Revised Geotechnical Engineering Investigation
Proposed Industrial Warehouse Development
1101 California Street
Redlands, California

North Palisade Partners, LLC
240 Newport Center Drive, Suite 200
Newport Beach, California 92660

Attn: Mr. Brian Wong

Project Number 23875-23
February 7, 2024

NorCal Engineering

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North Palisade Partners, LLC
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Newport Beach, California 92660

Attn.: Mr. Brian Wong

RE: ***Revised*** **Geotechnical Engineering Investigation** - Proposed Industrial Warehouse Development - Located at 1101 California Street, in the City of Redlands, California

Dear Mr. Wong:

Pursuant to your request, this firm has performed a Geotechnical Engineering Investigation for the above referenced project in accordance with your approval of our proposal dated March 17, 2023. The purpose of this investigation is to evaluate the geotechnical conditions of the subject site and to provide recommendations for the proposed self-storage building development.

The scope of work included the following: 1) site reconnaissance; 2) subsurface geotechnical exploration and sampling; 3) laboratory testing; 4) soil infiltration testing; 5) engineering analysis of field and laboratory data; 6) preparation of a geotechnical engineering report. It is the opinion of this firm that the proposed development is feasible from a geotechnical standpoint provided that the recommendations presented in this report are followed in the design and construction of the project.

1.0 Project Description

It is proposed to construct an industrial warehouse development consisting of 346,670 square feet building on the 15.95-acre subject site as shown on the attached Site Plan (Figure 1). The proposed concrete tilt-up building will be supported by a conventional slab-on-grade foundation system with perimeter-spread footings and isolated interior footings. Other improvements will include asphalt and concrete pavement areas, hardscape and landscaping. It is assumed that the proposed grading for the development will include cut and fill procedures on the order of a few feet to achieve finished grade elevations. Final building plans shall be reviewed by this firm prior to submittal for city approval to determine the need for any additional study and revised recommendations pertinent to the proposed development, if necessary.

2.0 Site Description

The subject property is located at 1101 California Street, bordered by Lugonia Avenue to the north and an Interstate I-10 on-ramp to the south, in the City of Redlands as shown on the attached Vicinity Map (Figure 2). The generally rectangular shaped parcel is currently occupied by an abandoned water park consisting of several in-ground pools, a lazy river, water slides, a miniature golf course, go-cart tracks and a concrete tilt-up building. The existing pools across the site extend to depths ranging between 2 and 7 feet below existing ground surface. The northwest corner of the site was once occupied by large water slide structures which likely contained deep, oversized foundations. An existing asphalt parking lot occupies the northeast corner of the site. Additional improvements include hardscape and landscaping.

3.0 Site Exploration

The investigation consisted of the placement of sixteen (16) subsurface exploratory borings by a truck mounted hollow stem auger and hand operated auger to depths ranging between 5 and 20 feet below current ground elevations. The explorations were visually classified and logged by a field engineer with locations of the subsurface explorations shown on the attached plan. The exploratory borings revealed the existing earth materials to consist of fill and natural soil.

Detailed descriptions of the subsurface conditions are listed on the boring logs in Appendix A. It should be noted that the transition from one soil type to another as shown on the trench logs is approximate and may in fact be a gradual transition. The soils encountered are described as follows:

Fill: Fill soils classified as a silty fine to medium grained SAND with occasional gravel and concrete was encountered across the site to depths ranging from 1 to 5 feet below ground surface in (with the exception of exploratory boring B-15). These fill soils were noted to be medium dense and moist. *Fill soils encountered in exploratory boring B-15 contained gravel, plastic, PVC and concrete pieces to a depth of 12 feet below existing ground surface. These fill soils were found to be loose and moist.*

Natural: Natural undisturbed soils encountered beneath the fill soils consisted of a brown, fine to medium grained silty SAND. The native soils were observed to be medium dense and damp to moist. Natural soils were *not* encountered in exploratory borings B-15 which was met with refusal a depth of 15 feet below existing ground surface due to concrete debris.

The overall engineering characteristics of the earth material were relatively uniform with each excavation. Groundwater was not encountered to the depth of our borings (20 feet). Historic high groundwater in the vicinity has been recorded at 149 feet below ground surface (last measured10/22/2008) at a nearby well located 0.9 miles to the west of the subject site as given on the California Department of Water Recourses database http://www.water.ca.gov/waterdatalibrary/ (State well number 01S03W19L001S). Additionally, local groundwater maps (Carson & Matti 1982), record historic groundwater depths in excess of 100 feet.

4.0 Laboratory Tests

Relatively undisturbed samples of the subsurface soils were obtained to perform laboratory testing and analysis for direct shear, consolidation tests, and to determine in-place moisture/densities. These relatively undisturbed ring samples were obtained by driving a thin-walled steel sampler lined with one-inch-long brass rings with an inside diameter of 2.42 inches into the undisturbed soils. Bulk bag samples were obtained in the upper soils for expansion index tests and maximum density tests. All test results are included in Appendix B, unless otherwise noted.

4.1 **Field Moisture Content** (ASTM: D 2216) and the dry density of the ring samples were determined in the laboratory. This data is listed on the logs of explorations.

4.2 **Maximum Density tests** (ASTM: D 1557) were performed on typical samples of the upper soils. Results of these tests are shown on Table I.

4.3 **Expansion Index tests** (ASTM: D 4829) were performed on remolded samples of the upper soils to determine expansive characteristics. Results of these tests are provided on Table II.

4.4 **Corrosion tests** consisting of sulfate, pH, resistivity and chloride analysis to determine potential corrosive effects of soils on concrete and underground utilities. Test results are provided on Table III.

4.5 **R-Value test** per California Test Method 301 was performed on a representative sample, which may be anticipated to be near subgrade to determine pavement design. Results are provided within the pavement design section of the report.

4.6 **Direct Shear tests** (ASTM: D 3080) were performed on undisturbed and/or remolded samples of the subsurface soils. The test is performed under saturated conditions at loads of 1,000 lbs./sq.ft., 2,000 lbs./sq.ft., and 3,000 lbs./sq.ft. with results shown on Plate A and B.

4.7 **Consolidation tests** (ASTM: D 2435) were performed on undisturbed samples to determine the differential and total settlement which may be anticipated based upon the proposed loads. Water was added to the samples at a surcharge of one KSF and the settlement curves are plotted on Plates C to E.

5.0 Seismicity Evaluation

The proposed development lies outside of any Alquist Priolo Special Studies Zone and the potential for damage due to direct fault rupture is considered unlikely. The San Jacinto (San Bernardino Valley Segment) Fault zone is located approximately 6 kilometers from the site and is capable of producing a Magnitude 6.7 earthquake. Ground shaking originating from earthquakes along other active faults in the region is expected to induce lower horizontal accelerations due to smaller anticipated earthquakes and/or greater distances to other faults.

The seismic design parameters have been revised and are provided below are based upon the 2022 California Building Code (CBC) Standard ASCE/SEI 7-16. The data was obtained from the American Society of Civil Engineers (ASCE) website, https://asce7hazardtool.online/ and the ASCE 7 Hazards Report. A copy of this report may be found in Appendix B.

Seismic Design Acceleration Parameters

Latitude	34.068
Longitude	-117.227
Site Class	D
Risk Category	II
Mapped Spectral Response Acceleration	S_S = 1.971 S_1 = 0.779
Adjusted Maximum Acceleration	S_{MS} = 1.971
Design Spectral Response Acceleration Parameters	S_{DS} = 1.314
Peak Ground Acceleration	PGA_M = 0.915

Use of these values is dependent on requirements of Section 11-4.8, ASCE 7 exception 2 that requires the value of the seismic response coefficient C_s be determined by Equation 12.8.2 for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either 12.8-3 for $T_L \geq T \geq 1.5T_s$ or Equation 12.8-4 for $T > T_L$. Computations and verification of these conditions is referred to the structural engineer.

6.0 Liquefaction Evaluation

The site is expected to experience ground shaking and earthquake activity that is typical of the Southern California area. It is during severe shaking that loose, granular soils below the groundwater table can liquefy. Based on review of the *County of San Bernardino County Land Use Plan – General Plan – Geologic Hazard Overlays (FH31 C)*, the site lies *outside* a zone of "Suspected Liquefaction Susceptibility". Based on review of the City of Redlands 2035 General Plan, Chapter 7; Healthy Community, Figure 7-28, the site does not lie within an area designated as a high, medium, or low liquefaction susceptibility. Furthermore, local groundwater maps record the depth of groundwater in excess of 100 feet (Carson & Matti 1982). Therefore, the liquefaction potential of the site is considered to be low. A copy of the County of San Bernardino County Land Use Plan – General Plan – Geologic Hazard Overlays (2009) is attached in Appendix C.

Seismic induced settlements in dry sands should be on the order of less than one inch at the site. Differential settlements would be on the order of ½ inch over a 50 feet (horizontal) distance in the building pad area.

6.1 Geologic/Seismic Hazards

a.) Seiches

The property is not in proximity to an enclosed or partially enclosed body of water or basin with the potential to hold water; the property is not subject to seiche inundation.

b.) Slope Stability

The subject site is relatively flat with no surrounding slopes to be evaluated for stability. In addition, based on review of the San Bernardino County Land Use Plan, Sheet FH31C, the property is not within a designated zone of landslide susceptibility. Therefore, the potential for landslides to impact the site is considered very low.

c.) Subsidence

The subject property is situated on shallow alluvium with no groundwater encountered to a maximum depth drilled of 20 feet. Additionally, historic groundwater in the area has been recorded in excess of 100 feet (Carson & Matti 1982). The potential for subsidence to impact the site is considered low.

d.)Hydrocollapse

Based on review of the City of Redlands 2035 General Plan, Chapter 7; Healthy Community, Figure 7-28 and the *County of San Bernardino County Land Use Plan – General Plan – Geologic Hazard Overlays (FH31 C),* the subject site is not located within a liquefaction zone. Furthermore, historic groundwater in the area has been recorded in excess of 100 feet (Carson & Matti 1982. Therefore, the potential for hydrocollapse is considered low.

7.0 Infiltration Characteristics

Infiltration tests within the site were performed to provide preliminary infiltration rates for the purpose of planning and design of an on-site water disposal system. A truck mounted Simco 2800 Drill Rig equipped with a hollow stem auger was used to excavate the exploratory borings (B-1, B-2, B-3 and B-4) to depths of 5 and 10 feet below existing ground surface within the proposed infiltration area.

The borings consisted of six-inch diameter test holes. A three-inch diameter perforated PVC casing with solid end cap was installed in the borings and then surrounded with gravel materials to prevent caving. The infiltration holes were carefully filled with clean water and refilled after two initial readings. Based upon the initial rates of infiltration at each location, test measurements were measured at selected maximum intervals thereafter. Measurements were obtained by using an electronic tape measure with 1/16-inch divisions and timed with a stopwatch. Field data sheets are provided in Appendix D.

Based upon the results of our testing, the soils encountered in the planned on-site drainage disposal system area exhibit the following field infiltration rates calculated using the Porchet Method (aka Inverse Borehole Method). The drainage disposal system shall utilize design infiltration rates based on the safety factor required by the county standard.

Boring/Test No.	Depth	Soil Classification	Field Infiltration Rate
B-1/TH-1	5'	Silty SAND	8.8 in/hr
B-2/TH-2	10'	Silty SAND	3.8 in/hr
B-3/TH-3	10'	Silty SAND	5.0 in/hr
B-4/TH-4	5'	Silty SAND	12.6 in/hr

Groundwater was not encountered to the depth of our borings (20 feet). Historic high groundwater in the vicinity has been recorded at 149 feet below ground surface (last measured10/22/2008) at a nearby well located 0.9 miles to the west of the subject site as given on the California Department of Water Recourses database http://www.water.ca.gov/waterdatalibrary/ (State well number 01S03W19L001S). Additionally, local groundwater maps (Carson & Matti 1982), record historic groundwater depths in excess of 100 feet).

Based on the results of our field testing, the subsurface soils encountered in the proposed on-site drainage disposal system shall utilize the design infiltration rates based on a safety factor of 2.0 as required by the county standard. All systems must meet the latest city and/or county specifications and the California Regional Water Quality Control Board (CRWQCB) requirements.

It is recommended that foundations shall be setback a minimum distance of 10 feet from the drainage disposal system and the bottom of footing shall be a minimum of 10 feet from the expected zone of saturation. The boundary of the zone of saturation may be assumed to project downward from the top of the permeable portion of the disposal system at an inclination of 1 to 1 or flatter, as determined by the geotechnical engineer.

8.0 Conclusions and Recommendations

Based upon our evaluations, the proposed development is acceptable from a geotechnical engineering standpoint. By following the recommendations and guidelines set forth in our report, the structures will be safe from excessive settlements under the anticipated design loadings and conditions. The proposed development shall meet all requirements of the City Building Ordinance and will not impose any adverse effect on existing adjacent structures.

The following recommendations are based upon soil conditions encountered in our field investigation; these near-surface soil conditions could vary across the site. Variations in the soil conditions may not become evident until the commencement of grading operations for the proposed development and revised recommendations from the soils engineer may be necessary based upon the conditions encountered.

It is recommended that site inspections be performed by a representative of this firm during all grading and construction of the development to verify the findings and recommendations documented in this report. Any unusual conditions which may be encountered in the course of the project development may require the need for additional study and revised recommendations.

8.1 Site Grading Recommendations

Any vegetation and/or demolition debris shall be removed and hauled from proposed grading areas prior to the start of grading operations. Existing vegetation shall not be mixed or disced into the soils. Any removed soils may be reutilized as compacted fill once any deleterious material or oversized materials (in excess of eight inches) is removed. Grading operations shall be performed in accordance with the attached *Specifications for Placement of Compacted Fill.*

8.1.1 Removal and Recompaction Recommendations

All disturbed soils and/or fill (about 1 to 12 feet below ground surface) shall be removed to competent native material, the exposed surface scarified to a depth of 12 inches, brought to within 2% of optimum moisture content and compacted to a minimum of 90% of the laboratory standard (ASTM: D 1557) prior to placement of any additional compacted fill soils, foundations, slabs-on-grade and pavement. Grading shall extend a minimum of five horizontal feet outside the edges of foundations or equidistant to the depth of fill placed, whichever is greater.

As previously noted, the site currently contains several in ground swimming pools and a lazy river. These underground structures shall be completely removed prior to grading activities. The exposed bottom shall be observed and approved by a representative of this firm prior to placement of compacted fill soils. In addition, the large water slide structures that once occupied the northwest corner of the site are assumed to have contained deep, oversized foundations. *Therefore, it is possible that isolated areas of undiscovered fill not described in this report are present on site; if found, these areas should be treated as discussed earlier.* A diligent search shall also be conducted during grading operations in an effort to uncover any underground structures, irrigation or utility lines. If encountered, these structures and lines shall be either removed or properly abandoned prior to the proposed construction.

Any imported fill material should be preferably soil similar to the upper soils encountered at the subject site. All soils shall be approved by this firm prior to importing at the site and will be subjected to additional laboratory testing to assure concurrence with the recommendations stated in this report.

If placement of slabs-on-grade and pavement is not completed immediately upon completion of grading operations, additional testing and grading of the areas may be necessary prior to continuation of construction operations. Likewise, if adverse weather conditions occur which may damage the subgrade soils, additional assessment by the soils engineer as to the suitability of the supporting soils may be needed.

Care should be taken to provide or maintain adequate lateral support for all adjacent improvements and structures at all times during the grading operations and construction phase. Adequate drainage away from the structures, pavement and slopes should be provided at all times.

8.1.2 Fill Blanket Recommendations

Due to the potential for differential settlement of foundations placed on compacted fill and native materials, it is recommended that all foundations be underlain by a uniform compacted fill blanket at least three feet in thickness. Floor slab areas shall be underlain by a uniform compacted fill blanket at least two feet in thickness. This fill blanket shall extend a minimum of five horizontal feet outside the edges of foundations or equidistant to the depth of fill placed, whichever is greater.

8.2 Shrinkage and Subsidence

Results of our in-place density tests reveal that the soil shrinkage will be on the order of 5 to 10% due to excavation and recompaction, based upon the assumption that the fill is compacted to 92% of the maximum dry density per ASTM standards. Subsidence should be 0.2 feet due to earthwork operations. The volume change does not include any allowance for vegetation or organic stripping, removal of subsurface improvements, or topographic approximations. Although these values are only approximate, they represent our best estimate of lost yardage, which will likely occur during grading. If more accurate shrinkage and subsidence factors are needed, it is recommended that field testing the actual equipment and grading techniques should be conducted.

8.3 **Temporary Excavations**

Temporary *unsurcharged* excavations in the existing site materials may be made at vertical inclinations up to 4 feet in height unless cohesionless soils are encountered. In areas where soils with little or no binder are encountered, where adverse geological conditions are exposed, or where excavations are adjacent to existing structures, shoring or flatter excavations may be required. The temporary cut slope gradients given above do not preclude local raveling and sloughing. All excavations shall be made in accordance with the requirements of the soils engineer, CAL-OSHA and other public agencies having jurisdiction. Care should be taken to provide or maintain adequate lateral support for all adjacent improvements and structures at all times during the grading operations and construction phase.

8.4 **Foundation Design**

All foundations may be designed utilizing the following allowable bearing capacities for an embedded depth of 18 inches into approved engineered fill with the corresponding widths:

Allowable Bearing Capacity (psf)		
Width (feet)	Continuous Foundation	Isolated Foundation
1.5	2000	2500
2.0	2075	2575
4.0	2375	2875
6.0	2500	3000

The bearing value may be increased by 500 psf for each additional foot of depth in excess of the 18-inch minimum depth, up to a maximum of 4,000 psf. A one-third increase may be used when considering short-term loading and seismic forces. Any foundations located along property line may utilize an allowable bearing capacity of 1,500 psf and embedded into competent native soils.

8.5 **Settlement Analysis**

Resultant pressure curves for the consolidation tests are shown on Plates B to C. Computations utilizing these curves and the recommended allowable soil bearing capacities reveal that the foundations will experience settlements on the order of ¾ inch and differential settlements of less than ¼ inch.

8.6 **Lateral Resistance**

The following values may be utilized in resisting lateral loads imposed on the structure. Requirements of the California Building Code should be adhered to when the coefficient of friction and passive pressures are combined.

Coefficient of Friction - 0.40

Equivalent Passive Fluid Pressure = 250 lbs./cu.ft.

Maximum Passive Pressure = 2,500 lbs./cu.ft.

The passive pressure recommendations are valid only for approved compacted fill soils or competent native materials.

8.7 **Retaining Wall Design Parameters**

Active earth pressures against retaining walls will be equal to the pressures developed by the following fluid densities. These values are for **approved granular backfill material** placed behind the walls at various ground slopes above the walls.

Surface Slope of Retained Materials (Horizontal to Vertical	Equivalent Fluid Density (lb./cu.ft.)
Level	30
5 to 1	35
4 to 1	38
3 to 1	40
2 to 1	45

Any applicable short-term construction surcharges and seismic forces should be added to the above lateral pressure values. An equivalent fluid pressure of 45 pcf may be utilized for the restrained wall condition with a level grade behind the wall.

The seismic-induced lateral soil pressure for walls greater than 6 feet may be computed using a triangular pressure distribution with the maximum value at the top of the wall. The maximum lateral pressure of (20 pcf) H where H is the height of the retained soils above the wall footing should be used in final design of retaining walls. Sliding resistance values and passive fluid pressure values may be increased by 1/3 during short-term wind and seismic loading conditions.

All walls shall be waterproofed as needed and protected from hydrostatic pressure by a reliable permanent subdrain system. The subsurface drainage system shall consist of a four-inch diameter perforated PVC pipe encased with gravel and wrapped with filter fabric. The granular backfill to be utilized immediately adjacent to retaining walls shall consist of an approved select granular soil with a sand equivalency greater than 30. This backfill zone of free draining material shall consist of a wedge beginning a minimum of one horizontal foot from the base of the wall extending upward at an inclination of no less than ¾ to 1 (horizontal to vertical).

8.8 **Slab Design**

All concrete slabs shall be a minimum of six inches in thickness in the proposed warehouse areas and four inches in office and hardscape and placed on approved subgrade soils. Additional reinforcement requirements and an increase in thickness of the slabs-on-grade may be necessary based upon soils expansion potential and proposed loading conditions in the structures and should be evaluated further by the project engineers and/or architect.

A vapor retarder (10-mil minimum thickness) should be utilized in areas which would be sensitive to the infiltration of moisture. This retarder shall meet requirements of ASTM E 96, *Water Vapor Transmission of Materials* and ASTM E 1745, *Standard Specification for Water Vapor Retarders used in Contact with Soil or Granular Fill Under Concrete Slabs.* The vapor retarder shall be installed in accordance with procedures stated in ASTM E 1643, *Standard practice for Installation of Water Vapor Retarders used in Contact with Earth or Granular Fill Under Concrete Slabs.*

The moisture retarder may be placed directly upon compacted subgrade soils conditioned to near optimum moisture levels, although one to two inches of sand beneath the membrane is desirable. The subgrade upon which the retarder is placed shall be smooth and free of rocks, gravel or other protrusions which may damage the retarder. Use of sand above the retarder is under the purview of the structural engineer; if sand is used over the retarder, it should be placed in a dry condition.

8.9 **Pavement Section Design**

The table found below provides a preliminary pavement design based upon an R-Value of 76 for the subgrade soils for the proposed pavement areas. Final pavement design may need to be based on R-Value testing of the subgrade soils near the conclusion of site grading to assure that these soils are consistent with those assumed in this preliminary design.

Type of Traffic	Traffic Index	Asphalt (in.)	Base Material (in.)
Automobile Parking Stalls	4.0	3.0	3.0
Light Vehicle Circulation Areas	5.5	3.5	4.0
Heavy Truck Access Areas	7.0	4.0	8.0

Any concrete slab-on-grade in pavement areas shall be a *minimum* of six inches in thickness and placed on approved subgrade soils. *The recommendations are based upon estimated traffic loads. Client should submit any other anticipated traffic loadings to the geotechnical engineer, if necessary, so that pavement sections may be reviewed to determine adequacy to support the proposed loadings.*

All pavement areas shall have positive drainage toward an approved outlet from the site. Drain lines behind curbs and/or adjacent to landscape areas should be considered by client and the appropriate design engineers to prevent water from infiltrating beneath pavement. If such infiltration occurs, damage to pavement, curbs and flow lines, especially on sites with expansive soils, may occur during the life of the project.

Any approved base material shall consist of a Class II aggregate or equivalent and should be compacted to a minimum of 95% relative compaction. All pavement materials shall conform to the requirements set forth by the City of Redlands. The base material; and asphaltic concrete should be tested prior to delivery to the site and during placement to determine conformance with the project specifications. A pavement engineer shall designate the specific asphalt mix design to meet the required project specifications.

8.10 **Utility Trench and Excavation Backfill**

Trenches from installation of utility lines and other excavations may be backfilled with on-site soils or approved imported soils compacted to a minimum of 90% relative compaction. All utility lines shall be properly bedded with clean sand having a sand equivalency rating of 30 or more. This bedding material shall be thoroughly water jetted around the pipe structure prior to placement of compacted backfill soils.

8.11 **Corrosion Design Criteria**

Representative samples of the surficial soils, typical of the subgrade soils expected to be encountered within foundation excavations and underground utilities were tested for corrosion potential. The minimum resistivity value obtained for the samples tested is representative of an environment that may be severely corrosive to metals. The soil pH value was considered mildly alkaline and may not have a significant effect on soil corrosivity. Consideration should be given to corrosion protection systems for buried metal such as protective coatings, wrappings or the use of PVC where permitted by local building codes.

According to Table 4.3.1 of ACI 318 Building Code and Commentary, these contents revealed negligible sulfate concentrations. Therefore, a Type II cement according to latest CBC specifications may be utilized for building foundations at this time. It is recommended that additional sulfate tests be performed at the completion of site grading to assure that the as graded conditions are consistent with the recommendations stated in this design. Corrosion test results may be found on the attached Table III.

8.12 **Expansive Soil**

The upper on-site soils are very low in expansion potential (EI 0-20). When soils have an expansion index (EI) of 20 or more, special attention should be given to the project design and maintenance. The attached *Expansive Soil Guidelines* should be reviewed by the engineers, architects, owner, maintenance personnel and other interested parties and considered during the design of the project and future property maintenance.

9.0 Closure

The recommendations and conclusions contained in this report are based upon the soil conditions uncovered in our test excavations. No warranty of the soil condition between our excavations is implied. NorCal Engineering should be notified for possible further recommendations if unexpected to unfavorable conditions are encountered during construction phase. It is the responsibility of the owner to ensure that all information within this report is submitted to the Architect and appropriate Engineers for the project.

A preconstruction conference should be held between the developer, general contractor, grading contractor, city inspector, architect, and soil engineer to clarify any questions relating to the grading operations and subsequent construction. Our representative should be present during the grading operations and construction phase to certify that such recommendations are complied within the field.

This geotechnical investigation has been conducted in a manner consistent with the level of care and skill exercised by members of our profession currently practicing under similar conditions in the Southern California area. No other warranty, expressed or implied is made.

We appreciate this opportunity to be of service to you. If you have any further questions, please do not hesitate to contact the undersigned.

Respectfully submitted,
NORCAL ENGINEERING

Keith D. Tucker
Project Engineer
R.G.E. 841

REGISTERED PROFESSIONAL ENGINEER
KEITH D. TUCKER
No. 841
Exp. 12/31/2024
GEOTECHNICAL
STATE OF CALIFORNIA

Mike Barone
Project Manager

SPECIFICATIONS FOR PLACEMENT OF COMPACTED FILL

Excavation

Any existing low-density soils and/or saturated soils shall be removed to competent natural soil under the inspection of the Geotechnical Engineering Firm. After the exposed surface has been cleansed of debris and/or vegetation, it shall be scarified until it is uniform in consistency, brought to the proper moisture content and compacted to a minimum of 90% relative compaction (in accordance with ASTM: D 1557).

In any area where a transition between fill and native soil or between bedrock and soil are encountered, additional excavation beneath foundations and slabs will be necessary in order to provide uniform support and avoid differential settlement of the structure.

Material for Fill

The on-site soils or approved import soils may be utilized for the compacted fill provided they are free of any deleterious materials and shall not contain any rocks, brick, asphaltic concrete, concrete or other hard materials greater than eight inches in maximum dimensions. Any import soil must be approved by the Geotechnical Engineering firm a minimum of 72 hours prior to importation of site.

Placement of Compacted Fill Soils

The approved fill soils shall be placed in layers not excess of six inches in thickness. Each lift shall be uniform in thickness and thoroughly blended. The fill soils shall be brought to within 2% of the optimum moisture content, unless otherwise specified by the Soils Engineering firm. Each lift shall be compacted to a minimum of 90% relative compaction (in accordance with ASTM: D 1557) and approved prior to the placement of the next layer of soil. Compaction tests shall be obtained at the discretion of the Geotechnical Engineering firm but to a minimum of one test for every 500 cubic yards placed and/or for every 2 feet of compacted fill placed.

The minimum relative compaction shall be obtained in accordance with accepted methods in the construction industry. The final grade of the structural areas shall be in a dense and smooth condition prior to placement of slabs-on-grade or pavement areas. No fill soils shall be placed, spread or compacted during unfavorable weather conditions. When the grading is interrupted by heavy rains, compaction operations shall not be resumed until approved by the Geotechnical Engineering firm.

Grading Observations

The controlling governmental agencies should be notified prior to commencement of any grading operations. This firm recommends that the grading operations be conducted under the observation of a Geotechnical Engineering firm as deemed necessary. A 24-hour notice must be provided to this firm prior to the time of our initial inspection.

Observation shall include the clearing and grubbing operations to assure that all unsuitable materials have been properly removed; approve the exposed subgrade in areas to receive fill and in areas where excavation has resulted in the desired finished grade and designate areas of overexcavation; and perform field compaction tests to determine relative compaction achieved during fill placement. In addition, all foundation excavations shall be observed by the Geotechnical Engineering firm to confirm that appropriate bearing materials are present at the design grades and recommend any modifications to construct footings.

EXPANSIVE SOIL GUIDELINES

The following expansive soil guidelines are provided for your project. The intent of these guidelines is to inform you, the client, of the importance of proper design and maintenance of projects supported on expansive soils. ***You, as the owner or other interested party, should be warned that you have a duty to provide the information contained in the soil report including these guidelines to your design engineers, architects, landscapers and other design parties in order to enable them to provide a design that takes into consideration expansive soils.***

In addition, you should provide the soil report with these guidelines to any property manager, lessee, property purchaser or other interested party that will have or assume the responsibility of maintaining the development in the future.

Expansive soils are fine-grained silts and clays which are subject to swelling and contracting. The amount of this swelling and contracting is subject to the amount of fine-grained clay materials present in the soils and the amount of moisture either introduced or extracted from the soils. Expansive soils are divided into five categories ranging from "very low" to "very high". Expansion indices are assigned to each classification and are included in the laboratory testing section of this report. *If the expansion index of the soils on your site, as stated in this report, is 21 or higher, you have expansive soils.* The classifications of expansive soils are as follows:

Classification of Expansive Soil*

Expansion Index	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
Above 130	Very High

*From Table 18A-I-B of California Building Code (1988)

When expansive soils are compacted during site grading operations, care is taken to place the materials at or slightly above optimum moisture levels and perform proper compaction operations. Any subsequent excessive wetting and/or drying of expansive soils will cause the soil materials to expand and/or contract. These actions are likely to cause distress of foundations, structures, slabs-on-grade, sidewalks and pavement over the life of the structure. ***It is therefore imperative that even after construction of improvements, the moisture contents are maintained at relatively constant levels, allowing neither excessive wetting or drying of soils.***

Evidence of excessive wetting of expansive soils may be seen in concrete slabs, both interior and exterior. Slabs may lift at construction joints producing a trip hazard or may crack from the pressure of soil expansion. Wet clays in foundation areas may result in lifting of the structure causing difficulty in the opening and closing of doors and windows, as well as cracking in exterior and interior wall surfaces. In extreme wetting of soils to depth, settlement of the structure may eventually result. Excessive wetting of soils in landscape areas adjacent to concrete or asphaltic pavement areas may also result in expansion of soils beneath pavement and resultant distress to the pavement surface.

Excessive drying of expansive soils is initially evidenced by cracking in the surface of the soils due to contraction. Settlement of structures and on-grade slabs may also eventually result along with problems in the operation of doors and windows.

Projects located in areas of expansive clay soils will be subject to more movement and "hairline" cracking of walls and slabs than similar projects situated on non-expansive sandy soils. There are, however, measures that developers and property owners may take to reduce the amount of movement over the life the development. The following guidelines are provided to assist you in both design and maintenance of projects on expansive soils:

- Drainage away from structures and pavement is essential to prevent excessive wetting of expansive soils. Grades should be designed to the latest building code and maintained to allow flow of irrigation and rain water to approved drainage devices or to the street. Any "ponding" of water adjacent to buildings, slabs and pavement after rains is evidence of poor drainage; the installation of drainage devices or regrading of the area may be required to assure proper drainage. Installation of rain gutters is also recommended to control the introduction of moisture next to buildings. Gutters should discharge into a drainage device or onto pavement which drains to roadways.

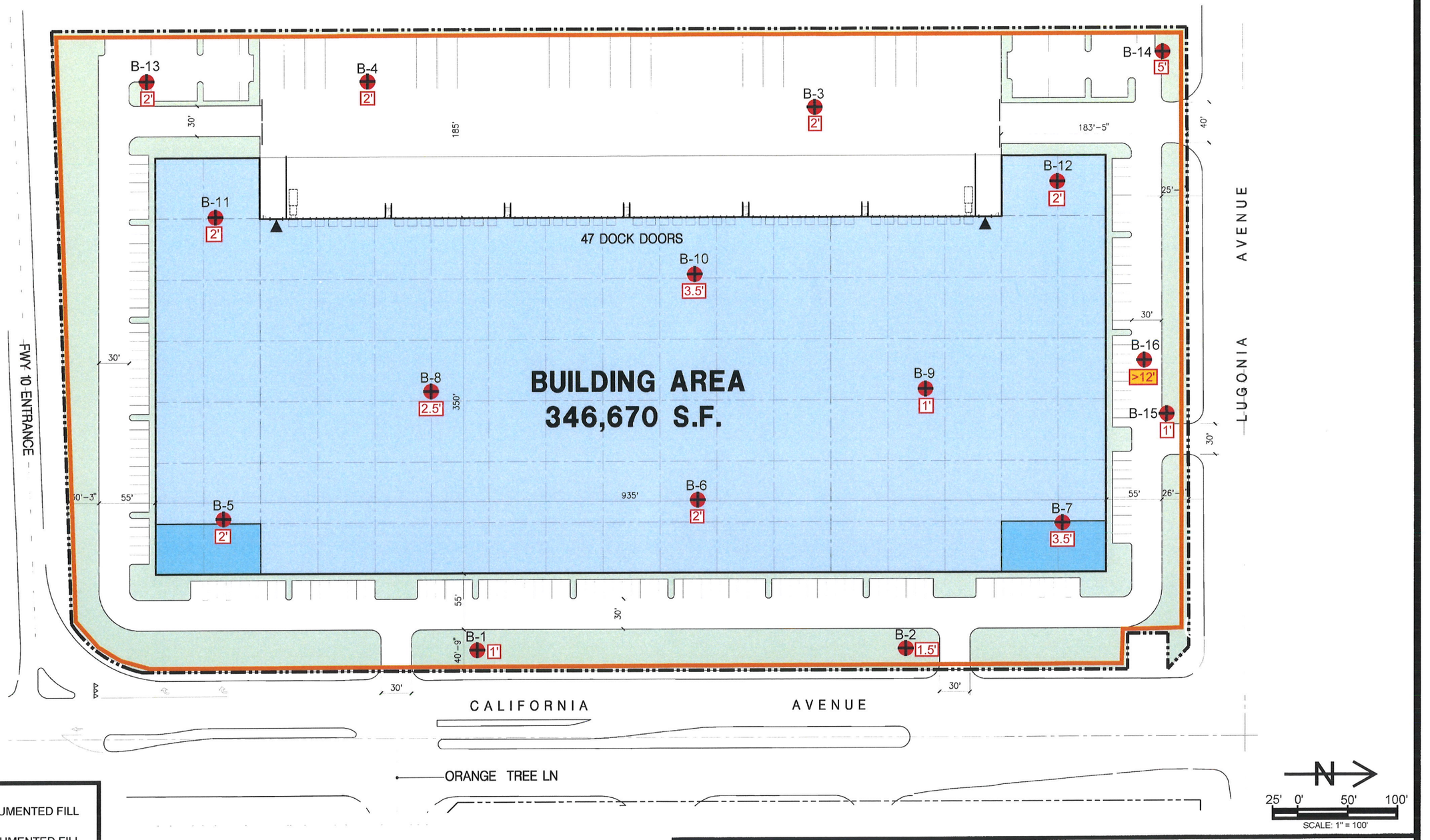
- Irrigation should be strictly controlled around building foundations, slabs and pavement and may need to be adjusted depending upon season. This control is essential to maintain a relatively uniform moisture content in the expansive soils and to prevent swelling and contracting. Over-watering adjacent to improvements may result in damage to those improvements. NorCal Engineering makes no specific recommendations regarding landscape irrigation schedules.

- Planting schemes for landscaping around structures and pavement should be analyzed carefully. Plants (including sod) requiring high amounts of water may result in excessive wetting of soils. Trees and large shrubs may actually extract moisture from the expansive soils, thus causing contraction of the fine-grained soils.

- Thickened edges on exterior slabs will assist in keeping excessive moisture from entering directly beneath the concrete. A six-inch thick or greater deepened edge on slabs may be considered. Underlying interior and exterior slabs with 6 to 12 inches or more of non-expansive soils and providing presaturation of the underlying clayey soils as recommended in the soil report will improve the overall performance of on-grade slabs.

- Increase the amount of steel reinforcing in concrete slabs, foundations and other structures to resist the forces of expansive soils. The precise amount of reinforcing should be determined by the appropriate design engineers and/or architects.

- Recommendations of the soil report should always be followed in the development of the project. Any recommendations regarding presaturation of the upper subgrade soils in slab areas should be performed in the field and verified by the Soil Engineer.



= LIMITS OF UNDOCUMENTED FILL

= DEPTH OF UNDOCUMENTED FILL ENCOUNTERED IN ASSOCIATED EXPLORATORY BORING

= NO NATIVE SOILS ENCOUNTERED MINOR AMOUNT OF DEBRIS ENCOUNTERED

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SOILS AND GEOTECHNICAL CONSULTANTS

NORTH PALISADE PARTNERS, LLC

PROJECT: 23875-23 | DATE: FEBRUARY 2024

SITE PLAN

FIGURE 1

NorCal Engineering SOILS AND GEOTECHNICAL CONSULTANTS	
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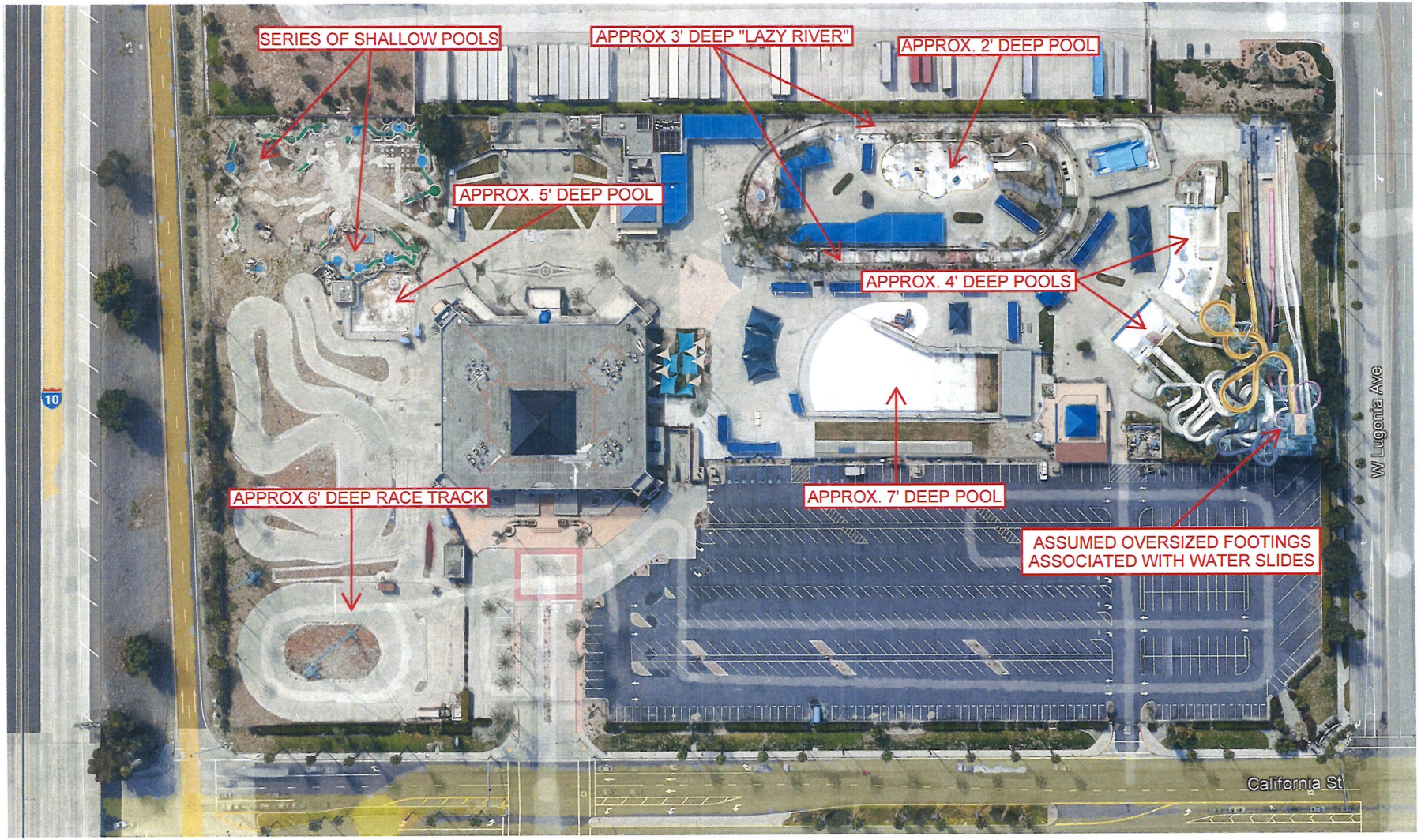
VICINITY MAP

(FIGURE 2)



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SOILS AND GEOTECHNICAL CONSULTANTS

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PROJECT: 23875-23 | DATE: FEBRUARY 2024

EXISTING IMPROVEMENTS PLAN

(FIGURE 3)

List of Appendices
(in order of appearance)

Appendix A – Log of Excavations

Log of Borings B-1 to B-16

Appendix B – Laboratory Tests

Table I – Maximum Dry Density
Table II – Expansion
Table III – Corrosion
Plate A and B – Direct Shear
Plates C to E - Consolidation

Appendix C – ASCE Seismic Hazards Report

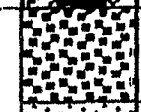
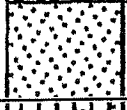
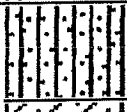
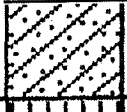
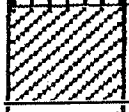
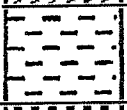
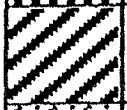
ASCE 7 Hazards Report

San Bernardino County Land Use Plan
General Plan – Geologic Overlays (FH31 C)

Appendix D – Soil Infiltration Data

Field Data Sheets and Calculations

Appendix A
Log of Excavations

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

KEY:

 Indicates 2.5-inch Inside Diameter. Ring Sample.

 Indicates 2-inch OD Split Spoon Sample (SPT).

 Indicates Shelby Tube Sample.

 Indicates No Recovery.

 Indicates SPT with 140# Hammer 30 in. Drop.

 Indicates Bulk Sample.

 Indicates Small Bag Sample.

 Indicates Non-Standard

 Indicates Core Run.

COMPONENT PROPORTIONS

DESCRIPTIVE TERMS	RANGE OF PROPORTION
Trace	1 - 5%
Few	5 - 10%
Little	10 - 20%
Some	20 - 35%
And	35 - 50%

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5mm) to No. 200 (0.074mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074 mm)

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch.
DAMP	Some perceptible moisture; below optimum
MOIST	No visible water; near optimum moisture content
WET	Visible free water, usually soil is below water table.

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N -VALUE

COHESIONLESS SOILS		COHESIVE SOILS		
Density	N (blows/ft)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	Very Soft	0 to 2	< 250
Loose	4 to 10	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	Very Stiff	15 to 30	2000 - 4000
		Hard	over 30	> 4000

North Palisade Partners, LLC
23875-23

Log of Boring B-1

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		Asphalt pavement					
		FILL					
		Silty (fine to medium grained) SAND					
		Brown, medium dense, moist					
		NATURAL					
		Silty (fine to medium grained) SAND					
5		Brown, medium dense, damp			4.8		
		Boring completed at depth of 5'					
10							
15							
20							
25							
30							
35							

GWT not encountered

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\23875-23.log Date: 5/2/2023

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Log of Boring B-2

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		Asphalt pavement					
		FILL					
		Silty (fine to medium grained) SAND					
		Brown, medium dense, moist; with occasional gravel					
		NATURAL					
5		Silty (fine to medium grained) SAND					
		Brown, medium dense, damp to moist					
10		Boring completed at depth of 10'			5.5		
15							
20							
25							
30							
35							

GWT not encountered

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NorCal Engineering

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23875-23

Log of Boring B-3

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, medium dense, moist; with occasional gravel					
		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, damp					
5		GWT not encountered					
10		Boring completed at depth of 10'	☑		2.5		
15							
20							
25							
30							
35							

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\23875-23.log Date: 5/2/2023

North Palisade Partners, LLC
23875-23

Log of Boring B-4

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, medium dense, moist; with occasional gravel and concrete					
		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist					
5		Boring completed at depth of 5'			6.3		
10							
15							
20							
25							
30							
35							

GWT not encountered

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Log of Boring B-5

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, medium dense, moist					
		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist		2/3	8.5	99.7	
5				3/3	11.1	102.3	
		Silty (fine grained) SAND Light grey, medium dense, damp					
10				4/6	6.5	92.6	
15				4/6	8.4	90.7	
		Silty (fine to medium grained) SAND Light grey, medium dense, damp					
20				7/10	3.8	95.5	
		Boring completed at depth of 20.5'					
25							
30							
35							

GWT not encountered

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Log of Boring B-6

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		Asphalt pavement					
		FILL					
		Silty (fine grained) SAND	■	3/4	7.1	107.6	
		Brown, medium dense, moist; with occasional gravel					
		NATURAL					
5		Silty (fine to medium grained) SAND	■	3/4	8.1	93.9	
		Brown, medium dense, damp					
		Slightly Silty (fine to medium grained) SAND	■	4/7	3.7	99.4	
10		Light brown, medium dense, damp					
		Boring completed at depth of 10'					
15							
20							
25							
30							
35							

GWT not encountered

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Log of Boring B-7

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Hand Auger

Hammer Weight: | Drop:

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		Asphalt pavement					
		FILL Silty (fine grained) SAND Brown, medium dense, moist	■		14.2	96.2	
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist	■		8.1	98.0	
10		Silty (fine grained) SAND Light brown, medium dense, damp	■		14.4	93.0	
15			■		9.6	96.4	
		Boring completed at depth of 15.5'					
20							
25							
30							
35							

GWT not encountered

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23875-23

Log of Boring B-8

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | **Groundwater Depth:** None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | **Drop:** 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, loose, moist; with occasional gravel, rootlets and concrete					
		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist					
5			■	3/3	11.7	91.8	
		Slightly Silty (fine to medium grained) SAND Light brown, medium dense, damp					
10			■	5/7	3.2	98.3	
		Silty (fine grained) SAND Brown, medium dense, damp					
15			■	4/5	6.8	97.9	
		Boring completed at depth of 15.5'					
20							
25							
30							
35							

GWT not encountered

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog\423875-23.log Date: 5/2/2023

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23875-23

Log of Boring B-9

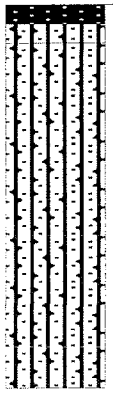
Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:



Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		Asphalt pavement					
		FILL					
		Silty (fine to medium grained) SAND					
		Brown, medium dense, moist					
		NATURAL	■	4/4	5.3	100.3	
5		Silty (fine to medium grained) SAND					
		Brown, medium dense, damp to moist	■	4/5	9.5	98.5	
10		Boring completed at depth of 10'					
15							
20							
25							
30							
35							

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\23875-23.log Date: 5/2/2023

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Log of Boring B-10

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, loose to medium dense with depth, moist; with occasional gravel	■	13/16	9.0	114.3	
5		NATURAL Silty (fine grained) SAND Brown, medium dense, damp	■	7/9	7.0	95.0	
		Boring completed at depth of 5.5'					
10							
15							
20							
25							
30							
35							

GWT not encountered

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23875-23

Log of Boring B-11

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Hand Auger

Hammer Weight: | Drop:

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, loose, moist; with occasional gravel					
		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, moist	■		9.3	110.2	
5			■		6.1	95.4	
10		Boring completed at depth of 10'					
15							
20							
25							
30							
35							

GWT not encountered

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\23875-23.log Date: 5/2/2023

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Log of Boring B-12

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, medium dense, moist	■	3/3	17.1	93.9	
		NATURAL Silty (fine grained) SAND Brown, medium dense, moist	■	3/5	15.4	89.9	
5							
		Sandy SILT Grey brown, medium stiff, damp	■	5/6	8.4	92.3	
10		Silty (fine grained) SAND Grey brown, medium dense, moist					
		Slightly Silty (fine to coarse grained) SAND Light brown, medium dense, damp; with occasional gravel	■	5/7	3.5	107.0	
15							
20		Boring completed at depth of 20.5'	■	9/12	2.3	94.6	
25							
30							
35							

GWT not encountered

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\23875-23.log Date: 5/2/2023

North Palisade Partners, LLC
23875-23

Log of Boring B-13

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL					
		Silty (fine to medium grained) SAND					
		Brown, medium dense, moist; with occasional gravel					
		NATURAL					
		Silty (fine to medium grained) SAND					
5		Brown, medium dense, damp					
		Boring completed at depth of 5'					
10							
15							
20							
25							
30							
35							

GWT not encountered

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\23875-23.log Date: 5/2/2023

North Palisade Partners, LLC
23875-23

Log of Boring B-14

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Hand Auger

Hammer Weight: | Drop:

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, medium dense, moist; with occasional gravel and concrete	■		10.6	98.2	
5		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, damp	■		6.8	92.4	
10		Boring completed at depth of 10'					
15							
20							
25							
30							
35							

GWT not encountered

SuperLog CivilTech Software, USA www.civiltech.com File: C:\Superlog4\23875-23.log Date: 5/2/2023

NorCal Engineering

North Palisade Partners, LLC
23875-23

Log of Boring B-15

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Hand Auger

Hammer Weight: | Drop:

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		Asphalt pavement					
		FILL					
		Silty (fine to medium grained) SAND					
		Brown, loose, moist; with gravel, plastic, pvc, concrete pieces up to 24 inches					
5			■		9.1	116.7	
10			■	3/4	6.9	100.7	
		Refusal at 12' bgs due to debris, concrete					
		No native soils encountered					
15							
20							
25							
30							
35							

GWT not encountered

Date: 5/2/2023 File: C:\Superlog4\23875-23.log

SuperLog CivilTech Software, USA www.civiltech.com

NorCal Engineering

North Palisade Partners, LLC
23875-23

Log of Boring B-16

Boring Location: 1050 Lugonia Avenue, Redlands

Date of Drilling: 4/10/2023 | Groundwater Depth: None Encountered

Drilling Method: Hand Auger

Hammer Weight: | Drop:

Surface Elevation:

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		FILL Silty (fine to medium grained) SAND Brown, medium dense, moist	■		8.8	100.0	
		NATURAL Silty (fine to medium grained) SAND Brown, medium dense, damp					
5		Boring completed at depth of 5'					
10							
15							
20							
25							
30							
35							

GWT not encountered

Date: 5/2/2023 File: C:\Superlog4\23875-23.log

SuperLog CivilTech Software, USA www.civiltech.com

NorCal Engineering

Appendix B
Laboratory Tests

TABLE I
MAXIMUM DENSITY TESTS

Sample	Classification	Optimum Moisture (%)	Maximum Dry Density (lbs/cu.ft)
B-1 @ 2'	Silty SAND	9.5	110.0

TABLE II
EXPANSION TESTS

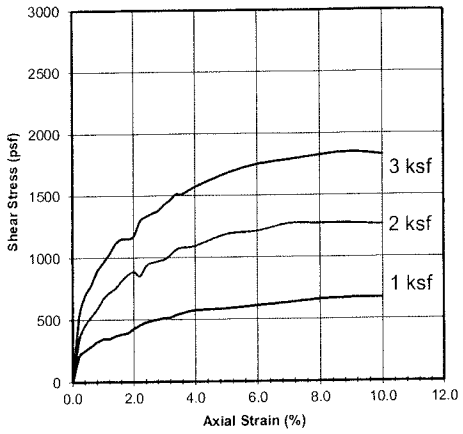
Sample	Classification	Expansion Index
B-1 @ 2'	Silty Sand	02

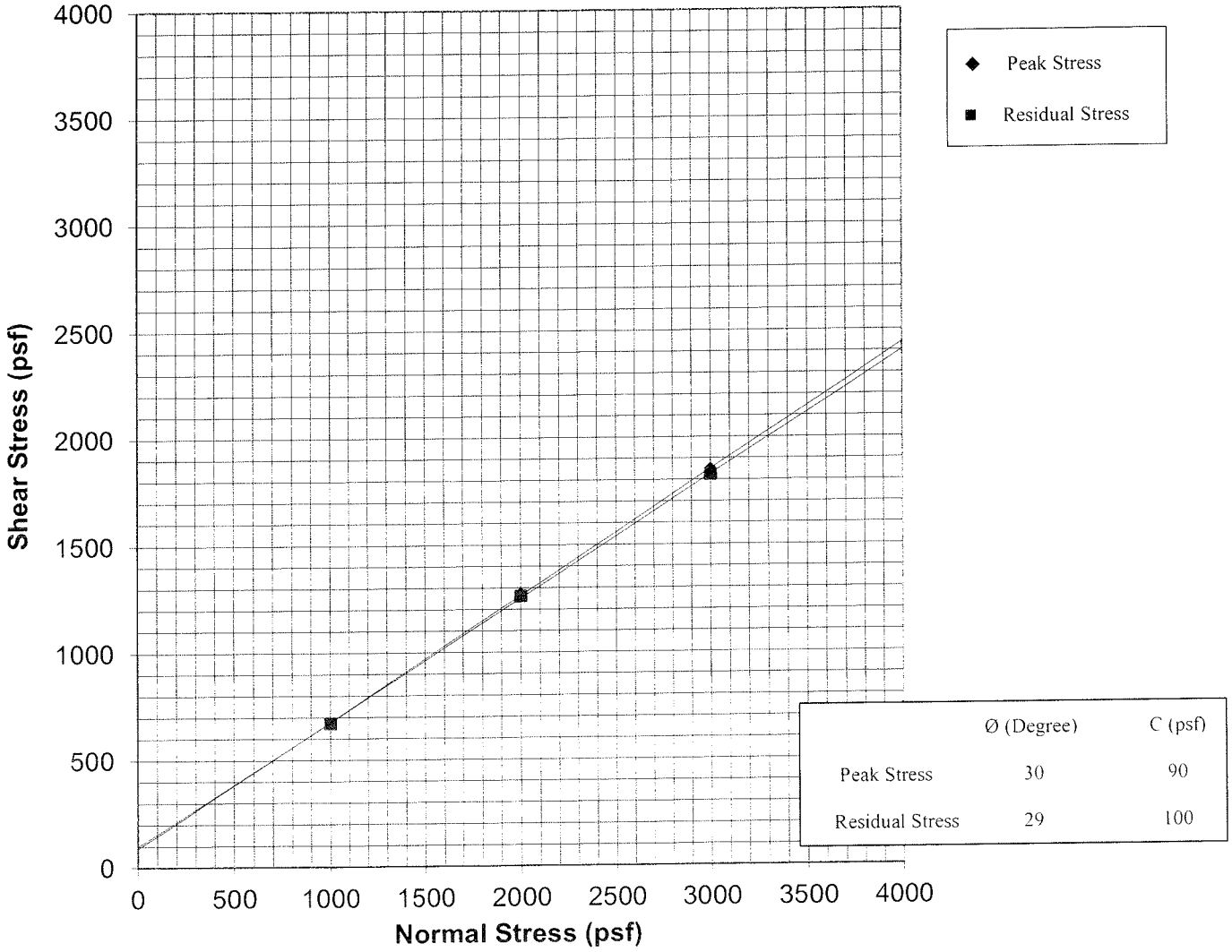
TABLE III
CORROSION TESTS

Sample	pH	Electrical Resistivity	Sulfate (%)	Chloride (ppm)
B-3 @ 1'	7.4	3,289	0.0003	135

% by weight
ppm – mg/kg

Sample No.		B6@4'		
Sample Type:		Undisturbed/Saturated		
Soil Description:		Fine-Medium Grained Sand w/ Some Silt		
		1	2	3
Normal Stress	(psf)	1000	2000	3000
Peak Stress	(psf)	672	1272	1848
Displacement	(in)	0.225	0.175	0.225
Residual Stress	(psf)	672	1260	1824
Displacement	(in.)	0.250	0.250	0.250
In Situ Dry Density	(pcf)	93.9	93.9	93.9
In Situ Water Content	(%)	8.1	8.1	8.1
Saturated Water Content	(%)	29.4	29.4	29.4
Strain Rate	(in/min)	0.020	0.020	0.020





	Ø (Degree)	C (psf)
Peak Stress	30	90
Residual Stress	29	100

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SOILS AND GEOTECHNICAL CONSULTANTS

North Palisade Partners, LLC

PROJECT NUMBER: 23875-23 DATE: 4/25/2023

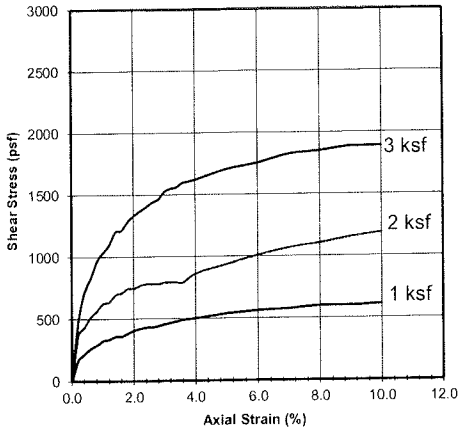
DIRECT SHEAR TEST

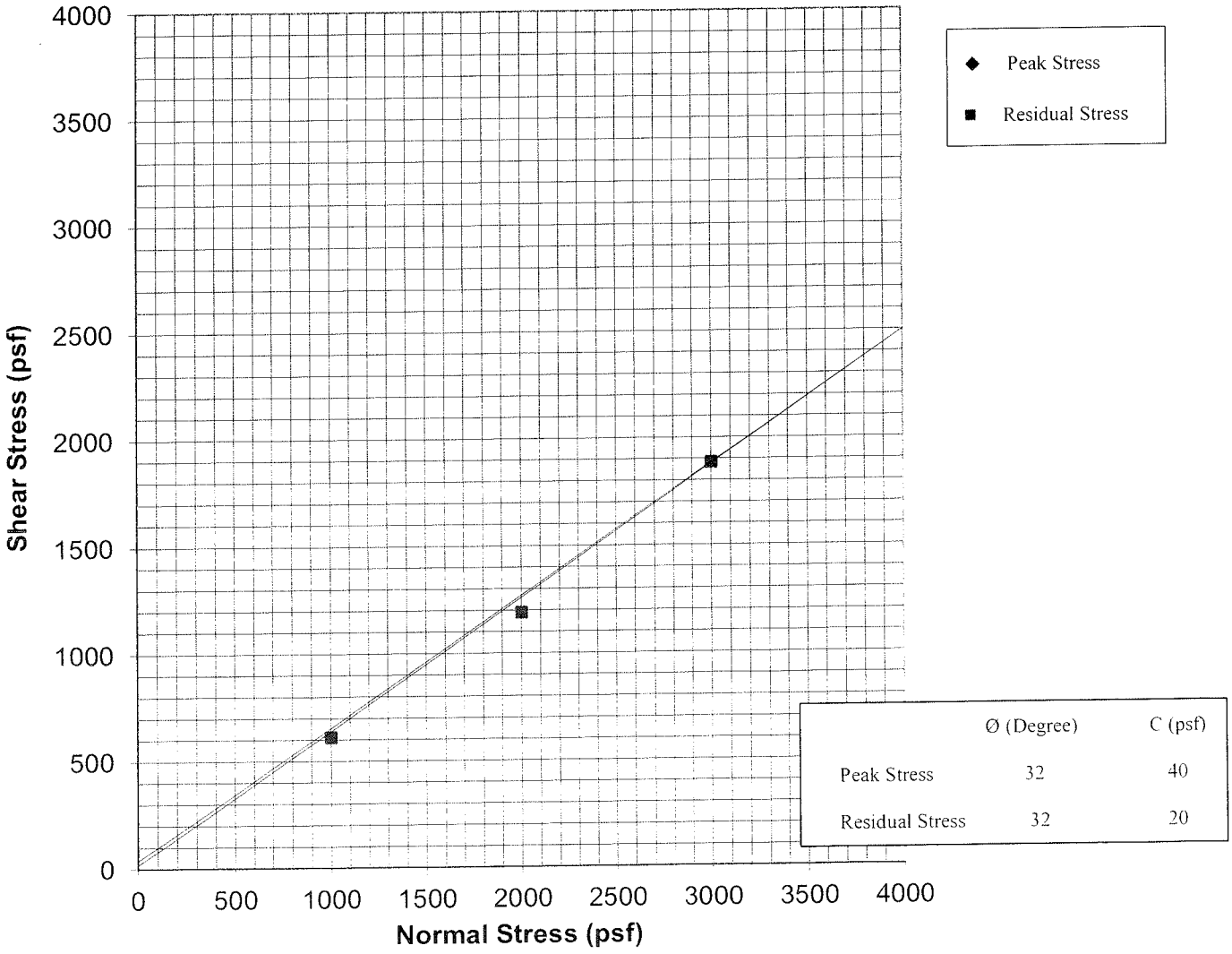
ASTM D3080

Plate A

Sample No.	B12@2'
Sample Type:	Undisturbed/Saturated
Soil Description:	Sandy Silt w/ Some Clay

		1	2	3
Normal Stress	(psf)	1000	2000	3000
Peak Stress	(psf)	612	1188	1884
Displacement	(in)	0.250	0.250	0.225
Residual Stress	(psf)	612	1188	1884
Displacement	(in.)	0.250	0.250	0.250
In Situ Dry Density	(pcf)	93.9	93.9	93.9
In Situ Water Content	(%)	17.1	17.1	17.1
Saturated Water Content	(%)	29.3	29.3	29.3
Strain Rate	(in/min)	0.020	0.020	0.020





	Ø (Degree)	C (psf)
Peak Stress	32	40
Residual Stress	32	20

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SOILS AND GEOTECHNICAL CONSULTANTS

North Palisade Partners, LLC

PROJECT NUMBER: 23875-23 DATE: 4/25/2023

DIRECT SHEAR TEST

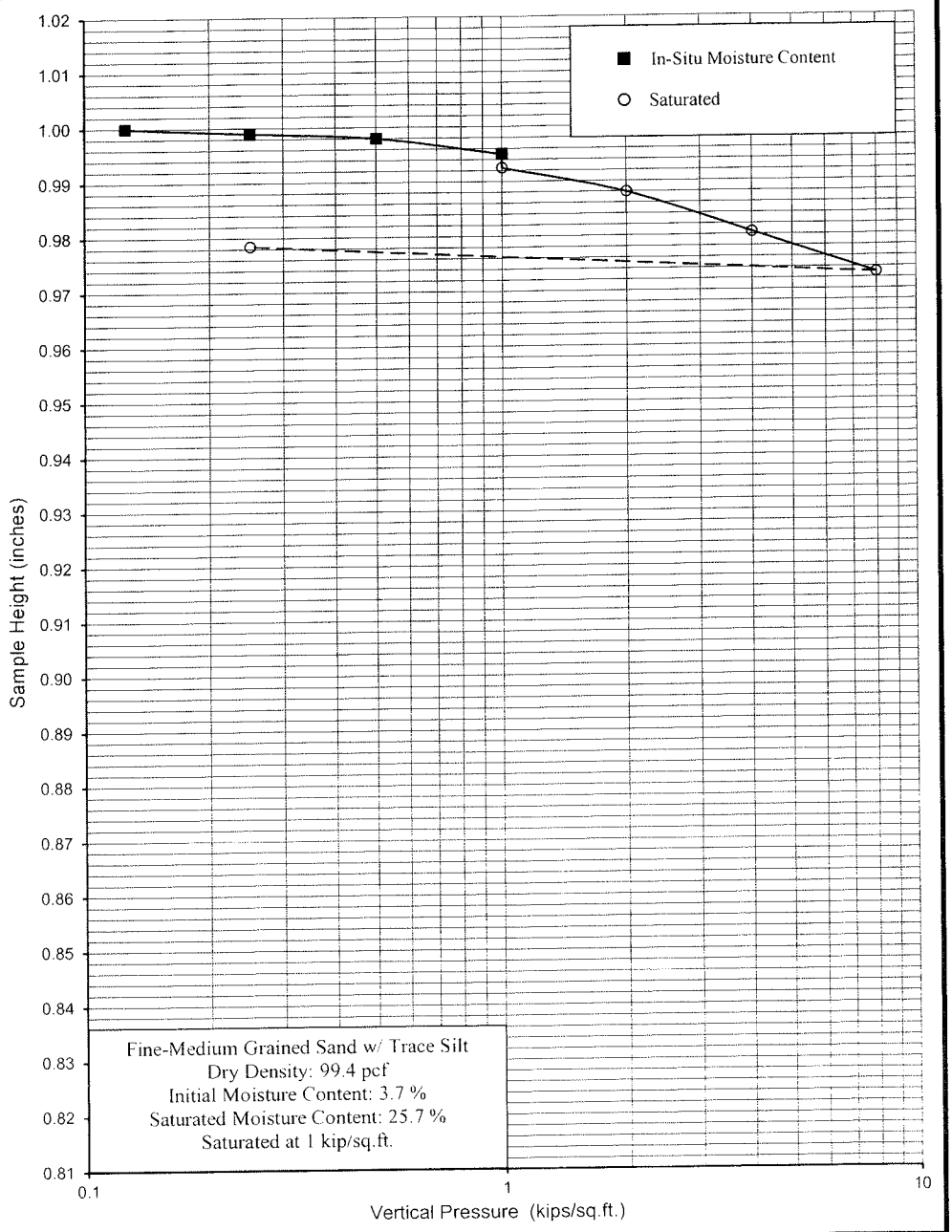
ASTM D3080

Plate B

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)	
0.125	1.0000	0.0	
0.25	0.9990	0.1	
0.5	0.9980	0.2	
1	0.9950	0.5	
1	0.9925	0.8	Saturated
2	0.9880	1.2	
4	0.9805	2.0	
8	0.9730	2.7	
0.25	0.9785	2.2	

Date Tested:	**4/18/2023**
Sample:	**B6**
Depth:	**8'**

Sample No.	B6	Depth	8'	Date	4/25/2023



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SOILS AND GEOTECHNICAL CONSULTANTS

North Palisade Partners, LLC

PROJECT NUMBER: 23875-23 DATE: 4/25/2023

CONSOLIDATION TEST

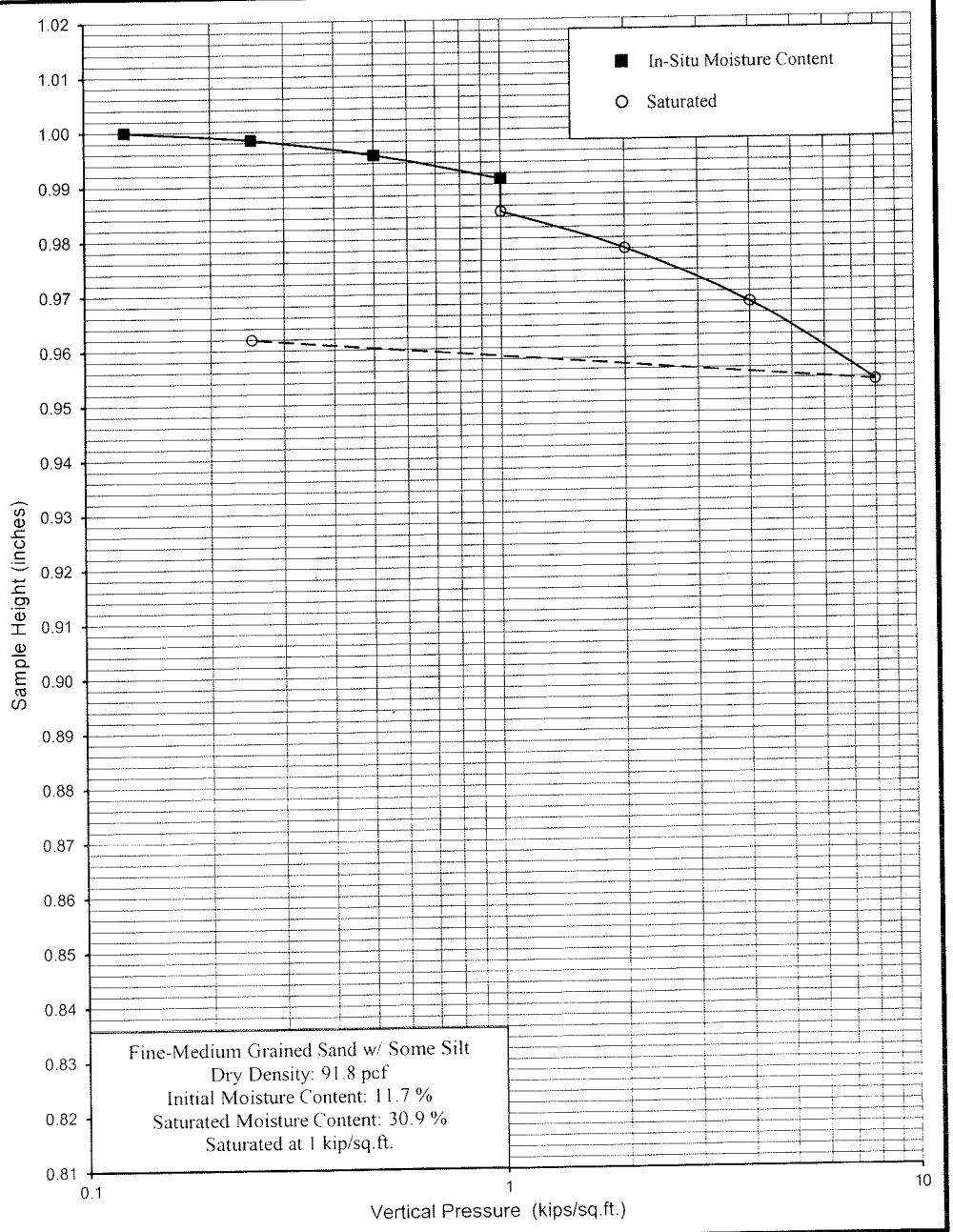
ASTM D2435

Plate C

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)	
0.125	1.0000	0.0	
0.25	0.9985	0.2	
0.5	0.9955	0.4	
1	0.9910	0.9	
1	0.9850	1.5	Saturated
2	0.9780	2.2	
4	0.9680	3.2	
8	0.9535	4.7	
0.25	0.9620	3.8	

Date Tested:	**4/18/2023**
Sample:	**B8**
Depth:	**5'**

Sample No.	B8	Depth	5'	Date	4/25/2023



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SOILS AND GEOTECHNICAL CONSULTANTS

North Palisade Partners, LLC

PROJECT NUMBER: 23875-23 DATE: 4/25/2023

CONSOLIDATION TEST

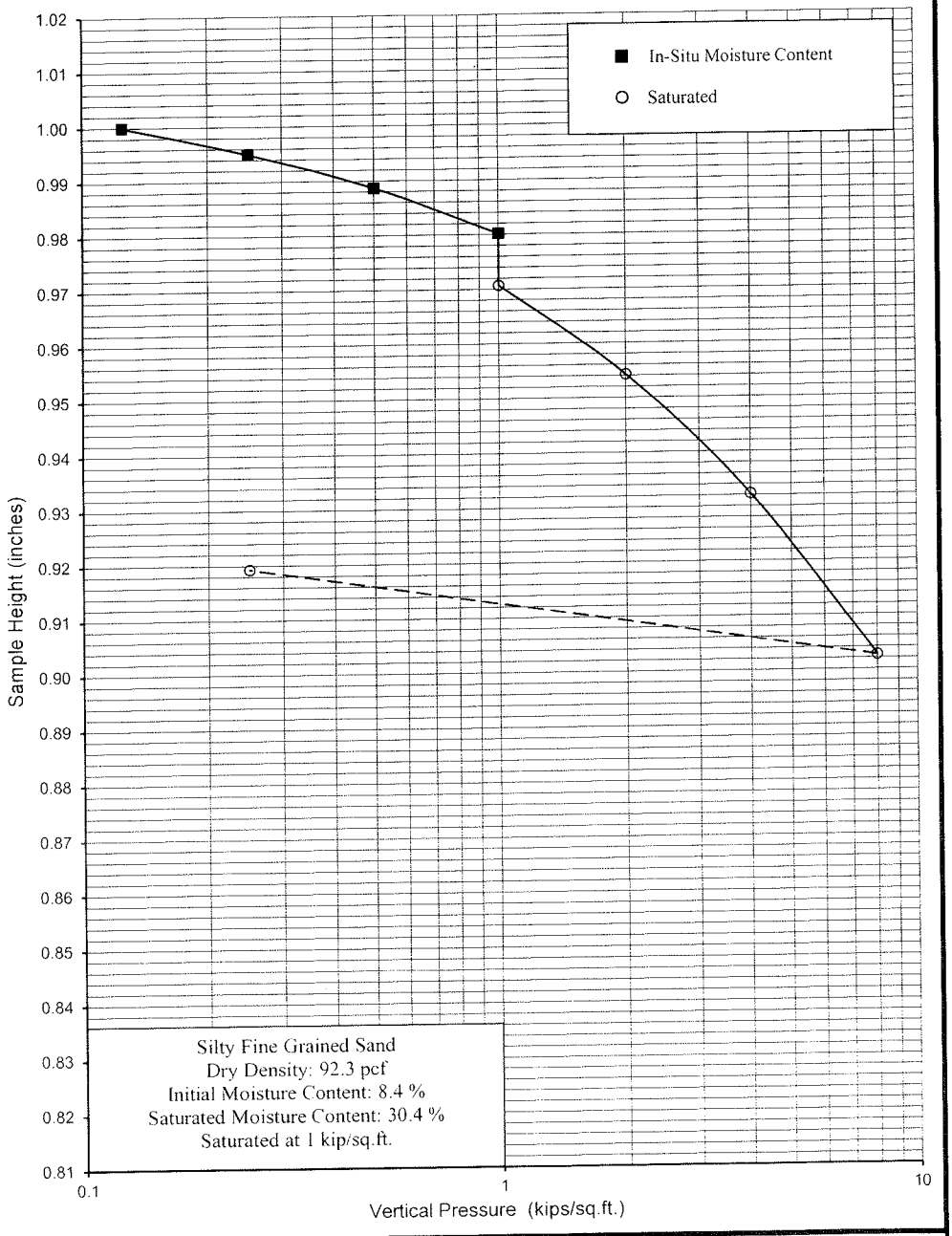
ASTM D2435

Plate D

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)	
0.125	1.0000	0.0	
0.25	0.9950	0.5	
0.5	0.9887	1.1	
1	0.9802	2.0	
1	0.9707	2.9	
2	0.9542	4.6	
4	0.9322	6.8	
8	0.9026	9.7	Saturated
0.25	0.9193	8.1	

Sample No.	B12	Depth	10'	Date	4/25/2023

Date Tested: 4/18/2023
Sample: B12
Depth: 10'



NorCal Engineering

SOILS AND GEOTECHNICAL CONSULTANTS

North Palisade Partners, LLC

PROJECT NUMBER: 23875-23 DATE: 4/25/2023

CONSOLIDATION TEST

ASTM D2435

Plate E

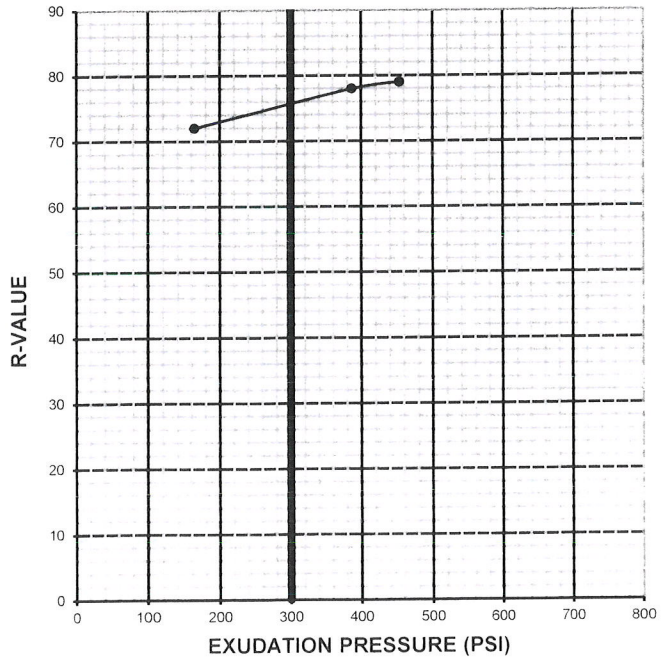
R-VALUE TEST REPORT

☑ CT-301 ☐ ASTM-D2844

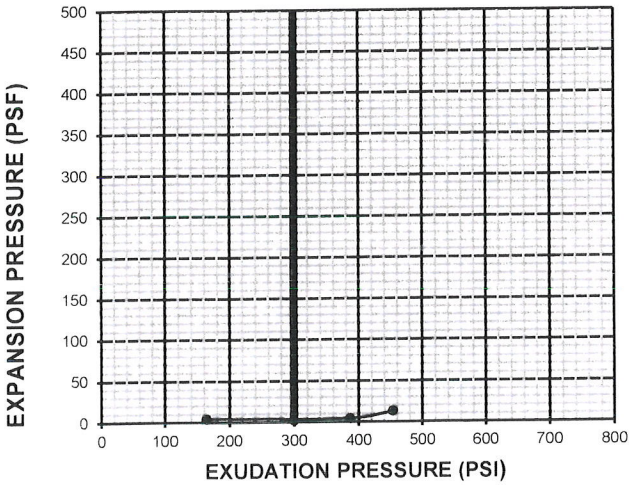
PROJECT NAME:	Norcal: North Palisade Partners, LLC (23875-23)	PROJECT NUMBER:	L-230401
SAMPLE LOCATION:	1050 Lugonia Avenue, Redlands, CA	SAMPLE NUMBER:	B1
SAMPLE DESCRIPTION:	SILTY SAND (SM), dark brown	SAMPLE DEPTH:	2'
SAMPLED BY:	Norcal	TESTED BY:	JPG
		DATE TESTED:	4/18/2023

TEST SPECIMEN	A	B	C
MOISTURE AT COMPACTION %	9.8	9.5	8.7
WEIGHT OF SAMPLE, grams	1110	1070	1098
HEIGHT OF SAMPLE, Inches	2.53	2.44	2.32
DRY DENSITY, pcf	121.1	121.4	131.9
COMPACTOR AIR PRESSURE, psi	300	300	300
EXUDATION PRESSURE, psi	164	387	454
EXPANSION, Inches x 10exp-4	1	1	3
STABILITY Ph 2,000 lbs (160 psi)	25	18	17
TURNS DISPLACEMENT	5.38	5.18	5.12
R-VALUE UNCORRECTED	72	79	80
R-VALUE CORRECTED	72	78	79
EXPANSION PRESSURE (psf)	4.3	4.3	13.0

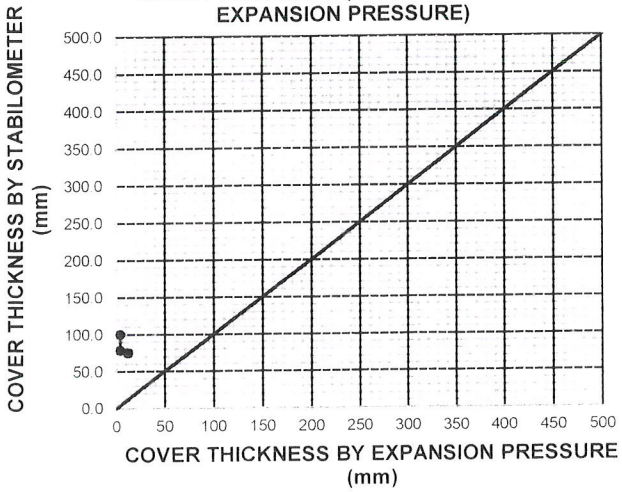
R-VALUE VS. EXUDATION PRESSURE



EXPANSION PRESSURE VS. EXUDATION PRESSURE



COVER THICKNESS (STABILOMETER BY EXPANSION PRESSURE)



R-VALUE AT EQUILIBRIUM:	76

R-VALUE BY EXUDATION PRESSURE:	76
R-VALUE BY EXPANSION PRESSURE:	N.A.
EXPANSION PRESSURE AT 300 PSI EXUDATION:	0
TRAFFIC INDEX (Assumed):	5.5
GRAVEL FACTOR (Assumed):	1.5
UNIT MASS OF COVER MATERIAL, kg/m^3 (Assumed):	2100.0

Appendix C
Seismic Hazards Report

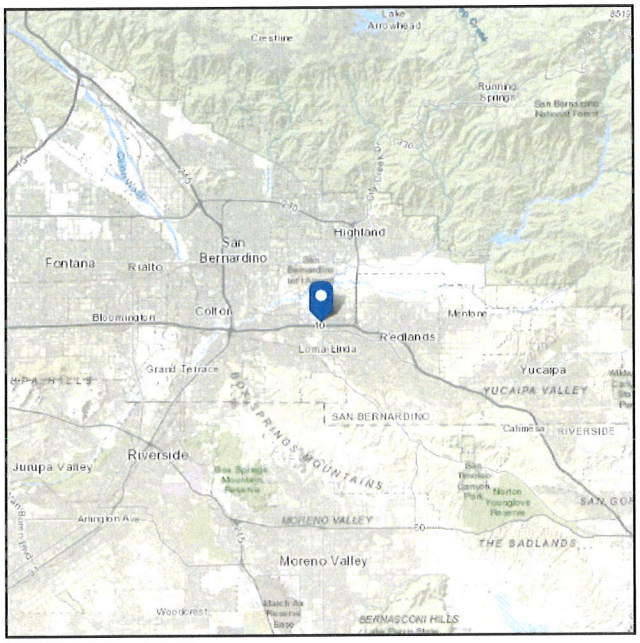
NorCal Engineering

ASCE Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Stiff Soil

Latitude: 34.068795
Longitude: -117.227561
Elevation: 1155.6971161391307 ft (NAVD 88)



ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

Seismic

Site Soil Class: D - Stiff Soil

Results:

S_S :	1.971	S_{D1} :	N/A
S_1 :	0.779	T_L :	8
F_a :	1	PGA :	0.832
F_v :	N/A	PGA_M :	0.915
S_{MS} :	1.971	F_{PGA} :	1.1
S_{M1} :	N/A	I_e :	1
S_{DS} :	1.314	C_v :	1.494

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

Data Accessed: Wed Feb 07 2024

Date Source: USGS Seismic Design Maps

The ASCE Hazard Tool is provided for your convenience, for informational purposes only, and is provided "as is" and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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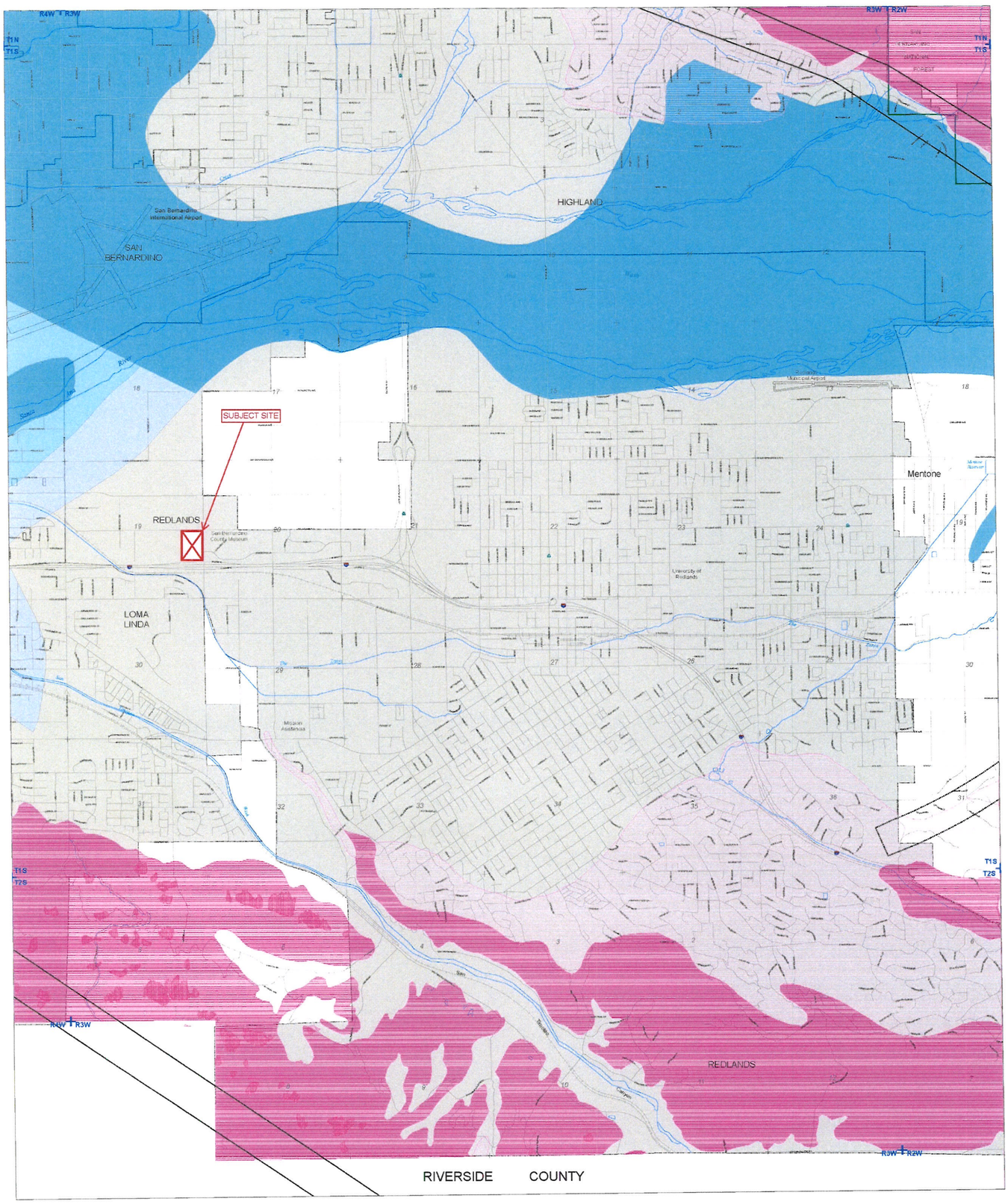

San Bernardino County Land Use Plan
GENERAL PLAN
Geologic Hazard Overlays

N.T.S.

N.T.S.

FH31 C
Redlands

NorCal Engineering SOILS AND GEOTECHNICAL CONSULTANTS	SAN BERNARDINO COUNTY LAND USE PLAN GENERAL PLAN GEOLOGIC OVERLAYS (FH31 C)
NORTH PALISADE PARTNERS, LLC	
PROJECT 23875-23	DATE FEBRUARY 2024

Appendix D
Soil Infiltration Data

NORCAL ENGINEERING

SOILS AND GEOTECHNICAL CONSULTANTS

PERCOLATION TEST DATA

Client: North Palisade Partners, LLC	**Tested By**: J.S.
Project No.: 23875-23	**Date Tested**: 4/10/2023
Test Hole: 1	**Caving**:
Depth of Test Hole: 5' (60")	**Notes**:
Diameter of Test Hole:	**Strata Peculiarities**:
Date Excavated: 4/10/2023	

Sandy Soil Criteria Test

TIME	TRIAL NO.	T1	H1	H2	D
7:54	1	15	0.0	60.0	60.0
8:09					
8:09	2	22	0.0	60.0	60.0
8:31					

____Soil Criteria

TIME	T1	TE	H1	H2	D
8:31	10	10	0.0	36.0	36.0
8:41					
8:41	10	20	0.0	31.0	31.0
8:51					
8:51	10	30	0.0	31.0	31.0
9:01					
9:01	10	40	0.0	30.0	30.0
9:11					
9:11	10	50	0.0	30.0	30.0
9:21					
9:21	10	60	0.0	30.0	30.0
9:31					
9:31	10	70	0.0	30.0	30.0
9:41					
9:41	10	80	0.0	29.0	29.0
9:51					
9:51	10	90	29.0	45.0	16.0
10:01					
10:01	10	100	45.0	57.0	12.0
10:11					

T1 – Time Interval (min)
H2 – Final Water Level (in)

TE – Total Elapsed Time (min)
D – Change in H_2O Level (in)

H1 – Initial Water Level

NORCAL ENGINEERING

SOILS AND GEOTECHNICAL CONSULTANTS

PERCOLATION TEST DATA

Client: North Palisade Partners, LLC	**Tested By**: J.S.
Project No.: 23875-23	**Date Tested**: 4/10/2023
Test Hole: 2	**Caving**:
Depth of Test Hole: 10' (120")	**Notes**:
Diameter of Test Hole:	**Strata Peculiarities**:
Date Excavated: 4/10/2023	

Sandy Soil Criteria Test

TIME	TRIAL NO.	T1	H1	H2	D
8:36	1	23	0.0	120.0	120.0
8:59					
8:59	2	28	0.0	120.0	120.0
9:27					

____Soil Criteria

TIME	T1	TE	H1	H2	D
9:27	10	10	0.0	76.0	76.0
9:37					
9:37	10	20	0.0	71.0	71.0
9:47					
9:47	10	30	0.0	71.0	71.0
9:57					
9:57	10	40	0.0	70.5	70.5
10:07					
10:07	10	50	0.0	70.5	70.5
10:17					
10:17	10	60	0.0	70.0	70.0
10:27					
10:27	10	70	0.0	70.0	70.0
10:37					
10:37	10	80	0.0	70.0	70.0
10:47					
10:47	10	90	70.0	84.0	14.0
10:57					
10:57	10	100	84.0	95.0	11.0
11:07					

T1 – Time Interval (min)
H2 – Final Water Level (in)

TE – Total Elapsed Time (min)
D – Change in H_2O Level (in)

H1 – Initial Water Level

NORCAL ENGINEERING

SOILS AND GEOTECHNICAL CONSULTANTS

PERCOLATION TEST DATA

Client: North Palisade Partners, LLC	**Tested By**: J.S.
Project No.: 23875-23	**Date Tested**: 4/10/2023
Test Hole: 3	**Caving**:
Depth of Test Hole: 10' (120")	**Notes**:
Diameter of Test Hole: 8"	**Strata Peculiarities:**
Date Excavated: 4/10/2023	

Sandy Soil Criteria Test

TIME	TRIAL NO.	T1	H1	H2	D
10:39	1	30	0.0	119.5	119.5
11:09					
11:09	2	30	0.0	109.0	109.0
11:39					

____Soil Criteria

TIME	T1	TE	H1	H2	D
11:39	10	10	0.0	62.5	62.5
11:49					
11:49	10	20	0.0	60.5	60.5
11:59					
11:59	10	30	0.0	59.5	59.5
12:09					
12:09	10	40	0.0	58.5	58.5
12:19					
12:19	10	50	0.0	57.5	57.5
12:29					
12:29	10	60	0.0	56.0	56.0
12:39					
12:39	10	70	0.0	55.0	55.0
12:49					
12:49	10	80	0.0	55.0	55.0
12:59					
12:59	10	90	55.0	80.5	25.5
1:09					
1:09	10	100	80.5	94.5	14.0
1:19					

T1 – Time Interval (min)
H2 – Final Water Level (in)

TE – Total Elapsed Time (min)
D – Change in H_2O Level (in)

H1 – Initial Water Level

NORCAL ENGINEERING

SOILS AND GEOTECHNICAL CONSULTANTS

PERCOLATION TEST DATA

Client: North Palisade Partners, LLC	**Tested By**: J.S.
Project No.: 23875-23	**Date Tested**: 4/10/2023
Test Hole: 4	**Caving**:
Depth of Test Hole: 5' (60")	**Notes**:
Diameter of Test Hole: 8"	**Strata Peculiarities**:
Date Excavated: 4/10/2023	

Sandy Soil Criteria Test

TIME	TRIAL NO.	T1	H1	H2	D
11:16	1	13	0.0	60.0	60.0
11:29					
11:29	2	18	0.0	60.0	60.0
11:47					

____Soil Criteria

TIME	T1	TE	H1	H2	D
11:47	10	10	0.0	46.0	46.0
11:57					
11:57	10	20	0.0	44.0	44.0
12:07					
12:07	10	30	0.0	42.5	42.5
12:17					
12:17	10	40	0.0	42.0	42.0
12:27					
12:27	10	50	0.0	41.5	41.5
12:37					
12:37	10	60	0.0	40.5	40.5
12:47					
12:47	10	70	0.0	40.5	40.5
12:57					
12:57	10	80	0.0	39.5	39.5
1:07					
1:07	10	90	39.5	54.0	14.5
1:17					
1:17	6	96	54.0	60.0	6.0
1:23					

T1 – Time Interval (min)
H2 – Final Water Level (in)

TE – Total Elapsed Time (min)
D – Change in H_2O Level (in)

H1 – Initial Water Level

SOIL INFILTRATION RATE CALCS ⇒ PORCHET METHOD

Location:	TH-1	TH-2	TH-3	TH-4
• Depth of Hole =	5.0'	10.0'	10.0'	5.0'
• Hole Radius =	4"	4"	4"	4"
• Drop = Δh	28"	25"	39.5"	20.5"
• Time = Δt Interval	20 min	20 min	20 min	16 min.
• Initial Water Depth = H_o	31"	50"	65"	20.5"
• Final Water Depth = H_t	3"	25"	25.5"	∅
• Average Water Head = H_{avg}	17"	37.5"	45.25"	10.25"
• INFILTRATION RATE	8.8 in/hr	3.8 in/hr	5.0 in/hr	12.6 in/hr

$$\text{Infiltration Rate} = \frac{\Delta h\,(60)(r)}{\Delta t\,(r + 2 \cdot H_{avg})}$$

$$\text{Average Water Head} = \tfrac{1}{2}(H_t - H_o)$$

NorCal Engineering
SOILS AND GEOTECHNICAL CONSULTANTS

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