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GEOTECHNICAL INVESTIGATION

Proposed Three Story Apartment Building
415 Natural Bridges Drive
Santa Cruz, California
APN's: 003-011-06 & 003-011-10

For:
Housing Authority of the County of Santa Cruz
2160 41st Avenue
Capitola, California 95010

Project No. 21064
February 8, 2022

1100 Main Street, Suite A, Watsonville, California 95076 • (831) 724-5868 • Email: office@rocksolidengineers.com

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Project No. 21064
February 8, 2022

Housing Authority of the County of Santa Cruz
2160 41st Avenue
Capitola, California 95010

ATTN: Jenny Panetta

SUBJECT: **GEOTECHNICAL INVESTIGATION**
Proposed Three Story Apartment Building
415 Natural Bridges Drive, Santa Cruz, California
APN's: 003-011-06 & 003-011-10

Dear Mrs. Panetta:

In accordance with your authorization, we have completed a geotechnical investigation for the proposed three story apartment building at 415 Natural Bridges Drive in Santa Cruz, California. This report summarizes the findings, conclusions, and recommendations from our field exploration, laboratory testing, and engineering analysis. The conclusions and recommendations included herein are based upon applicable standards at the time this report was prepared.

It is a pleasure being associated with you on this project. If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office.

Sincerely,

ROCK SOLID ENGINEERING, INC.

Signed: February 8, 2022

Yvette M. Wilson, P.E.
Principal Engineer
R.C.E. 60245

John D. Buringa, E.I.T.
Staff Engineer

Distribution: (4) Addressee and via email
(1) William Kempf via email

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1. INTRODUCTION

1.1 Purpose

The purpose of our investigation is to provide preliminary geotechnical design parameters and recommendations for development of the site. Conclusions and recommendations related to site grading, foundations, and slabs-on-grade are presented herein.

1.2 Proposed Development

a. Based on our conversations with you, it is our understanding that the project consists of construction of a three story, 20 unit single room occupancy building at the subject site.

b. Anticipated construction consists of standard light frame construction with slab floors. Exact wall, column, and foundation loads are unavailable, but are expected to be typical of such construction.

c. Final grading and foundation plans were unavailable at the time of this report. It is our understanding that the information obtained during our investigation will be used in the development of a finalized plan set.

d. Also anticipated, is a lot line adjustment, and the construction of parking areas, drainage systems and associated landscaping improvements.

1.3 Scope of Services

The scope of services provided during the course of our investigation included:

a. Review of the referenced geotechnical, geologic, and seismological reports and maps pertinent to the development of the site (available in our files).

b. Field exploration consisting of 5 borings, drilled to depths between 14 feet and 15.5 feet below existing grade in the area of the proposed development.

c. Logging and sampling of the borings by our Field Engineer, including the collection of soil samples for laboratory testing.

d. Laboratory testing of soil samples considered representative of subsurface conditions.

e. Geotechnical analyses of field and laboratory data.

f. Preparation of a report (4 copies) presenting our findings, conclusions and recommendations.

1.4 Authorization

This investigation, as outlined in our Proposal dated October 26, 2021, was performed in accordance with your written authorization on October 29, 2021.

1.5 Exclusions

Our services on this project are limited to the proposed apartment building. Our services specifically exclude all existing structures, pavements, foundations and associated improvements to the site.

2. FIELD EXPLORATION AND LABORATORY TESTING PROGRAM

Details of the field exploration and laboratory testing are presented in Appendix A.

3. SITE DESCRIPTION

3.1 Location

The subject project is located at 415 Natural Bridges Drive, in Santa Cruz, California. The location is shown on the Location Map, **Figure 1**.

3.2 Surface Conditions

The project includes a lot line adjustment to accommodate the parking. An L-shaped portion of 2929 Mission Street (APN: 003-011-10) is going to be added to the westside of 415 Natural Bridges Drive to create a parcel that is approximately 15,000 square feet in size. The east portion of the proposed parcel is currently clear of all development and vegetated with wild grasses and trees. The west portion of the site is currently occupied by an asphalt parking lot. There is a stucco wall along the north and east existing property lines of 415 Natural Bridges Drive. The east property line is developed with a sidewalk. For further information see **Figure A-1**, Boring Location Plan.

3.3 Subsurface Conditions

a. Based on our review of the Geologic Map of Santa Cruz County, California (Reference 3), the site is mapped as Lowest Emergent Coastal Terrace Deposits (Qcl). The Lowest Emergent Coastal Terrace Deposits (Qcl) in this area generally overlie Santa Cruz Mudstone (Tsc). The results of our field exploration are more consistent with Colluvium over Lowest Emergent Coastal Terrace Deposits over Santa Cruz Mudstone.

b. **Groundwater was not encountered during the course of our field exploration.**

REFERENCE 6: Santa Cruz County GIS.

ROCK SOLID ENGINEERING, INC.	LOCATION MAP	FIGURE
	415 Natural Bridges Drive, Santa Cruz	1

c. The upper stratum consists of yellowish brown and dark grayish brown silty sand. The silty sand was observed from the surface to between 1.5 and 2 feet below existing grade. This material is generally moist to wet, loose to medium dense, and slightly plastic to non-plastic.

d. Underlying the silty sand stratum, dark grayish brown, black, yellowish brown clayey sand with mudstone gravel is present. The clayey sand with mudstone gravel was observed to between 4 feet and 6.5 feet below existing grade. This material is generally moist, medium dense to dense with depth, and has slightly plastic to plastic fines.

e. Underlying the clayey sand with mudstone gravel stratum, yellowish brown clayey sand and silty sand is present. The sand was observed to between 13 and 14.5 feet below existing grade. This material is generally moist, medium dense, and non-plastic.

f. Beneath the silty sand stratum, gray and grayish brown Santa Cruz Mudstone was observed. The mudstone was observed to the extent of our borings at approximately 15.5 feet below existing grade. This material is generally damp, hard, and strongly cemented.

g. In Boring B-2 at approximately 1.5 feet below existing grade the soil had a strong smell of organics or manure.

h. Complete soil profiles are presented on the Logs of Exploratory Borings and the boring locations are shown on the Boring Location Plan in Appendix A.

4. GEOTECHNICAL HAZARDS

a. Potential geotechnical hazards to man made structures include ground shaking, surface rupture, landsliding, liquefaction, lateral spreading, and differential compaction. The potential for each of these to impact the site is discussed below.

b. Ground shaking caused by earthquakes is a complex phenomenon. Structural damage can result from the transmission of earthquake vibrations from the ground into the structure. The intensity of an earthquake at any given site depends on many variables including, the proximity of the site to the hypocenter, and the characteristics of the underlying soil and/or rock. The subject site is situated at the approximate latitude of 36.9587° and longitude -122.0578°. The project location (latitude and longitude) were used in conjunction with the American Society of Civil Engineers website (Reference 2) to obtain the seismic design parameters presented in **Table 1**. All proposed structures at the subject site shall be designed with the corresponding seismic design parameters in accordance with the 2019 California Building Code (Reference 4).

Table 1: 2019 CBC Seismic Design Criteria									
Site Class	Seismic Design Category	Spectral Response Accelerations							
		S_S	S_1	F_A	F_V	S_{MS}	S_{M1}	S_{DS}	S_{D1}
C	D	1.612	0.61	1.2	1.4	1.934	0.854	1.289	0.57

c. Surface rupture usually occurs along lines of previous faulting. Based on our review of the Faults and Their Potential Hazards in Santa Cruz County map (Reference 8), no faults are shown to cross the property. Therefore, the potential for surface rupture should be considered low.

d. Landslides are generally mass movements of loose rock and soil, both dry and water saturated, and usually gravity driven. Based on our review of the Preliminary Map of Landslide Deposits in Santa Cruz County (Reference 5), no landslides are mapped on the subject parcel. In addition, the subject site is relatively level, therefore, the potential for landsliding to occur across the site and cause damage to structures should be considered low.

e. Liquefaction, lateral spreading, and differential compaction tend to occur in loose, unconsolidated, noncohesive soils with shallow groundwater. Based on our review of Geology and Liquefaction Potential of Quaternary Deposits in Santa Cruz County, California (Reference 7) the site is mapped as Zone D, low potential for liquefaction. Our field observations confirm that the potential for these hazards to occur should be considered low, due to the presence of relatively dense, cohesive soils and the lack of a shallow groundwater table.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 General

a. Based on the results of our investigation, it is our opinion that from the geotechnical standpoint, the subject site will be suitable for the proposed development provided the recommendations presented herein are implemented during grading and construction.

b. It is our opinion that the subject site will be suitable for the support of the proposed structure on a **foundation system composed of conventional, shallow, continuous and pad footings**. Recommendations for this foundation system are provided in Section 5.3, Foundations.

c. Site preparation, consisting of over excavation and recompaction of the native subgrade will be required prior to placement of shallow foundations, slabs-on-grade, and pavements. See Section 5.2.6 for Preparation of On-Site Soils recommendations.

d. The results of our laboratory testing indicate that the soluble sulfate content of the on-site soils likely to come into contact with concrete is as high as 170 ppm. According to Table 19.3.1.1 of ACI 318-19 (Reference 1), this is considered **moderate sulfate exposure**, Class S1. See Section 5.2.9 for recommendations for concrete mix design to resist this moderate sulfate condition.

e. At the time we prepared this report, grading and foundation plans had not been finalized. We request an opportunity to review these plans during the design stages to determine if supplemental recommendations will be necessary.

f. The design recommendations of this report must be reviewed during the grading phase when subsurface conditions in the excavations become exposed.

g. **Field observation and testing must be provided by a representative of Rock Solid Engineering, Inc**., to enable them to form an opinion regarding the adequacy of the site preparation, and the extent to which the earthwork is performed in accordance with the geotechnical conditions present, the requirements of the regulating agencies, the project specifications and the recommendations presented in this report. Any earthwork performed in connection with the subject project without the full knowledge of, and not under the direct observation of Rock Solid Engineering, Inc., the Geotechnical Consultant, will render the recommendations of this report invalid.

h. **The Geotechnical Consultant should be notified at least five (5) working days prior to any site clearing or other earthwork operations** on the subject project in order to observe the stripping and disposal of unsuitable materials and to ensure coordination with the grading contractor. During this period, a preconstruction conference should be held on the site to discuss project specifications, observation/testing requirements and responsibilities, and scheduling. This conference should include at least the Grading Contractor, the Architect, and the Geotechnical Consultant.

5.2 Grading

5.2.1 General

All grading and earthwork should be performed in accordance with the recommendations presented herein and the requirements of the regulating agencies.

5.2.2 Site Clearing

a. Prior to grading, the areas to be developed for structures, pavements and other improvements, should be stripped of any vegetation and cleared of any surface or subsurface obstructions, including any existing foundations, utility lines, basements, septic tanks, pavements, stockpiled fills, and miscellaneous debris.

b. All pipelines encountered during grading should be relocated as necessary to be completely removed from construction areas or be capped and plugged according to applicable code requirements.

c. Any wells encountered shall be capped in accordance with the local health department requirements. The strength of the cap shall be at least equal to the adjacent soil and shall not be located within 5 feet of any structural element.

d. Surface vegetation and organically contaminated topsoil should be removed from areas to be graded. The required depth of stripping will vary with the time of year the work is done and must be observed by the Geotechnical Consultant. It is generally anticipated that the required depth of stripping will be 6 to 12 inches.

e. Holes resulting from the removal of buried obstructions that extend below finished site grades should be backfilled with compacted engineered fill per Section 5.2.5.

5.2.3 Excavating Conditions

a. We anticipate that excavation of the on-site soils may be accomplished with standard earthmoving and trenching equipment.

b. Groundwater was not encountered during the course of our field exploration, and is not expected to present a problem during construction. Perched water has been observed in the vicinity of the project and may be encountered especially after rains.

c. Although not anticipated, any excavations adjacent to existing structures should be reviewed, and recommendations obtained to prevent undermining or distress to these structures.

5.2.4 Fill Material

a. The on-site soils **may** be used as compacted fill. The clayey sand with mudstone gravel may be difficult to process and may be replaced with import.

b. All soils, both on-site and imported, to be used as fill, should contain less than 3% organics and be free of debris and cobbles over 6 inches in maximum dimension.

c. Any imported soil to be used as engineered fill shall meet the following requirements:

(i) free of organics, debris and other deleterious materials
(ii) be granular (sandy) in nature and have sufficient fines to allow for excavation of the foundation trenches.
(iii) free of rock and cobbles in excess of 3 inches
(iv) have an expansion potential not greater than low (EI<20)
(v) have a soluble sulfate content less than 150 ppm

d. Imported fill material should be approved by the Geotechnical Consultant prior to importing. The Geotechnical Consultant should be notified not less than 5 working days in advance of placing any fill or base course material proposed for import. Each proposed source of import material should be sampled, tested and approved by the Geotechnical Consultant prior to delivery of any soils imported for use on the site.

5.2.5 Fill Placement and Compaction

a. Any fill or backfill required should be placed in accordance with the recommendations presented below.

b. Material to be compacted or reworked should be moisture-conditioned or dried to achieve near-optimum conditions, and compacted to achieve the following minimum relative compaction:
(a) All fill and compacted building subgrade: 90%
(b) Upper 6 inches of subgrade in pavement/drive areas: 95%
(c) Baserock and subbase: 95%.

c. The placement moisture content of imported material should be evaluated prior to grading.

d. The relative compaction and required moisture content shall be based on the maximum dry density and optimum moisture content obtained in accordance with ASTM D1557.

e. The in-place dry density and moisture content of the compacted fill shall be tested in accordance with ASTM D8167/D8167M-18 or ASTM D6938.

f. The number and frequency of field tests required will be based on applicable county standards and at the discretion of the Geotechnical Consultant. As a minimum standard every 1 vertical foot of engineered fill placed within a building pad area, and every 2 vertical feet in all other areas shall be tested, unless specified otherwise by a Rock Solid Engineering, Inc. representative.

g. Fill should be compacted by mechanical means in uniform horizontal loose lifts not exceeding 8 inches in thickness.

h. All fill should be placed and all grading performed in accordance with applicable codes and the requirements of the regulating agency.

5.2.6 Preparation of On-Site Soils

a. Laboratory consolidation test results indicate that the native, near-surface soils are slightly compressible under the anticipated loads and slightly collapsible upon wetting. Site preparation, consisting of over excavation and recompaction of the native subgrade will be required prior to placement of shallow foundations, slabs-on-grade, and pavements.

b. The native subgrade beneath **shallow foundations** should be reworked to a depth sufficient to provide a zone of compacted fill extending at least 2 feet below the bottom of all footings.

c. The native subgrade beneath **slabs-on-grade floors** should be reworked to a depth sufficient to provide a zone of compacted fill extending at least 1.5 feet below the bottom of the capillary break.

d. The native subgrade beneath **pavements** should be reworked to a depth sufficient to provide a zone of compacted fill extending at least 12 inches below the bottom of aggregate base coarse.

e. The zone of compacted fill must extend a minimum of 3 feet laterally beyond all shallow foundations and a minimum of 2 feet laterally beyond all pavements.

f. A representative of our firm shall observe the bottom of the excavation once the required depth of overexcavation has been achieved to verify suitability. Prior to replacing the excavated soil, the exposed surface should be scarified to a depth of 6 to 8 inches, moisture conditioned, and compacted.

g. The depths of reworking required are subject to review by the Geotechnical Consultant during grading when subsurface conditions become exposed.

5.2.7 Groundwater Table

Groundwater **was not** encountered during the course of our investigation, and is not expected to interfere with the proposed construction. Perched water has been observed in the vicinity of the project and may be encountered especially after rains.

5.2.8 Expansive Soils

Our laboratory testing shows that the expansion index of the near surface soils are equal to 37, this indicates that the expansion potential of the near surface soils should be considered **low**.

The California Building Code (Section 1803.5.3) defines soils with an Expansion Index greater than 20 to be expansive. The foundation and grading recommendations presented herein are intended to be in accordance with CBC Section 1808.6.

5.2.9 Sulfate Content

The results of our laboratory testing indicate that the soluble sulfate content of the on-site soils likely to into contact with concrete is as high as 170 ppm (parts per million). According to the American Concrete Institute (ACI), this is considered moderate sulfate exposure, Class S1. Concrete that will be in contact with soil should be designed in accordance with the recommendations presented in the current ACI 318 Code.

5.2.10 Surface Drainage

a. Pad drainage should be designed to collect and direct surface water away from structures to approved drainage facilities. Where soil is adjacent to foundations, a minimum gradient of **5 percent for a distance of no less than 10 feet** measured perpendicularly from the wall face, should be maintained and drainage should be directed toward approved swales or drainage facilities. If 10 horizontal feet can not be satisfied due to lot lines or physical constraints, the drainage shall be designed in accordance with the requirements of Section 1804.4 of the 2019 California Building Code.

b. Swales and impervious surfaces shall be sloped a minimum of 2 percent towards an approved drainage inlet or discharge point or as specified by the Project Civil Engineer.

c. All roof eaves should be guttered with downspouts provided. The downspouts shall discharge to either splash blocks or solid pipe to carry the storm water away from the structure to reduce the possibility of soil saturation and erosion. It may be necessary to use swales or pipes to direct the runoff to an appropriate drainage system or discharge location.

d. We recommend that any infiltration areas be located at least 10 feet from structures.

e. Drainage patterns approved at the time of construction should be maintained throughout the life of the structures. The building and surface drainage facilities must not be altered nor any grading, filling, or excavation conducted in the area without prior review by the Geotechnical Consultant.

f. Irrigation activities at the site should be controlled and reasonable. Planter areas should not be sited adjacent to walls without implementing approved measures to contain irrigation water and prevent it from seeping into walls and under foundations and slabs-on-grade. Large trees should be planted a minimum distance of ½ their mature height away from the foundation.

5.2.11 Utility Trenches

a. Bedding material may consist of sand with SE not less than 20 which may then be jetted, unless local jurisdictional requirements govern.

b. Existing on-site soils sandy soils may be be utilized for trench backfill. The clayey sand with Mudstone gravel **may not** be used for trench backfill.

c. If sand is used, a 3 foot concrete plug should be placed in each trench where it passes under the exterior footings.

d. Backfill of all exterior and interior trenches should be placed in thin lifts and mechanically compacted to achieve a relative compaction of not less than 95% in paved areas and 90% in other areas per ASTM D-1557. Care should be taken not to damage utility lines.

e. Utility trenches that are parallel to the sides of a building should be placed so that they do not extend below a line sloping down and away at an inclination of 2:1 (H:V) from the bottom outside edge of all footings.

f. Trenches should be capped with 1.5± feet of impermeable material. Import material must be approved by the Geotechnical Consultant prior to its use.

g. Trenches must be shored as required by the local regulatory agency, the State Of California Division of Industrial Safety Construction Safety Orders, and Federal OSHA requirements.

5.3 Foundations

5.3.1 General

a. It is our opinion that the subject site will be suitable for the support of the proposed structure on a **foundation system composed of conventional, shallow, continuous and pad footings**.

b. At the time we prepared this report, grading and foundation plans had not been finalized. We request an opportunity to review these plans during the design stages to determine if supplemental recommendations will be necessary.

5.3.2 Conventional Shallow Foundations

a. Footing widths should be based on the allowable bearing values but not less than 18 inches for 3 story structures.

b. **The minimum recommended depth of embedment is 24 inches for all footings.** Should local building codes require deeper embedment of the footings or wider footings the codes must apply.

c. Footing excavations must be checked by the Geotechnical Consultant before steel is placed and concrete is poured to insure bedding into proper material. Excavations should be thoroughly wetted down just prior to pouring concrete.

d. The **allowable bearing capacity** shall not exceed **2,000 psf.**

e. The allowable bearing capacity values above may be increased by one-third in the case of short duration loads, such as those induced by wind or seismic forces.

f. In the event that footings are founded in structural fill consisting of imported soil, the recommended allowable bearing capacity may need to be re-evaluated.

5.4 Settlements

Total and differential settlements beneath foundation elements are expected to be within tolerable limits. Vertical movements are not expected to exceed 1 inch. Differential movements are expected to be within the normal range (½ inch) for the anticipated loads and spacings. These preliminary estimates should be reviewed by the Geotechnical Consultant when foundation plans for the proposed structures become available.

5.5 Slabs-on-Grade

a. Concrete floor slabs may be founded on compacted engineered fill per the recommendations in Section 5.2.6. The subgrade should be proof-rolled just prior to construction to provide a firm, relatively unyielding surface, especially if the surface has been loosened by the passage of construction traffic.

b. It is important that the subgrade soils be thoroughly saturated for 24 to 48 hours prior to the time the concrete is poured. **For compacted engineered fill with a low expansion potential, the subgrade should be presoaked 4 percentage points above optimum to a depth of 1.0 feet**.

c. The slab-on-grade section should incorporate a minimum 4 inch capillary break consisting of 3/4 inch, clean, crushed rock, or approved equivalent. Class II baserock is not recommended. Structural considerations may govern the thickness of the capillary break.

d. Where moisture sensitive floor coverings are anticipated or vapor transmission may be a problem, a 15 mil waterproof membrane should be placed between the floor slab and the capillary break in order to reduce moisture condensation under the floor coverings. Refer to ACI 302.2R-06 for additional criteria.

e. We have provided generalized recommendations associated with standard construction practices for the reduction of moisture transmission through concrete slab-on-grade floors. We are not moisture-proofing specialists. A waterproofing or moisture proofing expert should be consulted for project specific moisture protection recommendations

f. Slab thickness, reinforcement, and doweling should be determined by the Project Structural Engineer, based on the design live and dead loads, including vehicles.

6. LIMITATIONS

a. Our investigation was performed in accordance with the usual and current standards of the profession, as they relate to this and similar localities. No other warranty, expressed or implied, is provided as to the conclusions and professional advice presented in this report.

b. The samples taken and tested, and the observations made, are considered to be representative of the site; however, soil and geologic conditions can vary significantly between sample locations.

c. As in most projects, conditions revealed during construction excavation may be at variance with preliminary findings. If this occurs, the changed conditions must be evaluated by the Project Geotechnical Consultant, and revised recommendations be provided as required.

d. This report is issued with the understanding that it is the responsibility of the Owner, or of his Representative, to ensure that the information and recommendations contained herein are brought to the attention of the Architect and Engineer for the project and incorporated into the plans, and that it is ensured that the Contractor and Subcontractors implement such recommendations in the field.

e. This firm does not practice or consult in the field of safety engineering. We do not direct the Contractor's operations, and we are not responsible for other than our own personnel on the site; therefore, the safety of others is the responsibility of the Contractor. The Contractor should notify the Owner if he considers any of the recommended actions presented herein to be unsafe.

f. The findings of this report are considered valid as of the present date. However, changes in the conditions of a site can occur with the passage of time, whether they be due to natural events or to human activities on this or adjacent sites. In addition, changes in applicable or appropriate codes and standards may occur, whether they result from legislation or the broadening of knowledge.

g. Accordingly, this report may become invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and revision as changed conditions are identified.

REFERENCES

1. American Concrete Institute, 2019, Building Code Requirements for Structural Concrete (ACI 318-19), Published June 2019.

2. American Society of Civil Engineers, ASCE 7 Hazards Report, Site Utilized January 5, 2022. https://www.asce7hazardtool.online/

3. Brabb, E.E., 1989, Geologic Map of Santa Cruz County, California, U.S. Geological Survey Miscellaneous Investigations Series Map I-1905, Scale: 1:62,500.

4. California Building Standards Commission, July 2019, 2019 California Building Code, California Code of Regulations, Title 24, Part 2, Effective January 1, 2020.

5. Cooper-Clark and Associates, 1975, Preliminary Map of Landslide Deposits in Santa Cruz County, California, Santa Cruz County Planning Dept., Scale: 1:62,500.

6. County of Santa Cruz, PublicGISWeb, Site Utilized January 5, 2022. http://gis.co.santa-cruz.ca.us/PublicGISWeb.

7. Dupré, W.R., 1975, Geology and Liquefaction Potential of Quaternary Deposits in Santa Cruz County, California, U.S. Geological Survey Miscellaneous Field Studies Map MF-648, Scale: 1:62,500.

8. Hall, N.T., Sarna-Wojcicki, A.M., and Dupré, W.R., 1974, Faults and their Potential Hazards in Santa Cruz County, California, U.S. Geological Survey Miscellaneous Field Studies Map MF-626, Scale: 1:62,500.

9. Thatcher & Thompson Architects, Housing Authority of Santa Cruz County, 415 Natural Bridges Drive, Santa Cruz, CA 95060, Sheets A1 through A4, Dated 9/20/21.

APPENDIX A

FIELD EXPLORATION AND LABORATORY TESTING PROGRAM

FIELD EXPLORATION PROCEDURES

A-1. Subsurface conditions were explored by drilling 5 borings to depths between 14 and 15.5 feet below existing grade. The borings were advanced with a truck mounted drill rig equipped with 6 inch solid stem augers. The approximate locations of the borings are shown on the Boring Location Plan, **Figure A-1**. The Key to Logs, **Figure A-2**, gives definitions of the terms used in the Logs of Exploratory Borings. The Logs of Exploratory Borings are presented in **Figures A-3** and **A-7**.

A-2. Drilling of the borings was observed by our Field Engineer who logged the soils and obtained bulk and relatively undisturbed samples for classification and laboratory testing. The soils were classified, based on field observations and laboratory testing, in accordance with Unified Soil Classification System.

A-3. Relatively undisturbed soil samples were obtained by means of a drive sampler. The hammer weight and drop being 140 pounds and 30 inches, respectively. The number of "Blows/Foot" required to drive samplers are indicated on the logs.

A-4. Exploratory borings were located in the field by measuring from known landmarks. The locations, as shown, are therefore within the accuracy of such a measurement.

A-5. Groundwater was not encountered during the course of our field exploration.

LABORATORY TESTING PROCEDURES

A-6. Classification

Soils were classified in accordance with the Unified Soil Classification System. Moisture content and in-situ density determinations were made from relatively undisturbed soil samples. The results are presented in the Logs of Exploratory Borings and in the Summary of Laboratory Test Results, **Figures A-8.1 and A-8.2**.

A-7. Direct Shear

Direct shear strength tests were performed on representative samples of the on-site soils in accordance with laboratory test standard ASTM D 3080-98. Samples were relatively undisturbed, or remolded as specified. To simulate possible adverse field conditions, the samples were saturated prior to testing unless otherwise noted. A saturating device was used which permitted the samples to absorb moisture while preventing volume change. The direct shear test results are presented in **Figures A-9 and A-10**.

A-8. Consolidation

Consolidation tests were performed on representative, relatively undisturbed samples of the underlying soils to determine compressibility characteristics. The samples were saturated during the tests to simulate possible adverse field conditions. The test results are presented in **Figures A-11 through A-13**.

A-9. Expansion Index

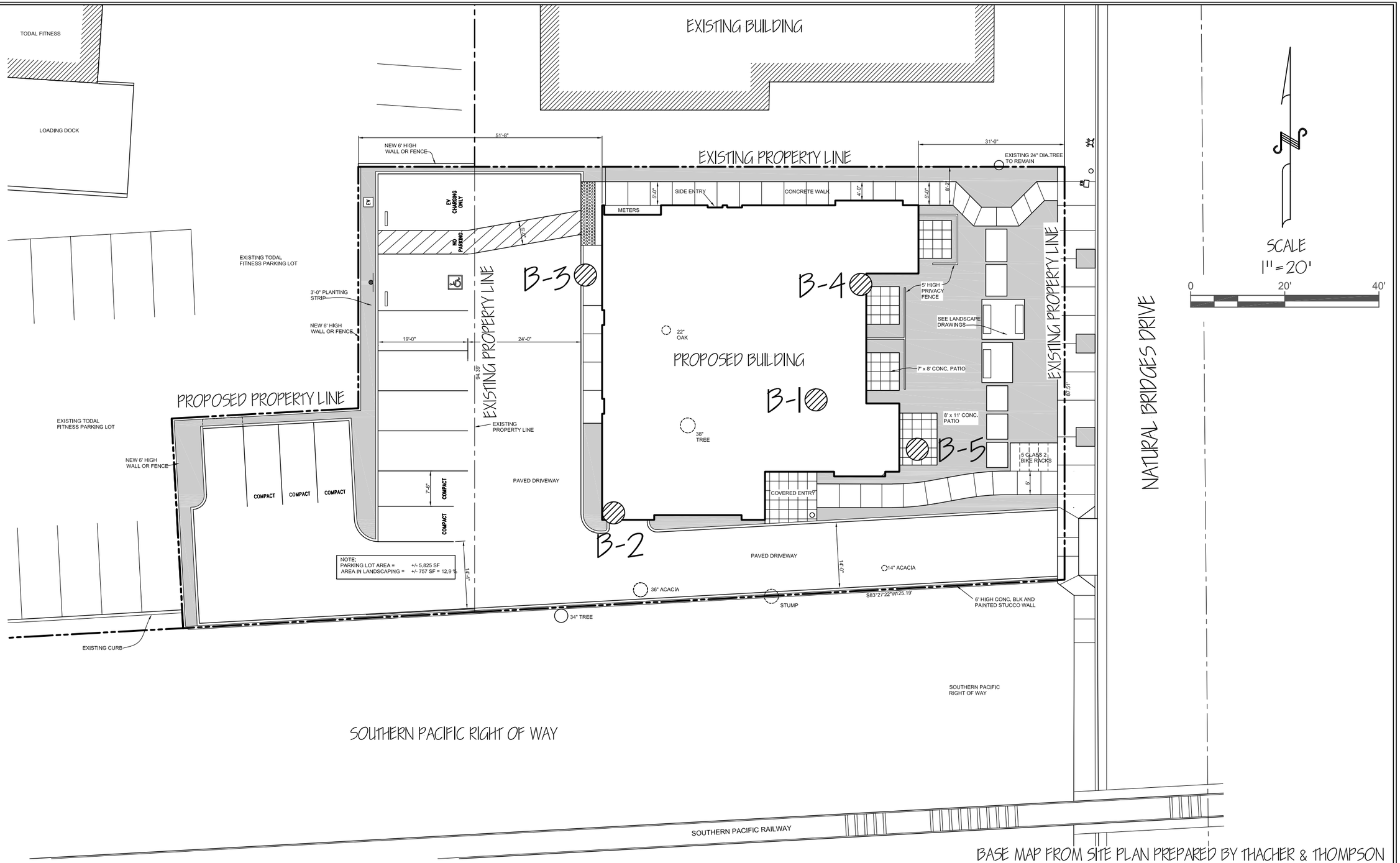
Expansion tests were performed on representative, remolded samples of the on-site soils in accordance with laboratory test standard ASTM D 4829-11. The test results are presented in **Figure A-8.1**.

A-10. Amount of Materials in Soil Finer than the No. 200 Sieve

Determination of the amount of materials in the soil finer than the No. 200 sieve analyses were performed on samples considered representative of the on-site soils. The laboratory test was performed in accordance with ASTM: D 1140. The test results are presented in **Figure A-8.1**.

A-11. Soluble Sulfates

The soluble sulfate content was determined for samples considered representative of the on-site soils likely to come in contact with concrete in accordance with test method California 417. The test results are presented in **Figure A-8.1**.



SOUTHERN PACIFIC RIGHT OF WAY

B-1 APPROXIMATE LOCATION OF BORING B1, TYPICAL

BASE MAP FROM SITE PLAN PREPARED BY THACHER & THOMPSON ARCHITECTS, DATED BY SEPTEMBER 20th 2021.

ROCK SOLID ENGINEERING, INC.

BORING LOCATION PLAN

415 Natural Bridges Drive, Santa Cruz

FIGURE A-1

KEY TO LOGS

UNIFIED SOIL CLASSIFICATION SYSTEM

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS More than half of the material is larger than the No. 200 sieve	GRAVELS More than half of the coarse fraction is larger than the No. 4 sieve	CLEAN GRAVELS (Less than 5% fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS More than half of the coarse fraction is smaller than the No. 4 sieve	CLEAN SANDS (Less than 5% fines)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		SAND WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines
			SC	Clayey sands, sand-clay mixtures, plastic fines
FINE GRAINED SOILS More than half of the material is smaller than the No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50		ML	Inorganic silts and very fine sands, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomacaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils

GRAIN SIZE LIMITS

SILT AND CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
No. 200	No. 40	No. 10	No. 4	3/4 in.	3 in.	12 in.	

US STANDARD SIEVE SIZE

RELATIVE DENSITY	
SAND AND GRAVEL	BLOWS/FT*
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

CONSISTENCY	
SILT AND CLAY	BLOWS/FT*
VERY SOFT	0 - 2
SOFT	2 - 4
FIRM	4 - 8
STIFF	8 - 16
VERY STIFF	16 - 32
HARD	OVER 32

MOISTURE CONDITION
DRY
DAMP
MOIST
WET

* Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1 3/8 inch I.D.) split spoon (ASTM D-1586).

LOG OF EXPLORATORY BORING

Project No.:	21064	Boring:	B1
Project:	415 Natural Bridges Drive	Location:	Approximate Center of Proposed Building
	Santa Cruz, California	Elevation:	
Date:	December 10, 2021	Method of Drilling:	Truck Mounted Drill Rig
Logged By:	JDB		6 in. Solid Stem Auger, 140 lb. Hammer

2" DIA Sample | 2.5" DIA Sample | Bulk Sample | Terzaghi Split Spoon Sample | Static Water Table

Depth (ft.)	Soil Type	Undisturbed	Bulk	Description	Blows	Dry Density (pcf)	Moisture Content (%)	Wet Density (pcf)	Direct Shear c (psf)	Direct Shear ϕ °	Miscellaneous Laboratory Testing
	SM			Yellowish Brown Silty SAND. Moist, Medium Dense, Slightly Plastic. Fine to Medium Grained Sand.	24		15.7				42% Fines
	SC-(CL)			Dark Grayish Brown Clayey SAND and Mudstone Gravel. Moist, Medium Dense, Plastic Fines. Gravel-up to 2.5". Oxidized.	43	89.9	24.1 17.5	111.4			37% Fines Consolidation 34% Fines
5				Material Consistent. Pale Brown. Dense. Gravel-up to 1.5", Mudstone.							
				Material Consistent. Very Dense. More Gravel.	21 50/6"	75.6	29.9	98.2			
10	SM			Yellowish Brown Silty SAND. Moist, Dense, Non-Plastic. Fine to Coarse Grained Sand.	37		10.9				
				Hard @ 14.0 Feet.							
15	(CL)			Gray MUDSTONE. Damp, Hard, Strongly Cemented. Fine Grained	50/0"		18.6				
				Boring Terminated @ 15 Feet (Auger Refusal) Groundwater Not Encountered Boring Backfilled With Cuttings							
20											
25											

ROCK SOLID ENGINEERING, INC.

FIGURE A-3

LOG OF EXPLORATORY BORING

Project No.:	21064	Boring:	B2
Project:	415 Natural Bridges Drive	Location:	Southwest Portion of Proposed Building
	Santa Cruz, California	Elevation:	
Date:	December 10, 2021	Method of Drilling:	Truck Mounted Drill Rig
Logged By:	JDB		6 in. Solid Stem Auger, 140 lb. Hammer

2" DIA Sample | 2.5" DIA Sample | Bulk Sample | Terzaghi Split Spoon Sample | Static Water Table

Depth (ft.)	Soil Type	Undisturbed	Bulk	Description	Blows	Dry Density (pcf)	Moisture Content (%)	Wet Density (pcf)	Direct Shear c (psf)	Direct Shear ϕ °	Miscellaneous Laboratory Testing
	SM			Dark Grayish Brown Silty SAND. Moist, Medium Dense, Non-Plastic. Fine to Medium Grained Sand. (Strong Organics/Manure Smell)	25		12.7				
	SC-(CL)			Dark Grayish Brown and Yellowish Brown Clayey SAND and Mudstone Gravel. Moist, Medium Dense to Dense, Plastic Fines. Gravel-up to 2.5".	45	96.3	17.7 16.7	113.3			
5	SM-SC			Yellowish Brown Silty SAND to Clayey SAND. Moist, Dense, Non-Plastic. Fine to Medium Grained Sand. Trace Gravel.	23 50$^{6"}$	96.9	10.6	107.2	40	33	Sulfate
10	SC			Yellowish Brown Clayey SAND. Moist, Dense, Non-Plastic. Fine to Medium Grained Sand. Slightly Cemented.	30 50$^{5"}$	108.0	7.8	116.4			
	(CL)			Grayish Brown MUDSTONE. Damp, Hard, Strongly Cemented.	50$^{0"}$		18.6				
15				Boring Terminated @ 14 Feet Groundwater Not Encountered Boring Backfilled With Cuttings							
20											
25											

LOG OF EXPLORATORY BORING

Project No.:	21064	Boring:	B3
Project:	415 Natural Bridges Drive	Location:	Northwest Portion of Proposed Building
	Santa Cruz, California	Elevation:	
Date:	December 10, 2021	Method of Drilling:	Truck Mounted Drill Rig
Logged By:	JDB		6 in. Solid Stem Auger, 140 lb. Hammer

2" DIA Sample | 2.5" DIA Sample | Bulk Sample | Terzaghi Split Spoon Sample | Static Water Table

Depth (ft.)	Soil Type	Undisturbed	Bulk	Description	Blows	Dry Density (pcf)	Moisture Content (%)	Wet Density (pcf)	Direct Shear c (psf)	Direct Shear ϕ °	Miscellaneous Laboratory Testing
	SM			Dark Grayish Brown Silty SAND. Wet, Medium Dense, Non-Plastic. Fine to Medium Grained Sand.	49		13.5				
	SC-(CL)			Yellowish Brown and Black Clayey SAND and Mudstone Gravel. Moist, Dense, Plastic Fines. Gravels-up to 2.5".	18 50/6"	88.8	19.6 20.6	106.3			Consolidation
5				Material Consistent.	30 50/3"	75.4	23.3	93.0			
10	SM-SC			Yellowish Brown Silty SAND to Clayey SAND. Moist, Dense, Non-Plastic. Fine to Medium Grained Sand.	34		8.4				
	(CL)			Dark Gray MUDSTONE. Moist, Hard, Strongly Cemented. Oxidized.	50/1"		40.7				
15				Boring Terminated @ 14.0 Feet Groundwater Not Encountered Boring Backfilled With Cuttings							
20											
25											

ROCK SOLID ENGINEERING, INC.

FIGURE A-5

LOG OF EXPLORATORY BORING

Project No.:	21064	Boring:	B4
Project:	415 Natural Bridges Drive	Location:	Northeast Portion of Proposed Building
	Santa Cruz, California	Elevation:	
Date:	December 10, 2021	Method of Drilling:	Truck Mounted Drill Rig
Logged By:	JDB		6 in. Solid Stem Auger, 140 lb. Hammer

2" DIA Sample | 2.5" DIA Sample | Bulk Sample | Terzaghi Split Spoon Sample | Static Water Table

Depth (ft.)	Soil Type	Undisturbed	Bulk	Description	Blows	Dry Density (pcf)	Moisture Content (%)	Wet Density (pcf)	Direct Shear c (psf)	Direct Shear φ °	Miscellaneous Laboratory Testing
	SM			Dark Grayish Brown Silty SAND. Wet, Loose, Non-Plastic. Fine to Medium Grained Sand.	13		15.2				
	SC-(CL)			Yellowish Brown and Black Clayey SAND and Mudstone Gravel. Moist, Medium Dense, Plastic Fines. Fine to Medium Grained Sand. Gravel-up to 2.5".	28	94.3	32.4 31.6	124.8	960	19	E.I. = 37 Consolidation
5				Material Consistent. Yellowish Brown. Moist, Very Dense, Slightly Plastic. Gravel-up to 2.5", Angular. Less Clay.	7 50$^{6"}$	75.4	30.9	98.8			
10	SM-SC			Yellowish Brown Silty SAND to Clayey SAND. Moist, Dense, Non-Plastic. Mudstone Gravel-up to 1.5".	43		7.5				
	(CL)			Dark Grayish MUDSTONE. Damp, Hard, Strongly Cemented.	50$^{1"}$		24.3				
15				Boring Terminated @ 14.5 Feet Groundwater Not Encountered Boring Backfilled With Cuttings							
20											
25											

ROCK SOLID ENGINEERING, INC.

FIGURE A-6

LOG OF EXPLORATORY BORING

Project No.:	21064	Boring:	B5
Project:	415 Natural Bridges Drive	Location:	Southeast Portion of Proposed Building
	Santa Cruz, California	Elevation:	
Date:	December 10, 2021	Method of Drilling:	Truck Mounted Drill Rig
Logged By:	JDB		6 in. Solid Stem Auger, 140 lb. Hammer

2" DIA Sample | 2.5" DIA Sample | Bulk Sample | Terzaghi Split Spoon Sample | Static Water Table

Depth (ft.)	Soil Type	Undisturbed	Bulk	Description	Blows	Dry Density (pcf)	Moisture Content (%)	Wet Density (pcf)	Direct Shear c (psf)	Direct Shear ϕ °	Miscellaneous Laboratory Testing
	SM		X	Dark Grayish Brown Silty SAND. Wet, Medium Dense, Non-Plastic. Fine to Coarse Grained Sand.			14.6				
	SC-(CL)		X	Dark Grayish Brown and Yellowish Brown Clayey SAND and Mudstone Gravel. Moist, Medium Dense, Plastic Fines. Gravel-up to 1".	20	101.2	21.4	122.8			
			X	Material Consistent.	27		21.3				
5			X	Material Consistent. Dense. Gravel-up to 1.5".	40		33.4				
	SM-SC		X	Yellowish Brown Silty SAND to Clayey SAND. Moist, Medium Dense, Non-Plastic. Fine to Medium Grained Sand.	27		10.9				
15	(CL)			No Recovery. Likely Mudstone.	$50^{0.5"}$						
				Boring Terminated @ 15 Feet Groundwater Not Encountered Boring Backfilled With Cuttings							
20											
25											

ROCK SOLID ENGINEERING, INC.

FIGURE A-7

SUMMARY OF LABORATORY TEST RESULTS

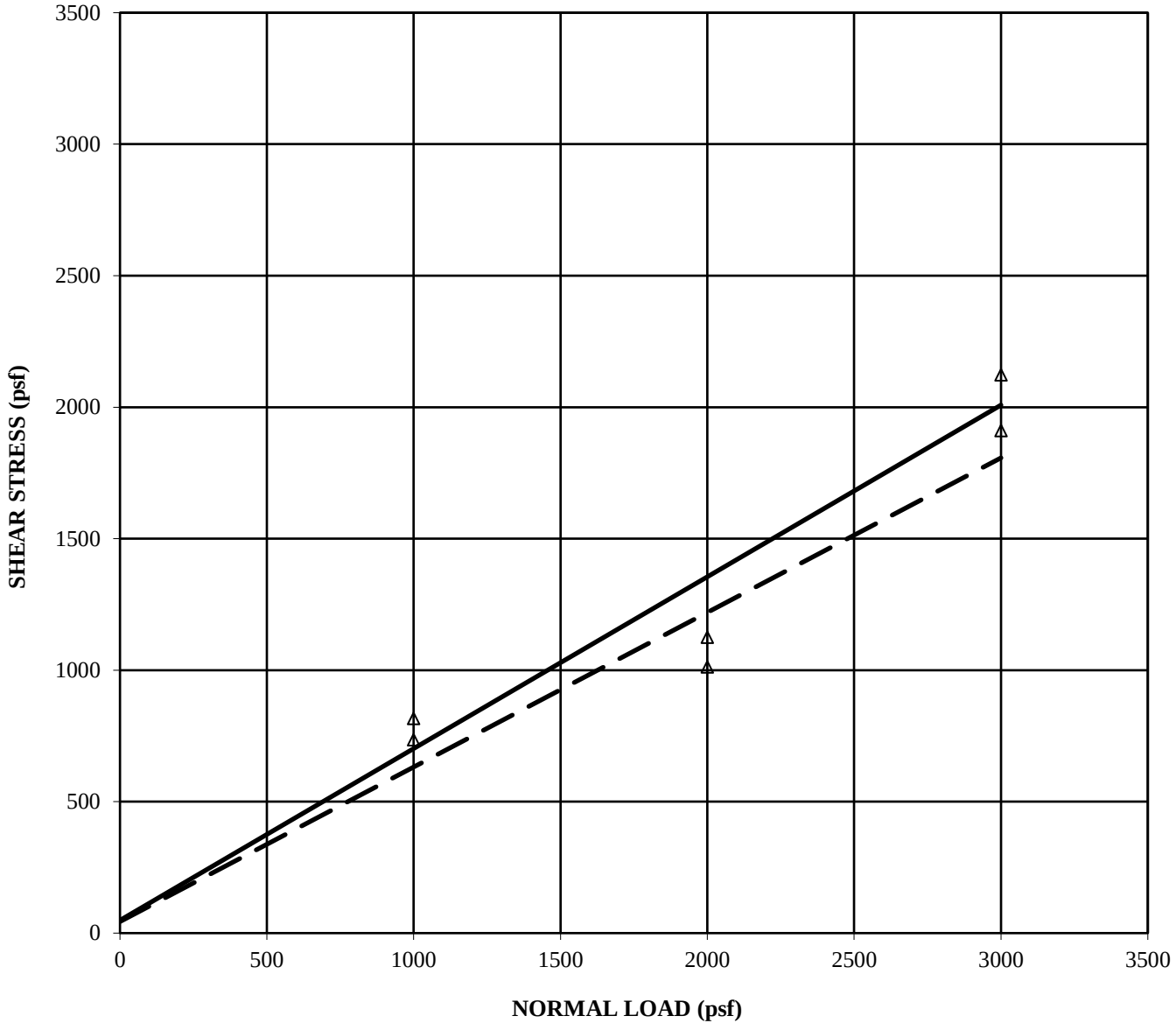
BORING	DEPTH	SOIL TYPE	IN-SITU			DIRECT SHEAR		GRAIN SIZE (%)				EXPANSION INDEX	SOLUBLE SULFATES (ppm)
			DRY DENSITY (pcf)	MOISTURE CONTENT (%)	WET DENSITY (pcf)	COHESION (psf) (PEAK)	FRICTION ANGLE (PEAK)	GRAVEL	SAND	SILT	CLAY		
B1	1T	SM		15.7						42			
B1	1B	SC-(CL)	89.8	24.1	111.4					37			170
B1	2.5	SC-(CL)		17.5						34			
B1	5.0	SC-(CL)	75.6	29.9	98.2								
B1	10.0	SM		10.9									
B1	15.0	(CL)		18.6									
B2	1T	SM		12.7									
B2	1B	SC-(CL)	96.3	17.7	113.3								
B2	2.5	SC-(CL)		16.7									
B2	5.0	SM-SC	96.9	10.6	107.2	40	33						11
B2	10.0	SC	108.0	7.8	116.4								
B2	14.0	(CL)		18.6									
B3	1T	SM		13.5									
B3	1B	SC-(CL)	88.8	19.6	106.3								90
B3	2.5	SC-(CL)		20.6									
B3	5.0	SC-(CL)	75.4	23.3	93.0								
B3	10.0	SM-SC		8.4									
B3	13.5	(CL)		40.7									
B4	1T	SM		15.2									
B4	1B	SC-(CL)	94.3	32.4	124.8	960	19					37	
B4	2.5	SC-(CL)		31.6									

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH	SOIL TYPE	IN-SITU			DIRECT SHEAR		GRAIN SIZE (%)				EXPANSION INDEX	SOLUBLE SULFATES (ppm)
			DRY DENSITY (pcf)	MOISTURE CONTENT (%)	WET DENSITY (pcf)	COHESION (psf) (PEAK)	FRICTION ANGLE (PEAK)	GRAVEL	SAND	SILT	CLAY		
B4	5.0	SC-(CL)	75.4	30.9	98.8								
B4	10.0	SM-SC		7.5									
B4	14.0	(CL)		24.3									
B5	1T	SM		14.6									
B5	1B	SC-(CL)	101.2	21.4	122.8								
B5	2.5	SC-(CL)		21.3									
B5	5.0	SC-(CL)		33.4									
B5	10.0	SM-SC		10.9									

BORING:	B2		COHESION	FRICTION
DEPTH (ft):	5.0		(psf)	ANGLE
SOIL TYPE (USCS):	SM-SC	PEAK	40	33
		RESIDUAL	40	30

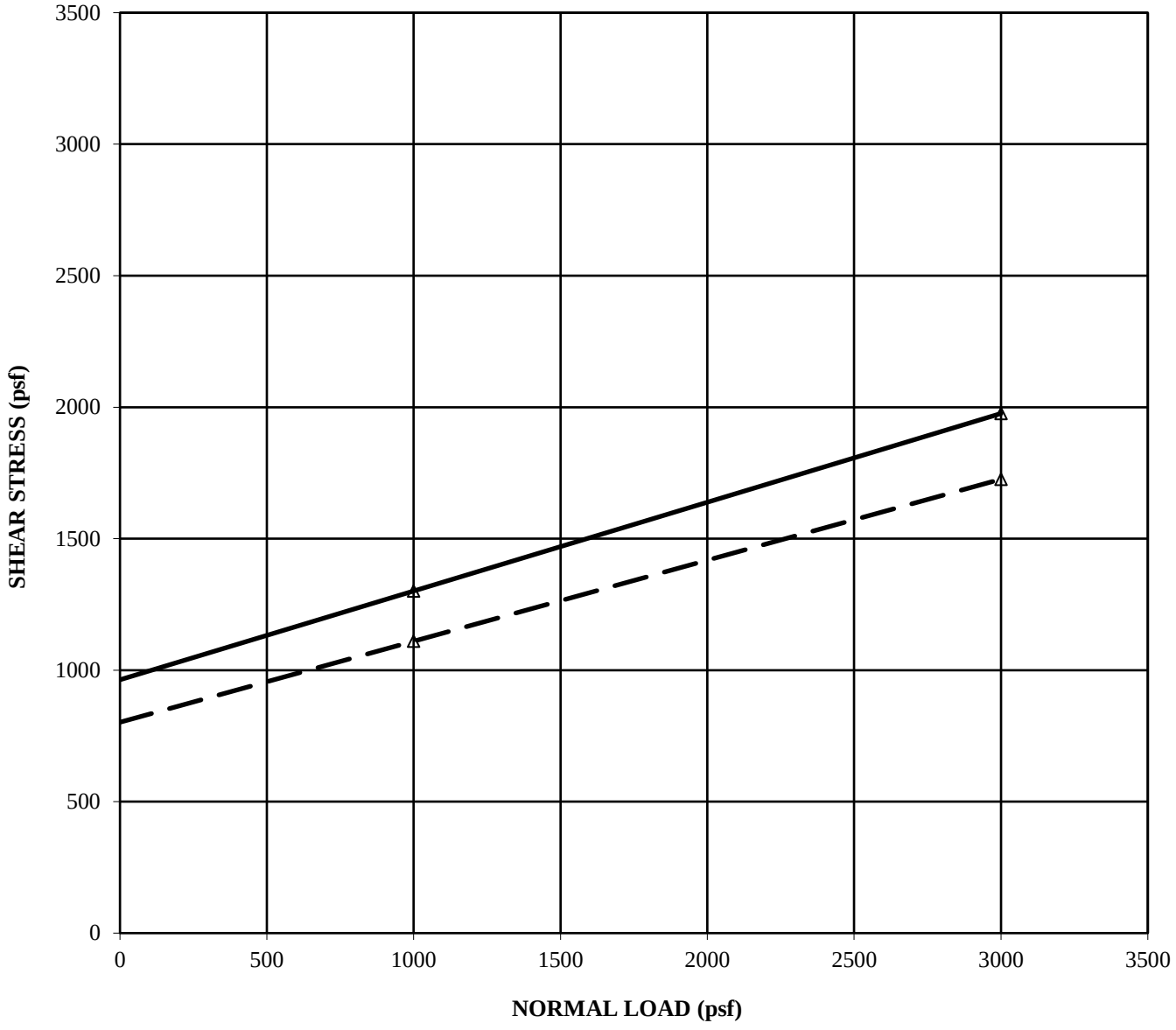
TEST SAMPLE TYPE:	FIELD MOISTURE:	10.6%
IN-SITU (SATURATED)	SATURATED MOIST:	22.6%



ROCK SOLID ENGINEERING, INC.	**DIRECT SHEAR TEST RESULTS**	FIGURE
	415 Natural Bridges Drive, Santa Cruz	A-9

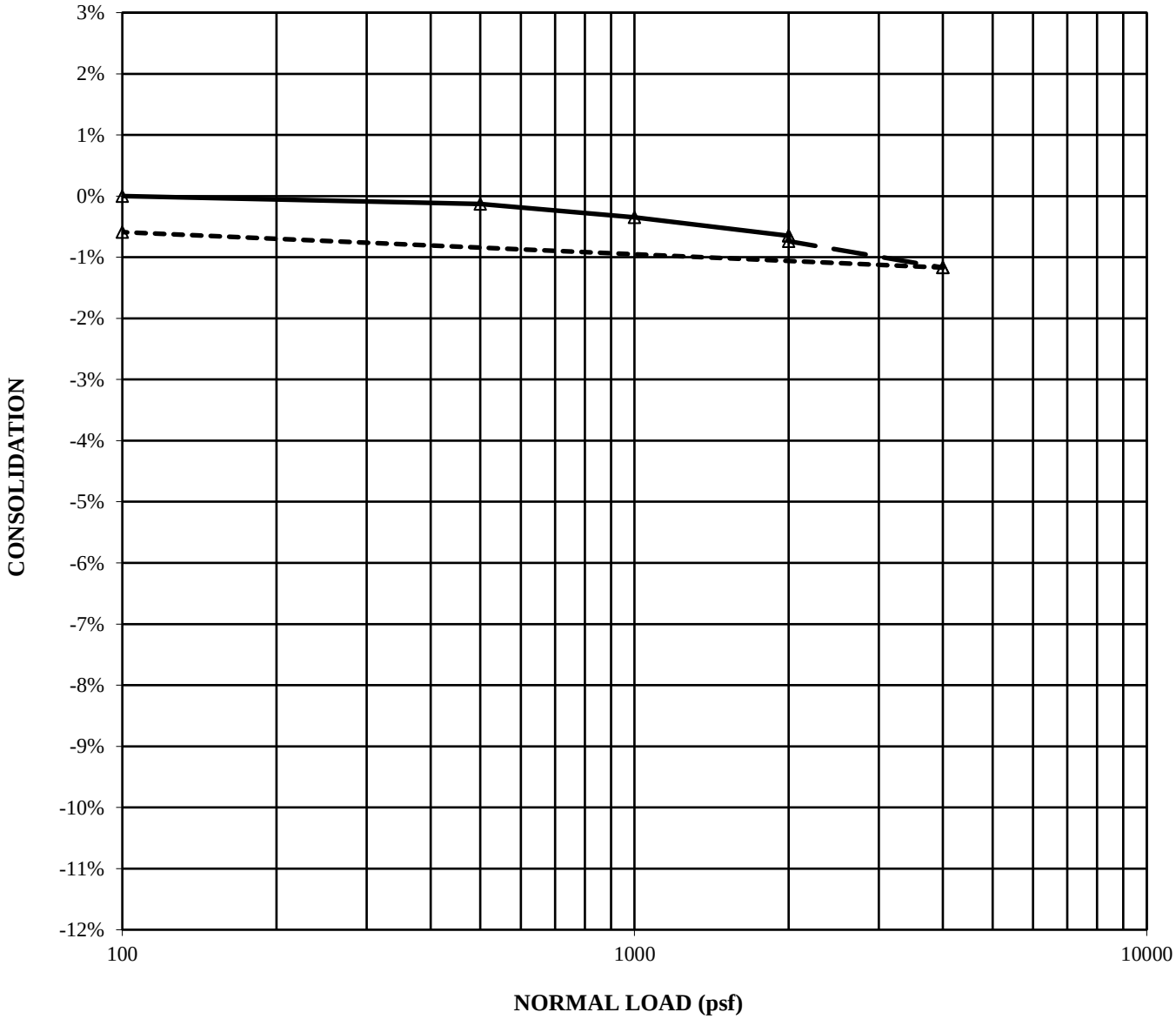
BORING:	B4		COHESION	FRICTION
DEPTH (ft):	1B		(psf)	ANGLE
SOIL TYPE (USCS):	SC-(CL)	PEAK	960	19
		RESIDUAL	800	17

TEST SAMPLE TYPE:	FIELD MOISTURE:	32.4%
IN-SITU (SATURATED)	SATURATED MOIST:	26.9%



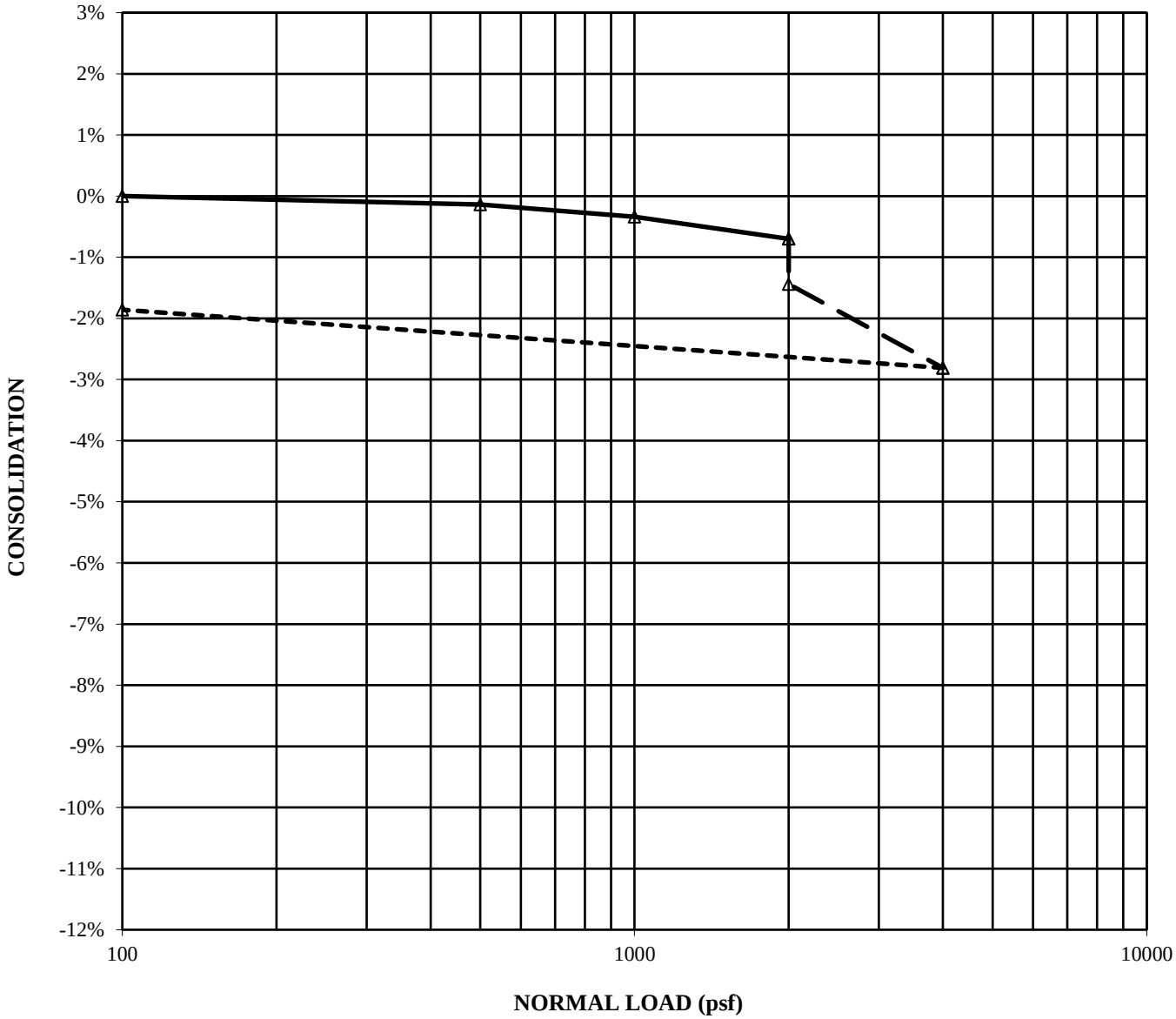
ROCK SOLID ENGINEERING, INC.	**DIRECT SHEAR TEST RESULTS**	FIGURE
	415 Natural Bridges Drive, Santa Cruz	A-10

BORING:	B1	FIELD MOISTURE	
DEPTH (ft):	1B	SATURATED	
SOIL TYPE (USCS):	SC-(CL)	REBOUND	
SEATING WEIGHT:	220 psf	FIELD MOISTURE:	24.1%
		SATURATED MOIST:	24.5%



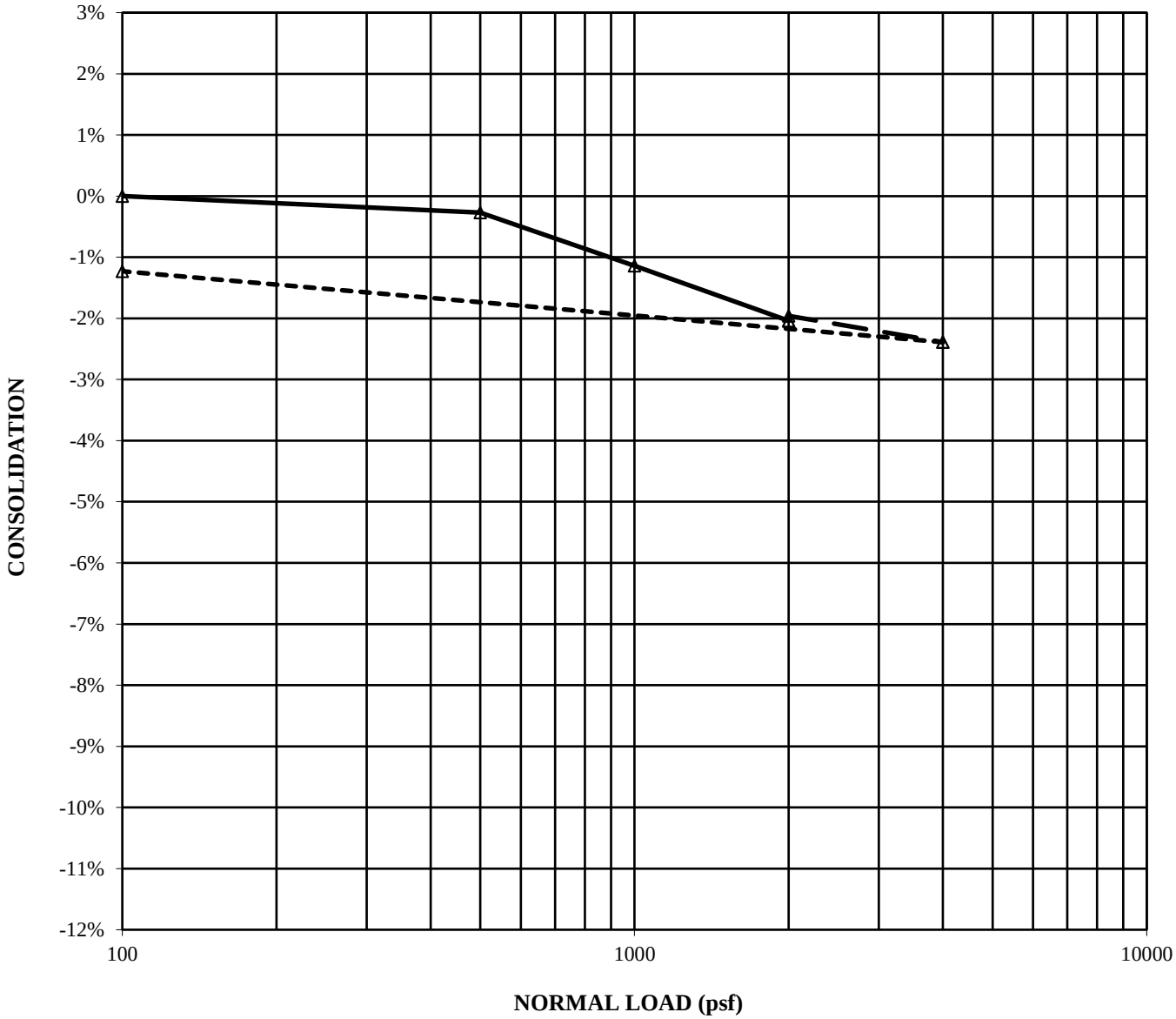
ROCK SOLID ENGINEERING, INC.	**CONSOLIDATION TEST RESULTS**	FIGURE
	415 Natural Bridges Drive, Santa Cruz	A-11

BORING:	B3	FIELD MOISTURE	
DEPTH (ft):	1B	SATURATED	
SOIL TYPE (USCS):	SC-(CL)	REBOUND	
SEATING WEIGHT:	220 psf	FIELD MOISTURE:	19.6%
		SATURATED MOIST:	34.0%



ROCK SOLID ENGINEERING, INC.	**CONSOLIDATION TEST RESULTS**	FIGURE
	415 Natural Bridges Drive, Santa Cruz	A-12

BORING:	B4	FIELD MOISTURE	
DEPTH (ft):	1B	SATURATED	
SOIL TYPE (USCS):	SC-(CL)	REBOUND	
SEATING WEIGHT:	250 psf	FIELD MOISTURE:	32.4%
		SATURATED MOIST:	24.0%



ROCK SOLID ENGINEERING, INC.	**CONSOLIDATION TEST RESULTS**	FIGURE
	415 Natural Bridges Drive, Santa Cruz	A-13