Upon completion of the over-excavation to allow the placement of the moisture conditioned structural fill, the exposed subgrade should be proofrolled with a loaded tandem-axle dump truck or similar pneumatic-tired equipment with a minimum weight of 15 tons. Areas that deflect excessively should be over-excavated, moisture conditioned and recompacted.

Following satisfactory completion of the proofroll, the undercut material can be reused provided it is properly mixed, cleaned (if necessary), moisture conditioned and recompacted in accordance with Section 5.2 of this report. If soft, wet or unsuitable materials are encountered, the material should be removed and wasted in non-structural areas of the site or properly disposed of in an off-site location.

PSI has provided recommendations for footing size and bearing depth to limit the amount of vertical movements that the foundations could potentially exhibit. The foundation excavations should be observed by a representative of PSI prior to reinforcing steel or concrete placement to assess that the foundation bearing materials are capable of supporting the design loads and are consistent with the materials discussed in this report.

The allowable bearing capacity has been calculated using minimum footing widths of 18-inches, and for bearing depths of 1-½ and 3-feet below the proposed adjacent grade. The potential movement through settlement of foundations has been estimated for the footing depths and can be found in *Section 6.1 Foundations*.

Groundwater was not apparent within the boreholes during our exploration. Therefore, the need for dewatering is not anticipated for the majority of the expected construction activities. However, water levels may fluctuate, as nearby creeks exist.

Based upon the soils encountered, the recommended minimum pavement thicknesses for the subject development have been based on a subgrade support R-Value of 10. All pavement areas should be scarified, moisture conditioned and recompacted to a depth of no less than 2-feet from finished grade elevation.

The following geotechnical design recommendations have been developed on the basis of the described project characteristics and subsurface conditions encountered. Once final design/grading plans and specifications are available, a general review by PSI is required as a means to check that the recommendations presented in the following sections of this report are properly interpreted and implemented.

5.0 SITE GRADING RECOMMENDATIONS

PSI recommends the on-site soils be overexcavated to a depth of at least 5-feet below finished floor slab elevation and replaced as moisture conditioned structural fill, or no less than 2-feet



below bottom of foundations, whichever is greater. Pavements should bear on no less than 2-feet of scarified and recompacted structural fill. Overexcavations required to allow the placement of the structural fill should extend laterally 5-feet beyond building footprint, or 1-foot beyond foundation limits, whichever is greater. Following overexcavation and prior to fill placement the site should be proofrolled with a loaded tandem-axle dump truck or similar pneumatic-tired equipment with a minimum weight of 15 tons. Areas that deflect excessively should be over-excavated and replaced. Deleterious materials or debris, if encountered, should also be removed. If materials are encountered that differ from those observed in our exploration, PSI should be notified, and the areas will need to be evaluated.

We anticipate the majority of the on-site overburden soils can be reused as structural fill provided it is properly mixed, cleaned (if necessary), moisture conditioned and recompacted in accordance with Section 5.2 of this report.

5.1 Structural Fill

Based on PSI’s field and laboratory data, it is our opinion that the majority of the on-site overburden soils will be suitable for re-use as backfill soils and for use as structural fill, provided the material is properly mixed, moisture conditioned and compacted. If material such as construction debris, trash, or other undesirable material is encountered during construction, they should be removed off site. Bedrock, if encountered, should NOT be reused as structural fill. The apparent fill in Boring B5 may be reused provided it is properly processed.

Imported structural fill, if required, should be free of organic or other deleterious materials, have a liquid limit less than 30, a plasticity index less than 10, and meet the following gradation outlined below. This structural fill criteria is intended as a general guideline. Imported structural fill materials should have a swell potential of less than 1 percent when compacted to 95 percent of maximum dry unit weight (MDUW) and at 2 percent below optimum moisture content (OMC) and tested under a swell test surcharge of 500 psf. The MDUW and OMC should be determined by ASTM D698 (Standard Proctor).

Screen Size	Percent Passing
2 Inch	100
#4	50 – 100
#200	10 - 30

Imported fill material proposed for use on this site that does not meet these criteria should be submitted to the project geotechnical engineer for evaluation and approval. The geotechnical engineer should evaluate the proposed import fill prior to purchase and delivery. Fine-grained soils used for fill require close moisture content control and careful placement by the contractor to achieve the recommended degree of compaction and to address swell potential and settlement issues.



5.2 General Fill Placement and Testing

Unless otherwise specified, fill material should be compacted to at least 95 percent of the maximum dry unit weight as determined by the Standard Proctor Test (ASTM D 698). For fill depths in excess of 5 feet, compaction should be 100 percent maximum dry unit weight. Each lift of compacted fill should be tested for density by a representative of the geotechnical engineer prior to placement of subsequent lifts. Fill soils should be moisture conditioned to a range from optimum moisture content to four percent above optimum moisture content. Fill material should be placed in maximum eight-inch loose lifts.

A sample(s) of the proposed backfill soil(s) should be obtained for moisture density relationship (proctor test) three to four days prior to backfilling operations to expedite compaction and moisture content testing by the materials testing service provider.

Weather conditions in the site area are typically dry in the summer and early fall. Precipitation in the form of snowfall is common from October through March. While grading can be inhibited for short periods during and following times of precipitation, grading can generally be conducted year-round. The major factor that must be considered during the winter months is ground freezing. During extended periods of sub-freezing weather, it can be difficult to properly moisture condition and compact soils. Grading must be conducted during the warmer parts of the day in freezing weather.

A typical swell factor for the clayey sand to sandy clay soils encountered is estimated to be 15 to 25 percent. A typical shrinkage factor for clayey sand to sandy clay soils is estimated to be 10 to 20 percent but can vary depending on the in-situ density of the borrow material and the desired level of compaction for placed fill material. If more accurate estimates of shrink and swell volumes are desired, additional testing can be performed.

6.0 GEOTECHNICAL RECOMMENDATIONS

The proposed structure may be founded on a continuous and individual column footing foundation system bearing on no less than 2-feet of moisture conditioned and recompacted structural fill.

6.1 Foundations

PSI recommends that the proposed structure be supported on continuous or individual column footings provided the **loads are less than 1.5 kips per linear foot for wall loads and 75 kips for column loads**, and should be designed for an allowable soil bearing capacity as shown in the following tables:



Allowable Bearing Capacity of Continuous Footing (18 Inches Wide Minimum)		Allowable Bearing Capacity	Estimated Potential Settlement
Bearing Depth of Foundation Below Finished Grade	1 ½ feet	2,200 psf	1 inch
	3 feet	2,500 psf	1 inch

Allowable Bearing Capacity of Individual Column Pad Footing (minimum 3-foot square)		Allowable Bearing Capacity	Estimated Potential Settlement
Bearing Depth of Foundation Below Finished Grade	1-½ feet	2,750 psf	1 inch
	3 feet	3,000 psf	1 inch

The allowable bearing capacities provided in the tables above are based on the foundations bearing on moisture conditioned and compacted structural fill, maximum loads of 1.5 kips per linear foot for continuous footings, up to 75-kip column loads, a safety factor of 3, and that the final floor elevation is within 2-feet of existing grade. The potential settlements displayed in the above tables were calculated using the corresponding allowable soil bearing capacities.

Continuous footings supporting bearing walls should incorporate a minimum lateral dimension of 18 inches. Exterior footings should bear at a minimum of 36 inches below final grade for frost protection. Interior footings should bear at a minimum of 18 inches below final grade. Column footings should be at least 3-foot square and limited to a maximum dimension 6-feet by 6-feet to limit settlement to 1 inch or less.

The uplift capacity of shallow foundations should be limited to the weight of the foundation concrete plus the weight of the soil immediately above the footing. A concrete unit weight of 145 pcf and a soil unit weight of 115 pcf should be used for design purposes.

Lateral loads applied to the foundations will be resisted by a combination of passive pressure against the sides and friction along the base. For design purposes, PSI recommends using an equivalent fluid pressure of 38 pcf for the “active” case and 57 pcf for the “at-rest” case. A passive pressure of 172 pcf to a depth of 10 feet and a coefficient of friction of 0.38 is recommended. A factor safety of 2.0 was applied to the recommended passive pressure.

The foundation excavations should be observed by a representative of PSI prior to reinforcing steel or concrete placement to assess that the foundation bearing materials are capable of



supporting the design loads and are consistent with the materials discussed in this report. Soft or loose zones encountered at the bottom of the footing should be removed and replaced with properly compacted fill as directed by the geotechnical engineer. Please note that due to sandy nature of soils, excavations may cave. Shoring may be necessary.

After the foundation bearing materials have been approved, steel reinforcement and concrete should be placed as quickly as possible to avoid exposure of the footing bottoms to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. If possible, the foundation concrete should be placed during the same day the excavation is made. If it is required that the excavation be left open for more than one day, they should be protected to reduce evaporation or entry of moisture.

6.2 Slabs on Grade

A slab-on-grade interior floor slab system may be utilized for the proposed structure. PSI anticipates that slab-on-grade sections placed on 5-feet of moisture conditioned and recompacted soil could experience total movement on the order of a 1 inch with differential movements on the order of a ½ inch between adjacent columns or over a 50-foot span.

PSI understands the typical slab section includes 5-inches of PCC over 2-inches of sand over 6-inches of aggregate base course (CDOT Class 5 or 6 is typical in Colorado).

PSI recommends a subgrade support modulus (k-value) of 100-pci (based on a 1-foot square plate load test) be used for slab design. The value should be adjusted for larger areas using the following expression for cohesive and cohesionless soil:

Modulus of Subgrade Reaction, $k_s = \left(\frac{k}{B} \right)$ for cohesive soil and

$$k_s = k \left(\frac{B+1}{2B} \right)^2 \text{ for cohesionless soil}$$

where: k_s = coefficient of vertical subgrade reaction for loaded area,

k = coefficient of vertical subgrade reaction for 1x1 square foot area, and

B = width of area loaded, in feet

The precautions listed below are considered good construction practice. These recommendations are not required but can be followed to prevent moisture content variation and help reduce potential damage caused by movement of the supporting subgrade.

- Cracking of slabs-on-grade can occur as a result of heaving or compression of the supporting soil, but also as a result of concrete curing stresses. The occurrence of concrete shrinkage cracks, and problems associated with concrete curing may be reduced and/or controlled by limiting the slump of the concrete, proper concrete placement, finishing, and curing, and by the placement of crack control joints at frequent intervals, particularly, where re-entrant slab corners occur.



The American Concrete Institute (ACI) recommends a maximum panel size (in feet) equal to approximately three times the thickness of the slab (in inches) in both directions. For example, joints are recommended at a maximum spacing of 12 feet based on using a four-inch thick slab. We also recommend that control joints be scored three feet in from and parallel to all foundation walls. Using fiber reinforcement in the concrete can also control shrinkage cracking.

- Slabs should be separated from exterior walls, column posts, interior bearing members and utility lines to allow independent vertical movement of the slab. If project structural and architectural details require the slab on grade to be structurally tied to the exterior wall/foundation system, then control joints should be placed in the slab within approximately 3 feet of the wall. The owner must understand and accept the risk of cracking at or near the control joints if the slab on grade is tied to the foundation system.
- Some increase in moisture content is inevitable as a result of development and associated landscaping. However, extreme moisture content increases can be largely controlled by proper and responsible site drainage, building maintenance and irrigation practices. Landscape irrigation should be kept to a minimum, however, if it is required, limited drip irrigation should be used. Proper slope away from building (5 to 10 percent) and in parking areas (3 to 5 percent) should be maintained.
- Utility backfill in areas supporting slabs should be moisture conditioned or dried by scarification, and compacted. Backfill in all interior and exterior water and sewer line trenches should be uniformly compacted.
- Exterior slabs should be isolated from the building. These slabs should be reinforced to function as independent units. Movement of these slabs should not be transmitted to the building foundation or superstructure.

6.3 Seismic Parameters

The project site is located within a municipality that employs the International Building Code, 2018 edition. As part of this code, the design of structures must consider dynamic forces resulting from seismic events. These forces are dependent upon the magnitude of the earthquake event as well as the properties of the soils that underlie the site. As part of the procedure to evaluate seismic forces, the code requires the evaluation of the Seismic Site Class, which categorizes the site based upon the characteristics of the subsurface profile within the upper 100 feet of the ground surface. To define the Site Class for this project, we have interpreted the expected results of soil test borings drilled with the project site and estimated appropriate soil properties below grade to a depth of 100 feet, as permitted by Section 1615.1.1 of the code. The estimated soil properties were based upon data available in published geologic reports and our experience with subsurface conditions in the general site area.

Based upon our evaluation, it is our opinion that the subsurface conditions within the site are consistent with the characteristics of Site Class C as defined in Table 1615.1.1 of the building code.



The USGS-NEHRP interpolated probabilistic ground motion values near latitude 39.5435° North and -104.7726° West obtained from the USGS geohazards web page are as follows:

Period (seconds)	2% Probability of Event in 50 years (g)	Site Coefficients	Maximum Spectral Acceleration Parameters	Design Spectral Acceleration Parameters	
				S_{Ds}	T_0
0.2 (S_s)	0.2	$F_a = 1.3$	$S_{ms} = 0.261$	$S_{Ds} = 0.174$	$T_0 = 0.064$
1.0 (S_1)	0.056	$F_v = 1.5$	$S_{m1} = 0.084$	$S_{D1} = 0.056$	$T_s = 0.321$
			$S_{ms} = F_a S_s$ $S_{m1} = F_v S_1$	$S_{Ds} = \frac{2}{3} * S_{ms}$ $S_{D1} = \frac{2}{3} * S_{m1}$	$T_0 = 0.2 * S_{D1} / S_{Ds}$ $T_s = S_{D1} / S_{Ds}$

The Site Coefficients, F_a and F_v presented in the above table were interpolated from IBC Tables 1613.3.1(1) and 1613.3.1(2) as a function of the site classification and mapped spectral response acceleration at the short (S_s) and 1 second (S_1) periods.

6.4 Pavement Recommendations

The following analysis and minimum pavement thickness recommendations are in general accordance with AASHTO, the Colorado Department of Transportation Manual for Road and Bridge Construction, the INO Grading and Paving Standards, and based upon our current understanding of the project.

6.4.1 Subgrade Preparation Recommendations

To mitigate swell potential of the subgrade for support of the proposed pavement sections, PSI recommends that the onsite material be overexcavated to a depth of no less than 2-feet below final grade and recompacted as moisture conditioned and compacted structural fill. This should extend to back of curb and/or beneath sidewalks.

Once the areas below the parking area have been recompacted, the existing site soils should be proofrolled to identify areas of loose soils prior to placement of moisture conditioned, compacted soils (either on-site or imported). The proofroll should be conducted with a loaded tandem-axle dump truck or similar pneumatic-tired equipment with a minimum weight of 15 tons.

6.4.2 Pavement Thickness Recommendations

Based on the materials encountered during our subsurface exploration, PSI has used an R-value of 10 for the support soils of the proposed pavement sections. PSI has identified two pavement categories based on the proposed development anticipated traffic use and traffic loads. We have assigned estimated traffic loads to each category expressed in EDLA's, where the EDLA is the equivalent daily load applications of vehicles relative to an 18-kip single axle load. We have also used the following design criteria; a 20-yr design life, a Pavement Serviceability Index (PSI) of 2.5 and a Reliability of 80%.



PSI has assigned an estimated EDLA of 5. PSI anticipates that traffic in this area will be mixed use consist of delivery vehicles of varying size and weight and passenger vehicles.

Minimum pavement section options are provided for asphalt over aggregate base course, and rigid (Portland Cement Concrete) pavement over aggregate base course. Based on this information for the subject pavement, the following minimum pavement sections were determined, as presented in the following table.

Minimum Pavement Thicknesses*		
	Flexible Pavement	Rigid Pavement
Asphalt/PCC	4 inches	5 inches
CDOT Class 5 or 6 Aggregate Base Course	6 inches	
Subgrade	12 inches of moisture conditioned and recompactd on-site soils	

*In-N-Out minimum pavement thicknesses

Concrete pavement at least **seven inches thick** is recommended for the **trash dumpster run-ups** due to the heavy wheel and impact loads that this area receives. The run-up should extend far enough away to support all wheels of the sanitation truck while stopped and in the loading position. Concrete pavement is also recommended in areas, which receive continuous repetitive traffic such as product unloading areas and parking lot entrances.

6.4.3 Flexible Pavement

Flexible pavement is not recommended for Dumpster Pad/ Sanitation Truck Run-up areas. For Dumpster Pad/Sanitation Truck Run-up areas, we recommend rigid pavement as discussed in the following *Rigid Pavement Section*. Allowances for proper drainage and proper material selection of base materials are most important for performance of asphaltic pavements. Ruts and birdbaths in asphalt pavement allow for quick deterioration of the pavement primarily due to saturation of the underlying base and subgrade.

Hot bituminous pavement should meet the requirements as detailed for SuperPave Mixtures in Colorado Department of Transportation Standard Specifications for Road and Bridge Construction. Material meeting the Colorado Department of Transportation requirements for Grading S (¾ inch nominal) or Grading SG (1½ inch nominal) is recommended. In addition, the following are presented as general guidelines for properties of asphaltic concrete.



Parking Lot	
Asphalt Cement	PG 64-22
Asphalt Content	As per mix design
Percent Air Voids	3½-5

Asphalt material should be obtained from an approved mix design stating the SuperPave Mixture properties, including optimum asphalt content, job mix formula, and recommended mixing and placing temperatures. Materials and construction methods should be in accordance with the CDOT Standard Specifications for Road and Bridge Construction Section 403.

6.4.4 Aggregate Base Course

If aggregate base course is used as part of the pavement section, the materials should conform to CDOT requirements for Class 5 or 6 aggregate base course per Table 703-2 and construction methods should conform to Section 304 of the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction.

6.4.5 Rigid Pavement

The use of concrete for on-site pavements may be considered by the owner. Should concrete pavement be utilized, the concrete should be properly reinforced and jointed and should be constructed from a concrete mixture, which has a 28-day minimum laboratory compressive strength of 4,000 psi. We recommend a maximum water cement ratio of 0.45 and an air-entrainment specification of 5 percent (±1.5 percent) be followed. Expansion joints should be sealed with a polyurethane sealant so that moisture infiltration into the subgrade soils and resultant concrete deterioration at the joints is reduced.

6.5 Soil Corrosivity

Composite samples obtained in the subsurface profile of the upper 5 feet was tested to evaluate the chemical reactivity of the on-site soils and are shown in the following table. Soil pH was performed using method AASHTO T289-91. Resistivity testing was performed using AASHTO T288-91. Water Soluble Sulfate testing was performed using AASHTO T290-91/ASTM D4327.

Summary of Chemical Reactivity Testing

Boring ID	Depth (feet)	Soil pH	Water Soluble Sulfates
Bulk	0-5	8.6	0.015%

The existing soil has a potential for corrosion issues. However, due to the expected depth to groundwater, PSI does not believe correction action is necessary for installations less than 5 feet below existing grade. Consideration should be given to providing cathodic protection for metal surfaces buried deeper than 5 feet below final FFE grade.



Our test results indicated water-soluble sulfate concentrations of less than 0.1 percent, which are classified in the “negligible” sulfate exposure category according to the American Concrete Institute (ACI) Design Manual Section 318, Chapter 4, 2014 Edition. It is our opinion that concrete in contact with the existing soils may be designed for “negligible” sulfate exposure. PSI recommends using Type I/II Portland Cement.

6.6 Percolation Test

PSI performed a percolation test near Boring B6 by filling the completed bore hole with water and measuring the water level change over time intervals. The measured percolation rate was approximately 16 inches/hour. An appropriate factor of safety should be applied to the field test measurement.

7.0 LIMITATIONS

The recommendations submitted are based on the available subsurface information obtained by PSI and design details furnished by In-N-Out Burger. If there are revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. This report has been prepared for the exclusive use of In-N-Out Burger and their consultants for the specific application to the proposed In-N-Out Burger Restaurant located near the southwest corner of East Pine Lane and South Parker Road in Parker, Colorado.



Taken From Google Earth

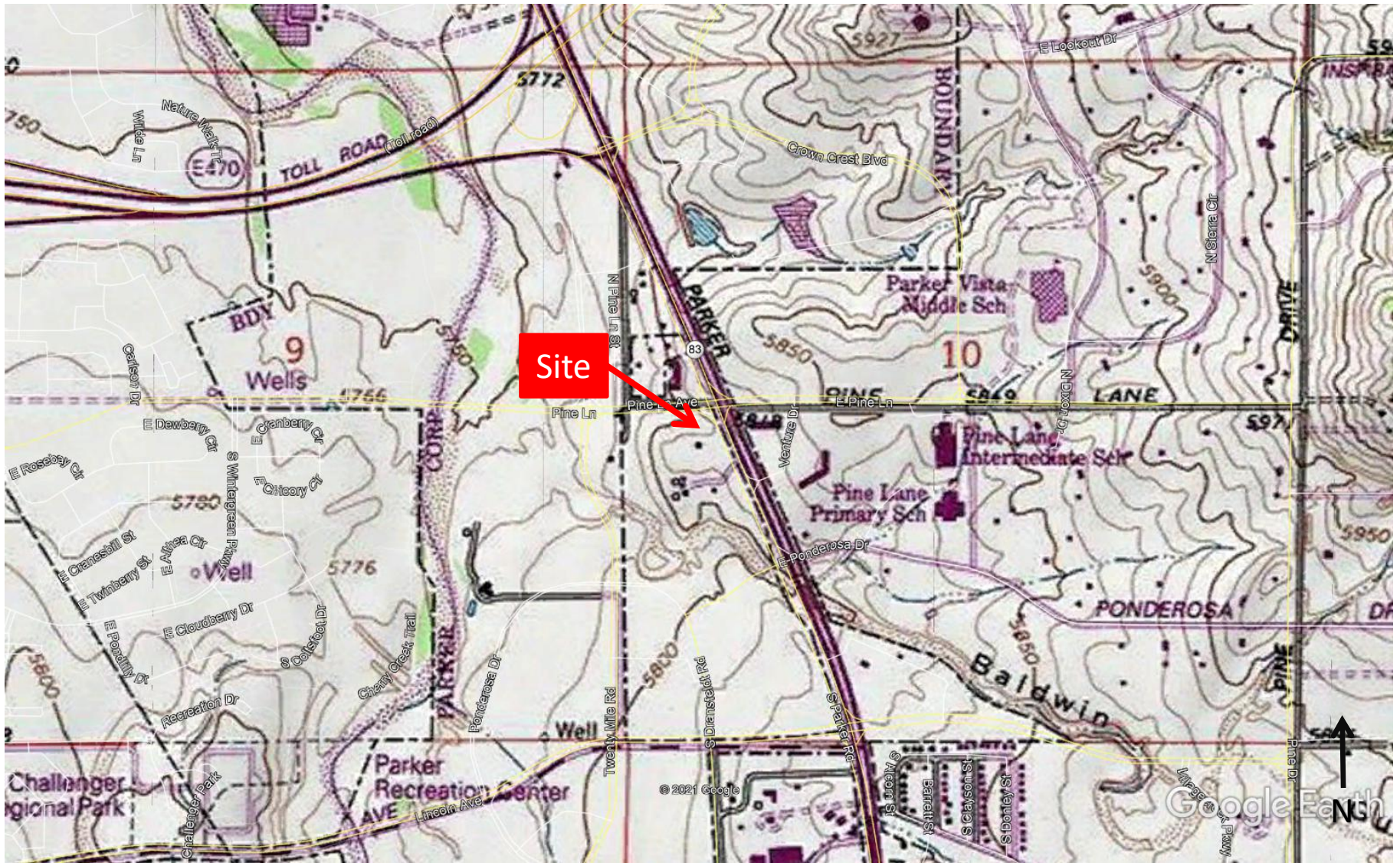


INO - Parker

JOB NO. 532222

Site Vicinity Map

FIGURE NO. 1a



Taken From USGS Map -

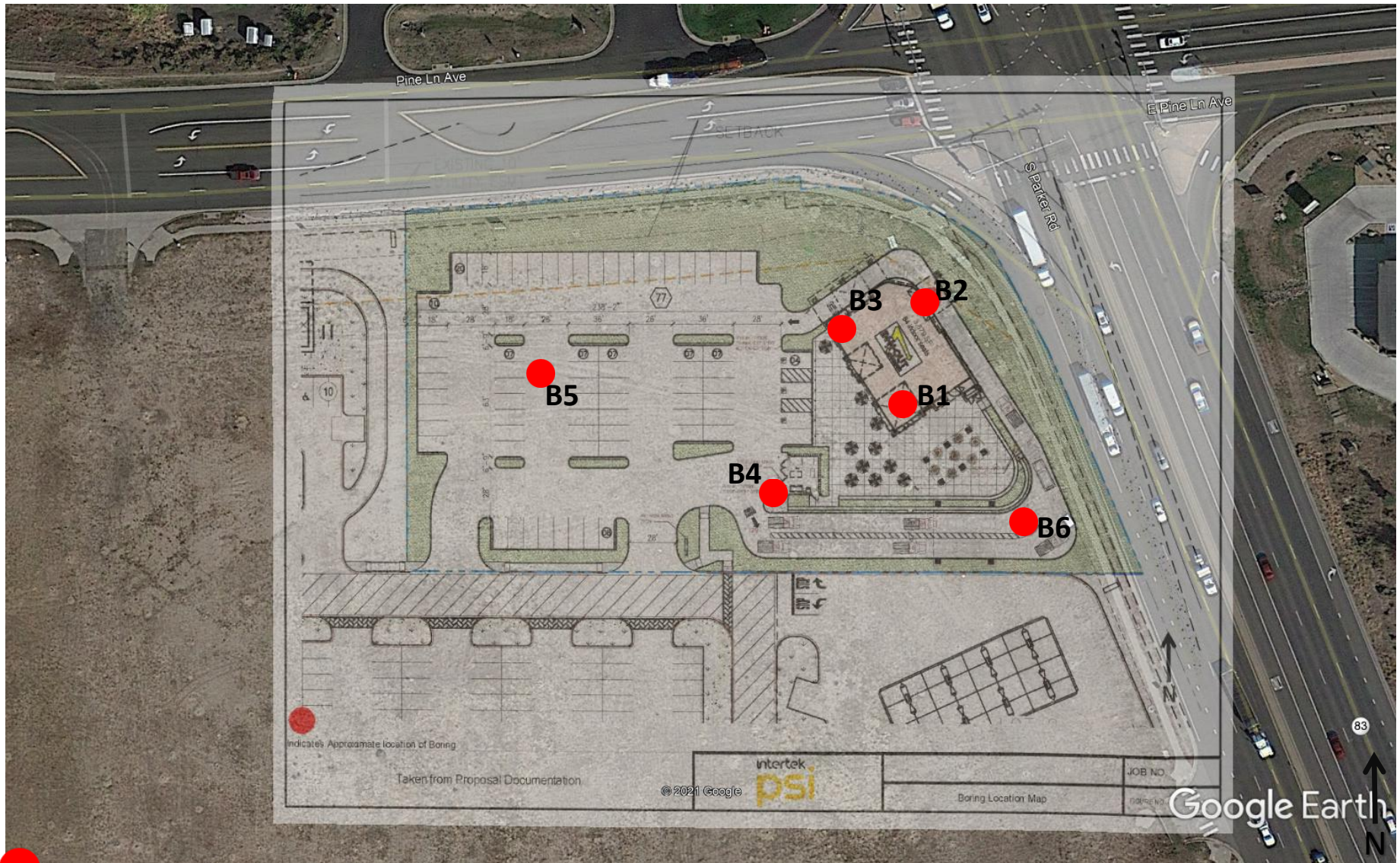


INO - Parker

JOB NO. 5322222

Site Vicinity Map

FIGURE NO. 1b

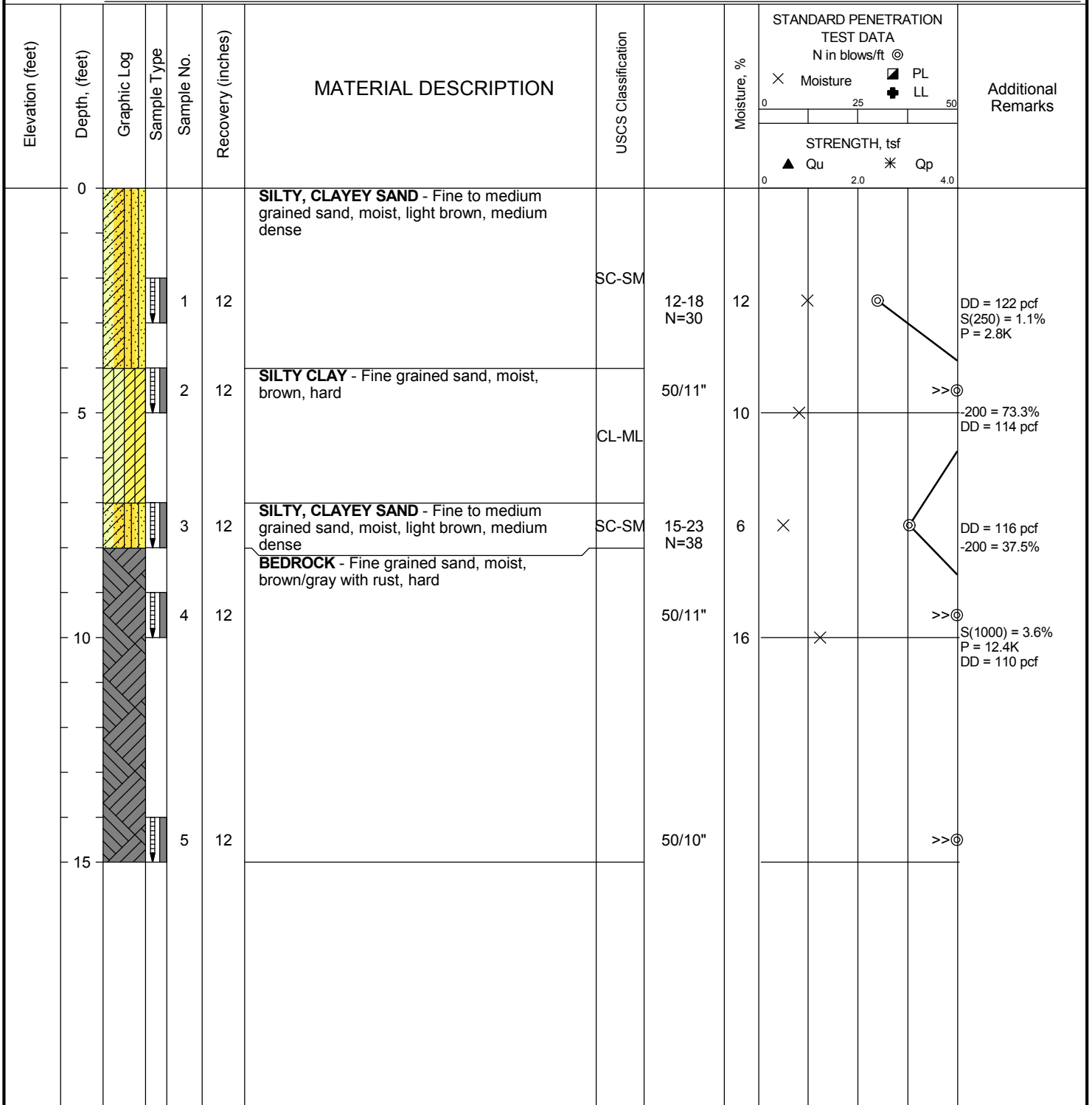


Indicates Approximate location of Boring

Taken From Google Earth		INO - Parker	JOB NO.	5322222
		Boring Location Map	FIGURE NO.	2

FIGURE: 3

DATE STARTED: 4/19/21	DRILL COMPANY: Dakota Drilling	BORING B1
DATE COMPLETED: 4/19/21	DRILLER: JC LOGGED BY: BP	
COMPLETION DEPTH: 15.0 ft	DRILL RIG: CME-55	Water <input type="checkbox"/> While Drilling Not Observed
BENCHMARK: N/A	DRILLING METHOD: Solid Stem Auger	<input type="checkbox"/> Upon Completion Not Observed
ELEVATION: N/A	SAMPLING METHOD: Modified California	<input type="checkbox"/> Delay N/A
LATITUDE: 39.5435°	HAMMER TYPE: Manual	BORING LOCATION:
LONGITUDE: -104.7726°	EFFICIENCY: N/A	Building
STATION: N/A OFFSET: N/A	REVIEWED BY: KD	See Figure 2
REMARKS:		

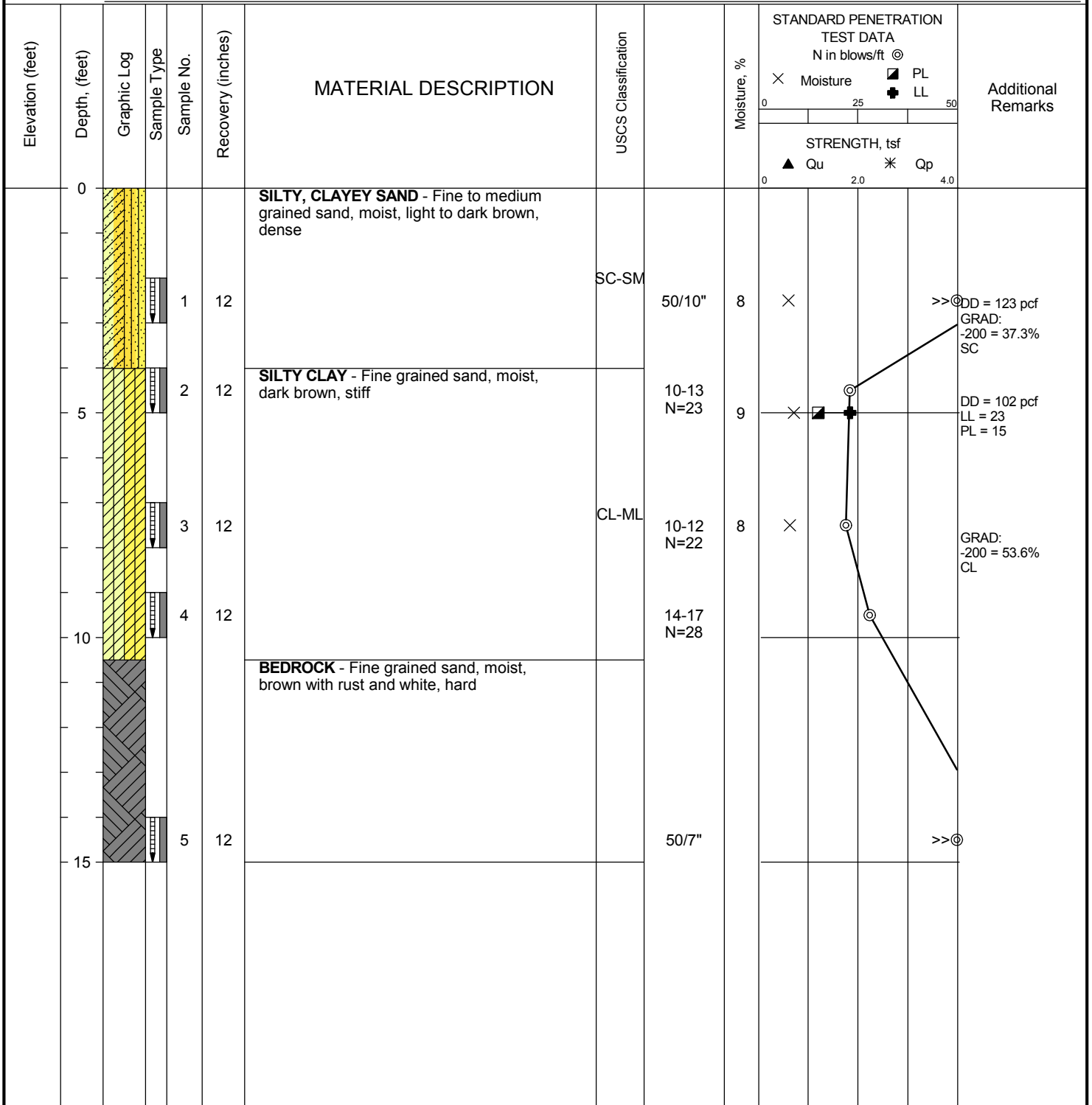


	Professional Service Industries, Inc. 1070 West 124th Avenue, Suite 800 Westminster, CO 80234 Telephone: (303) 424-5578	PROJECT NO.: 05322222
		PROJECT: INO - Parker
		LOCATION: S Parker Rd & E Pine Ln Parker, CO

The stratification lines represent approximate boundaries. The transition may be gradual.

FIGURE: 4

DATE STARTED: 4/19/21	DRILL COMPANY: Dakota Drilling	BORING B2
DATE COMPLETED: 4/19/21	DRILLER: JC LOGGED BY: BP	
COMPLETION DEPTH: 15.0 ft	DRILL RIG: CME-55	Water ▽ While Drilling Not Observed ▼ Upon Completion Not Observed ▽ Delay N/A
BENCHMARK: N/A	DRILLING METHOD: Solid Stem Auger	BORING LOCATION: Drive-Thru Window
ELEVATION: N/A	SAMPLING METHOD: Modified California	
LATITUDE: 39.5435°	HAMMER TYPE: Manual	See Figure 2
LONGITUDE: -104.7726°	EFFICIENCY: N/A	
STATION: N/A OFFSET: N/A	REVIEWED BY: KD	
REMARKS:		

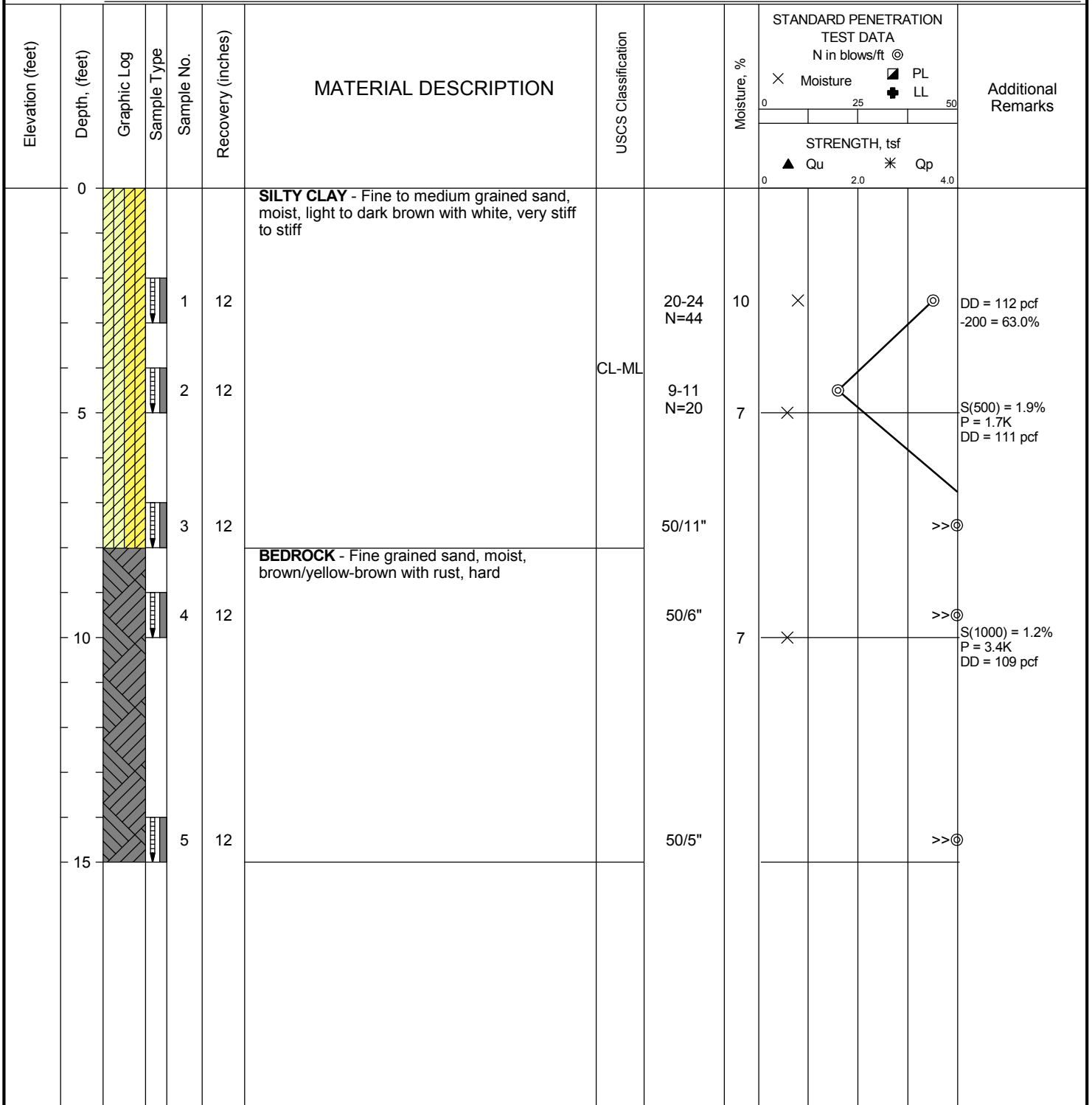


Professional Service Industries, Inc.
 1070 West 124th Avenue, Suite 800
 Westminster, CO 80234
 Telephone: (303) 424-5578

PROJECT NO.: 05322222
 PROJECT: INO - Parker
 LOCATION: S Parker Rd & E Pine Ln
 Parker, CO

FIGURE: 5

DATE STARTED: 4/19/21	DRILL COMPANY: Dakota Drilling	BORING B3
DATE COMPLETED: 4/19/21	DRILLER: JC LOGGED BY: BP	
COMPLETION DEPTH: 15.0 ft	DRILL RIG: CME-55	Water ▽ While Drilling Not Observed
BENCHMARK: N/A	DRILLING METHOD: Solid Stem Auger	▽ Upon Completion Not Observed
ELEVATION: N/A	SAMPLING METHOD: Modified California	▽ Delay N/A
LATITUDE: 39.5435°	HAMMER TYPE: Manual	BORING LOCATION:
LONGITUDE: -104.7726°	EFFICIENCY: N/A	Building
STATION: N/A OFFSET: N/A	REVIEWED BY: KD	See Figure 2
REMARKS:		

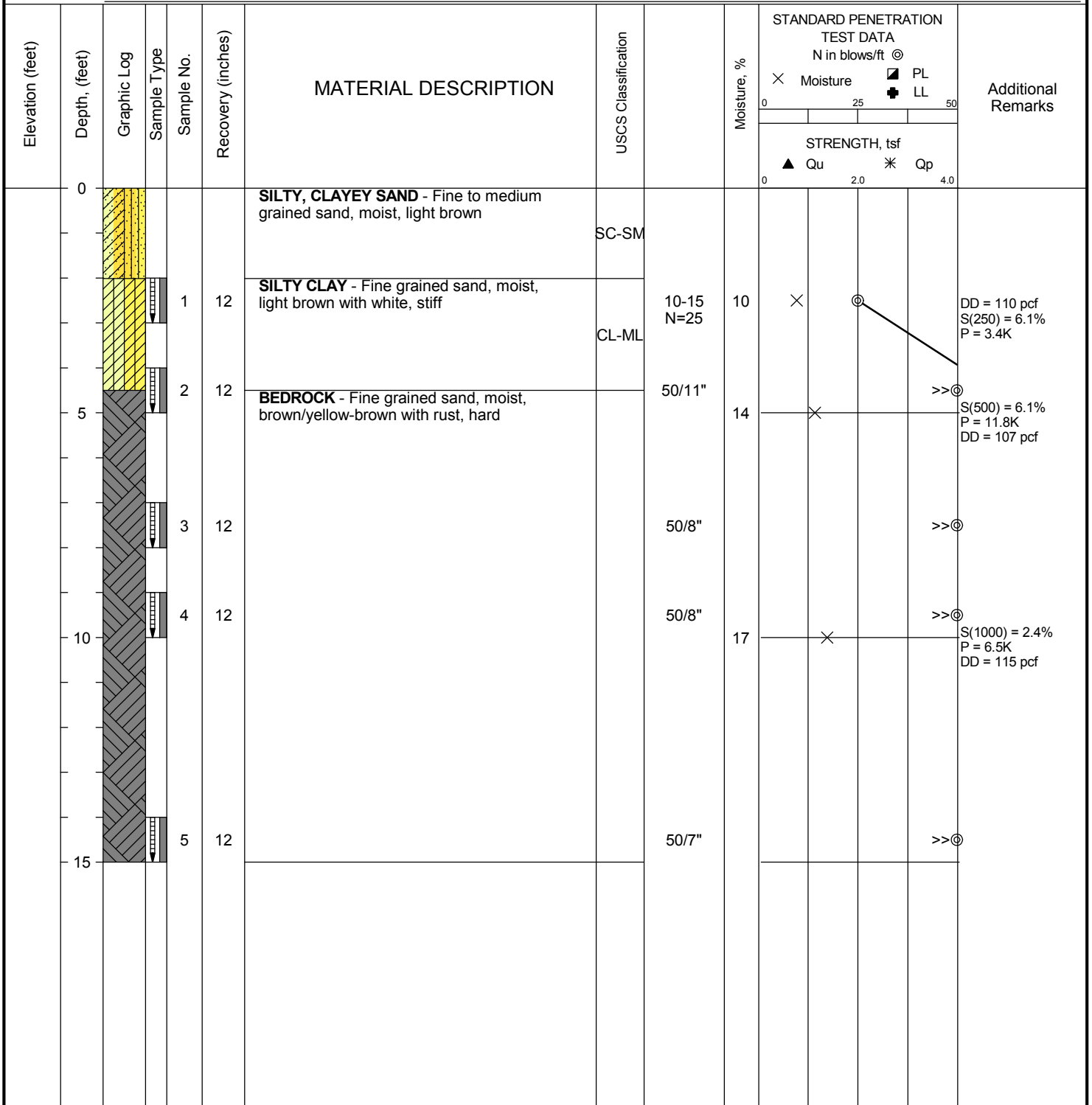


	Professional Service Industries, Inc. 1070 West 124th Avenue, Suite 800 Westminster, CO 80234 Telephone: (303) 424-5578	PROJECT NO.: 05322222
		PROJECT: INO - Parker
		LOCATION: S Parker Rd & E Pine Ln Parker, CO

The stratification lines represent approximate boundaries. The transition may be gradual.

FIGURE: 6

DATE STARTED: 4/19/21	DRILL COMPANY: Dakota Drilling	BORING B4
DATE COMPLETED: 4/19/21	DRILLER: JC LOGGED BY: BP	
COMPLETION DEPTH: 15.0 ft	DRILL RIG: CME-55	Water <input type="checkbox"/> While Drilling Not Observed
BENCHMARK: N/A	DRILLING METHOD: Solid Stem Auger	<input checked="" type="checkbox"/> Upon Completion Not Observed
ELEVATION: N/A	SAMPLING METHOD: Modified California	<input checked="" type="checkbox"/> Delay N/A
LATITUDE: 39.5435°	HAMMER TYPE: Manual	BORING LOCATION:
LONGITUDE: -104.7726°	EFFICIENCY: N/A	Trash Enclosure
STATION: N/A OFFSET: N/A	REVIEWED BY: KD	See Figure 2
REMARKS:		



	Professional Service Industries, Inc. 1070 West 124th Avenue, Suite 800 Westminster, CO 80234 Telephone: (303) 424-5578	PROJECT NO.: 05322222
		PROJECT: INO - Parker
		LOCATION: S Parker Rd & E Pine Ln Parker, CO

The stratification lines represent approximate boundaries. The transition may be gradual.

FIGURE: 7

DATE STARTED: 4/19/21	DRILL COMPANY: Dakota Drilling	BORING B5
DATE COMPLETED: 4/19/21	DRILLER: JC LOGGED BY: BP	
COMPLETION DEPTH: 10.0 ft	DRILL RIG: CME-55	Water <input type="checkbox"/> While Drilling Not Observed <input type="checkbox"/> Upon Completion Not Observed <input type="checkbox"/> Delay N/A
BENCHMARK: N/A	DRILLING METHOD: Solid Stem Auger	BORING LOCATION: Parking
ELEVATION: N/A	SAMPLING METHOD: Modified California	
LATITUDE: 39.5435°	HAMMER TYPE: Manual	See Figure 2
LONGITUDE: -104.7726°	EFFICIENCY: N/A	
STATION: N/A OFFSET: N/A	REVIEWED BY: KD	
REMARKS:		

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	Moisture, %	STRENGTH, tsf	Additional Remarks
0				1	12	APPARENT FILL - Fine to medium grained sand, moist, dark brown with rust, stiff				
				2	12	SILTY CLAY - Fine grained sand, moist, light brown with white	CL-ML	22		DD = 97 pcf -200 = 68.2%
5				3	12	BEDROCK - Fine grained sand, moist, brown with rust and white, hard		13		>>⊙ -200 = 37.3% DD = 113 pcf
				4	12					>>⊙
10										>>⊙

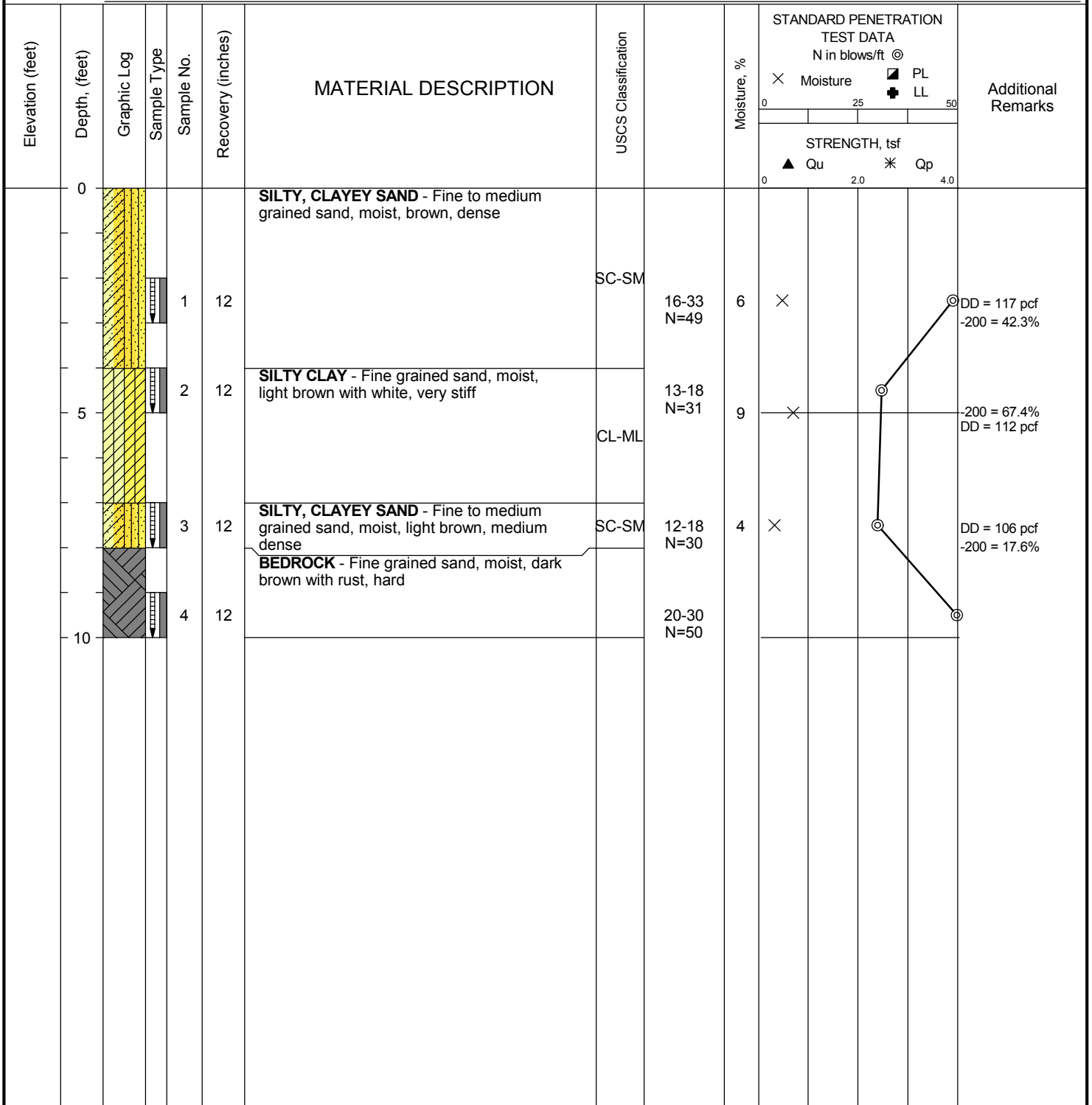


Professional Service Industries, Inc.
 1070 West 124th Avenue, Suite 800
 Westminster, CO 80234
 Telephone: (303) 424-5578

PROJECT NO.: 05322222
 PROJECT: INO - Parker
 LOCATION: S Parker Rd & E Pine Ln
 Parker, CO

FIGURE: 8

DATE STARTED: 4/19/21	DRILL COMPANY: Dakota Drilling	BORING B6
DATE COMPLETED: 4/19/21	DRILLER: JC LOGGED BY: BP	
COMPLETION DEPTH: 10.0 ft	DRILL RIG: CME-55	Water <input type="checkbox"/> While Drilling Not Observed
BENCHMARK: N/A	DRILLING METHOD: Solid Stem Auger	<input checked="" type="checkbox"/> Upon Completion Not Observed
ELEVATION: N/A	SAMPLING METHOD: Modified California	<input checked="" type="checkbox"/> Delay N/A
LATITUDE: 39.5435°	HAMMER TYPE: Manual	BORING LOCATION:
LONGITUDE: -104.7726°	EFFICIENCY: N/A	Parking
STATION: N/A OFFSET: N/A	REVIEWED BY: KD	See Figure 2
REMARKS:		



Professional Service Industries, Inc.
1070 West 124th Avenue, Suite 800
Westminster, CO 80234
Telephone: (303) 424-5578

PROJECT NO.: 05322222
PROJECT: INO - Parker
LOCATION: S Parker Rd & E Pine Ln
Parker, CO

KEY TO SYMBOLS



Apparent Fill



USCS Clayey Sand



USCS Low Plasticity Silty Clay



Bedrock

SSA = Solid Stem Auger

HSA = Hollow Stem Auger

CFA = Continuous Flight Auger

SPT = Standard Penetration Test

MC - Modified California Sampler

SS = Split-spoon Sampler

ST = Shelby Tube Sampler

RC = Rock Core

DD = Dry Density

MC = Moisture Content

LL = Liquid Limit

PL = Plastic Limit

-200 = Percent Passing the
No. 200 Sieve (%)S(250) = Swell under 250 psf
surcharge pressure (%)S(500) = Swell under 500 psf
surcharge pressure (%)S(1000) = Swell under 1000 psf
surcharge pressure (%)Qu = Unconfined Compressive
Strength

RQD = Rock Quality Designation

REC'D = Rock Core Recovery Percentage

PID = Photo Ionic Detector (ppm)

The borings were advanced into the ground using 4-inch solid stem augers. At regular intervals throughout the boring depths, soil samples were obtained with either a 1.4-inch I.D., 2.0-inch O.D., split-spoon sampler or a 2.0-inch I.D., 2.4-inch O.D. Modified California sampler. The samplers were first seated 6-inches to penetrate any loose cuttings and then driven an additional foot where possible with blows of a 140-pound hammer falling 30-inches. The number of hammer blows required to drive the sampler each 6-inch increment is recorded in the field. The penetration resistance "N-value" is redesignated as the number of hammer blows required to drive the sampler the final foot and, when properly evaluated, is an index to cohesion for clays and relative density for sands. N-values recorded on the boring logs are uncorrected. The split-spoon sampling procedures used during this exploration are in general accordance with ASTM Designation D 1586.



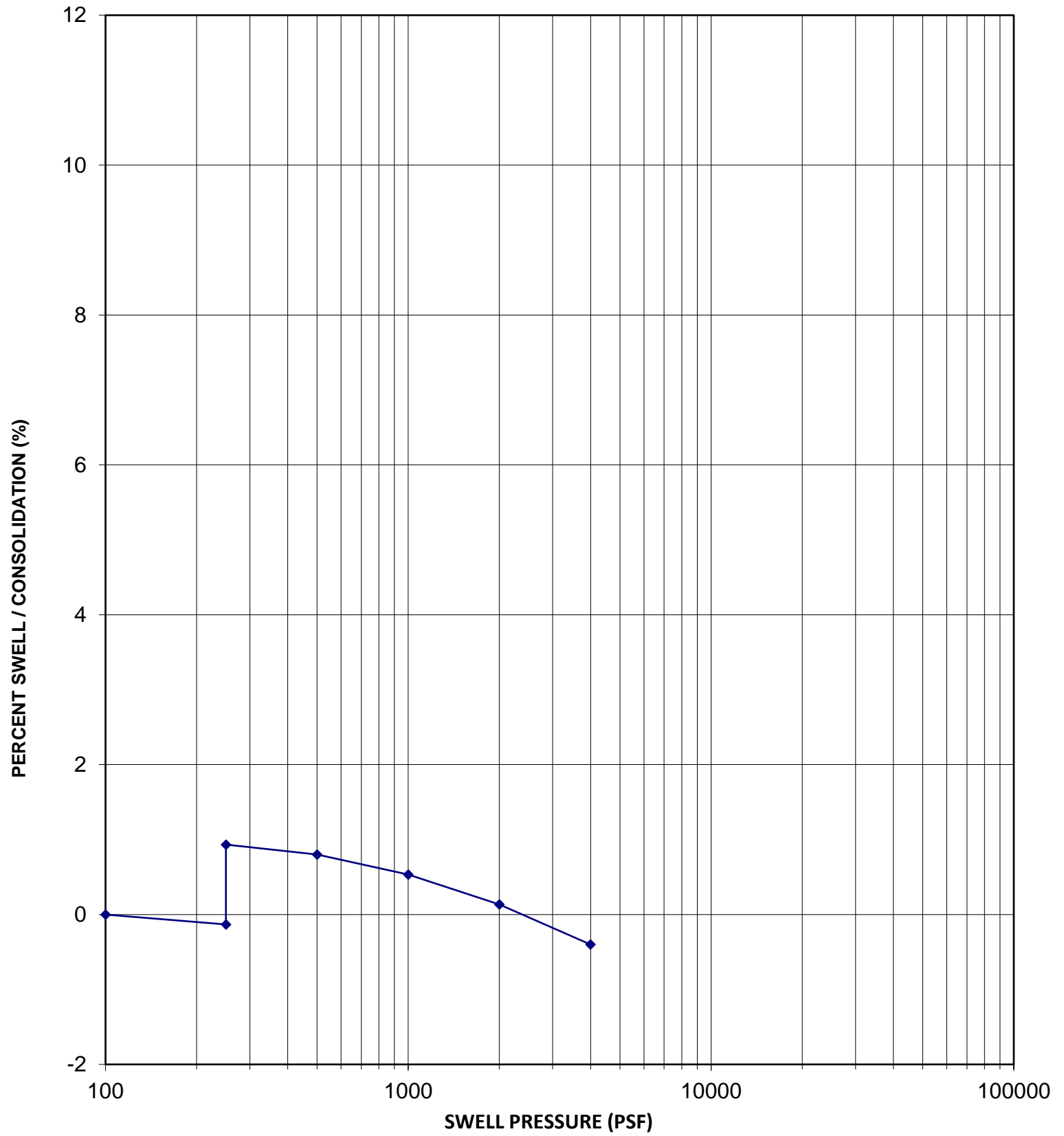
Professional Service Industries, Inc.
1070 West 124th Avenue, Suite 800
Westminster, CO 80234
Telephone: (303) 424-5578
Fax: (303) 423-5625

PSI Job No.: 05322222
Project: INO - Parker
Location: S Parker Rd & E Pine Ln
Parker, CO

Appendix A

Laboratory Test Results

SWELL-CONSOLIDATION TEST



Sample Location	B1
Sample Depth	2.5 feet
Sample Description	Silty, Clayey Sand
USCS Classification	SC-SM

Dry Density	122 pcf
In-Situ Moisture Content	12.3 %
Volume Change	1.1 %
Swell Pressure	2,800 psf



INO - Parker

JOB NO.

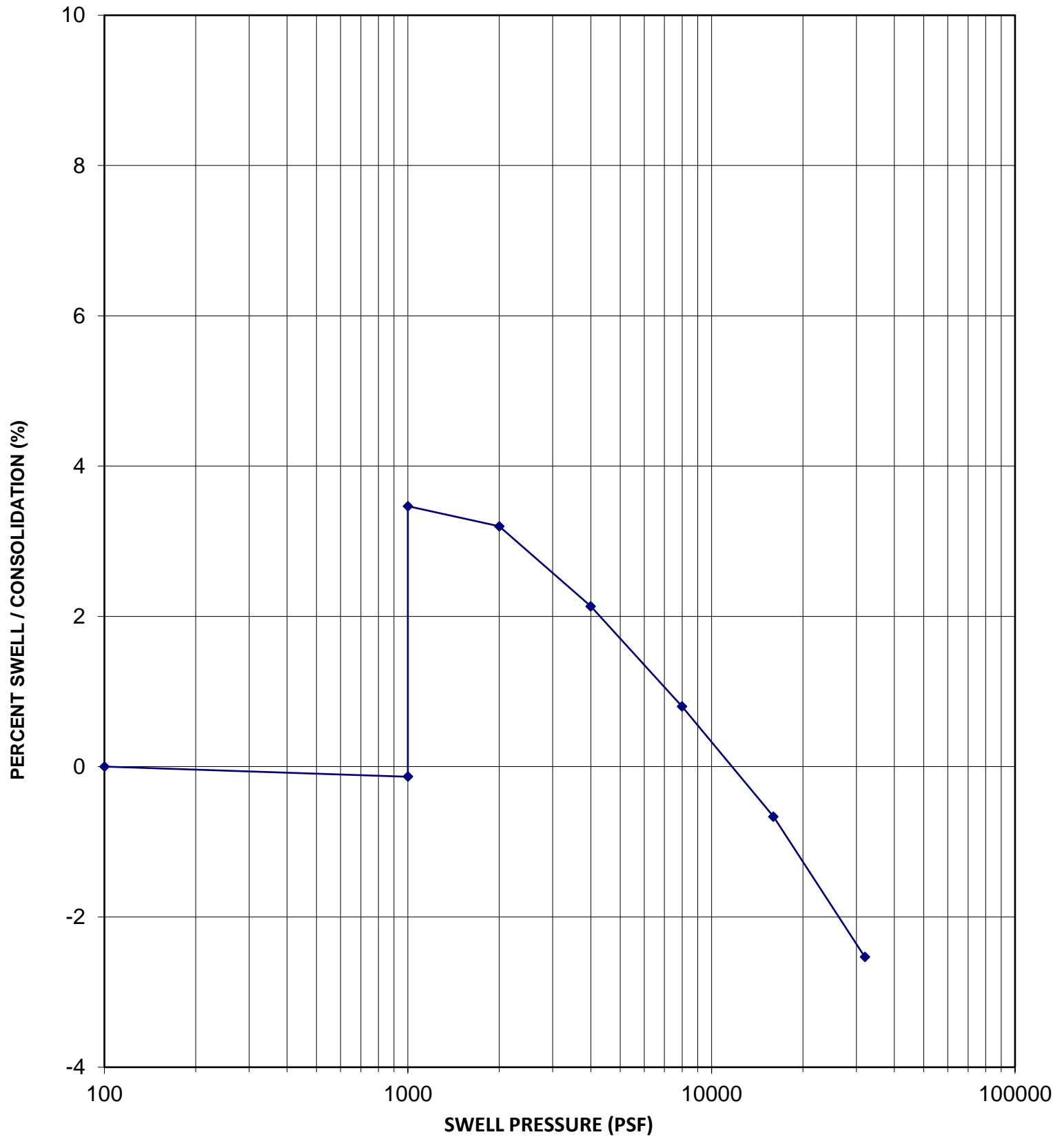
5322222

SWELL - CONSOLIDATION TEST

FIGURE NO.

A1

SWELL-CONSOLIDATION TEST



Sample Location	B1
Sample Depth	10 feet
Sample Description	Bedrock
USCS Classification	

Dry Density	110 pcf
In-Situ Moisture Content	15.5 %
Volume Change	3.6 %
Swell Pressure	12,400 psf



INO - Parker

JOB NO.

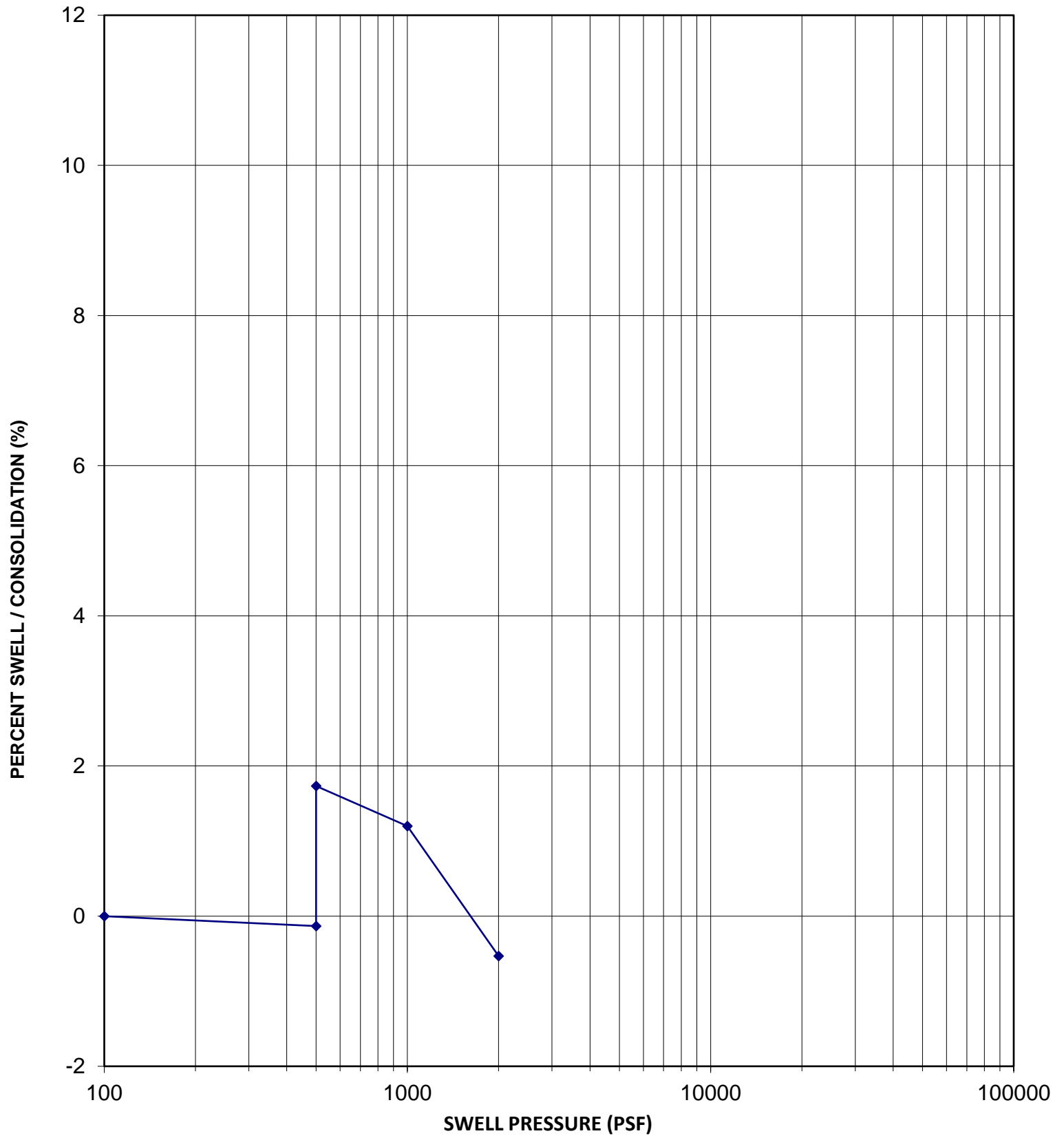
5322222

SWELL - CONSOLIDATION TEST

FIGURE NO.


A2

SWELL-CONSOLIDATION TEST

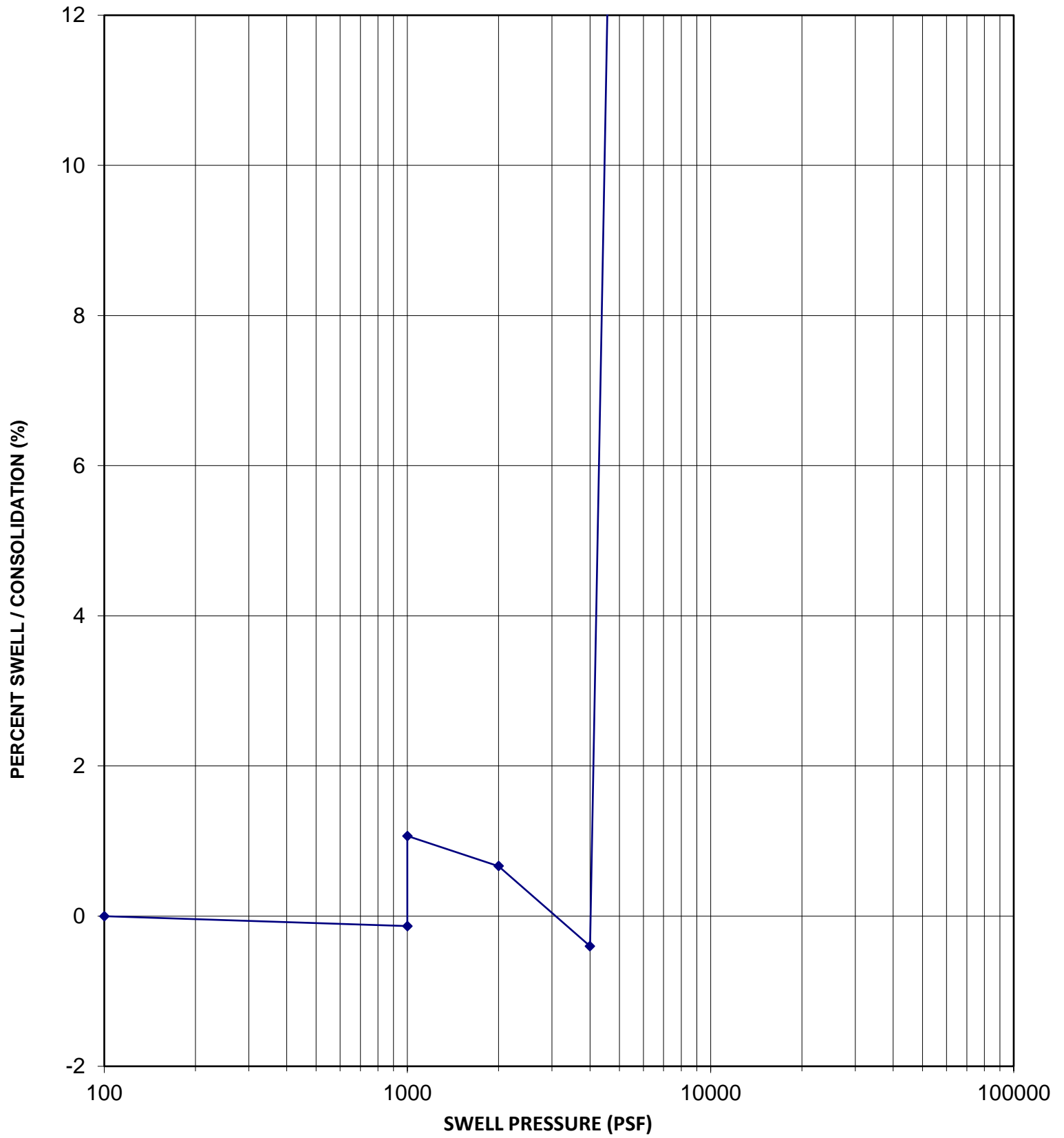


Sample Location	B3
Sample Depth	5 feet
Sample Description	Silty Clay
USCS Classification	CL-ML

Dry Density	111 pcf
In-Situ Moisture Content	7.2 %
Volume Change	1.9 %
Swell Pressure	1,700 psf

	INO - Parker	JOB NO.	5322222
	SWELL - CONSOLIDATION TEST	FIGURE NO.	A3

SWELL-CONSOLIDATION TEST



Sample Location	B3
Sample Depth	10 feet
Sample Description	Bedrock
USCS Classification	

Dry Density	109 pcf
In-Situ Moisture Content	7.2 %
Volume Change	1.2 %
Swell Pressure	3,400 psf



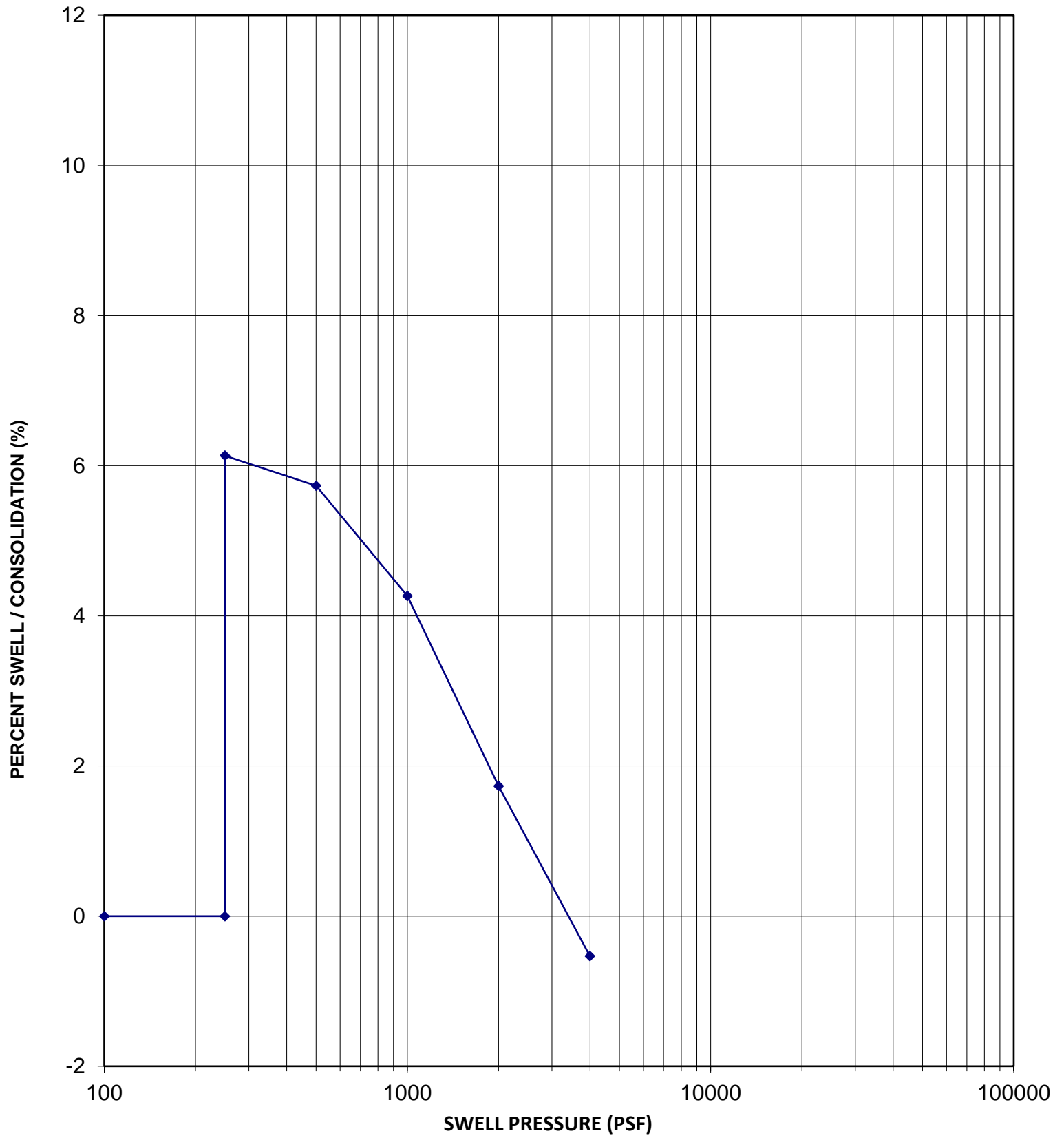
INO - Parker

JOB NO. 5322222

SWELL - CONSOLIDATION TEST

FIGURE NO. A4

SWELL-CONSOLIDATION TEST



Sample Location	B4
Sample Depth	2.5 feet
Sample Description	Clay
USCS Classification	CL

Dry Density	110 pcf
In-Situ Moisture Content	9.6 %
Volume Change	6.1 %
Swell Pressure	3,400 psf



INO - Parker

JOB NO.

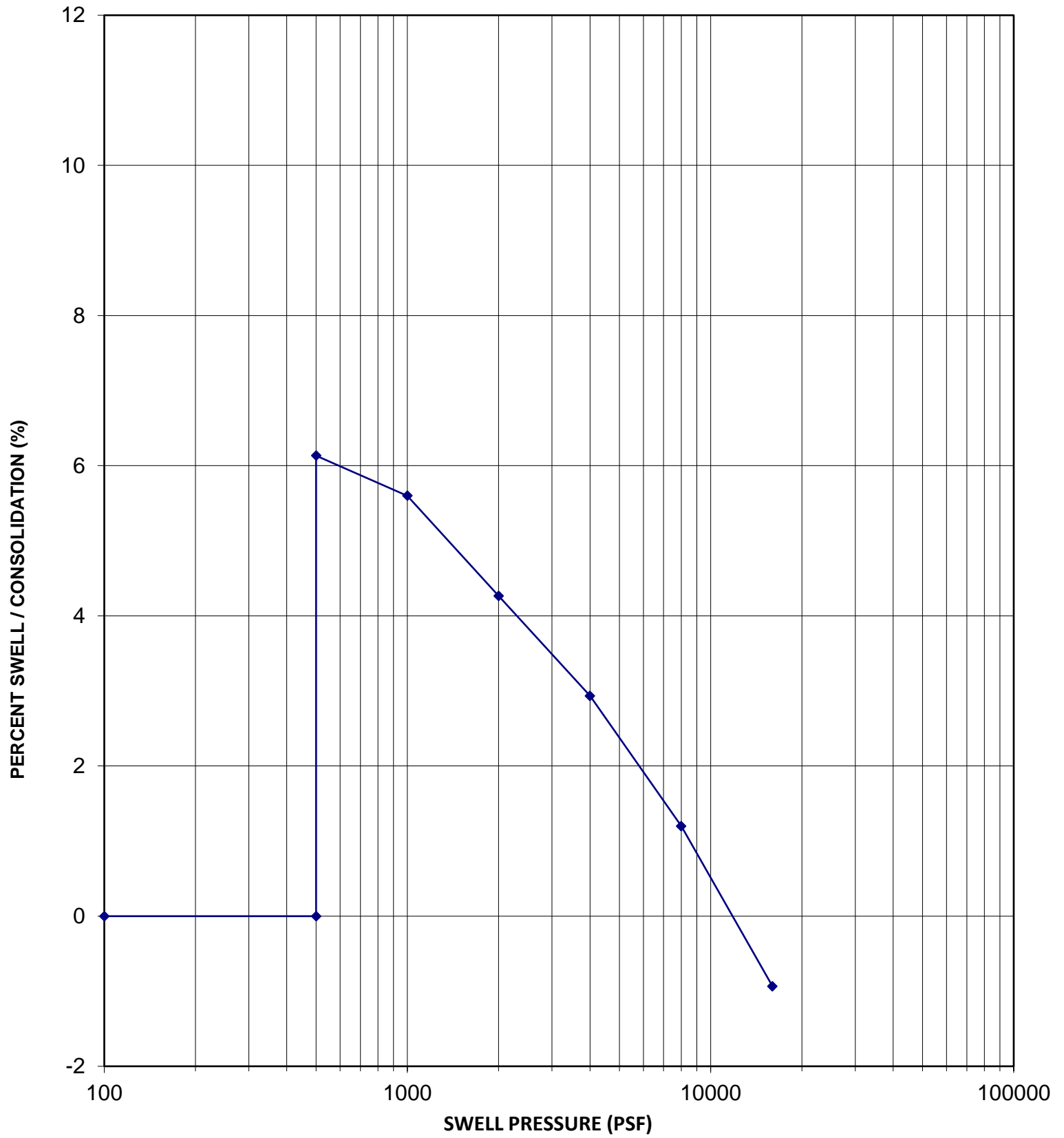
5322222

SWELL - CONSOLIDATION TEST

FIGURE NO.

A5

SWELL-CONSOLIDATION TEST



Sample Location	B4
Sample Depth	5 feet
Sample Description	Clay
USCS Classification	CL

Dry Density	107 pcf
In-Situ Moisture Content	14.2 %
Volume Change	6.1 %
Swell Pressure	11,800 psf



INO - Parker

JOB NO.

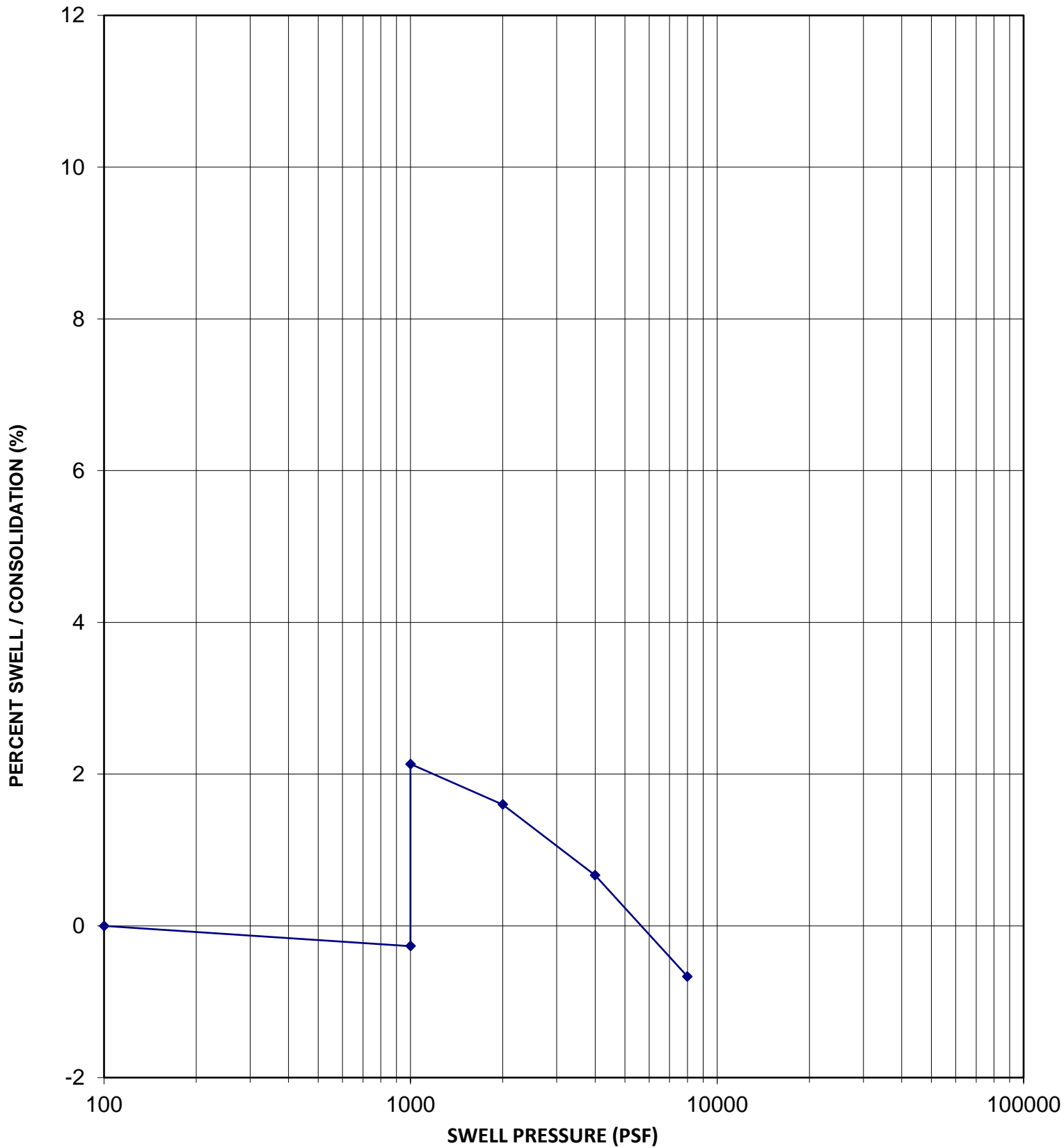
5322222

SWELL - CONSOLIDATION TEST

FIGURE NO.


A6

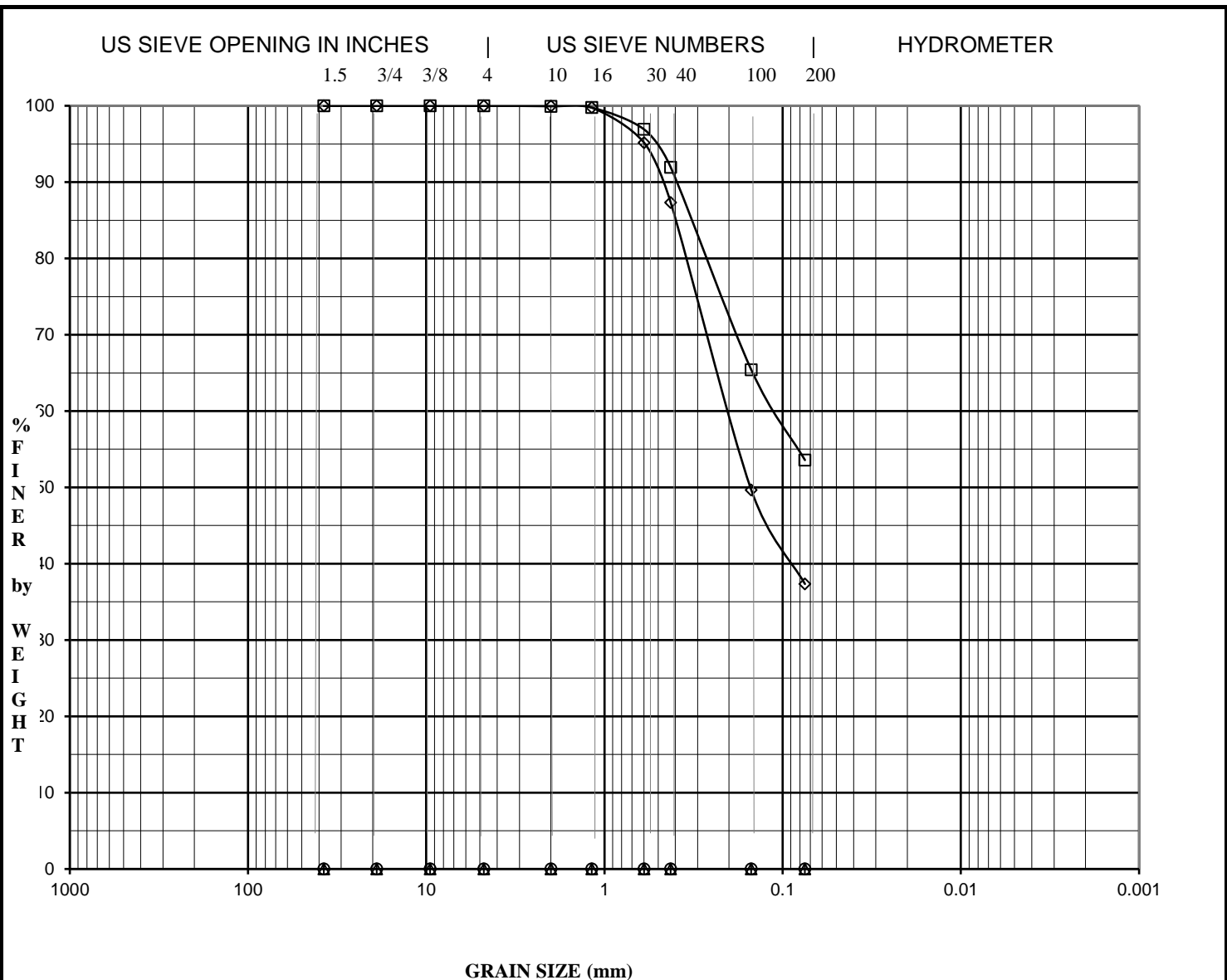
SWELL-CONSOLIDATION TEST



Sample Location	B4
Sample Depth	10 feet
Sample Description	Bedrock
USCS Classification	

Dry Density	115 pcf
In-Situ Moisture Content	17.3 %
Volume Change	2.4 %
Swell Pressure	6,500 psf

	INO - Parker	JOB NO.	5322222
	SWELL - CONSOLIDATION TEST	FIGURE NO.	A7



COBBLES	GRAVEL		SAND		SILT OR CLAY
	COARSE	FINE	CRS	MED FINE	

Specimen I.D.	Description	USCS	AASHTO	Group Index	LL	PI	PL
◇ B2 @ 2.5 FEET	Clayey Sand	SC	A-4	0	23	8	15
□ B2 @ 7.5 FEET	Clay	CL	A-4	1	23	8	15
Δ							
0							
+							

Specimen I.D.	D100	D60	D30	D10	Cc	Cu	%Gravel	%Sand	%Silt&Clay
◇ B2 @ 2.5 FEET	4.75	0.23					0	63	37
□ B2 @ 7.5 FEET	4.75	0.12					0	46	54
Δ									
0									
+									

	INO - Parker	JOB NO. 05322222
	GRADATION CURVES	FIGURE NO. A7