Geotechnical Engineering Investigation

Proposed Industrial Warehouse Development
SE and SW Corners of Allessandro Blvd and Chagall Ct
Moreno Valley, California

CDREP LLC
523 Main Street
El Segundo, California 90245

Attn: Mr. Mark Bachli

Project Number 21631-20
January 31, 2019

NorCal Engineering

NorCal Engineering
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Attn: Mr. Mark Bachli

RE: **Geotechnical Engineering Investigation** - Proposed Industrial Warehouse Development - Located at the Southeast and Southwest Corners of Allessandro Boulevard and Chagall Court, in the City of Moreno Valley, California

Dear Mr. Bachli:

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 January 13, 2020. The purpose of this investigation is to evaluate the geotechnical conditions of the subject site and to provide recommendations for the proposed industrial warehouse 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; 5) 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 a 102,669 and 295,470 square feet buildings as shown on the attached Site Plan by Herdman Architecture + Design dated December 18, 2019. The proposed concrete tilt-up buildings 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 18.05-acre subject property is located at the southeast and southwest corners of Allessandro Boulevard and Chagall Court, in the City of Moreno Valley. The generally rectangular-shaped parcel is elongated in an east to west direction with topography of the relatively level descending slightly from a north to south direction on the order of a few feet. The site is undeveloped parcel covered with a low vegetation growth of natural grasses and weeds.

3.0 Site Exploration

The investigation consisted of the placement of ten (10) subsurface exploratory trenches by a backhoe to depths ranging between 5 and 15 feet and two (2) exploratory borings by a truck mounted drill rig both to a depth of 50 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 trenches/borings revealed the existing earth materials to consist of fill and natural soil. Detailed descriptions of the subsurface conditions are listed on the trench and 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:** A fill soil classifying as a brown, fine to medium grained, silty to clayey SAND was encountered across the site to depths ranging from 1 to 1½ feet below ground surface. These soils were noted to be loose and moist.
>
> **Natural:** A natural undisturbed soil classifying as a brown, fine to medium grained, clayey to silty SAND to sandy CLAY was encountered beneath the upper fill soils. The native soils as encountered were observed to be dense/stiff to very dense/stiff and moist.

The overall engineering characteristics of the earth material were relatively uniform with each excavation. Groundwater was encountered to the depth of 33 and 39 feet ground surface in Borings B-1 and B-2 respectively, and no caving occurred.

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 **Atterberg Limits** (ASTM: D 4318) consisting of liquid limit, plastic limit and plasticity index were performed on representative soil samples. Results are shown on Table III.

4.5 **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 IV.

4.6 **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.

4.7 **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 Plates A and B.

4.8 **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 site is situated in an area of high regional seismicity and the San Jacinto (San Jacinto Valley) fault is located about 6 kilometers from the site. 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 are provided below and are based on the 2019 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/. The ASCE 7 Hazards Report is attached in Appendix C.

Seismic Design Acceleration Parameters

Latitude	33.916
Longitude	-117.257
Site Class	D
Risk Category	I/II/III
Mapped Spectral Response Acceleration	S_S = 1.500 S_1 = 0.600
Adjusted Maximum Acceleration	S_{MS} = 1.500
Design Spectral Response Acceleration Parameters	S_{DS} = 1.000
Peak Ground Acceleration	PGA_M = 0.674

6.0 Liquefaction Evaluation

The site is expected to experience ground shaking and earthquake activity that is typical of Southern California area. It is during severe ground shaking that loose, granular soils below the groundwater table can liquefy. A review of the exploratory boring log and the laboratory test results on selected soil samples obtained indicate the following soil classifications, field blowcounts and amounts of fines passing through the No. 200 sieve.

Field Blowcount and Gradation Data

Boring No.	Classification	Blowcounts (blows/ft)	Relative Density	% Passing No. 200 Sieve
B-1 @ 5’	SC	>50	Very Dense	47
B-1 @ 10’	ML/CL	>50	Very Stiff	62
B-1 @ 15’	SC	82	Very Dense	45
B-1 @ 20’	SC	76	Very Dense	44
B-1 @ 25’	SC	>50	Very Dense	42
B-1 @ 30’	SC	34	Dense	42
B-1 @ 35’	SM	32	Dense	37
B-1 @ 40’	CL	65	Very Stiff	60
B-1 @ 45’	CL	42	Dense	61
B-1 @ 50’	CL	36	Stiff	56

Boring No.	Classification	Blowcounts (blows/ft)	Relative Density	% Passing No. 200 Sieve
B-2 @ 5'	SM	>50	Very Dense	21
B-2 @ 10'	SC	36	Very Dense	47
B-2 @ 15'	SM	52	Very Dense	33
B-2 @ 20'	SM	30	Dense	14
B-2 @ 25'	SC	>50	Very Dense	46
B-2 @ 30'	SC	41	Very Dense	45
B-2 @ 35'	SC	42	Very Dense	40
B-2 @ 40'	SC	56	Very Dense	48
B-2 @ 45'	SC	46	Very Dense	47
B-2 @ 50'	SM	37	Dense	29

The analysis indicates the potential for liquefaction at this site to be low based on the density of the subsurface soils. The associated seismic-induced settlements would be on the order of less than 3/4 inch and would occur rather uniformly across the site. Differential settlements would be on the order of ½ inch over a 50-foot (horizontal) distance. Thus, the design of the proposed construction in conformance with the latest Building Code provisions for earthquake design is expected to provide mitigation of ground shaking hazards that are typical to Southern California.

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. The infiltration tests consisted of the double ring infiltration test per ASTM Method D 3385. The field infiltration rate was computed using a reduction factor – R_f based on the field measurements with our calculations given 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 infiltration rates.

Test No.	Depth	Soil Classification	Infiltration Rate
T-1	5'	Silty SAND	26.8 in/hr
T-2	7.5'	Sandy CLAY	0.1 in/hr
T-3	10'	Sandy CLAY	0.7 in/hr

The correction factors CFt, CFv and CFs are given below based on soils at 5 to 10 feet from our field tests.

a) CFt = Rf =1.0 for our double ring infiltration test holes.

b) CFv = 1.0 based on uniform soils encountered in three (3) trenches for infiltration tests.

c) CFs = 3.0 for long-term siltation, plugging and maintenance. The subsurface soils are likely to have some plugging and regular maintenance of storm water discharge devices is required.

Based on the results of our field testing, the subsurface soils encountered in the proposed on-site drainage disposal system at 5 feet below ground surface and into sandy soils shall utilize a design infiltration rate of 8 in/hr. The infiltration rate at a depth below 5 feet to 10 feet indicates the very stiff fine-grained clayey soils which are not suitable for seepage pits at the site. All systems must meet the latest 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 1½ 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.

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 including floor slab areas 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 less than 5% 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 die 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 24 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. All foundations shall be reinforced a minimum of one, No. 4 bar, top and bottom. A representative of this firm shall inspect all foundation excavations prior to pouring concrete.

8.5 Settlement Analysis

Resultant pressure curves for the consolidation tests are shown on Plates C and D. 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 - 0.35
Equivalent Passive Fluid Pressure = 200 lbs./cu.ft.
Maximum Passive Pressure = 2,000 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 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 both reinforced a minimum of No. 3 bars, sixteen inches in each direction and positioned in the center of slab 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. All subgrade soils shall be moisture conditioned to 3% over optimum moisture content to a depth eighteen inches.

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 on the following page provides a preliminary pavement design based upon an R-Value of 16 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.

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.

Type of Traffic	Traffic Index	Asphalt (in.)	Base Material (in.)
Automobile Parking Stalls	4.0	3.0	6.0
Light Vehicle Circulation Areas	5.5	3.5	9.5
Heavy Truck Access Areas	7.0	4.0	14.0

Any concrete slab-on-grade in pavement areas shall be a minimum of seven inches in thickness and may be placed on approved subgrade soils. 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 Moreno Valley. 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 IV.

8.12 **Expansive Soil**

Since expansive soils were encountered, 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 geotechnical 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

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

REGISTERED PROFESSIONAL ENGINEER
KEITH D. TUCKER
No. 841
Exp. 12/31/2020
GEOTECHNICAL
STATE OF CALIFORNIA

Scott D. Spensiero
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 Soils 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.

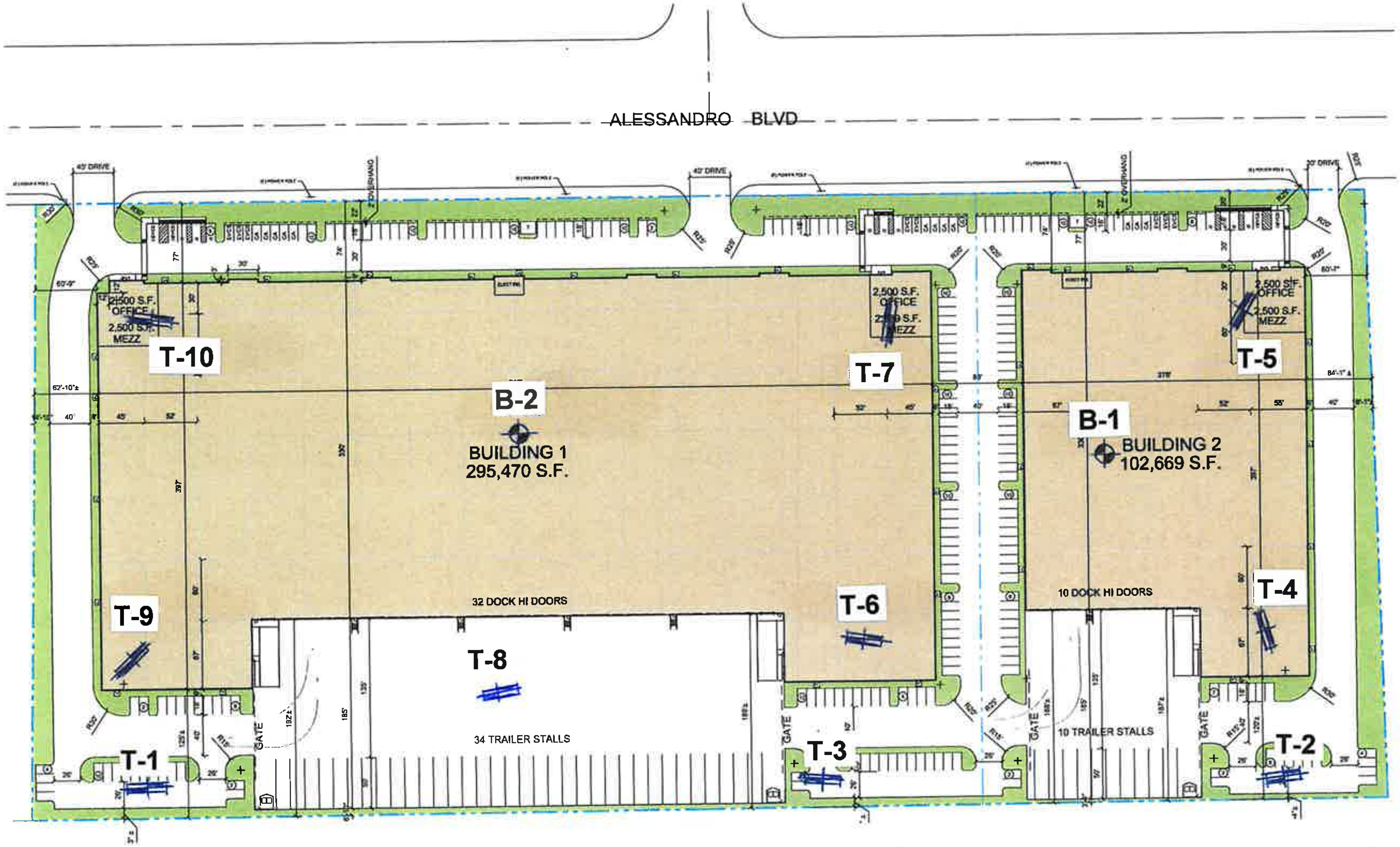
- Irrigation should be strictly controlled around building foundations, slabs and pavement and may need to be adjusted depending upon season. This control is essential to maintain a relatively uniform moisture content in the expansive soils and to prevent swelling and contracting. Over-watering adjacent 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.



NorCal Engineering
SOILS AND GEOTECHNICAL CONSULTANTS

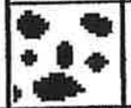
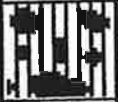
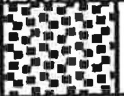
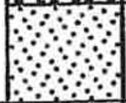
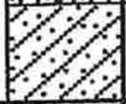
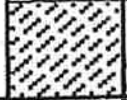
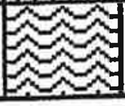
PROJECT 21631-20 | **DATE** FEBRUARY 2020

SITE PLAN

List of Appendices

(in order of appearance)

Appendix A

MAJOR DIVISION			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	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
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	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
		SANDS WITH FINE (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	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
	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

CDREP
21631-20

Log of Trench T-1

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020

Groundwater Depth: None Encountered

Drilling Method: Backhoe

Hammer Weight:

Drop:

Surface Elevation: Not Measured

Depth (feet)	Lithology		Material Description	Samples		Laboratory		
				Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	▨	GWT not encountered	FILL Silty SAND Brown, loose, moist					
	▨		NATURAL Silty SAND Brown, dense to very dense, moist					
5			Trench completed at depth of 5'					
10								
15								
20								
25								
30								
35								

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21631-20

Log of Trench T-2

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020 | **Groundwater Depth:** None Encountered

Drilling Method: Backhoe

Hammer Weight: | **Drop:**

Surface Elevation: Not Measured

Depth (feet)	Lith-ology		Material Description	Samples		Laboratory		
				Type	Blow Counts	Moisture	Dry Density	Fines Content %
0		GWT not encountered	FILL Clayey SAND Brown, loose, moist					
			NATURAL Clayey SAND to Sandy CLAY Brown, dense to very dense, moist					
5								
			Trench completed at depth of 7.5'					
10								
15								
20								
25								
30								
35								

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21631-20

Log of Trench T-3

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020

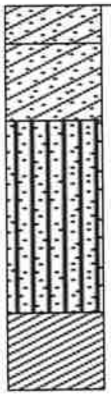
Groundwater Depth: None Encountered

Drilling Method: Backhoe

Hammer Weight:

Drop:

Surface Elevation: Not Measured



GWT not encountered

Depth (feet)	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0	FILL Clayey SAND Brown, loose, moist					
	NATURAL Clayey SAND Brown, dense, moist					
5	Silty SAND Brown, dense, moist					
	Sandy CLAY Brown, stiff, moist					
10	Trench completed at depth of 10'					
15						
20						
25						
30						
35						

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Log of Trench T-4

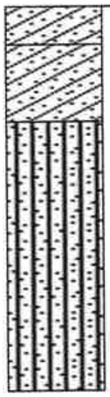
Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020 **Groundwater Depth:** None Encountered

Drilling Method: Backhoe

Hammer Weight: **Drop:**

Surface Elevation: Not Measured



Depth (feet)	Lith-ology	Material Description	Samples		Laboratory		
			Type	Blow Counts	Moisture	Dry Density	Fines Content %
0		FILL Clayey SAND Brown, loose, moist					
2			■		11.6	119.0	
			☐				
3		NATURAL Silty SAND Brown, dense to very dense, moist					
4			■		13.2	117.6	
5		Silty (fine to coarse grained) SAND Brown, dense, moist					
8			■		9.7	118.8	
10		Trench completed at depth of 10'					
15							
20							
25							
30							
35							

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21631-20

Log of Trench T-5

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020

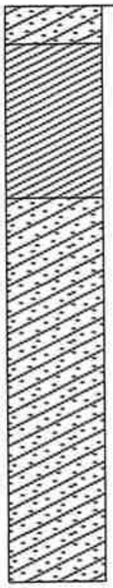
Groundwater Depth: None Encountered

Drilling Method: Backhoe

Hammer Weight:

Drop:

Surface Elevation: Not Measured



GWT not encountered

Depth (feet)	Material Description	Samples		Laboratory		
		Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	FILL Clayey SAND Brown, loose, moist					
	NATURAL Sandy CLAY Brown, stiff, moist	■ ▽		12.1	117.2	
5	Clayey SAND Brown, very dense, moist	■		11.7	120.4	
10		■		9.4	122.6	
15	Trench completed at depth of 15'	■		10.3	119.6	
20						
25						
30						
35						

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Log of Trench T-6

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020

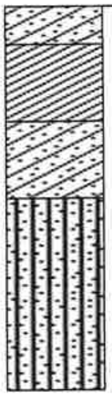
Groundwater Depth: None Encountered

Drilling Method: Backhoe

Hammer Weight:

Drop:

Surface Elevation: Not Measured

Depth (feet)	Lith-ology		Material Description	Samples		Laboratory		
				Type	Blow Counts	Moisture	Dry Density	Fines Content %
0		GWT not encountered	FILL Clayey SAND Brown, loose, moist					
			NATURAL Sandy CLAY Brown, stiff, moist	■		8.4	115.7	
5			Clayey SAND Brown, dense, moist					
			Silty SAND Brown, dense, moist	■		7.0	117.8	
10			Trench completed at depth of 10'					
15								
20								
25								
30								
35								

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21631-20

Log of Trench T-7

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020 | **Groundwater Depth: None Encountered**

Drilling Method: Backhoe

Hammer Weight: | **Drop:**

Surface Elevation: Not Measured

Depth (feet)	Lith-ology		Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0		GWT not encountered	FILL Clayey SAND Brown, loose, moist					
				■		7.4	115.9	
			NATURAL Clayey SAND Brown, dense to very dense, moist	■		8.3	117.8	
5								
10			Trench completed at depth of 10'	■		11.0	118.8	
15								
20								
25								
30								
35								

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Log of Trench T-8

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020

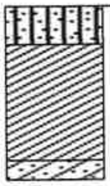
Groundwater Depth: None Encountered

Drilling Method: Backhoe

Hammer Weight:

Drop:

Surface Elevation: Not Measured



GWT not encountered

Depth (feet)	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0	FILL Clayey SAND Brown, loose, moist	■		11.0	117.5	
	NATURAL Sandy CLAY Brown, stiff, moist					
5	Clayey SAND Brown, dense, moist					
	Trench completed at depth of 4.5'					
10						
15						
20						
25						
30						
35						

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Log of Trench T-9

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020

Groundwater Depth: None Encountered

Drilling Method: Backhoe

Hammer Weight:

Drop:

Surface Elevation: Not Measured

Depth (feet)	Lith-ology		Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0	▨	GWT not encountered	FILL Clayey SAND Brown, loose, moist	■ ☐		10.6	115.5	
	▨		NATURAL Clayey SAND Brown, dense to very dense, moist					
5	▨			■		11.1	119.5	
10	▨			■		9.8	116.1	
15			Trench completed at depth of 15'	■		11.4	116.8	
20								
25								
30								
35								

CDREP

21631-20

Log of Trench T-10

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/20/2020

Groundwater Depth: None Encountered

Drilling Method: Backhoe

Hammer Weight:

Drop:

Surface Elevation: Not Measured

Depth (feet)	Lith-ology		Material Description	Samples		Laboratory		
				Type	Blow Counts	Moisture	Dry Density	Fines Content %
0	▨	GWT not encountered	FILL Silty SAND Brown, loose, moist					
	▨		NATURAL Silty SAND Brown, dense to very dense, moist	■		6.1	114.2	
5	▨							
	▨			■		7.4	117.0	
10			Trench completed at depth of 10'					
15								
20								
25								
30								
35								

CDREP
21631-20

Log of Boring B-1

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/22/2020

Groundwater Depth: 39'

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs

Drop: 30"

Surface Elevation: Not Measured

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0	▨	FILL Clayey SAND Brown, loose, moist					
	▨	NATURAL Clayey SAND Brown, dense to very dense, moist					
5	▨		☒	32/50-4"	12.3		47
	▥	Sandy SILT Brown, very stiff, moist					
10	▥		☒	19/50-5"	11.8		62
	▨	Clayey (fine to coarse grained) SAND Red-brown, very dense, moist					
15	▨		☒	24/37/45	14.0		45
20	▨		☒	17/26/50	14.5		44
25	▨		☒	23/50-5"	14.7		42
30	▨		☒	15/18/16	18.3		42
	▥	Silty SAND Brown, dense, moist					
35							

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21631-20

Log of Boring B-1

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/22/2020 | **Groundwater Depth: 39'**

Drilling Method: Simco 2800HS

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

Surface Elevation: Not Measured

Depth (feet)	Lith-ology		Material Description	Samples		Laboratory		
				Type	Blow Counts	Moisture	Dry Density	Fines Content %
35	▦		Silty SAND Brown, dense, moist	☒	10/15/17	19.6		37
	▨	▽	Sandy CLAY Red-brown, stiff, wet					
40	▨			☒	18/27/38	21.0		60
45	▨			☒	13/19/23	20.0		61
50	▨			☒	10/13/23	19.3		56
			Boring completed at depth of 51.5'					
55								
60								
65								
70								

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Log of Boring B-2

Boring Location: Alessandro & Chagall Ct, Moreno Valley

Date of Drilling: 1/22/2020 | Groundwater Depth: 33'

Drilling Method: Simco 2800HS

Hammer Weight: 140 lbs | Drop: 30"

Surface Elevation: Not Measured

Depth (feet)	Lith-ology	Material Description	Samples: Type	Samples: Blow Counts	Laboratory: Moisture	Laboratory: Dry Density	Laboratory: Fines Content %
0	▥	FILL Silty SAND Brown, loose, moist					
	▥	NATURAL Silty SAND Brown, dense to very dense, moist					
5	▥		☒	38/50-5"	11.9		21
	▨	Clayey (fine to coarse grained) SAND Red-brown, very dense, moist					
10	▨		☒	8/17/19	8.2		47
	▥	Silty SAND Brown, dense, wet					
15	▥		☒	10/17/35	12.9		33
20	▥		☒	10/11/19	6.0		14
	▨	Clayey SAND Brown, dense, wet					
25	▨		☒	25/50-4"	11.3		46
30	▨		☒	18/21/20	15.2		45
	▨ ▽						
35							

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21631-20

Log of Boring B-2

Boring Location: Alessandro & Chagall Ct, Moreno Valley
Date of Drilling: 1/22/2020 | **Groundwater Depth: 33'**
Drilling Method: Simco 2800HS
Hammer Weight: 140 lbs | **Drop: 30"**
Surface Elevation: Not Measured

Depth (feet)	Material Description	Samples		Laboratory		
		Type	Blow Counts	Moisture	Dry Density	Fines Content %
35	Clayey SAND Brown, dense, wet	☒	14/16/26	16.2		40
40		☒	18/25/31	19.5		48
45		☒	13/21/25	16.7		47
	Silty SAND Brown, dense, wet					
50		☒	10/15/22	13.8		29
	Boring completed at depth of 51.5'					
55						
60						
65						
70						

Appendix B

TABLE I
MAXIMUM DENSITY TESTS

Sample	Classification	Optimum Moisture (%)	Maximum Dry Density (lbs/cu.ft)
T-4 @ 2’	Silty SAND	9.0	130.0
T-5 @ 2’	Sandy CLAY	13.5	125.0
T-9 @ 2’	Clayey SAND	12.0	128.0

TABLE II
EXPANSION TESTS

Sample	Classification	Expansion Index
T-4 @ 2’	Silty SAND	3
T-5 @ 2’	Sandy CLAY	65
T-9 @ 2’	Clayey SAND	25

TABLE III
ATTERBERG LIMITS

Sample	Liquid Limit	Plastic Limit	Plasticity Index
T-5 @ 2-5’	32	19	13
T-5 @ 8-10’	25	19	6

TABLE IV
CORROSION TESTS

Sample	pH	Electrical Resistivity	Sulfate (%)	Chloride (ppm)
T-5 @ 2’	7.2	1,820	0.008	257
T-9 @ 2’	7.1	2,540	0.007	285

% by weight
ppm – mg/kg

GMU

R-VALUE TEST REPORT

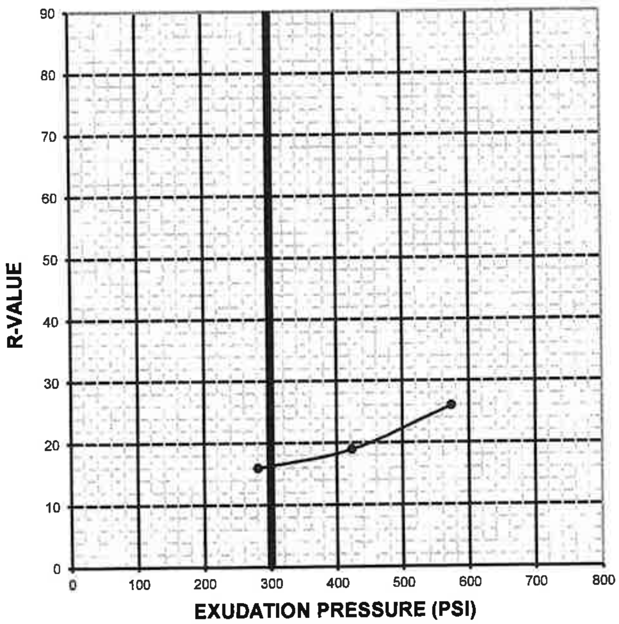
☑ CT-301 ☐ ASTM-D2844

PROJECT NAME: Norcal (CDREP LLC)
SAMPLE LOCATION: SEC of SWC of Alessandro Blvd and Chega II CT. Moreno Valley
SAMPLE DESCRIPTION: Sandy Lean Clay (CL-CH)
SAMPLED BY: Norcal

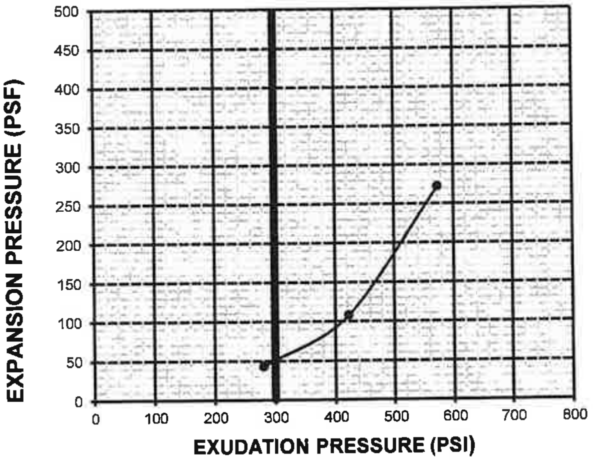
PROJECT NUMBER: L-200101
SAMPLE NUMBER: T3
SAMPLE DEPTH: 1.0'
TESTED BY: CC/ER
DATE TESTED: 1/24/2020

TEST SPECIMEN	A	B	C
MOISTURE AT COMPACTION %	14.4	15.5	16.9
WEIGHT OF SAMPLE, grams	1117	1191	1227
HEIGHT OF SAMPLE, Inches	2.30	2.48	2.67
DRY DENSITY, pcf	128.7	126.1	119.3
COMPACTOR AIR PRESSURE, psi	250	200	100
EXUDATION PRESSURE, psi	573	423	281
EXPANSION, Inches x 10exp-4	63	25	10
STABILITY Ph 2,000 lbs (160 psi)	100	119	125
TURNS DISPLACEMENT	3.51	3.76	4.19
R-VALUE UNCORRECTED	30	19	14
R-VALUE CORRECTED	26	19	16
EXPANSION PRESSURE (psf)	272.2	108.0	43.2

R-VALUE VS. EXUDATION PRESSURE



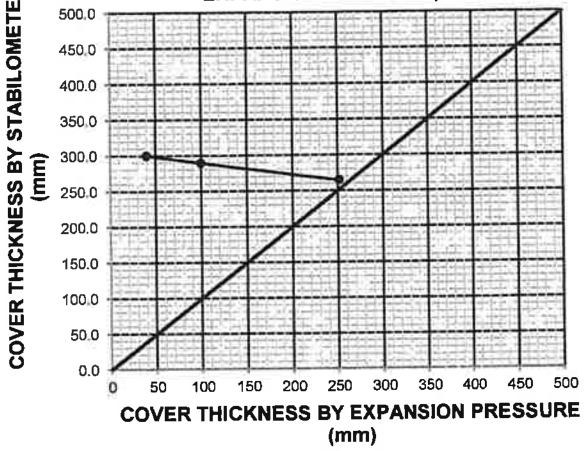
EXPANSION PRESSURE VS. EXUDATION PRESSURE



R-VALUE AT EQUILIBRIUM:	16

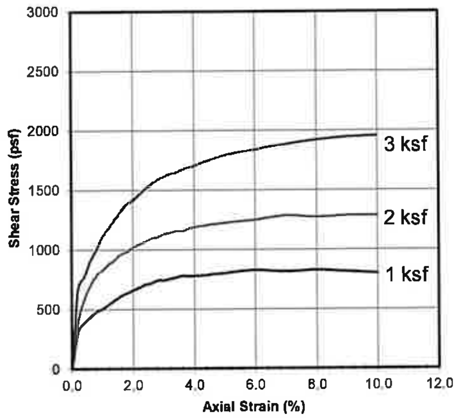
R-VALUE BY EXUDATION PRESSURE:	16
R-VALUE BY EXPANSION PRESSURE:	N.A.
EXPANSION PRESSURE AT 300 PSI EXUDATION:	52
TRAFFIC INDEX (Assumed):	5.5
GRAVEL FACTOR (Assumed):	1.5
UNIT MASS OF COVER MATERIAL, kg/m^3 (Assumed):	2100.0

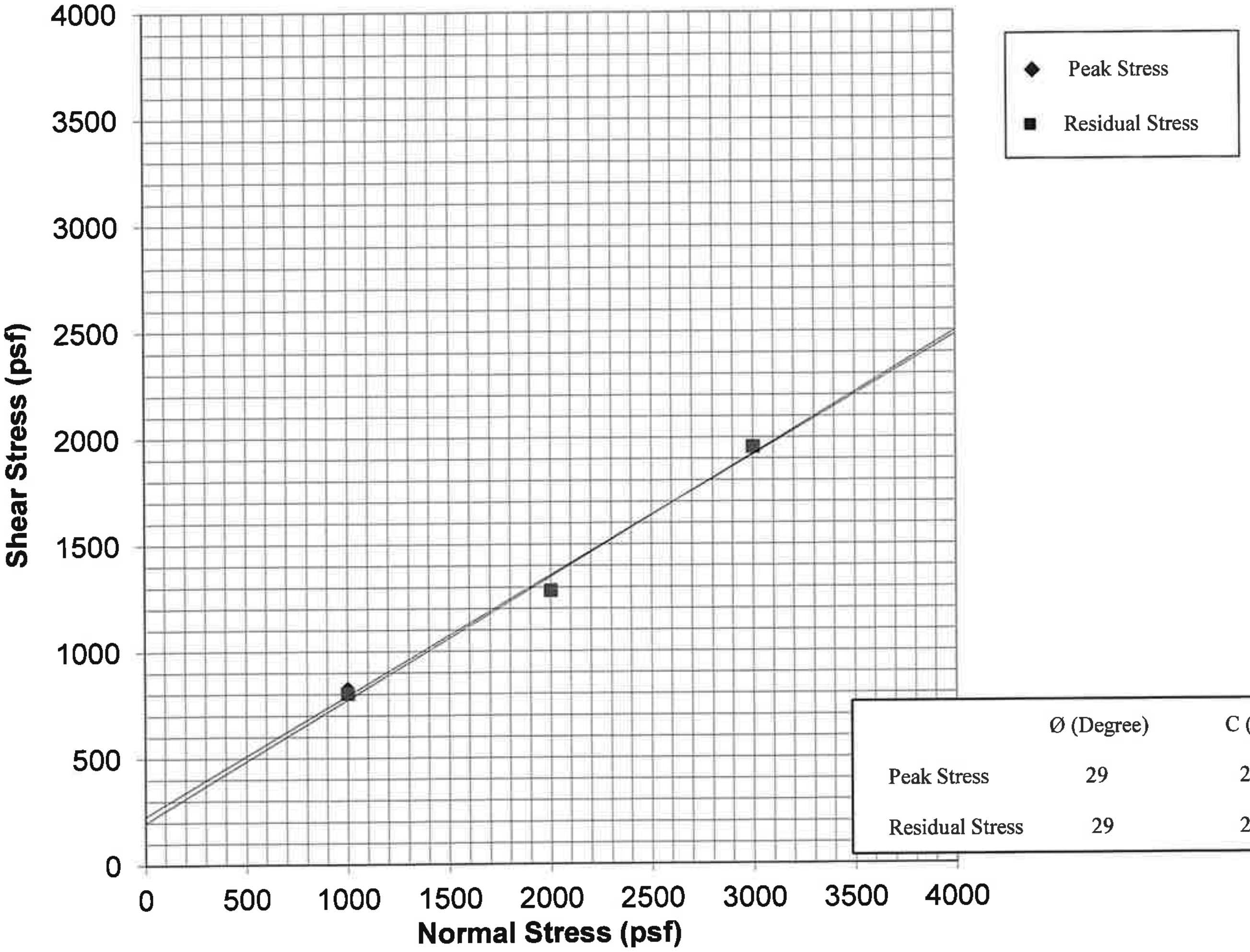
COVER THICKNESS (STABILOMETER BY EXPANSION PRESSURE)



Sample No. T5@2'
Sample Type: Undisturbed/Saturated
Soil Description: Silty Clay

		1	2	3
Normal Stress	(psf)	1000	2000	3000
Peak Stress	(psf)	828	1284	1956
Displacement	(in)	0.150	0.175	0.250
Residual Stress	(psf)	804	1284	1956
Displacement	(in.)	0.250	0.250	0.250
In Situ Dry Density	(pcf)	117.2	117.2	117.2
In Situ Water Content	(%)	12.1	12.1	12.1
Saturated Water Content	(%)	16.1	16.1	16.1
Strain Rate	(in/min)	0.020	0.020	0.020





	Ø (Degree)	C (psf)
Peak Stress	29	230
Residual Stress	29	200

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SOILS AND GEOTECHNICAL CONSULTANTS

CDREP, LLC

PROJECT NUMBER: 21631-20 DATE: 1/30/2020

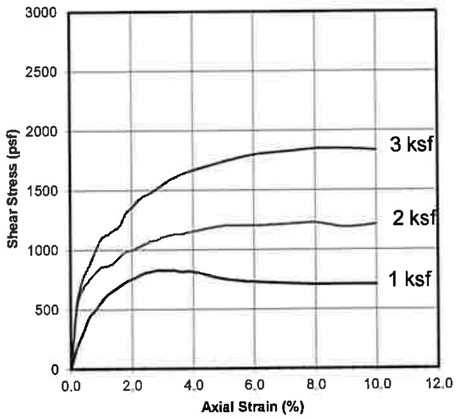
DIRECT SHEAR TEST

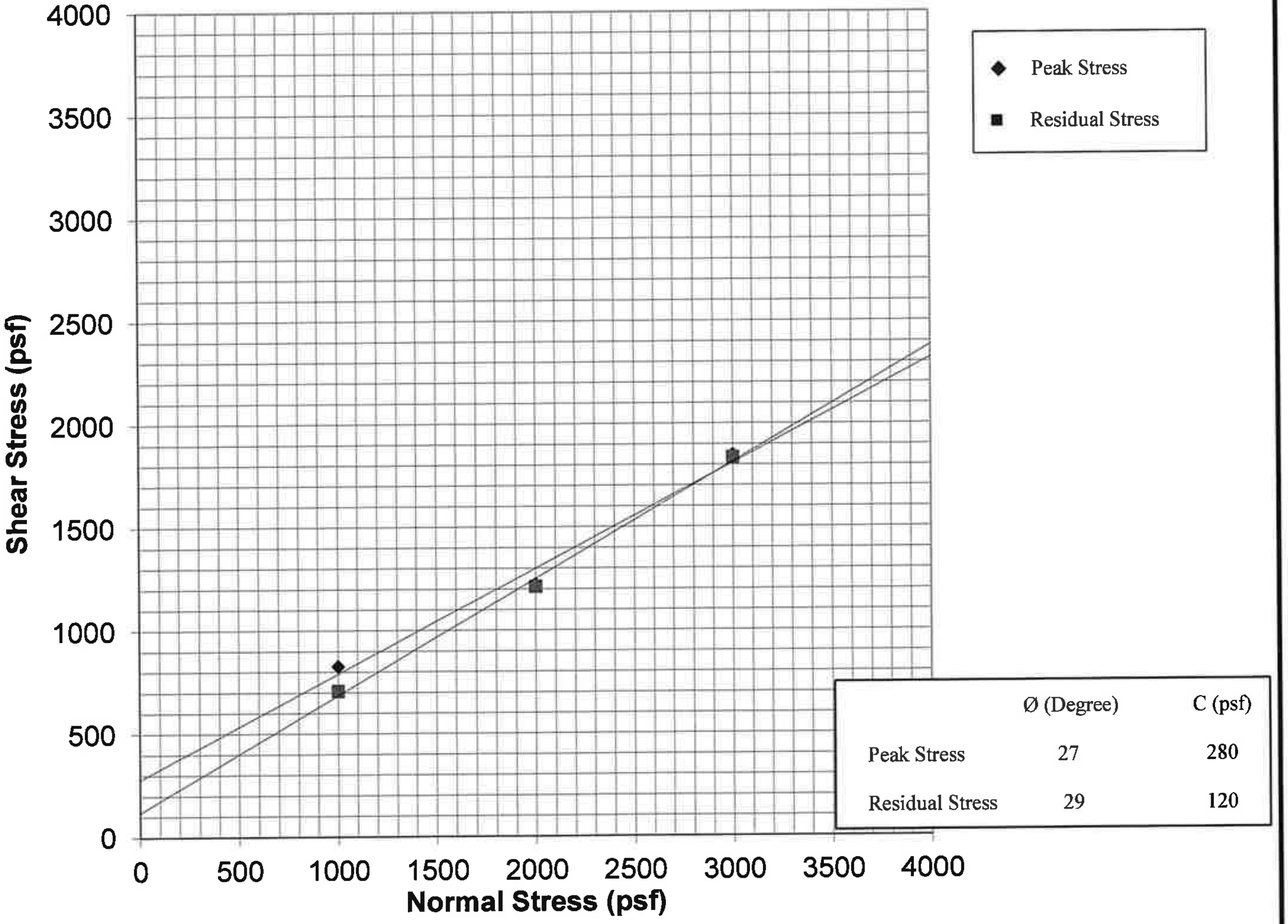
ASTM D3080

Plate A

Sample No. T9@2'
Sample Type: Undisturbed/Saturated
Soil Description: Silty Clay w/ Some Sand

		1	2	3
Normal Stress	(psf)	1000	2000	3000
Peak Stress	(psf)	828	1224	1848
Displacement	(in.)	0.070	0.200	0.200
Residual Stress	(psf)	708	1212	1836
Displacement	(in.)	0.250	0.250	0.250
In Situ Dry Density	(pcf)	115.5	115.5	115.5
In Situ Water Content	(%)	10.6	10.6	10.6
Saturated Water Content	(%)	16.9	16.9	16.9
Strain Rate	(in/min)	0.020	0.020	0.020





	Ø (Degree)	C (psf)
Peak Stress	27	280
Residual Stress	29	120

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CDREP, LLC

PROJECT NUMBER: 21631-20 DATE: 1/30/2020

DIRECT SHEAR TEST

ASTM D3080

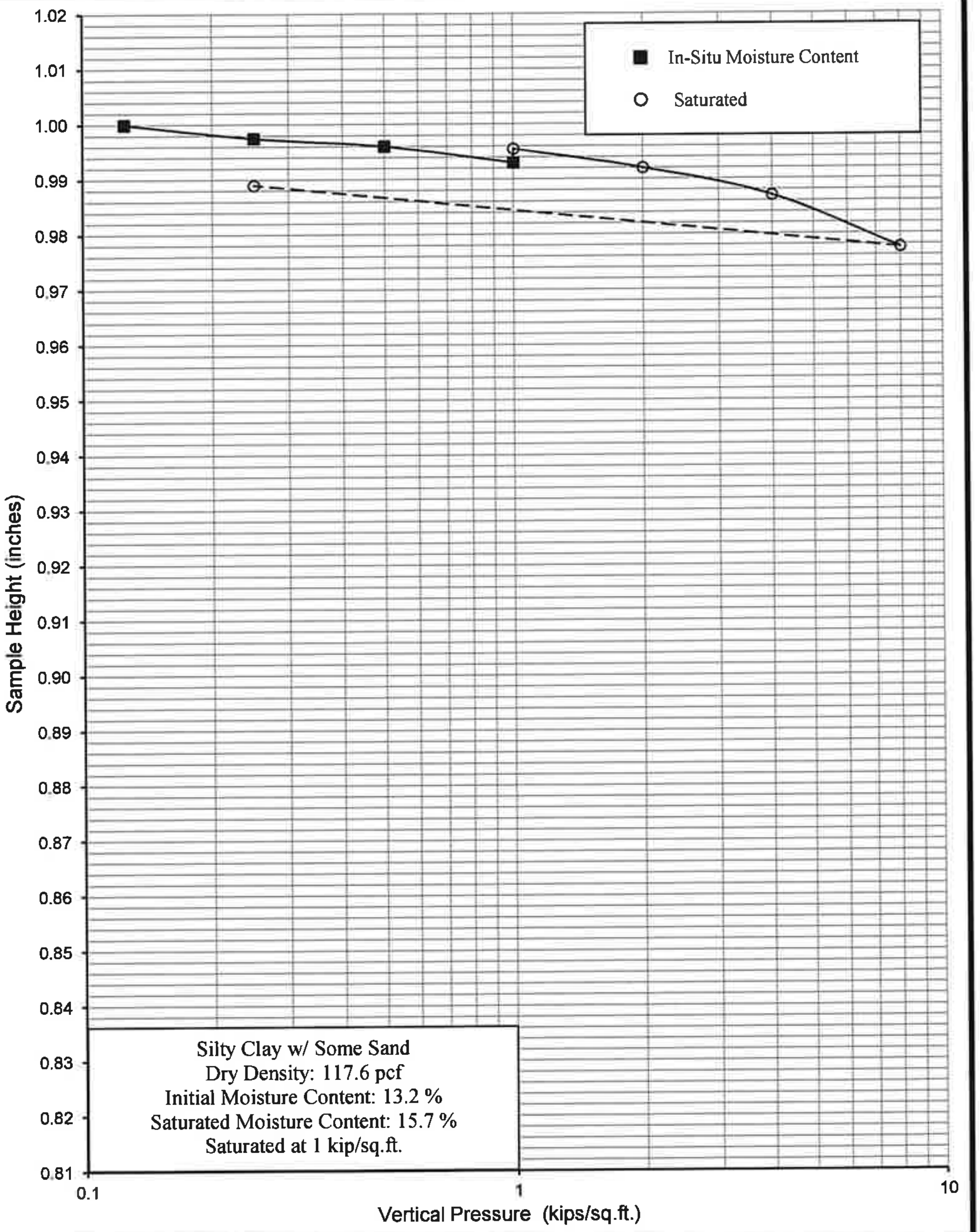
Plate B

Sample No. T4 | Depth 4' | Date 1/30/2020

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)
0.125	1.0000	0.0
0.25	0.9975	0.2
0.5	0.9960	0.4
1	0.9930	0.7
1	0.9955	0.4
2	0.9920	0.8
4	0.9870	1.3
8	0.9775	2.3
0.25	0.9890	1.1

Saturated

Date Tested: 1/29/2020
Sample: T4
Depth: 4'



Silty Clay w/ Some Sand
Dry Density: 117.6 pcf
Initial Moisture Content: 13.2 %
Saturated Moisture Content: 15.7 %
Saturated at 1 kip/sq.ft.

NorCal Engineering

SOILS AND GEOTECHNICAL CONSULTANTS

CDREP, LLC

PROJECT NUMBER: 21631-20 DATE: 1/30/2020

CONSOLIDATION TEST

ASTM D2435

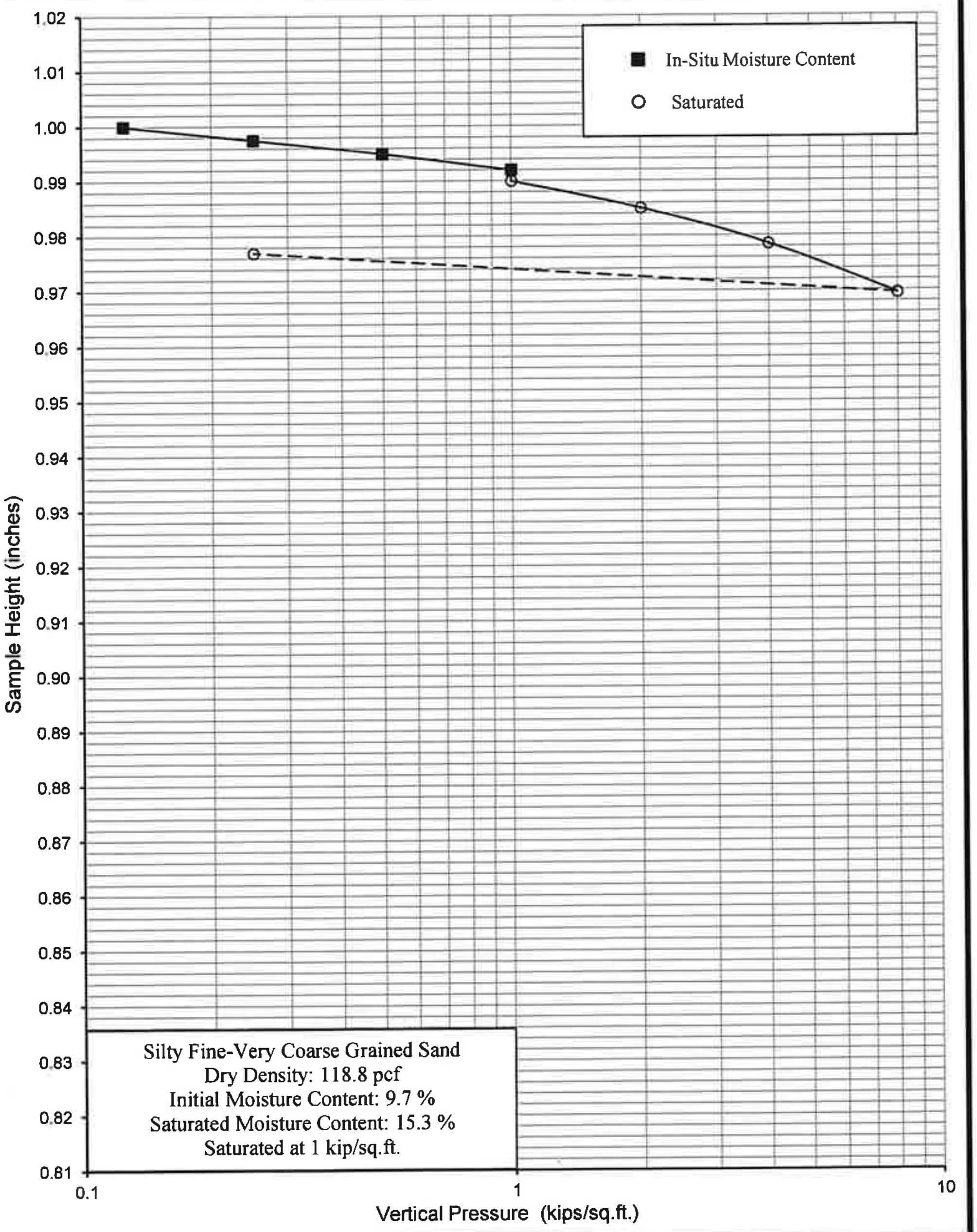
Plate C

Sample No. T4 Depth 8' Date 1/30/2020

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)
0.125	1.0000	0.0
0.25	0.9975	0.2
0.5	0.9950	0.5
1	0.9920	0.8
1	0.9900	1.0
2	0.9850	1.5
4	0.9785	2.2
8	0.9695	3.1
0.25	0.9770	2.3

Saturated

Date Tested: 1/29/2020
Sample: T4
Depth: 8'



NorCal Engineering

SOILS AND GEOTECHNICAL CONSULTANTS

CDREP, LLC

PROJECT NUMBER: 21631-20 DATE: 1/30/2020

CONSOLIDATION TEST

ASTM D2435

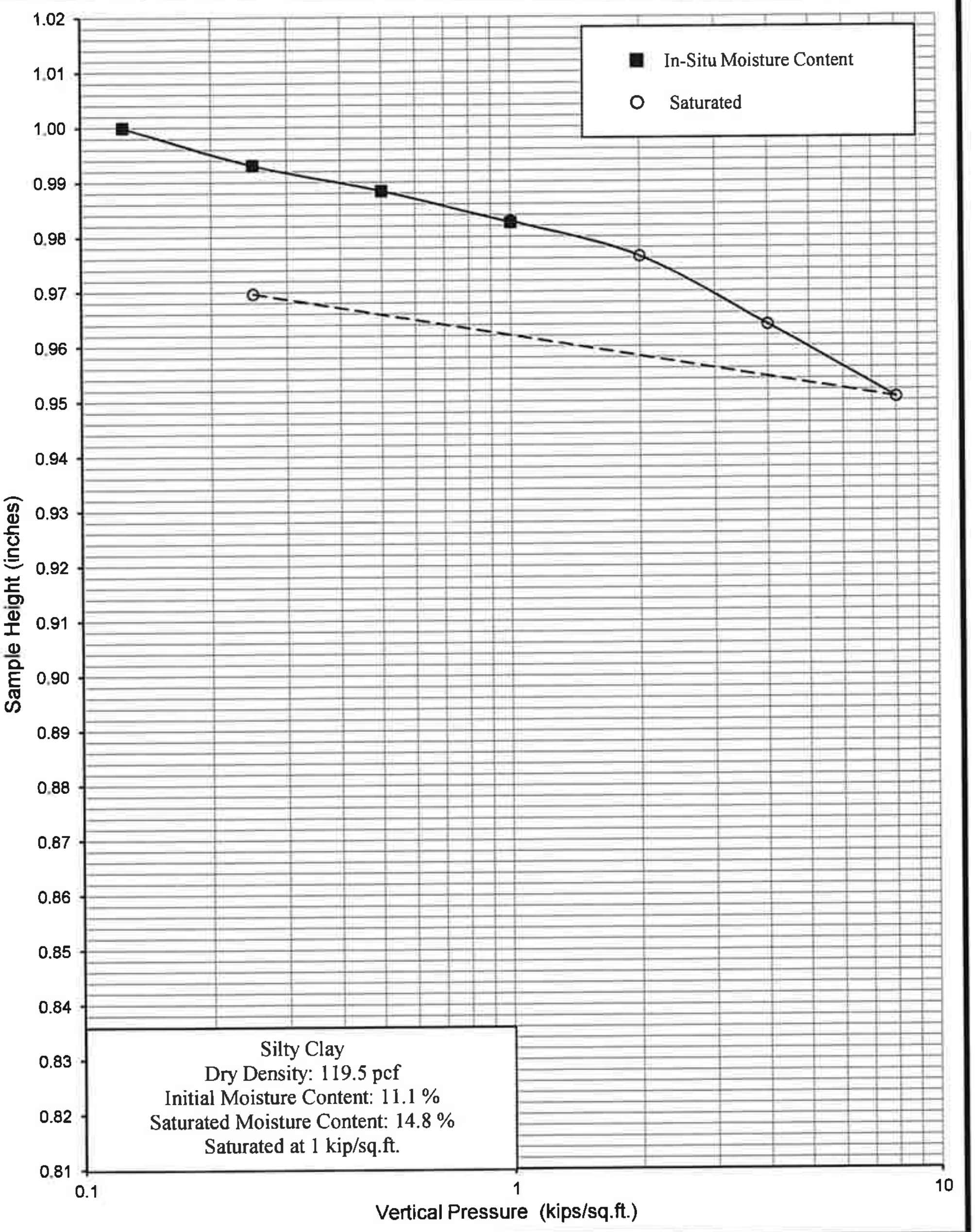
Plate D

Vertical Pressure (kips/sq.ft.)	Sample Height (inches)	Consolidation (percent)	Sample No.	T9	Depth 5'	Date 1/30/2020

0.125	1.0000	0.0
0.25	0.9931	0.7
0.5	0.9884	1.2
1	0.9826	1.7
1	0.9829	1.7
2	0.9764	2.4
4	0.9639	3.6
8	0.9506	4.9
0.25	0.9697	3.0

Saturated

Date Tested: 1/29/2020
Sample: T9
Depth: 5'



Silty Clay
Dry Density: 119.5 pcf
Initial Moisture Content: 11.1 %
Saturated Moisture Content: 14.8 %
Saturated at 1 kip/sq.ft.

NorCal Engineering

SOILS AND GEOTECHNICAL CONSULTANTS

CDREP, LLC

PROJECT NUMBER: 21631-20 DATE: 1/30/2020

CONSOLIDATION TEST

ASTM D2435

Plate E

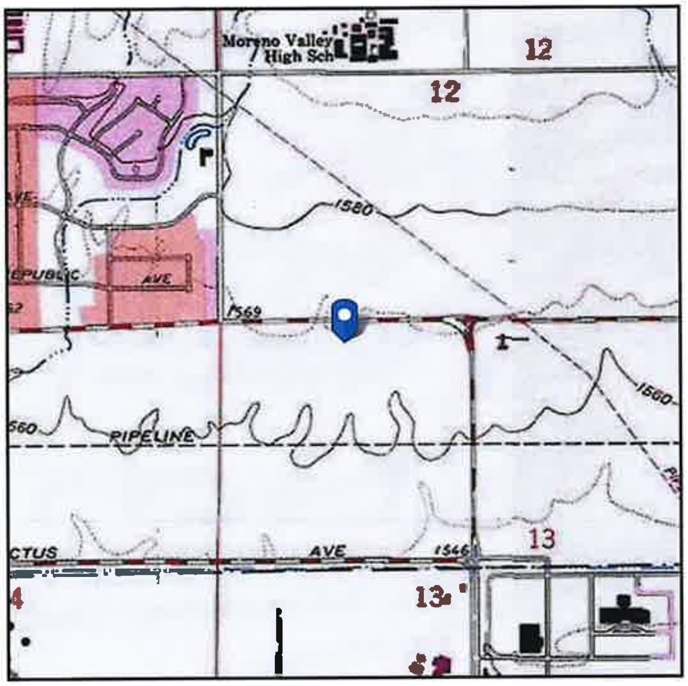
Appendix C

ASCE 7 Hazards Report

Address:
No Address at This Location

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

Elevation: 1570.6 ft (NAVD 88)
Latitude: 33.916457
Longitude: -117.256778



Seismic

Site Soil Class: D - Stiff Soil

Results:

S_S :	1.5	S_{D1} :	N/A
S_1 :	0.6	T_L :	8
F_a :	1	PGA :	0.612
F_v :	N/A	PGA_M :	0.674
S_{MS} :	1.5	F_{PGA} :	1.1
S_{M1} :	N/A	I_e :	1.25
S_{DS} :	1	C_v :	1.4

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

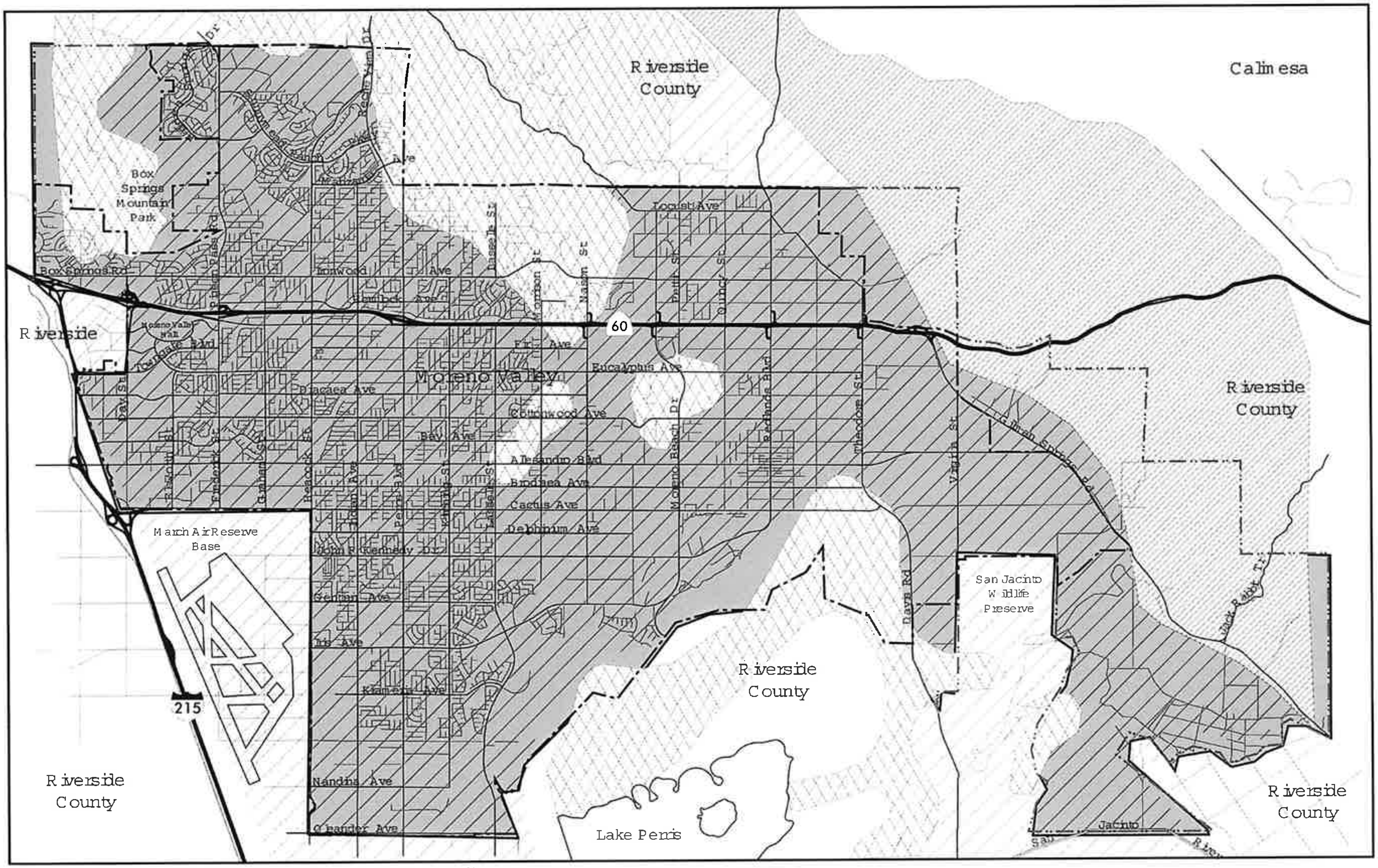
Data Accessed: Tue Jan 28 2020

Date Source: USGS Seismic Design Maps

The ASCE 7 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 7 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.

ASCE does not intend, nor should anyone interpret, the results provided by this Tool to replace the sound judgment of a competent professional, having knowledge and experience in the appropriate field(s) of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the contents of this Tool or the ASCE 7 standard.

In using this Tool, you expressly assume all risks associated with your use. Under no circumstances shall ASCE or its officers, directors, employees, members, affiliates, or agents be liable to you or any other person for any direct, indirect, special, incidental, or consequential damages arising from or related to your use of, or reliance on, the Tool or any information obtained therein. To the fullest extent permitted by law, you agree to release and hold harmless ASCE from any and all liability of any nature arising out of or resulting from any use of data provided by the ASCE 7 Hazard Tool.



Source: Generalized Geologic Map of Part of the Northern Peninsular Ranges, 1985. University of California Riverside, Campus Museum Contributions No.1, page 64.

Note: This map is not a substitute for detailed Alquist-Priolo Special Studies Maps or Riverside County Hazard Management Zone Maps. For Accurate sitings refer to California State and Riverside County Geologists.

0 6,000 12,000 ft

North

▨ Perris Bedrock

▨ Quarternary Alluvium

☐ Semi Consolidated Sandstone, Siltstone and beds of gravel

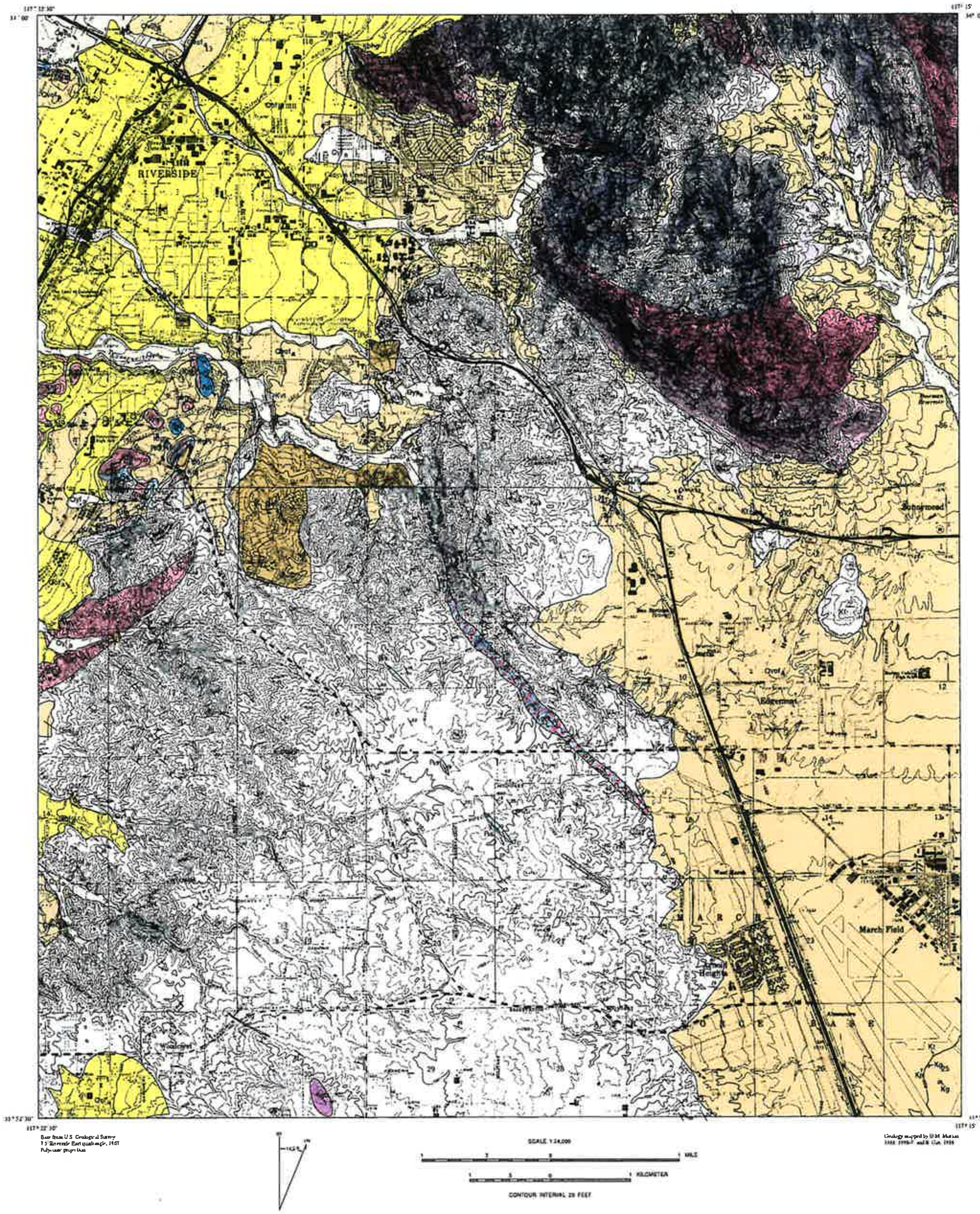
▨ Granite Rocks of the Southern California Batholith

Figure 5.6-1
Geology

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
CALIFORNIA DIVISION OF MINES AND GEOLOGY
and
UNITED STATES AIR FORCE

OPEN-FILE REPORT 01-452



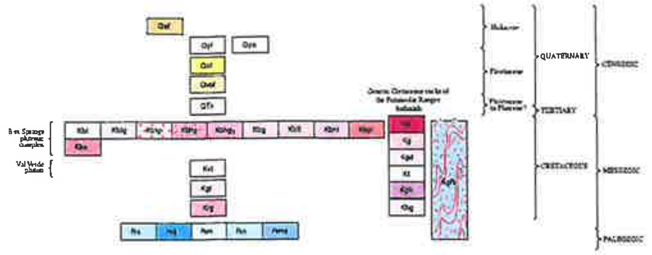
GEOLOGIC MAP OF THE RIVERSIDE EAST 7.5' QUADRANGLE, RIVERSIDE COUNTY, CALIFORNIA

Version 1.0

By

Douglas M. Morton[1] and Brett Cox[2]

CORRELATION OF MAP UNITS



On some SCAMP geologic map plots, including the Riverside East 7.5' quadrangle, characteristic grain size information is displayed using subscripted alpha characters (e.g. Qyf_g, $Qvof_a$), where the characters conform to the following definitions:

a - arenaceous (very coarse sand through very fine sand)
b - boulder gravel (>25mm)
g - gravel (cobble through granule gravel)
s - silty
c - clayey
m - mud
p - peat

In the Description of Map Units, the Ma following U/Pb ages has an attached subscript, Ma_d for isotope dilution analyses, and Ma_p for ion probe analyses.

Contact—Generally located within ±15 meters

Fault—High angle. Strike-slip component on all faults is right-lateral; dip-slip component is unknown, but probably reflects valley-highland relations. Dashed where located within ±30 meters, dotted where concealed. Arrow and number indicate measured dip of fault plane that was exposed in trench.

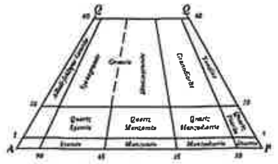
Strike and dip of igneous foliation
70 Inclined
Vertical

Strike and dip of metamorphic foliation
70 Inclined
Vertical

Strike and dip of joints in igneous rocks
70 Inclined
Vertical

Bearing and plunge of linear features
70 Inclined

SURROUNDING 7.5' QUADRANGLES



Classification of plutonic rock types (from IUGA, 1973, and Streckeisen, 1973). A, alkali feldspar; P, plagioclase feldspar; Q, quartz

This map was printed on an electronic plotter directly from digital files. Dimensional calibration may vary between electronic plotters and between X and Y directions on the same plotter, and paper may change size due to atmospheric conditions; therefore, scale and proportions may not be true on plots of this map.

Digital files available on World Wide Web at http://geopubs.wr.usgs.gov

DESCRIPTION OF MAP UNITS

VERY YOUNG SURFICIAL DEPOSITS—Sediment recently transported and deposited in channels and washes, on surfaces of alluvial fans and alluvial plains, and on hillslopes. Soil-profile development is non-existent. Includes:

Qaf **Artificial fill (late Holocene)**—Deposits of fill resulting from human construction or mining activities; restricted to large area of regrading related to residential development in west central part of quadrangle and several smaller areas nearby

YOUNG SURFICIAL DEPOSITS—Sedimentary units that are slightly consolidated to cemented and slightly to moderately dissected. Alluvial fan deposits (Qyf series) typically have high coarse:fine clast ratios. Younger surficial units have upper surfaces that are capped by slight to moderately developed pedogenic-soil profiles (A/C to $A/AC/B_{cambric}C_{ox}$ profiles). Includes:

Qyf **Young alluvial fan deposits (Holocene and late Pleistocene)**—Gray-hued sand and cobble- and gravel-sand deposits derived chiefly from rocks of Peninsular Ranges batholith. Found in restricted drainages along west edge of quadrangle, but contiguous with much more extensively developed deposits west of quadrangle

Qya **Young axial channel deposits (Holocene and late Pleistocene)**—Gray, unconsolidated alluvium consisting of medium- to fine-grained sand and lesser silt flooring several low relief valleys and their tributaries in northwestern and northeastern part of quadrangle. Includes sediments in Tequesquite Arroyo and Pigeon Pass Valley

OLD SURFICIAL DEPOSITS—Sedimentary units that are moderately consolidated and slightly to moderately dissected. Older surficial deposits have upper surfaces that are capped by moderately to well-developed pedogenic soils ($A/AB/B/C_{ox}$ profiles and Bt horizons as much as 1 to 2 m thick and maximum hues in the range of 10YR 5/4 and 6/4 through 7.5YR 6/4 to 4/4 and mature Bt horizons reaching 5YR 5/6). Includes:

Qof **Old alluvial fan deposits (late to middle Pleistocene)**—Indurated, sandy alluvial fan deposits developed extensively in western part of quadrangle. Most of unit is slightly to moderately dissected and reddish-brown. Some Qof includes thin, discontinuous surface layer of Holocene alluvial fan material

VERY OLD SURFICIAL DEPOSITS—Sediments that are slightly to well consolidated to indurated, and moderately to well dissected. Upper surfaces are capped by moderate to well developed pedogenic soils ($A/AB/B/C_{ox}$ profiles having Bt horizons as much as 2 to 3 m thick and maximum hues in the range 7.5YR 6/4 and 4/4 to 2.5YR 5/6)

Qvof **Very old alluvial fan deposits (early Pleistocene)**—Mostly well-dissected, well-indurated, reddish-brown sand deposits. Commonly contains duripans and locally silcretes. Forms large area in southeastern part of quadrangle in area of March Air Force Base, and numerous smaller areas in northern part of quadrangle. Derived chiefly from rocks of southern California batholith

QTs **Unnamed late Cenozoic sedimentary rocks in Riverside and Corona areas (early Pleistocene to late Pliocene?)**—Lithologically diverse, moderately indurated, gray to brown, coarse-grained sandstone, pebbly sandstone, and conglomerate. Restricted to two small areas near southeast end of Box Springs Canyon. In the Riverside West 7.5' quadrangle, most clasts in unit were derived from San Bernardino Mountains. In Riverside East 7.5' quadrangle, appears to be derived from units found in Santa Ana River drainage. Southeast of Riverside, clasts are locally derived from Peninsular Ranges sources

Box Springs plutonic complex (Cretaceous)—Box Springs plutonic complex is an elliptical, horizontally-floored basin-shaped granitic complex centered on Box Springs Mountains, apparently lower part of granitic diapir. Layering and foliation in granitic rocks is primary. Complex consists of essentially massive to indistinctly primary layered biotite tonalite in core, surrounded by layer of foliated biotite granodiorite to tonalite. Further outward in complex is discontinuous layer of foliated, heterogeneous, porphyritic granodiorite, succeeded by uniform porphyritic granodiorite. Other compositionally and texturally diverse granitic rocks also occur within complex, but in relatively small amounts. All rocks of complex were included in Perris quartz diorite by Dudley (1935) and in Bonsall tonalite by Larsen (1948). Except for dike rocks, units are described in general order from core outward. Includes:

Kbt **Biotite tonalite**—Massive, fine- to medium-grained, equigranular biotite tonalite. Much has faintly to moderately developed, very regular compositional layering. Rocks contain about 35 to 40 percent quartz and 6 to 12 percent biotite. Hornblende is absent and potassium feldspar ranges from 1 to 4 percent. Mineral alignment is poorly developed or absent, but much of rock has incipient to well-developed primary layering defined by mineral concentrations. Unit contains sparse equant- to elliptical-shaped, fine-grained, mesocratic inclusions; some have relatively mafic rims. Inclusions tend to be aligned parallel to compositional layering. Zircon ages of rock are 98.6 Ma_d and 100.4 Ma_p

Kblg **Biotite granodiorite and tonalite**—Light gray, medium- to coarse-grained, foliated biotite granodiorite and tonalite. Contains 25 to 35 percent quartz, 8 to 15 percent biotite, and minor hornblende. Potassium feldspar occurs as small interstitial grains and sparse, subhedral phenocrysts up to 1.5 cm in diameter. Potassium feldspar content appears to decrease progressively toward tonalite most abundant in inner part. Mesocratic discoidal inclusions oriented parallel to foliation are common, but not abundant. Grades into biotite tonalite unit (Kbt)

Kblgi **Biotite granodiorite and tonalite containing abundant inclusions**—Biotite granodiorite and tonalite that contains abundant discoidal, mafic inclusions; restricted to east side of complex

Kbhg **Heterogeneous porphyritic granodiorite**—Heterogeneous porphyritic granodiorite and subordinate tonalite. In most places surrounds biotite granodiorite and tonalite unit (Kblg). Pinches out along west side of complex. Medium- to coarse-grained, light gray, foliated, and porphyritic. Quartz ranges from 25 to 35 percent; mafic minerals, biotite and subordinate hornblende, from 10 to 15 percent. Mafic minerals unevenly distributed imparting heterogeneous appearance to rock. Subhedral potassium feldspar crystals are up to 2.5 cm in length. Widespread discoidal mesocratic inclusions oriented parallel to foliation. Cut by numerous dikes of leucocratic granite and pegmatite

Kbhgl **Layered heterogeneous porphyritic granodiorite**—Heterogeneous porphyritic granodiorite having pronounced layering that is defined chiefly by variations in grain size. Restricted to single mass west of Sugarloaf Mtn in north-central part of quadrangle

Kpg **Porphyritic granodiorite**—Coarse-grained, light gray, foliated, porphyritic biotite granodiorite and subordinate tonalite. In most places grades into heterogeneous porphyritic granodiorite unit (Kbhg). Groundmass is plagioclase, quartz (30 to 40 percent), and mafic minerals (5 to 10 percent). Mafic minerals are biotite and sparse hornblende, which are more evenly distributed than in heterogeneous granodiorite (Kbhg). Subhedral potassium feldspar phenocrysts are up to 2.5 cm in length. Discoidal mesocratic inclusions are oriented parallel to foliation

Kbht **Biotite-hornblende tonalite**—Light to medium gray, medium- to coarse-grained, foliated tonalite. Forms discontinuous, pod-shaped masses surrounding, but not in contact with, biotite tonalite (Kbt). Contains 20 to 25 percent quartz and about 25 percent biotite and hornblende in subequal amounts. Hornblende and biotite occur as ragged crystals. Potassium feldspar present, but very sparse. Anhedral, interstitial sphene is conspicuous accessory mineral. Contains abundant, fine-grained, mesocratic, ellipsoidal- to discoidal-shaped mafic inclusions aligned parallel to foliation

Khbt **Heterogeneous biotite tonalite**—Light-gray, inequigranular, medium- to coarse-grained, foliated biotite tonalite; restricted to northwestern Box Springs Mountains. Leucocratic, containing 1 to 4 percent biotite, which occurs as thin, subhedral plates, irregularly concentrated and aligned to produce wispy, swirled foliation. Leucocratic tonalite encloses pods and lenses of tonalite containing about 15 percent biotite as large ragged plates. Both types of tonalite contain abundant quartz (30 to 40 percent) and very sparse potassium feldspar (1 percent or less). Contains dispersed, mesocratic discoidal inclusions. Granitic pegmatite dikes are abundant

Khgt **Heterogeneous granodiorite and tonalite**—Light- to medium-gray, medium- to coarse-grained, texturally heterogeneous, foliated, hornblende-biotite tonalite and granodiorite; restricted to northern Box Springs Mountains near Pigeon Pass. Common discoidal, mesocratic inclusions oriented parallel to foliation

Kba **Amphibolitic gabbro**—Dark-gray to black, fine- to medium-grained, foliated, hornblende-rich amphibolitic gabbro forming lenses and elongate masses within biotite granodiorite and tonalite (Kblg). Foliation is parallel to foliation in that unit

Val Verde pluton (Cretaceous)—Relatively uniform pluton composed of biotite-hornblende tonalite. Termed Perris quartz diorite by Dudley (1935), Val Verde tonalite by Osborn (1939), and included within Bonsall tonalite by Larsen (1948). Name Val Verde adopted by Morton (1999) based on detailed study of Osborn (1939) near Val Verde, a former settlement and railway siding midway between Perris and Riverside. Apparently steep-walled Val Verde pluton is eroded to mid-pluton level. Emplacement age of the pluton is 105.7 Ma_d. $^{40}Ar/^{39}Ar$ age of hornblende is 100 Ma, biotite 95 Ma and potassium feldspar 89.5 Ma. Includes:

Kvt **Val Verde tonalite**—Gray-weathering, relatively homogeneous, massive- to well-foliated, medium- to coarse-grained, hypautomorphic-granular biotite-hornblende tonalite; principal rock type of Val Verde pluton. Contains subequal biotite and hornblende, quartz and plagioclase. Potassium feldspar generally less than two percent of rock. Where present, foliation typically strikes northwest and dips moderately to steeply northeast. Northern part of pluton contains younger, intermittently developed, northeast-striking foliation. In central part of pluton, tonalite is mostly massive, and contains few segregational masses of mesocratic to melanocratic tonalite. Elliptical- to pancake-shaped, meso-to melanocratic inclusions are common.

Krg **Granite of the Riverside area (Cretaceous)**—Medium- to coarse-grained, massive- to faintly-foliated, leucocratic biotite granite. Contains about 1 to 3 percent biotite. Inclusions are sparse or absent except locally in western part of body, west of quadrangle, where rock contains 2 to 8 percent biotite and sparse to abundant inclusions of quartz diorite, granodiorite, and fine-grained mafic rock. At Mount Rubidoux, west of quadrangle, rocks contain sparse hypersthene and fayalitic olivine and moderately abundant equant inclusions of dark-gray fine-grained rock

Generic Cretaceous granitic rocks of the Peninsular Ranges batholith

Kp **Granitic pegmatite dikes (Cretaceous)**—Leucocratic, mostly tabular, pegmatite-textured granitic dikes. Most dikes range in thickness from a few centimeters to over a meter. Larger dikes are typically zoned compositionally and texturally, having a border and wall zone consisting of coarse-grained biotite, quartz, and alkali feldspars. Intermediate zone consists of large to giant crystals of quartz and alkali feldspars, and commonly contain muscovite, schorl, and garnet. Core zone consists of quartz and alkali feldspars. Line-rock layering is rare

Kg **Granitic dikes (Cretaceous)**—Includes texturally diverse group of leucocratic granitic dikes composed mainly of quartz and alkali feldspars. Dikes range in thickness from few centimeters to over a meter and are up to several hundred meters in length. Most are tabular, some are texturally and compositionally unzoned, irregular-shaped bodies. Some dike rock has a foliated or gneissoid fabric. Textures are mostly coarse grained and equigranular granitic, but range from aplitic to pegmatitic. Accessory minerals include biotite, muscovite, and garnet

Kgd **Granodiorite, undifferentiated (Cretaceous)**—Intermediate composition granitic rocks, mainly biotite-hornblende and biotite granodiorite; most is massive and medium grained. Restricted to single area just east of Sycamore Canyon

Kt **Tonalite, undifferentiated (Cretaceous)**—Mainly biotite-hornblende tonalite not associated with specific plutons. Gray, medium-grained, typically foliated. Forms relatively large mass on south side of Box Springs Mountains

Kgb **Gabbro (Cretaceous)**—Mainly hornblende gabbro. Typically brown-weathering, medium-to very coarse-grained hornblende gabbro. Very large poikilitic hornblende crystals in some rocks; locally pegmatitic. Commonly heterogeneous in composition and texture. Includes noritic and dioritic composition rocks. Exposed in southern part of quadrangle and as small masses in biotite granodiorite and tonalite (Kblg)

Khg **Heterogeneous granitic rocks (Cretaceous)**—Includes heterogeneous compositionally diverse granitic rocks mostly of tonalite and granodiorite composition, but includes some monzogranite and gabbro. Mapped in and east of Sycamore Canyon, and near west edge of quadrangle

End rocks of Peninsular Ranges batholith

Kgh **Intermixed Paleozoic(?) schist and gneiss and Cretaceous granitic rocks (Cretaceous and Paleozoic?)**—Intermixed Paleozoic(?) schist and gneiss and Cretaceous granitic rocks, mostly tonalite and granodiorite. Forms elongate mass within Val Verde tonalite (Kvt) west of Sycamore Canyon and small mass south of Tequesquite Arroyo

Pzs **Biotite Schist (Paleozoic?)**—Medium-to dark-gray, fine-grained biotite schist and biotite-quartz-feldspar schist. Locally contains sillimanite and andalusite. Commonly includes minor amounts of quartzite and calc-silicate hornfels. Limited exposures in hills south of Tequesquite Arroyo, and as pendants in Val Verde tonalite

Pzq **Impure quartzite (Paleozoic?)**—Quartzite, impure, light-gray to light-greenish-gray, fine-to medium-grained, layered to massive. Limited exposures in hills south of Tequesquite Arroyo

Pzm **Marble (Paleozoic?)**—Marble; white to light-gray, locally bluish-gray and blue, coarse to extremely coarse grained

Pzc **Calc-silicate rocks (Paleozoic?)**—Heterogeneous, massive to well-layered calc-silicate rocks

Pzms **Marble and schist, undifferentiated (Paleozoic?)**—Intermixed marble, calc-silicate rock, and biotite schist. Mapped on North Hill in northwestern part of quadrangle

GEOLOGIC SUMMARY

The Riverside East quadrangle is located in the northern part of the Peninsular Ranges Province within the central part of the Perris block, a relatively stable, rectangular in plan area located between the Elsinore and San Jacinto fault zones.

The quadrangle is underlain predominantly by Cretaceous plutonic rocks which are part of the composite Peninsular Ranges batholith. Within the quadrangle, the batholithic rocks represent a wide variety of mafic to intermediate composition granitic rocks ranging in composition from monzogranite to gabbro, but tonalite predominates. Most of the granitic rocks are faintly to intensely foliated. Many are heterogeneous and contain varying amounts of meso-and melanocratic discoidal-shaped inclusions. Some rock is composed almost wholly of inclusion material and some are migmatitic. Included within these granitic rocks are a few septa of Paleozoic(?) biotite schist, marble, and subordinate rock of upper amphibolite metamorphic grade.

Metamorphic rocks of Paleozoic(?) age occur primarily in the northwest part of the quadrangle. These rocks include coarse-grained marble bodies that have been quarried in the past. North Hill, at the northwest corner of the quadrangle is the site of the 'Old City' quarry, where tonalite intrudes marble producing pyroxene-hornfels grade garnet-pyroxene skarn. South of Riverside several disconnected bodies of marble, impure quartzite, and calc-silicate rock were quarried at the 'New City' (Victoria Ave) quarry. There, the thicker of the two marble bodies was quarried exposing skarn developed at a contact between the marble and intrusive biotite-hornblende tonalite. The composition of the skarn is highly varied and includes pyroxene-garnet, idocrase, scapolite-pyroxene, and magnetite-pargasite skarns.

Biotite-hornblende tonalite of the relatively large Val Verde pluton dominates the quadrangle west of Interstate 215. In most places this tonalite has a northwest oriented crude to well developed planar fabric produced by oriented biotite and hornblende. In the northern part of the pluton northeast striking planar fabric dominates. Schlieren and massive clots of mafic tonalite occur locally. Discoidal to pancake-shaped mafic inclusions are widespread and are oriented in the plane of the biotite and hornblende. Typically, the planar fabric dips moderately to the northeast, but is locally horizontal to subhorizontal or grades to an isotropic fabric.

Granitic rocks in the northeastern part of the quadrangle are part of the Box Springs plutonic complex. This composite intrusion is an elliptical, flat-floored granitic complex centered on the Box Springs Mountains. The exposed part of the complex is apparently the lowest part of a granitic diapir. In the center of the complex massive to indistinctly primarily layered biotite tonalite grades outward into well foliated biotite tonalite. Further outward the rocks are a heterogeneous assemblage of primarily granodioritic plutonic rocks.

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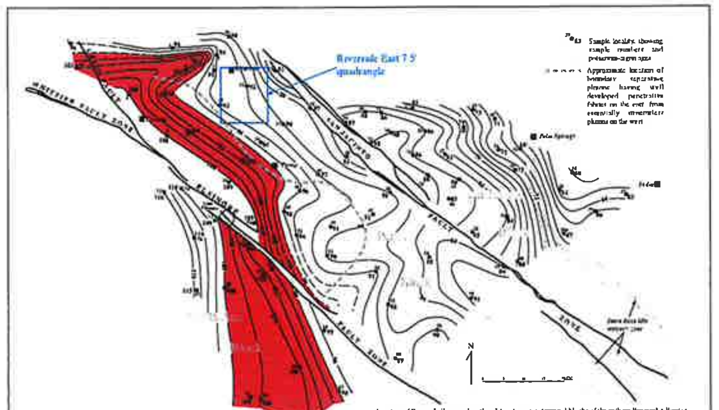
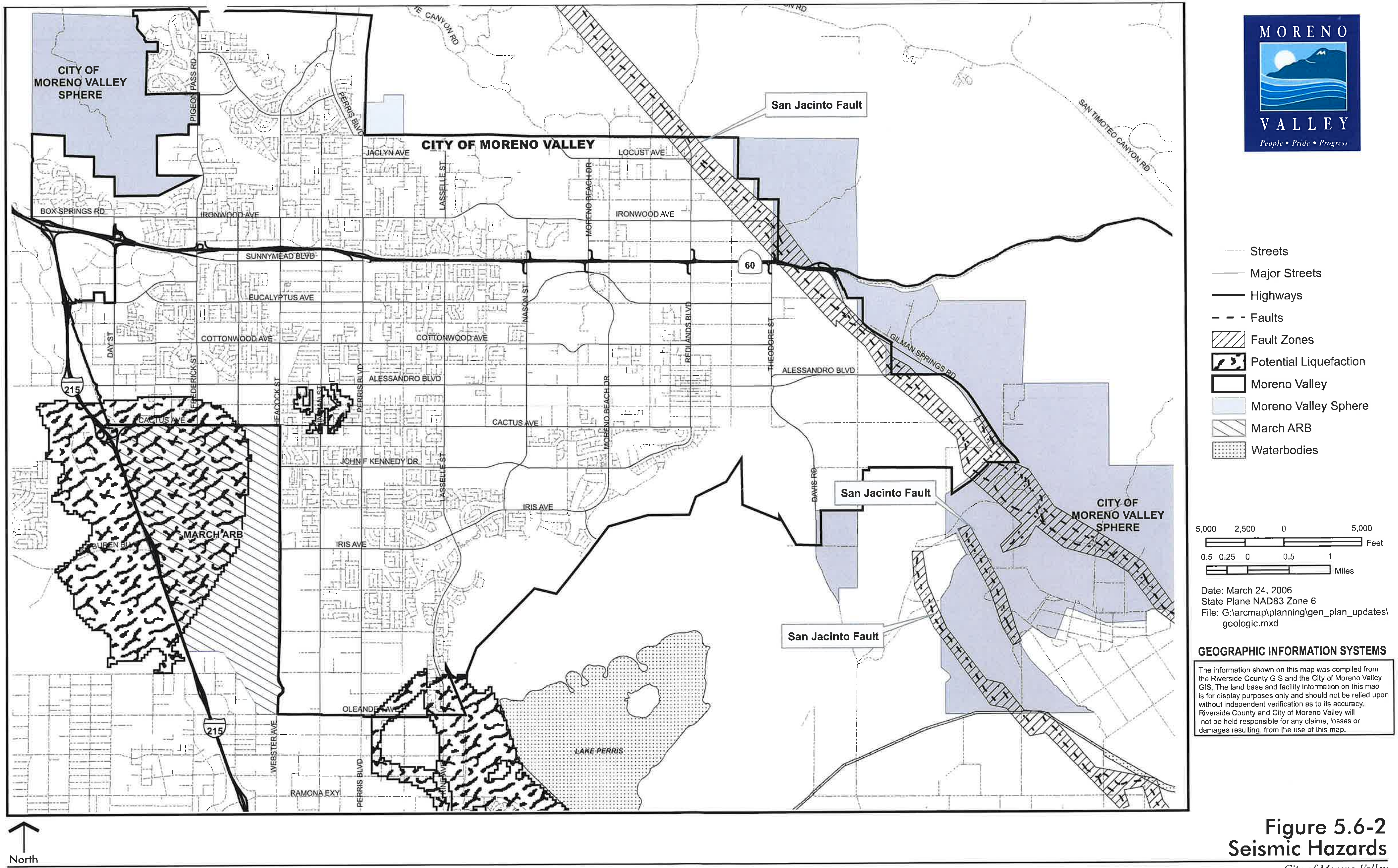


Location of Riverside East quadrangle relative to major structural blocks of the northern Peninsular Ranges batholith. Contoured potassium-argon biotite ages of Cretaceous granitic rocks are hand contoured, and are considered to reflect the cooling history of the batholith rather than representing ages of emplacement. Contouring of ages in each of the three structural blocks separated by the Elsinore and San Jacinto fault zones, was done independently of ages in adjacent blocks. Red band shows offset of 78 to 108 contours across Elsinore fault zone. Faults as shown are simplified from Rogers, 1965



Date: March 24, 2006
State Plane NAD83 Zone 6
File: G:\arcmap\planning\gen_plan_updates\geologic.mxd

GEOGRAPHIC INFORMATION SYSTEMS

The information shown on this map was compiled from the Riverside County GIS and the City of Moreno Valley GIS. The land base and facility information on this map is for display purposes only and should not be relied upon without independent verification as to its accuracy. Riverside County and City of Moreno Valley will not be held responsible for any claims, losses or damages resulting from the use of this map.

Figure 5.6-2
Seismic Hazards

Appendix D

NORCAL
ENGINEERING

SOILS AND GEOTECHNICAL CONSULTANTS

Project: CDREP, LLC
Project No.: 21631-20
Date: 1/20/2020
Test No. 1
Depth: 5’
Tested By: J.S. Jr.

TIME (hr/min)	CHANGE TIME (min)	CUMULATIVE TIME (min)	INNER RING READING (cm)	INNER RING CHANGE	INNER RING FLOW (cc)	OUTER RING READING (cm)	OUTER RING CHANGE	OUTER RING FLOW (cc)	INNER RING INF RATE (cm/hr)	OUTER RING INF RATE (cm/hr)	INNER RING INF RATE (ft/hr)
7:10			105.3			46.4					
7:15	5	5	111.5	6.2		52.8	6.4				
7:15			100.3			41.2					
7:20	5	10	106.4	6.1		47.3	6.1				
7:20			102.6			43.5					
7:25	5	15	108.6	6.0		49.7	6.2				
7:25			103.2			44.2					
7:30	5	20	109.1	5.9		50.3	6.1				
7:30			104.4			45.1					
7:35	5	25	110.4	6.0		51.2	6.1				
7:35			104.1			44.3					
7:40	5	30	109.9	5.8		50.3	6.0				
7:40			103.8			43.9					
7:45	5	35	109.8	6.0		49.9	6.0		72.0	72.0	
7:45			104.3			45.5					
7:50	5	40	110.1	5.8		51.0	5.5		69.6	66.0	
7:50			103.6			44.7					
7:55	5	45	109.3	5.7		50.3	5.6		68.4	67.2	
7:55			103.3			44.1					
8:00	5	50	108.5	5.2		49.4	5.3		62.4	63.6	
8:00			103.1			44.2					
8:05	5	55	108.6	5.5		47.8	5.6		66.0	67.2	
8:05			102.9			43.2					
8:10	5	60	108.2	5.3		48.7	5.5		63.6	66.0	

Average = 67.0 / 67.0 cm/hr

NORCAL
ENGINEERING

SOILS AND GEOTECHNICAL CONSULTANTS

Project: CDREP, LLC
Project No.: 21631-20
Date: 1/20/2020
Test No. 2
Depth: 7.5'
Tested By: J.S. Jr.

TIME (hr/min)	CHANGE TIME (min)	CUMULATIVE TIME (min)	INNER RING READING (cm)	INNER RING CHANGE	INNER RING FLOW (cc)	OUTER RING READING (cm)	OUTER RING CHANGE	OUTER RING FLOW (cc)	INNER RING INF RATE (cm/hr)	OUTER RING INF RATE (cm/hr)	INNER RING INF RATE (ft/hr)
8:15			73.0			45.6					
8:30	15	15	74.4	1.4		46.6	1.0				
8:30			74.4			46.6					
8:45	15	30	75.2	0.8		46.6	0.0				
8:45			75.2			46.6					
9:00	15	45	75.7	0.5		46.7	0.1				
9:00			75.7			46.7					
9:15	15	60	76.1	0.4		46.7	0.0				
9:15			76.1			46.7					
9:30	15	75	76.2	0.1		46.7	0.0				
9:30			76.2			46.7					
9:45	15	90	76.3	0.1		46.8	0.1		0.4	0.4	
9:45			76.3			46.8					
10:00	15	105	76.3	0.0		46.8	0.0		0.0	0.0	
10:00			76.3			46.8					
10:15	15	120	76.3	0.0		46.8	0.0		0.0	0.0	
10:15			76.3			46.8					
10:30	15	135	76.3	0.0		46.8	0.0		0.0	0.0	
10:30			76.3			46.8					
10:45	15	150	76.4	0.1		46.8	0.0		0.4	0.0	
10:45			76.4			46.8					
11:00	15	165	76.5	0.1		46.9	0.1		0.4	0.4	
11:00			76.5			46.9					
11:15	15	180	76.5	0.0		46.9	0.0		0.0	0.0	

Average = 0.17 / 0.11 cm/hr

NORCAL ENGINEERING

SOILS AND GEOTECHNICAL CONSULTANTS

Project: CDREP, LLC	
Project No.: 21631-20	
Date: 1/20/2020	
Test No. 3	
Depth: 10’	
Tested By: D.L.	

TIME (hr/min)	CHANGE TIME (min)	CUMULATIVE TIME (min)	INNER RING READING (cm)	INNER RING CHANGE	INNER RING FLOW (cc)	OUTER RING READING (cm)	OUTER RING CHANGE	OUTER RING FLOW (cc)	INNER RING INF RATE (cm/hr)	OUTER RING INF RATE (cm/hr)	INNER RING INF RATE (ft/hr)
9:06			100.0			42.5					
9:16	10	10	101.2	1.2		46.4	3.9				
9:16			99.9			37.9					
9:26	10	20	100.5	0.6		39.2	1.3				
9:26			100.5			39.2					
9:36	10	30	101.0	0.5		40.3	1.1				
9:36			101.0			40.3					
9:46	10	40	101.7	0.7		41.4	1.1				
9:46			101.7			41.4					
9:56	10	50	102.1	0.4		42.1	0.7				
9:56			102.1			42.1					
10:06	10	60	102.6	0.5		42.8	0.7				
10:06			102.6			42.8					
10:16	10	70	102.8	0.2		43.5	0.7		1.2	4.2	
10:16			102.8			43.5					
10:26	10	80	103.0	0.2		44.5	1.0		1.2	6.0	
10:26			103.0			44.5					
10:36	10	90	103.4	0.4		45.2	0.7		2.4	4.2	
10:36			103.4			45.2					
10:46	10	100	103.8	0.4		45.7	0.5		2.4	3.0	
10:46			103.8			45.7					
10:56	10	110	104.2	0.4		46.3	0.6		2.4	3.6	
10:56			104.2			46.3					
11:06	10	120	104.4	0.2		46.7	0.4		1.2	2.4	

Average = 1.8 / 3.9 cm/hr

SITE LOCATION: ______

GEOTECHNICAL REPORT: ______

GEOLOGY REPORT: ______

DEPTH TO WATER TABLE = 30'

EARTHQUAKE MAGNITUDE = 7.0

PEAK GROUND ACCELERATION = 0.67g

DEPTH BELOW FINAL GRADE (FEET)	MOIST DENSITY (PCF)	σ_o TOTAL STRESS (PSF)	$\bar{\sigma}_o$ EFFECTIVE STRESS (PSF)	$\sigma_o/\bar{\sigma}_o$ (-)	r_d (-)	① $\tau_h/\bar{\sigma}_o$ (-)	N VALUE (BLOWS/FT)	RELATIVE DENSITY (%)	C_N (-)	C_E (-)	C_B (-)	C_R (-)	C_S (-)	$(N_1)_{60}$ (Blows/ft)	FINES (%)	CRR M=7.5	MSF (-)	CRR M=7.0	LIQ. F.S.
5	120	600	Same	1.00	0.99	0.44	>50	>90	>1.6	1.00	1.05	0.70	1.20	>70	21	>0.50	1.25	>0.63	>1.4
10	125	1225	↓	↓	0.96	0.42	36	↓	1.2	↓	↓	0.75	↓	41	47	↓	↓	↓	>1.5
15	130	1875	↓	↓	0.92	0.40	52	↓	1.0	↓	↓	0.85	↓	56	33	↓	↓	↓	>1.6
20	↓	2525	↓	↓	0.87	0.38	30	85	0.9	↓	↓	0.90	↓	31	14	↓	↓	↓	>1.6
25	↓	3175	↓	↓	0.80	0.35	>50	>90	0.82	↓	↓	0.95	↓	49	46	↓	↓	↓	>1.6
30	↓	3825	↓	↓	0.74	0.32	41	85	0.77	↓	↓	1.00	↓	40	45	↓	↓	↓	>1.5
35	↓	4475	4163	1.07	0.68	0.32	42	85	0.74	↓	↓	↓	↓	39	40	↓	↓	↓	>1.5
40	↓	5125	4501	1.14	0.64	0.32	56	>90	0.71	↓	↓	↓	↓	50	48	↓	↓	↓	>1.5
45	↓	5775	4839	1.19	0.61	0.32	46	85	0.68	↓	↓	↓	↓	39	47	↓	↓	↓	>1.5
50	↓	6425	5177	1.24	0.58	0.32	37	70	0.65	↓	↓	↓	↓	30	29	↓	↓	↓	>1.5

① INDUCED CYCLIC STRESS RATIO = $\tau_{ave}/\bar{\sigma}_o = 0.65 \cdot \frac{a_{max}}{g} \cdot \frac{\sigma_o}{\bar{\sigma}_o} \cdot r_d$

- C_E = Corr. - Energy Ratio = Energy Ratio/60%
- C_B = Corr. - Borehole Dia. = 1.15 for 8" dia. borehole
- C_R = Corr. - Rod Length
- C_S = Corr. - Sampling Method

Actual Energy Ratio = 0.67-1.17 (Safety Hammer)
= 0.50-1.00 (Donut Hammer)

Sampling Method = 1.0 Standard sampler
= 1.2 Sampler w/o liners

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PROJECT

DATE

EVALUATION OF LIQUEFACTION POTENTIAL