LOR GEOTECHNICAL GROUP, INC.
Soil Engineering ▲ Geology ▲ Environmental

PRELIMINARY GEOTECHNICAL AND INFILTRATION FEASIBILITY INVESTIGATION PROPOSED IRIS PARK RESIDENTIAL DEVELOPMENT MORENO VALLEY, CALIFORNIA

PROJECT NO. 33591.1
NOVEMBER 25, 2019

Prepared For:

Passco Pacifica, LLC
333 City Boulevard, Suite 1700
Orange, California 92868

Attention: Mr. Oscar Graham

LOR GEOTECHNICAL GROUP, INC.
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November 25, 2019

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Attention: Mr. Oscar Graham

Subject: Preliminary Geotechnical and Infiltration Feasibility Investigation, Proposed Iris Park Residential Development, APN 312-020-025, Moreno Valley, California.

LOR Geotechnical Group, Inc., is pleased to present this report summarizing our geotechnical investigation for the above referenced project. In summary, it is our opinion that the proposed development is feasible from a geotechnical perspective, provided the recommendations presented in the attached report are incorporated into design and construction.

To provide adequate support for the proposed residential structures, we recommend that a compacted fill mat be constructed beneath footings and slabs. The compacted fill mat will provide a dense, high-strength soil layer to uniformly distribute the anticipated foundation loads over the underlying soils. All undocumented fill material and any loose alluvial materials should be removed from structural areas and areas to receive engineered compacted fill. The data developed during this investigation indicates that removals on the order of approximately 5 to 7 feet will be required within the currently planned development areas. The given removal depths are preliminary. The actual depths of the removals should be determined during the grading operation by observation and/or in-place density testing.

Very low expansion potential, fair R-value quality, poor infiltration characteristics, and a negligible soluble sulfate content generally characterize the onsite soil materials tested.

LOR Geotechnical Group, Inc.

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INTRODUCTION

During November of 2019, a Preliminary Geotechnical and Infiltration Feasibility Investigation was performed by LOR Geotechnical Group, Inc., for proposed Iris Park residential development of APN 312-020-025 in the City of Moreno Valley, California. The purpose of this investigation was to conduct a technical evaluation of the geologic setting of the site and to provide geotechnical design recommendations for the proposed improvements. The scope of our services included:

- Review of available pertinent geotechnical literature, reports, maps, and agency information pertinent to the study area;
- Interpretation of aerial photographs of the site and surrounding regions dated 1966 through 2018;
- Geologic field reconnaissance mapping to verify the areal distribution of earth units and significance of surficial features as compiled from documents, literature, and reports reviewed;
- A subsurface field investigation to determine the physical soil conditions pertinent to the proposed development;
- Infiltration testing via the constant head test method at two locations within the approximate area proposed for the infiltration of onsite runoff waters;
- Laboratory testing of selected soil samples obtained during the field investigation;
- Development of geotechnical recommendations for site grading and foundation design; and
- Preparation of this report summarizing our findings, and providing conclusions and recommendations for site development.

The approximate location of the site is shown on the attached Index Map, Enclosure A-1, within Appendix A.

To orient our investigation at the site, you provided us with Site Plan, prepared by IDE Arc Architecture & Planning, undated, that showed the proposed development. As noted on that map, the site will be developed with 84 residential lots and the associated interior streets. An infiltration basin is also proposed. The Site Plan was utilized as a base map for our field investigation and is presented as Enclosure A-2, within Appendix A.

PROJECT CONSIDERATIONS

Information furnished to this firm indicates that the proposed project will consist of the construction of single-family residences.

These will likely be one or two stories in height and are anticipated to be of wood frame construction with an exterior plaster veneer. Light to moderate foundation loads are anticipated with such structures. Cuts and fills on the order of a few feet are anticipated to create the planar building pads.

EXISTING SITE CONDITIONS

The subject site consists of a triangular shaped, relatively flat, vacant area of land that is approximately 10 acres in size. At the time of our investigation, vegetation on the site consisted of a light moderate growth of weeds. The topography of the site is planar, with a very gentle fall towards the southeast.

Iris Avenue, a fully improved roadway, bounds the site on the north followed by a tract of single family residences. A tract of single family residences bounds the site on the east. The California Aqueduct easement comprises the western 100 feet of the site with a shopping center and school beyond. South of the site is a tract of single family homes.

AERIAL PHOTOGRAPH ANALYSIS

The aerial photographs reviewed consisted of vertical aerial stereoscopic photographs of varying scales. We reviewed imagery available from Google Earth (2018) and from Historic Aerials (2019).

The site consisted of vacant land which appeared to be dry land farmed with surrounding properties from 1966, the earliest photograph available, to 1978. The 1997 photograph shows the site as vacant land with some stockpiles of fill material in the northeast corner. Numerous dirt paths are visible in this area. The 2006 photograph shows additional smoothed out fill to the west of the previously noted fill. An earthen berm is present on the north and west side of this area. A minor amount of additional end dumped fill is visible in the 2009 photograph.

Our review of the aerial photographs did not reveal any adverse geologic conditions, such as possible faults or landslides, as being present at or within close proximity to the site.

FIELD EXPLORATION PROGRAM

Our subsurface field exploration program was conducted on November 7, 2019 and consisted of drilling 5 exploratory borings with a truck-mounted Mobile B-61 drill rig equipped with 8-inch diameter hollow stem augers. The borings were drilled to depths of approximately 21 to 51.5 feet below the existing ground surface. The approximate locations of our exploratory borings are presented on the attached Site Plan, Enclosure A-2 within Appendix A.

The subsurface conditions encountered in the exploratory borings were logged by a geologist from this firm. Relatively undisturbed and bulk samples were obtained at a maximum depth interval of 5 feet and returned to our geotechnical laboratory in sealed containers for further testing and evaluation. A detailed description of the field exploration program and the boring logs are presented in Appendix B.

LABORATORY TESTING PROGRAM

Selected soil samples obtained during the field investigation were subjected to laboratory testing to evaluate their physical and engineering properties. Laboratory testing included in-place moisture content and dry density, laboratory compaction characteristics, direct shear, sieve analysis, sand equivalent, R-value, consolidation, expansion index, Atterberg limits, and soluble sulfate content. A detailed description of the laboratory testing program and the test results are presented in Appendix C.

GEOLOGIC CONDITIONS

Regional Geologic Setting

The site is located within the south-central portion of Moreno Valley which lies within the northern end of Perris Valley. This area is located on the Perris block, within the northern Peninsular Ranges geologic province of southern California. While the Perris block is considered to be a relatively stable structural block, it is bounded by active faults. The Perris block is underlain predominately by a very large mass of crystalline igneous rocks of Cretaceous age and older metasedimentary and metavolcanic rocks.

The Perris block has a series of erosional surfaces, marked by low topographic relief and capped with unconsolidated alluvial sediments stripped from the surrounding highlands, such as the Box Spring Mountains and the hills around Lake Perris located east of the site.

These were mapped by the California Division of Mines and Geology as being underlain by deposits of relatively unconsolidated, but weakly to moderately indurated younger to older alluvium (Morton and Matti, 2001 and Morton, 2003).

The nearest known active fault zone is the San Jacinto fault zone located approximately 9.8 kilometers (6.1 miles) to the northeast. Other major faults within the region include the Elsinore fault zone located approximately 26 kilometers (16.2 miles) to the southwest, and San Andreas fault zone located approximately 27 kilometers (17 miles) to the northeast. The site and the regional geologic setting are shown on Enclosure A-3 within Appendix A.

Site Geologic Conditions

Fill/Topsoil: As encountered within the majority of our exploratory borings, fill/topsoil materials on the order of 2 feet thick are present across much of the site. The fill materials were noted to be light brown, dry, and loose silty sand. These materials are most likely the result of weed abatement practices (discing).

Fill: As encountered within our exploratory boring placed in the northeast portion of the site, fill materials on the order of 5 feet are present. These materials consisted of dry, loose, silty sand with some debris and are believed to be end dumped fills noted in our review of aerial photographs.

Older Alluvium: Underlying the fill materials at the site, older alluvial materials were encountered within all of our exploratory borings to the maximum depths explored. These units were noted to consist of silty sand and sandy silt, and lessor amounts unit of well graded sand, clayey sand and lean clay with sand. The older alluvial materials were in a relatively loose to medium dense/stiff state upon first encounter, becoming medium dense/very stiff to dense/hard with depth based on our equivalent Standard Penetration Test (SPT) data and in-place density testing. Consolidation testing of the older alluvial materials indicate normal consolidation/hydro-consolidation characteristics at depths of 7 feet and greater.

A detailed description of the subsurface soil conditions as encountered within our exploratory borings is presented on the Boring Logs within Appendix B.

Groundwater Hydrology

Groundwater was encountered within our exploratory borings B-2 at a depth of approximately 33.5 feet below the existing ground surface.

Records for nearby wells which were readily available from the State of California Department of Water Resources online database (CDWR, 2019) and the Western Municipal Water District Cooperative Well Measurement Program (WMWD, 2019) were reviewed as a part of this investigation. In addition, historic groundwater level data was reviewed from a groundwater contour map prepared by the U.S.G.S. (Carson and Matti, 1985).

According to the State of California Department for Water resources online database, the nearest well with available data is State Well Number 03S03W32B001S located to the southeast, approximately 1.4 kilometers (0.9 miles). In this well, groundwater was last measured at a depth of 21 feet below the ground surface on April 26, 2019. The depth to groundwater in the past was noted to vary slightly over time. Data for this well was presented from 2011 to 2019 and the elevation was listed as 1,476 feet above mean sea level.

Groundwater well data from the Cooperative Well Measuring Program, Spring 2019, indicates that the nearest well is the well noted above and no additional relevant information is presented within this database.

As illustrated on Enclosure A-1, the elevation of the site is approximately 1,495 feet above mean sea level. Based on the information above, groundwater is anticipated to lie approximately 35 feet in the general site area.

Surface Runoff

Current surface runoff of precipitation waters across the site is generally as sheet flow to the south-southeast.

Mass Movement

Mass movement features such as landslides, rockfalls, or debris flows within the site vicinity are not known to exist and no evidence of mass movement was observed on the site or in the vicinity during our review of aerial photographs or reconnaissance.

Faulting

No active or potentially active faults are known to exist at the subject site. In addition, the subject site does not lie within a current State of California Earthquake Fault Zone (Hart and Bryant, 2003).

As previously mentioned, the closest known active fault is the San Jacinto Valley segment of the San Jacinto fault zone, located approximately 9.8 kilometers (6.1 miles) to the northeast. In addition, other relatively close active faults include the Glen Ivy segment of the Elsinore fault zone, located approximately 26 kilometers (16.2 miles) to the southwest, and the San Bernardino segment of the San Andreas fault zone located approximately 27 kilometers (17 miles) to the northeast.

The San Jacinto fault zone is a sub-parallel branch of the San Andreas fault zone, extending from the northwestern San Bernardino area, southward into the El Centro region. This fault has been active in recent times with several large magnitude events. It is believed that the San Jacinto fault is capable of producing an earthquake magnitude on the order of 6.5 or greater.

The Elsinore fault zone is one of the largest in southern California. At its northern end it splays into two segments and at its southern end it is cut by the Yuba Wells fault. The primary sense of slip along the Elsinore fault is right lateral strike-slip. It is believed that the Elsinore fault zone is capable of producing an earthquake magnitude on the order of 6.5 to 7.5.

The San Andreas fault is considered to be the major tectonic feature of California, separating the Pacific Plate and the North American Plate. While estimates vary, the San Andreas fault is generally thought to have an average slip rate on the order of 24mm/yr and capable of generating large magnitude events on the order of 7.5 or greater.

Current standards of practice often include a discussion of all potential earthquake sources within a 100 kilometer (62 mile) radius. However, while there are other large earthquake faults within a 100 kilometer (62 mile) radius of the site, none of these are considered as relevant to the site due to their greater distance and/or smaller anticipated magnitudes.

Historical Seismicity

In order to obtain a general perspective of the historical seismicity of the site and surrounding region a search was conducted for seismic events at and around the area within various radii. This search was conducted utilizing the historical seismic search website of the USGS. This website conducts a search of a user selected cataloged seismic events database, within a specified radius and selected magnitudes, and then plots the events onto a map. At the time of our search, the database contained data from January 1, 1932 through November 20, 2019.

In our first search, the general seismicity of the region was analyzed by selecting an epicenter map listing all events of magnitude 4.0 and greater, recorded since 1932, within a 100 kilometer (62 mile)radius of the site, in accordance with guidelines of the California Division of Mines and Geology. This map illustrates the regional seismic history of moderate to large events. As depicted on Enclosure A-4, within Appendix A, the site lies within a relatively active region associated with the San Andreas fault trending northwest and the northwest trending faulting of the Mojave Desert geomorphic province.

In the second search, the micro seismicity of the area lying within a 15 kilometer (9.3 mile) radius of the site was examined by selecting an epicenter map listing events on the order of 1.0 and greater since 1978. In addition, only the “A” events, or most accurate events were selected. Caltech indicates the accuracy of the “A” events to be approximately 1 km. The results of this search is a map that presents the seismic history around the area of the site with much greater detail, not permitted on the larger map. The reason for limiting the events to the last 40± years on the detail map is to enhance the accuracy of the map. Events recorded prior the mid 1970's are generally considered to be less accurate due to advancements in technology. As depicted on this map, Enclosure A-5, the San Jacinto fault zone appear to be the source of numerous events.

In summary, the historical seismicity of the site entails numerous small to medium magnitude earthquake events occurring around the subject site, predominately associated with the presence of the San Jacinto fault zone. Any future developments at the subject site should anticipate that moderate to large seismic events could occur very near the site.

Secondary Seismic Hazards

Other secondary seismic hazards generally associated with severe ground shaking during an earthquake include liquefaction, seiches and tsunamis, earthquake induced flooding, landsliding and rockfalls, and seismic-induced settlement.

Liquefaction: The potential for liquefaction generally occurs during strong ground shaking within granular, loose, sediments where the groundwater is usually less than 50 feet. The County of Riverside has mapped the overall site area as having low liquefaction potential (TLMA, 2019).

Liquefaction is a process in which strong ground shaking causes saturated soils to lose their strength and behave as a fluid (Matti and Carson, 1991). Ground failure associated with liquefaction can result in severe damage to structures. Soil types susceptible to liquefaction include sand, silty sand, sandy silt, and silt, as well as soils having a plasticity index (PI) less than 7 (Boulanger and Idriss, 2004) and loose soils with a PI less than 12 and a moisture content greater than 85 percent of the liquid limit (Bray and Sancio, 2006). The geologic conditions for increased susceptibility to liquefaction are: 1) shallow groundwater (generally less than 50 feet in depth); 2) the presence of unconsolidated sandy alluvium, typically Holocene in age; and 3) strong ground shaking. All three of these conditions must be present for liquefaction to occur.

Severe seismic shaking may cause dry and non-saturated sands to densify, resulting in settlement expressed at the ground surface. Seismic settlement in dry soils generally occurs in loose sands and silty sands, with cohesive soils being less prone to significant settlement.

A quantitative method using an index called the liquefaction potential index (LPI) was developed and presented by Iwasaki et al. (1978, 1982). The LPI is defined as:

$$LPI = \int_0^{20} F_1 W(z) dz$$

where W(z) = 10 – 0.5z, F_1 = 1 - FS for FS < 1.0, F_1 = 0 for FS > 1.0 and z is the depth below the ground surface in meters. The LPI presents the risk of liquefaction damage as a single value with the following indicators of liquefaction-induced damage:

LPI Range and Damage	
LPI Range	**Damage**
LPI = 0	Liquefaction risk is very low.
0 < LPI ≤ 5	Liquefaction risk is low.
5 < LPI ≤ 15	Liquefaction risk is high.
LPI > 15	Liquefaction risk is very high.

The most recent development for quantitative descriptions of liquefaction-induced surface damage, called "liquefaction vulnerability", was made by Tonkin & Taylor (2013) after the Christchurch earthquakes occurred between 2010 and 2011 and was based on field observations and analyses of approximately 7,500 CPT investigations. A new index, the liquefaction severity number (LSN), was proposed and defined as:

$$LSN = \int \frac{\varepsilon_v}{z} dz$$

where ε_v is the calculated volumetric densification strain in the subject layer from Zhang et al. (2002) and z is the depth to the layer of interest in meters below the ground surface. The typical behaviors of sites with a given LSN are summarized in following table.

LSN Ranges and Observed Land Effects

LSN Range	Predominant Performance
0-10	Little to no expression of liquefaction, minor effects
10-20	Minor expression of liquefaction, some sand boils
20-30	Moderate expression of liquefaction, with sand boils and some structural damage
30-40	Moderate to severe expression of liquefaction, settlement can cause structural damage
40-50	Major expression of liquefaction, undulations and damage to ground surface, severe total and differential settlement of structures
>50	Severe damage, extensive evidence of liquefaction at surface, severe total and differential settlements affecting structures, damage to services

Both LPI and LSN indices were calculated for the soil profiles of Exploratory Boring No. B-2. The results indicate that the liquefaction risk of the site is “very low” to "low" per the LPI index of 0. The site exhibits "little to no expression of liquefaction, minor effects" per the LSN index of 0.

The Idriss and Boulanger (2008) and Pradel (1998) methods were used to evaluate liquefaction-induced settlement and dry sand settlement. As input into our calculations a deaggregated modal moment magnitude of 6.5 and an acceleration of 0.553g were utilized for the representative soil profiles as provided in Boring B-2.

The results indicate that a maximum seismic settlement of less than one-half inch can be anticipated. Based on the relative uniformity of soil materials encountered, differential seismic settlement is anticipated to be approximately one-half of the total seismic settlement. The settlement calculated is accumulated from soil layers to a maximum depth of 50 feet and the result of our analysis is provided in Appendix E.

Seiches/Tsunamis: The potential for the site to be affected by a seiche or tsunami (earthquake generated wave) is considered nil due to the absence of any large bodies of water near the site.

Flooding (Water Storage Facility Failure): There are no large water storage facilities located on or upstream near the site which could possibly rupture during an earthquake and affect the site by flooding.

Seismically-Induced Landsliding: Our research, site reconnaissance and review of aerial imagery of the site and vicinity indicates that there are no known or suspected landslides at the site or in close proximity to the site and, therefore, the potential for seismically-induced landslides occurring at the site is considered very low.

Rockfalls: No large, exposed, loose or unrooted boulders that could affect the integrity of the site are present above the site.

Seismically-Induced Settlement: Settlement generally occurs within areas of loose, granular soils with relatively low density. Since the site is underlain by dense/stiff to dense/hard older alluvial materials, the potential for settlement is considered low. In addition, the earthwork operations recommended to be conducted during the development of the site will mitigate any near surface loose soil conditions.

SOILS AND SEISMIC DESIGN CRITERIA (California Building Code 2016)

Section 1613 of Chapter 16 of the 2016 California Building Code (CBC) contains the procedures and definitions for the calculations of the earthquake loads on structures and non structural components that are permanently attached to structures and their supports and attachments.

It should be noted that the classification of use and occupancy of all proposed structures at the site, and thus design requirements, shall be the responsibility of the structural engineer and the building official.

CBC Earthquake Design Summary

The following earthquake design criteria have been formulated for the site utilizing the source referenced above. However, these values should be reviewed and the final design should be performed by a qualified structural engineer familiar with the region.

CBC 2016 SEISMIC DESIGN SUMMARY* Site Location (WGS 84) 33.8872, -117.2226, Occupancy Category II	
Site Class Definition Chapter 20 ASCE 7	D
S_s Mapped Spectral Response Acceleration at 0.2s Period, (Figure 1613.3.1(1))	1.500
S_1 Mapped Spectral Response Acceleration at 1s Period, (Figure 1613.3.3(2))	0.605
F_a Short Period Site Coefficient at 0.2s Period, (Table 1613.3.3(1))	1.0
F_v Long Period Site Coefficient at 1s Period, (Table 1613.3.3(2))	1.5
S_{MS} Adjusted Spectral Response Acceleration at 0.2s Period, (eq .16-37)	1.500
S_{M1} Adjusted Spectral Response Acceleration at 1s Period, (eq .16-38)	0.907
S_{DS} Design Spectral Response Acceleration at 0.2s Period, (eq .16-39)	1.000
S_{D1} Design Spectral Response Acceleration at 1s Period, (eq .16-40)	0.605
Seismic Design Category - Short Period (Table 1613.3.5(1))	D
Seismic Design Category - Long Period (Table 1613.3.5(2))	D
*Values obtained from OSHPD online U.S. Seismic Design Maps tool	

INFILTRATION TESTING AND TEST RESULTS

Two constant head infiltration tests were conducted within the general area proposed for the infiltration of runoff waters. Testing consisted of two test holes which were excavated using a hollow stem auger drill rig to depths of approximately 5 feet below the existing ground surface. The holes were 8-inches in diameter. Two inches of gravel was placed in the bottom of the holes and perforated plastic liners were placed into each hole. A 2-inch PVC pipe with a preset water level of 0.5 feet was inserted into each liner. A 5-gallon glass bottle was then inverted over each pipe with a vacuum seal in order to maintain a constant 0.5 feet of water with each hole. The volume of water used in a given time period was recorded at various time intervals to establish the infiltration rates.

Infiltration test results are summarized in the following table:

Test No.	Depth (ft.)*	Infiltration Rate** in/hr
I-1	4	0.10
I-2	4	0.10
* depth measured below existing ground surface ** clear water rate		

The results of our infiltration testing are attached as Enclosures D-1 and D-2. The test results indicate poor infiltration characteristics for the soils tested.

CONCLUSIONS

General

This investigation provides a broad overview of the geotechnical and geologic factors which are expected to influence future site planning and development. On the basis of our field investigation and testing program, it is the opinion of LOR Geotechnical Group, Inc., that the proposed development is feasible from a geotechnical standpoint, provided the recommendations presented in this report are incorporated into design and implemented during grading and construction.

The subsurface conditions encountered in our exploratory borings are indicative of the locations explored. The subsurface conditions presented here are not to be construed as being present the same everywhere on the site. If conditions are encountered during the construction of the project which differ significantly from those presented in this report, this firm should be notified immediately so we may assess the impact to the recommendations provided.

Foundation Support

Based upon the field investigation and test data, it is our opinion that the existing fill/topsoil and fill soils will not, in their present condition, provide uniform and/or adequate support for the proposed improvements. Left as is, this condition could cause unacceptable differential and/or overall settlements upon application of the anticipated foundation loads.

To provide adequate support for the proposed structural improvements, we recommend that a compacted fill mat be constructed beneath footings and slabs.

This compacted fill mat will provide a dense, high-strength soil layer to uniformly distribute the anticipated foundation loads over the underlying soils. In addition, the construction of this compacted fill mat will allow for the removal of any undocumented fill soils that are present within the proposed building areas. Conventional foundation systems, using either individual spread footings and/or continuous wall footings, will provide adequate support for the anticipated downward and lateral loads when utilized in conjunction with the recommended fill mat.

Soil Expansiveness

Our laboratory testing found the soils tested to have a very low expansion potential. For very low expansive soils, no specialized construction procedures to resist expansive soil activity are necessary.

Careful evaluation of on-site soils and any import fill for their expansion potential should be conducted during the grading operation.

Sulfate Protection

The results of the soluble sulfate tests conducted on selected subgrade soils expected to be encountered at foundation levels indicate that there is a negligible sulfate exposure to concrete elements in contact with the on site soils per the 2016 CBC. Therefore, no specific recommendations are given for concrete elements to be in contact with the onsite soils.

Infiltration

The results of our field investigation and test data indicates the site soils are not conducive to infiltration or percolation. Therefore, water quality storm water systems should not incorporate on-site infiltration/percolation when determining storm water treatment capacity.

Geologic Mitigations

No special geologic recommendation methods are deemed necessary at this time, other than the geotechnical recommendations provided in the following sections.

Seismicity

Seismic ground rupture is generally considered most likely to occur along pre-existing active faults. Since no known faults are known to exist at, or project into the site, the probability of ground surface rupture occurring at the site is considered nil.

Due to the site's close proximity to the faults described above, it is reasonable to expect a strong ground motion seismic event to occur during the lifetime of the proposed development on the site. Large earthquakes could occur on other faults in the general area, but because of their lesser anticipated magnitude and/or greater distance, they are considered less significant than the faults described above from a ground motion standpoint.

The effects of ground shaking anticipated at the subject site should be mitigated by the seismic design requirements and procedures outlined in Chapter 16 of the California Building Code. However, it should be noted that the current building code requires the minimum design to allow a structure to remain standing after a seismic event, in order to allow for safe evacuation. A structure built to code may still sustain damage which might ultimately result in the demolishing of the structure (Larson and Slosson, 1992).

RECOMMENDATIONS

Geologic Recommendations

No special geologic recommendation methods are deemed necessary at this time, other than the geotechnical recommendations provided in the following sections.

General Site Grading

It is imperative that no clearing and/or grading operations be performed without the presence of a qualified geotechnical engineer. An on-site, pre-job meeting with the owner, the developer, the contractor, and geotechnical engineer should occur prior to all grading related operations. Operations undertaken at the site without the geotechnical engineer present may result in exclusions of affected areas from the final compaction report for the project.

Grading of the subject site should be performed in accordance with the following recommendations as well as applicable portions of the California Building Code, and/or applicable local ordinances.

All areas to be graded should be stripped of significant vegetation and other deleterious materials.

It is our recommendation that any existing fills under any proposed flatwork and/or paved areas be removed and replaced with engineered compacted fill. If this is not done, premature structural distress (settlement) of the flatwork and pavement may occur. Any undocumented fills encountered during grading should be completely removed and cleaned of significant deleterious materials. These may then be reused as compacted fill.

Cavities created by removal of undocumented fill soils and/or subsurface obstructions should be thoroughly cleaned of loose soil, organic matter and other deleterious materials, shaped to provide access for construction equipment, and backfilled as recommended in the following Engineered Compacted Fill section of this report.

Initial Site Preparation

Any and all existing uncontrolled fills and any loose/soft native alluvial soils should be removed from structural areas and areas to receive structural fills. The data developed during this investigation indicates that removals on the order of 5 to 7 feet will be required to encounter competent older alluvium. However, deeper removals may be required locally. Removals should extend horizontally at a distance equal to the depth of the removals plus proposed fill and at least a minimum of 5 feet. The actual depths of removals should be determined during the grading operation by observation and/or by in-place density testing.

Preparation of Fill Areas

After completion of the removals described above and prior to placing fill, the surfaces of all areas to receive fill should be scarified to a depth of at least 6 inches. The scarified soil should be brought to near optimum moisture content and compacted to a relative compaction of at least 90 percent (ASTM D 1557).

Preparation of Foundation Areas

All footings should rest upon a minimum of 24 inches of properly compacted fill material placed over competent natural alluvial soils. In areas where the required fill thickness is not accomplished by the removal of unsuitable soils, the footing areas should be further subexcavated to a depth of at least 24 inches below the proposed footing base grade, with the subexcavation extending at least 5 feet beyond the footing lines. The bottom of this excavation should then be scarified to a depth of at least 6 inches, brought to near optimum moisture content, and recompacted to at least 90 percent relative compaction (ASTM D 1557) prior to refilling the excavation to grade as properly compacted fill. Fill areas should not be constructed so as to place structures across any area where the maximum depth of fill to minimum depth of fill is greater than a 3:1 ratio.

To provide adequate support, concrete slabs-on-grade should bear on a minimum of 24 inches of compacted soil. The final pad surfaces should be rolled to provide smooth, dense surfaces upon which to place the concrete.

Engineered Compacted Fill

The on-site soils should provide adequate quality fill material, provided they are free from organic matter and other deleterious materials. Unless approved by the geotechnical engineer, rock or similar irreducible material with a maximum dimension greater than 6 inches should not be buried or placed in fills.

Import fill, if required, should be inorganic, non-expansive granular soils free from rocks or lumps greater than 6 inches in maximum dimension. Sources for import fill should be approved by the geotechnical engineer prior to their use.

Fill should be spread in maximum 8-inch uniform, loose lifts, with each lift brought to near optimum moisture content prior to, during and/or after placement, and compacted to a relative compaction of at least 90 percent in accordance with ASTM D 1557.

Based upon the relative compaction of the near surface soils determined during this investigation and the relative compaction anticipated for compacted fill soil, we estimate a compaction shrinkage factor of approximately 10 to 15 percent. Therefore, 1.10 to 1.15 cubic yards of in-place materials would be necessary to yield one cubic yard of properly compacted fill material. Subsidence is anticipated to be 0.10 feet. These values are for estimating purposes only, and are exclusive of losses due to stripping or the removal of subsurface obstructions.

These values may vary due to differing conditions within the project boundaries and the limitations of this investigation. Shrinkage should be monitored during construction. If percentages vary, provisions should be made to revise final grades or adjust quantities of borrow or export.

Short-Term Excavations

Following the California Occupational and Safety Health Act (CAL-OSHA) requirements, excavations 5 feet deep and greater should be sloped or shored. All excavations and shoring should conform to CAL-OSHA requirements.

Short-term excavations 5-feet deep and greater shall conform to Title 8 of the California Code of Regulations, Construction Safety Orders, Section 1504 and 1539 through 1547. Based on our exploratory borings, it appears that Type C soil is the predominant type of soil on the project and all short-term excavations should be based on this type of soil. Deviation from the standard short-term slopes are permitted using Option 4, Design by a Registered Professional Engineer (Section 1541.1).

Short-term slope construction and maintenance are the responsibility of the contractor, and should be a consideration of his methods of operation and the actual soil conditions encountered.

Slope Construction

Preliminary data indicates that cut and fill slopes should be constructed no steeper than two horizontal to one vertical. Fill slopes should be overfilled during construction and then cut back to expose fully compacted soil. A suitable alternative would be to compact the slopes during construction, then roll the final slopes to provide dense, erosion-resistant surfaces.

Slope Protection

Since the site soils are susceptible to erosion by running water, measures should be provided to prevent surface water from flowing over slope faces. Slopes at the project should be planted with a deep rooted ground cover as soon as possible after completion. The use of succulent ground covers such as iceplant or sedum is not recommended. If watering is necessary to sustain plant growth on slopes, the watering system should be monitored to assure proper operation and to prevent over watering.

Foundation Design

If the site is prepared as recommended, the proposed structures may be safely founded on conventional shallow foundations, either individual spread footings and/or continuous wall footings, bearing on a minimum of 24 inches of engineered compacted fill.

All foundations should have a minimum width of 12 inches and should be established a minimum of 12 inches below lowest adjacent grade.

For the minimum width and depth, spread foundations may be designed using an allowable bearing pressure of 1,800 psf. This bearing pressure may be increased by 400 psf for each additional foot of width, and by 400 psf for each additional foot of depth, up to a maximum of 4,000 psf. For example, a footing 3 feet wide and embedded 2 feet will have an allowable bearing pressure of 3,000 psf.

The above values are net pressures; therefore, the weight of the foundations and the backfill over the foundations may be neglected when computing dead loads. The values apply to the maximum edge pressure for foundations subjected to eccentric loads or overturning. The recommended pressures apply for the total of dead plus frequently applied live loads, and incorporate a factor of safety of at least 3.0. The allowable bearing pressures may be increased by one-third for temporary wind or seismic loading. The resultant of the combined vertical and lateral seismic loads should act within the middle one-third of the footing width. The maximum calculated edge pressure under the toe of foundations subjected to eccentric loads or overturning should not exceed the increased allowable pressure. Buildings should be setback from slopes in accordance with the California Building Code.

Resistance to lateral loads will be provided by passive earth pressure and base friction. For footings bearing against compacted fill, passive earth pressure may be considered to be developed at a rate of 400 pounds per square foot per foot of depth. Base friction may be computed at 0.30 times the normal load. Base friction and passive earth pressure may be combined without reduction. These values are for dead load plus live load and may be increased by one-third for wind or seismic loading.

Settlement

Total settlement of individual foundations will vary depending on the width of the foundation and the actual load supported. Maximum settlement of shallow foundations designed and constructed in accordance with the preceding recommendations are estimated to be on the order of 0.5 inch. Differential settlements between adjacent footings should be about one-half of the total settlement. Settlement of all foundations is expected to occur rapidly, primarily as a result of elastic compression of supporting soils as the loads are applied, and should be essentially completed shortly after initial application of the loads.

Building Area Slab-On-Grade

Concrete floor slabs should bear on a minimum of 24 inches of engineered compacted fill placed over competent native materials. The final pad surfaces should be rolled to provide smooth, dense surfaces upon which to place the concrete.

Slabs to receive moisture-sensitive coverings should be provided with a moisture vapor barrier. This barrier may consist of an impermeable membrane. Two inches of sand over the membrane will reduce punctures and aid in obtaining a satisfactory concrete cure. The sand should be moistened just prior to placing of concrete. The slabs should be protected from rapid and excessive moisture loss which could result in slab curling. Careful attention should be given to slab curing procedures, as the site area is subject to large temperature extremes, humidity, and strong winds.

Exterior Flatwork

To provide adequate support, exterior flatwork improvements should rest on a minimum of 12 inches of soil compacted to at least 90 percent (ASTM D 1557).

Flatwork surface should be sloped a minimum of 1 percent away from buildings and slopes, to approved drainage structures.

Wall Pressures

The design of footings for retaining structures should be performed in accordance with the recommendations described earlier under Preparation of Foundation Areas and Foundation Design. For design of retaining wall footings, the resultant of the applied loads should act in the middle one-third of the footing, and the maximum edge pressure should not exceed the basic allowable value without increase.

For design of retaining walls unrestrained against movement at the top, we recommend an equivalent fluid density of 48 pounds per cubic foot (pcf) be used. This assumes level backfill consisting of recompacted, non-expansive, native soils placed against the structures and with the backcut slope extending upward from the base of the stem at 35 degrees from the vertical or flatter.

To avoid overstressing or excessive tilting during placement of backfill behind walls, heavy compaction equipment should not be allowed within the zone delineated by a 45 degree line extending from the base of the wall to the fill surface.

The backfill directly behind the walls should be compacted using light equipment such as hand operated vibrating plates and rollers. No material larger than 3-inches in diameter should be placed in direct contact with the wall.

Wall pressures should be verified prior to construction, when the actual backfill materials and conditions have been determined. Recommended pressures are applicable only to level, non-expansive, properly drained backfill (with no additional surcharge loadings).

If inclined backfills are proposed, this firm should be contacted to develop appropriate active earth pressure parameters. Toe bearing pressure for non-structural walls on soils, not prepared as described earlier under Preparation of Foundation Areas, should not exceed California Building Code values.

Sulfate Protection

The results of the soluble sulfate tests conducted on selected subgrade soils expected to be encountered at foundation levels are presented on Enclosure C.

Based on the test results it appears that there is a negligible sulfate exposure to concrete elements in contact with on site soils. The CBC, therefore, does not recommend special design criteria for concrete elements in conduct with such materials.

Preliminary Pavement Design

Testing and design for preliminary on-site pavement was conducted in accordance with the California Highway Design Manual. Based upon our preliminary sampling and testing, and upon Traffic Index indicated by the City of Moreno Valley Standard Plans (2018), it appears that the structural section tabulated below should provide satisfactory pavement for the subject pavement improvements:

AREA	T.I.	DESIGN R-VALUE	PRELIMINARY SECTION
Local Street	6.0	30	0.35’ AC*/0.70' CAB
AC - Asphalt Concrete CAB - Crushed Aggregate Base * City of Moreno Valley minimum			

The above structural section is predicated upon 90 percent relative compaction (ASTM D 1557) of all utility trench backfills and 95 percent relative compaction (ASTM D 1557) of the upper 12 inches of pavement subgrade soils and of any aggregate base utilized.

In addition, the aggregate base should meet specifications for Crushed Aggregate Base.

In areas of the pavement which will receive high abrasion loads due to start-ups and stops, or where trucks will move on a tight turning radius, consideration should be given to installing concrete pads. Such pads should be a minimum of 0.5-foot thick concrete, with a 0.35-foot thick aggregate base. Concrete pads are also recommended in areas adjacent to trash storage areas where heavier loads will occur due to operation of trucks lifting trash dumpsters.

It should be noted that all of the above pavement design was based upon the results of preliminary sampling and testing, and should be verified by additional sampling and testing during construction when the actual subgrade soils are exposed.

Infiltration

Based upon our field investigation and infiltration test data, the site soils are not considered suitable for infiltration or percolation. Therefore water quality storm water systems should not incorporate on-site infiltration/percolation when determining storm water treatment capacity.

Construction Monitoring

Post investigative services are an important and necessary continuation of this investigation. Project plans and specifications should be reviewed by the project geotechnical consultant prior to construction to confirm that the intent of the recommendations presented herein have been incorporated into the design. Additional expansion index, R-value, and soluble sulfate testing may be required during site rough grading.

During construction, sufficient and timely geotechnical observation and testing should be provided to correlate the findings of this investigation with the actual subsurface conditions exposed during construction. Items requiring observation and testing include, but are not necessarily limited to, the following:

1. Site preparation-stripping and removals.

2. Excavations, including approval of the bottom of excavation prior to filling.

3. Scarifying and recompacting prior to fill placement.

4. Subgrade preparation for pavements and slabs-on-grade.

5. Placement of engineered compacted fill and backfill, including approval of fill materials and the performance of sufficient density tests to evaluate the degree of compaction being achieved.

6. Foundation excavations.

LIMITATIONS

This report contains geotechnical conclusions and recommendations developed solely for use by Passco Pacifica, LLC, and their design consultants, for the purposes described earlier. It may not contain sufficient information for other uses or the purposes of other parties. The contents should not be extrapolated to other areas or used for other facilities without consulting LOR Geotechnical Group, Inc.

The recommendations are based on interpretations of the subsurface conditions concluded from information gained from subsurface explorations and a surficial site reconnaissance. The interpretations may differ from actual subsurface conditions, which can vary horizontally and vertically across the site. If conditions are encountered during the construction of the project which differ significantly from those presented in this report, this firm should be notified immediately in order that we may assess the impact to the recommendations provided.

Due to possible subsurface variations, all aspects of field construction addressed in this report should be observed and tested by the project geotechnical consultant.

If parties other than LOR Geotechnical Group, Inc., provide construction monitoring services, they must be notified that they will be required to assume responsibility for the geotechnical phase of the project being completed by concurring with the recommendations provided in this report or by providing alternative recommendations.

The report was prepared using generally accepted geotechnical engineering practices under the direction of a state licensed geotechnical engineer. No warranty, expressed or implied, is made as to conclusions and professional advice included in this report. Any persons using this report for bidding or construction purposes should perform such independent investigations as deemed necessary to satisfy themselves as to the surface and subsurface conditions to be encountered and the procedures to be used in the performance of work on this project.

TIME LIMITATIONS

The findings of this report are valid as of this date. Changes in the condition of a property can, however, occur with the passage of time, whether they be due to natural processes or the work of man on this or adjacent properties. In addition, changes in the Standards-of-Practice and/or Governmental Codes may occur. Due to such changes, the findings of this report may be invalidated wholly or in part by changes beyond our control. Therefore, this report should not be relied upon after a significant amount of time without a review by LOR Geotechnical Group, Inc. verifying the suitability of the conclusions and recommendations.

CLOSURE

It has been a pleasure to assist you with this project. We look forward to being of further assistance to you as construction begins. Should conditions be encountered during construction that appear to be different than as indicated by this report, please contact this office immediately in order that we might evaluate these conditions.

Should you have any questions regarding this report, please do not hesitate to contact our office at your convenience.

Respectfully submitted,
LOR Geotechnical Group, Inc.

Andrew A. Tardie
Staff Geologist

Robert M. Markoff, CEG
Engineering Geologist

John P. Leuer, GE 2030
President

AAT:RMM:JPL:ss

Distribution: Addressee (4) and PDF via email oscar@pacificainvest.com

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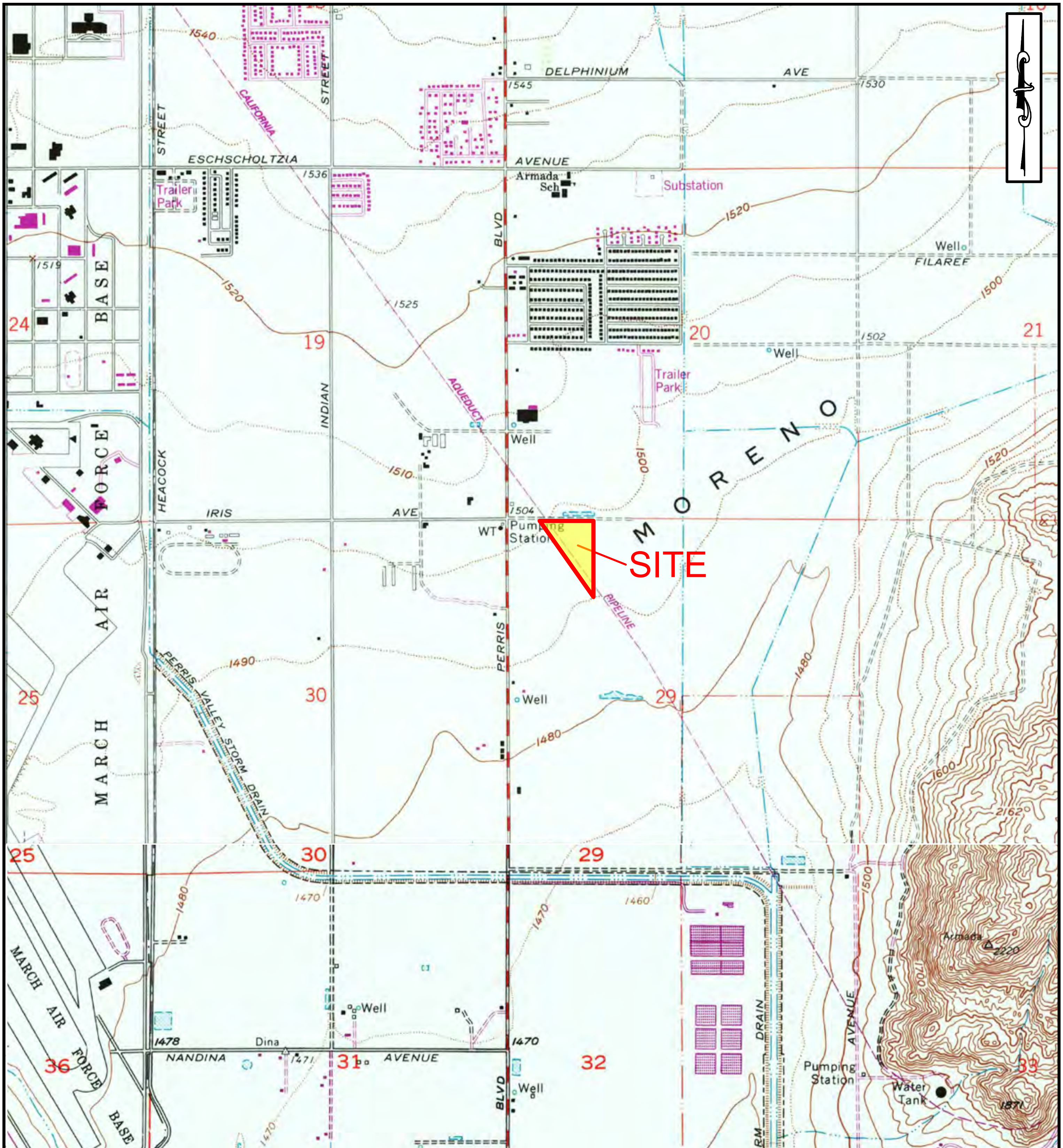
APPENDIX A

Index Map, Site Plan, Regional Geologic Map and Historical Seismicity Maps

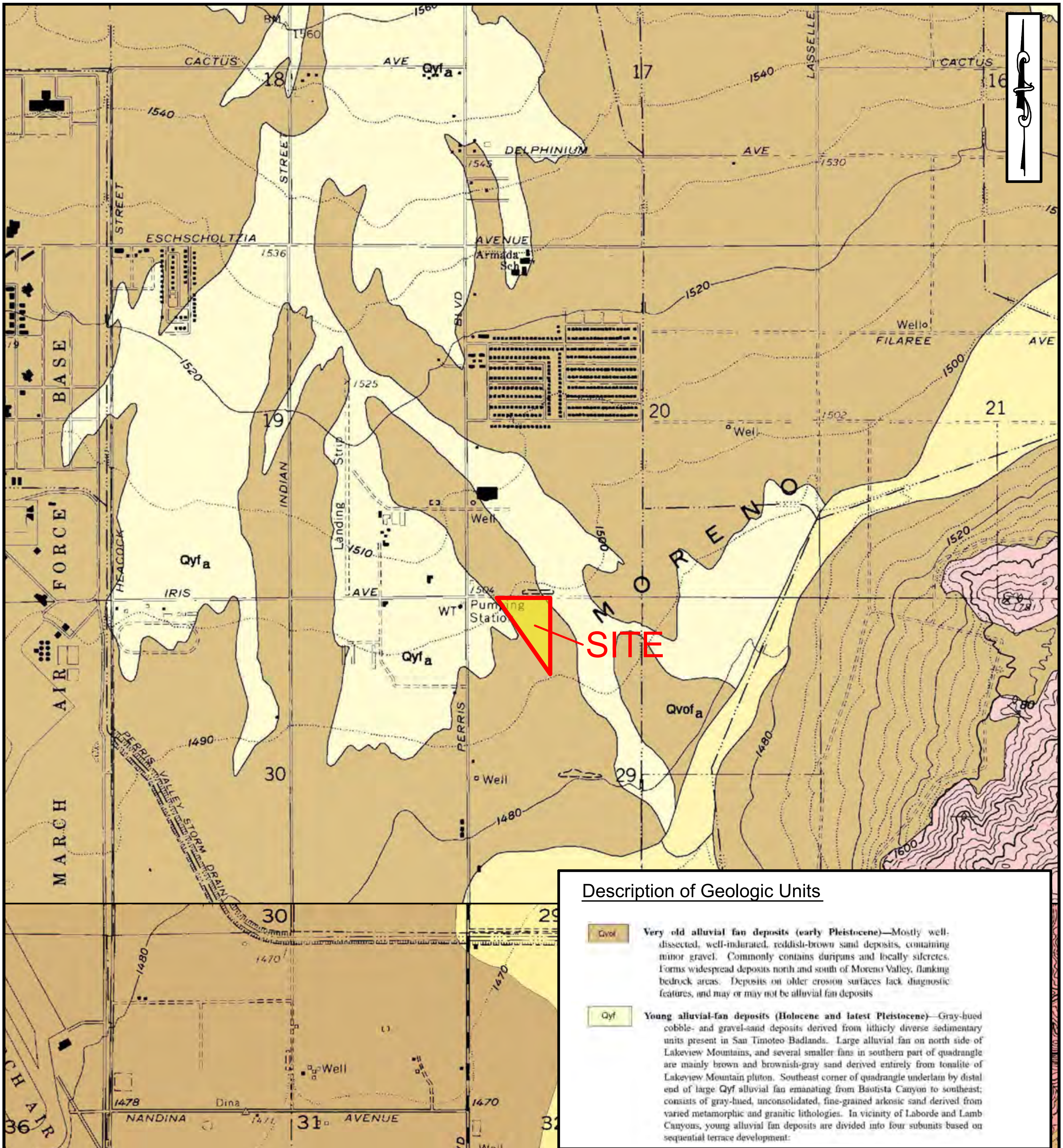


INDEX MAP

PROJECT:	IRIS PARK, MORENO VALLEY, CALIFORNIA	**PROJECT NO:**	33591.1
CLIENT:	PASSCO PACIFICA, LLC	**ENCLOSURE:**	A-1
LOR Geotechnical Group, Inc.		**DATE:**	NOVEMBER 2019
		SCALE:	1" = 2,000'

SITE PLAN

PROJECT:	IRIS PARK, MORENO VALLEY, CALIFORNIA	**PROJECT NO:**	33591.1
CLIENT:	PASSCO PACIFICA, LLC	**ENCLOSURE:**	A-2
LOR Geotechnical Group, Inc.		**DATE:**	NOVEMBER 2019
		SCALE:	1" ≈ 200'

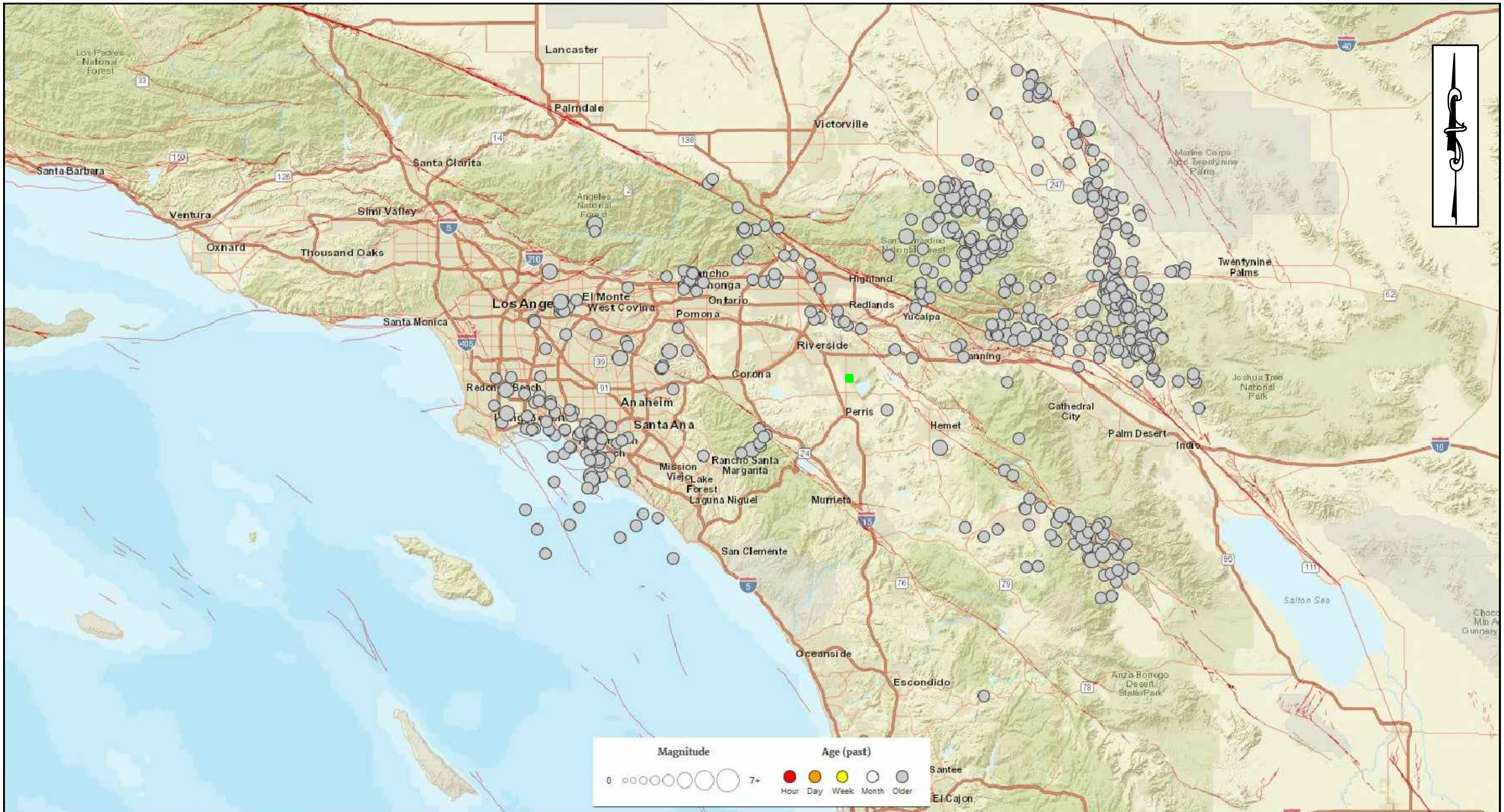


Description of Geologic Units

Qvof	**Very old alluvial fan deposits (early Pleistocene)**—Mostly well-dissected, well-indurated, reddish-brown sand deposits, containing minor gravel. Commonly contains duripans and locally silcretes. Forms widespread deposits north and south of Moreno Valley, flanking bedrock areas. Deposits on older erosion surfaces lack diagnostic features, and may or may not be alluvial fan deposits
Qyf	**Young alluvial-fan deposits (Holocene and latest Pleistocene)**—Gray-hued cobble- and gravel-sand deposits derived from lithicly diverse sedimentary units present in San Timoteo Badlands. Large alluvial fan on north side of Lakeview Mountains, and several smaller fans in southern part of quadrangle are mainly brown and brownish-gray sand derived entirely from tonalite of Lakeview Mountain pluton. Southeast corner of quadrangle underlain by distal end of large Qyf alluvial fan emanating from Bautista Canyon to southeast; consists of gray-hued, unconsolidated, fine-grained arkosic sand derived from varied metamorphic and granitic lithologies. In vicinity of Laborde and Lamb Canyons, young alluvial fan deposits are divided into four subunits based on sequential terrace development:

REGIONAL GEOLOGIC MAP (Morton, 2003 & Morton & Matti, 2001)

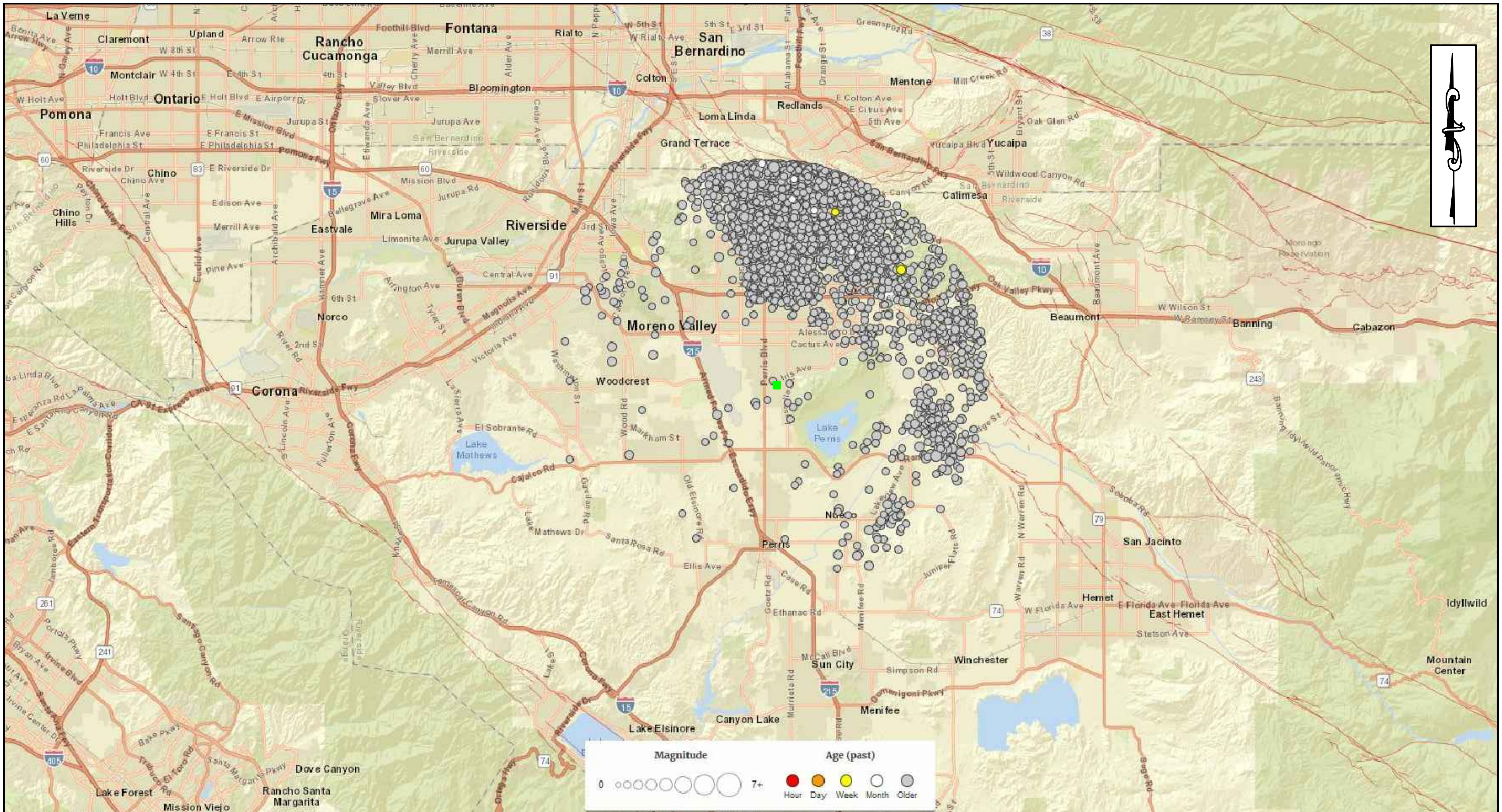
PROJECT:	IRIS PARK, MORENO VALLEY, CALIFORNIA	**PROJECT NO:**	33591.1
CLIENT:	PASSCO PACIFICA, LLC	**ENCLOSURE:**	A-3
LOR Geotechnical Group, Inc.		**DATE:**	NOVEMBER 2019
		SCALE:	1" = 2,000'



U.S. Geologic Survey (2017a) real-time earthquake epicenter map. Plotted are 544 epicenters of instrument-recorded events from 1978 to present (11/20/19) of local magnitude M4.0 or greater within a radius of ~62 miles (100 kilometers) of the site. Location accuracy varies. The site is indicated by the green square. The selected magnitude corresponds to a threshold intensity value where very light damage potential begins. These evens are also generally widely felt by persons. Red lines mark the surface traces of known Quaternary-age faults.

HISTORICAL SEISMICITY MAP - 100km Radius

PROJECT:	IRIS PARK, MORENO VALLEY, CALIFORNIA	**PROJECT NO:**	33591.1
CLIENT:	PASSCO PACIFICA, LLC	**FIGURE:**	A-4
LOR Geotechnical Group, Inc.		**DATE:**	NOVEMBER 2019
		SCALE:	1" ≈ 40km



U.S. Geologic Survey (2017a) real-time earthquake epicenter map. Plotted are 4,945 epicenters of instrument-recorded events from 1932 to present (11/20/19) of local magnitude M1.0 or greater within a radius of ~9.3 miles (15 kilometers) of the site. Location accuracy varies. The site is indicated by the green square. Red lines mark the surface traces of known Quaternary-age faults.

HISTORICAL SEISMICITY MAP - 15km Radius

PROJECT:	IRIS PARK, MORENO VALLEY, CALIFORNIA	**PROJECT NO:**	33591.1
CLIENT:	PASSCO PACIFICA, LLC	**FIGURE:**	A-5
LOR Geotechnical Group, Inc.		**DATE:**	NOVEMBER 2019
		SCALE:	1" ≈ 10km

APPENDIX B

Field Investigation Program and Boring Logs

APPENDIX B
FIELD INVESTIGATION

Subsurface Exploration

The site was investigated on November 7, 2019 and consisted of advancing 5 exploratory borings to depths between 21.5 feet and 51.5 feet below the existing ground surface. The approximate locations of the borings are shown on Enclosure A-2, within Appendix A.

The drilling exploration was conducted using a truck-mounted Mobile B-61 drill rig equipped with 8-inch diameter hollow stem augers. The soils were continuously logged by our geologist who inspected the site, created detailed logs of the borings, obtained undisturbed, as well as disturbed, soil samples for evaluation and testing, and classified the soils by visual examination in accordance with the Unified Soil Classification System.

Relatively undisturbed samples of the subsoils were obtained at a maximum interval of 5 feet. The samples were recovered by using a California split barrel sampler of 2.50 inch inside diameter and 3.25 inch outside diameter or a Standard Penetration Sampler (SPT) from the ground surface to the total depth explored. The samplers were driven by a 140 pound automatic trip hammer dropped from a height of 30 inches. The number of hammer blows required to drive the sampler into the ground the final 12 inches were recorded and further converted to an equivalent SPT N-value. Factors such as efficiency of the automatic trip hammer used during this investigation (80%), borehole diameter (8"), and rod length at the test depth were considered for further computing of equivalent SPT N-values corrected for field procedures (N60) which are included in the boring logs, Enclosures B-1 through B-5.

The undisturbed soil samples were retained in brass sample rings of 2.42 inches in diameter and 1.00 inch in height, and placed in sealed containers. Disturbed soil samples were obtained at selected levels within the borings and placed in sealed containers for transport to the laboratory.

All samples obtained were taken to our geotechnical laboratory for storage and testing. Detailed logs of the borings are presented on the enclosed Boring Logs, Enclosures B-1 through B-5. A Boring Log Legend and Soil Classification Chart are presented on Enclosures B-i and B-ii, respectively.

CONSISTENCY OF SOIL

SANDS

SPT BLOWS	CONSISTENCY
0-4	Very Loose
4-10	Loose
10-30	Medium Dense
30-50	Dense
Over 50	Very Dense

COHESIVE SOILS

SPT BLOWS	CONSISTENCY
0-2	Very Soft
2-4	Soft
4-8	Medium
8-15	Stiff
15-30	Very Stiff
30-60	Hard
Over 60	Very Hard

SAMPLE KEY

Symbol	Description
	INDICATES CALIFORNIA SPLIT SPOON SOIL SAMPLE
	INDICATES BULK SAMPLE
	INDICATES SAND CONE OR NUCLEAR DENSITY TEST
	INDICATES STANDARD PENETRATION TEST (SPT) SOIL SAMPLE

TYPES OF LABORATORY TESTS

1 Atterberg Limits
2 Consolidation
3 Direct Shear (undisturbed or remolded)
4 Expansion Index
5 Hydrometer
6 Organic Content
7 Proctor (4", 6", or Cal216)
8 R-value
9 Sand Equivalent
10 Sieve Analysis
11 Soluble Sulfate Content
12 Swell
13 Wash 200 Sieve

BORING LOG LEGEND

PROJECT: PROPOSED IRIS PARK RESIDENTIAL DEVELOPMENT, MORENO VALLEY, CALIFORNIA	**PROJECT NO.:** 33591.1
CLIENT: PASSCO PACIFICA, LLC	**ENCLOSURE:** B-i
LOR Geotechnical Group, Inc.	**DATE:** NOVEMBER 2019

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	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 SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (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
				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

PARTICLE SIZE LIMITS

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

12" 3" 3/4" No. 4 No. 10 No. 40 200
(U.S. STANDARD SIEVE SIZE)

SOIL CLASSIFICATION CHART

PROJECT PROPOSED IRIS PARK RESIDENTIAL DEVELOPMENT, MORENO VALLEY, CALIFORNIA	**PROJECT NO.** 33591.1
CLIENT: PASSCO PACIFICA, LLC	**ENCLOSURE:** B-ii
LOR Geotechnical Group, Inc.	**DATE:** NOVEMBER 2019

LOG OF BORING B-1

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0		3, 4, 7, 9, 10, 11						SM	@ 0 feet, FILL/TOPSOIL: **SILTY SAND, approximately 10% coarse grained sand, 20% medium grained sand, 30% fine grained sand, 40% silty fines, light brown, dry, loose.**
	14		6.0		120.0			ML	@ 2 feet, ALLUVIUM: **SANDY SILT, approximately 5% coarse grained sand, 15% medium grained sand, 20% fine grained sand, 60% silty fines, brown, damp, trace pinhole porosity.**
5	7		1.8		105.5			SW SM	**@ 5 feet, WELL GRADED SAND with SILT, approximately 25% coarse grained sand, 35% medium grained sand, 30% fine grained sand, 10% silty fines, light brown, dry.**
	21		9.5		101.2				**@ 7 feet, some sandy silt layers approximately 1 to 2" thick, damp.**
10	26		9.1		113.8			ML	**@ 10 feet, SANDY SILT, approximately 5% coarse grained sand, 10% medium grained sand, 10% fine grained sand, 75% silty fines with trace clay, brown, damp, trace pinhole porosity.**
15	32		10.6		117.5				**@ 15 feet, increase in clay, strong brown.**
20	40		10.9		112.3				**@ 20 feet, contains some secondary calcite.**
25	37		17.9		109.5			SM	**@ 25 feet, SILTY SAND, trace medium grained sand, approximately 80% fine grained sand, 20% silty fines, light brown, damp.**
									END OF BORING @ 26.5'
									Fill/topsoil to 2'
									No groundwater
									No bedrock
30									
35									

PROJECT: **Proposed Iris Park Residential Development**	PROJECT NUMBER: **33591.1**
CLIENT: **Passco Pacifica, LLC**	ELEVATION:
	DATE DRILLED: **November 7, 2019**
LOR GEOTECHNICAL GROUP INC.	EQUIPMENT: **Mobile B-61**
	HOLE DIA.: **8"** ENCLOSURE: **B-1**

LOG OF BORING B-2

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SM	@ 0 feet, FILL/TOPSOIL: **SILTY SAND, approximately 15% coarse grained sand, 20% medium grained sand, 20% fine grained sand, 45% silty fines, light brown, dry, loose.**
	9	2	3.7		112.4	▮			@ 2 feet, ALLUVIUM: **SILTY SAND, approximately 15% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 35% silty fines, brown, damp.**
5	8		3.5		100.8	▮			
	21		4.2		113.5	▮			**@ 5 feet, SILTY SAND, approximately 10% coarse grained sand, 20% medium grained sand, 50% fine grained sand, 20% silty fines, light brown, dry, trace thin calcite stringers.** **@ 7 feet, becomes coarser grained, approximately 25% coarse grained sand, 30% medium grained sand, 35% fine grained sand, 15% silty fines, brown, dry.**
10	36		4.0		112.4	▮		SP SM	**@ 10 feet, POORLY GRADED SAND with SILT, approximately 5% coarse grained sand, 25% medium grained sand, 60% fine grained sand, 10% silty fines, light brown, dry, micaceous.**
15	66		13.0		120.6	▮		CL	**@ 15 feet, LEAN CLAY with SAND, approximately 20% fine grained sand, 80% clayey fines of low plasticity, strong brown, damp.**
20	27		7.7		113.5	▮		SM	**@ 20 feet, SILTY SAND, approximately 20% coarse grained sand, 20% medium grained sand, 30% fine grained sand, 30% silty fines, brown, damp, some secondary calcite.**
25	48		7.6		115.2	▮			
30	31		12.2						
						∇			**@ 33.5 feet, groundwater.**
35	48		12.8					SW	**@ 35 feet, WELL GRADED SAND, approximately 35% coarse grained sand, 35% medium grained sand, 35% fine grained sand, 5% silty fines, speckled red-brown, wet.**
40	29		17.7					CL	**@ 40 feet, LEAN CLAY with SAND, approximately 10% medium grained sand, 20% fine grained sand, 70% clayey fines of low plasticity, brown, moist.**
45	17	1	14.9						
50	32		17.3						**END OF BORING @ 51.5'**
55									**Fill/topsoil to 2'** **Groundwater @ 33.5'** **No bedrock**

PROJECT: **Proposed Iris Park Residential Development**	PROJECT NUMBER: **33591.1**
CLIENT: **Passco Pacifica, LLC**	ELEVATION:
LOR GEOTECHNICAL GROUP INC.	DATE DRILLED: **November 7, 2019**
	EQUIPMENT: **Mobile B-61**
	HOLE DIA.: **8"** ENCLOSURE: **B-2**

LOG OF BORING B-3

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	U.S.C.S.	DESCRIPTION
0							SM	@ 0 feet, FILL/TOPSOIL: **SILTY SAND, approximately 10% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 40% silty fines, light brown, dry, loose.**
	9		6.7		106.3	▮	ML	@ 2 feet, ALLUVIUM: **SANDY SILT, approximately 5% coarse grained sand, 15% medium grained sand, 20% fine grained sand, 60% silty fines, brown, damp, trace pinhole porosity.**
5	6		3.5		106.1	▮	SM	**@ 5 feet, SILTY SAND, approximately 15% coarse grained sand, 25% medium grained sand, 35% fine grained sand, 20% silty fines, light brown, dry.**
	15		0.6		109.5	▮	SP	**@ 7 feet, POORLY GRADED SAND, approximately 5% coarse grained sand, 35% medium grained sand, 45% fine grained sand, 5% silty fines, red-brown, dry.**
10	25		11.8		116.9	▮	CL	**@ 10 feet, LEAN CLAY with SAND, approximately 5% coarse grained sand, 10% medium grained sand, 20% fine grained sand, 65% clayey fines of low plasticity, strong brown, damp, trace thin calcite stringers, trace pinhole porosity, some roothairs.**
15	22		10.6		117.0	▮	SC	**@ 15 feet, CLAYEY SAND, approximately 15% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 30% clayey fines of low plasticity, brown, damp.**
20	60		8.4		124.8	▮		
								END OF BORING @ 21.5' **Fill/topsoil to 2'** **No groundwater** **No bedrock**
25								

PROJECT: **Proposed Iris Park Residential Development**	PROJECT NUMBER: **33591.1**
CLIENT: **Passco Pacifica, LLC**	ELEVATION:
LOR GEOTECHNICAL GROUP INC.	DATE DRILLED: **November 7, 2019**
	EQUIPMENT: **Mobile B-61**
	HOLE DIA.: **8"** ENCLOSURE: **B-3**

LOG OF BORING B-4

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0		8, 9, 10, 11						SM	@ 0 feet, FILL/TOPSOIL: **SILTY SAND, approximately 10% coarse grained sand, 15% medium grained sand, 30% fine grained sand, 45% silty fines, brown, dry, loose.**
	19		5.8		106.8				@ 2 feet, ALLUVIUM: **SILTY SAND, approximately 15% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 35% silty fines, brown, dry, trace pinhole porosity.**
5	19		4.9		101.1			ML	**@ 5 feet, SANDY SILT, approximately 15% medium grained sand, 25% fine grained sand, 60% silty fines, light brown, dry, some roothairs, trace pinhole porosity.**
	21	2	2.6		109.8			SM	**@ 7 feet, SILTY SAND, approximately 10% coarse grained sand, 35% medium grained sand, 35% fine grained sand, 20% silty fines, light brown, dry.**
10	21		3.5		107.9				
15	38		8.1		128.2			SC	**@ 15 feet, CLAYEY SAND, approximately 20% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 30% clayey fines of low plasticity, brown, damp.**
20	55		8.8		121.3			ML	**@ 20 feet, SANDY SILT, approximately 5% coarse grained sand, 15% medium grained sand, 15% fine grained sand, 65% silty fines with trace clay, brown, damp.**
									END OF BORING @ 21.5'
									Fill/topsoil to 2'
									No groundwater
									No bedrock
25									

PROJECT: **Proposed Iris Park Residential Development**	PROJECT NUMBER: **33591.1**
CLIENT: **Passco Pacifica, LLC**	ELEVATION:
LOR GEOTECHNICAL GROUP INC.	DATE DRILLED: **November 7, 2019**
	EQUIPMENT: **Mobile B-61**
	HOLE DIA.: **8"** ENCLOSURE: **B-4**

LOG OF BORING B-5

TEST DATA

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0		9, 10, 11						SM	@ 0 feet, FILL: **SILTY SAND, approximately 10% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 40% silty fines, dry, loose.**
	43		7.7		104.4				**@ 2 feet, some rope debris.**
5	19		5.5		103.1			ML	@ 5 feet, ALLUVIUM: **SANDY SILT, approximately 10% medium grained sand, 30% fine grained sand, 60% silty fines, light brown, dry, some pinhole porosity.**
	16	2	7.4		105.4				
10	18	2	8.9		107.0				
15	25		11.6					SC	**@ 15 feet, CLAYEY SAND, approximately 20% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 25% clayey fines of low plasticity, brown, damp.**
20	28		13.9						
									END OF BORING @ 21.5' **Fill to 5'** **No groundwater** **No bedrock**
25									

PROJECT: **Proposed Iris Park Residential Development**	PROJECT NUMBER: **33591.1**
CLIENT: **Passco Pacifica, LLC**	ELEVATION:
	DATE DRILLED: **November 7, 2019**
LOR GEOTECHNICAL GROUP INC.	EQUIPMENT: **Mobile B-61**
	HOLE DIA.: **8"** ENCLOSURE: **B-5**

APPENDIX C

Laboratory Testing Program and Test Results

APPENDIX C
LABORATORY TESTING

General

Selected soil samples obtained from our borings were tested in our geotechnical laboratory to evaluate the physical properties of the soils affecting foundation design and construction procedures. The laboratory testing program performed in conjunction with our investigation included in-place moisture content and dry density, laboratory compaction characteristics, direct shear, sieve analysis, sand equivalent, R-value, consolidation, expansion index, Atterberg limits, and soluble sulfate content. Descriptions of the laboratory tests are presented in the following paragraphs:

Moisture Density Tests

The moisture content and dry density information provides an indirect measure of soil consistency for each stratum, and can also provide a correlation between soils on this site. The dry unit weight and field moisture content were determined for selected undisturbed samples, in accordance with ASTM D 2922 and ASTM D 2216, respectively, and the results are shown on the Boring Logs, Enclosures B-1 through B-5 for convenient correlation with the soil profile.

Laboratory Compaction

Selected soil samples were tested in the laboratory to determine compaction characteristics using the ASTM D 1557 compaction test method. The results are presented in the following table:

LABORATORY COMPACTION				
Boring Number	**Sample Depth (feet)**	**Soil Description (U.S.G.S.)**	**Maximum Dry Density (pcf)**	**Optimum Moisture Content (percent)**
B-1	0-3	(SM) Silty Sand	134.0	8.5

Direct Shear Tests

Shear tests are performed with a direct shear machine in general accordance with ASTM D 3080 at a constant rate-of-strain (usually 0.04 inches/minute). The machine is designed to test a sample partially extruded from a sample ring in single shear. Samples are tested at varying normal loads in order to evaluate the shear strength parameters, angle of internal friction and cohesion. Samples are tested in a remolded condition (90 percent relative compaction per ASTM D 1557) and soaked, to represent the worst case conditions expected in the field.

The results of the shear tests are presented in the following table:

DIRECT SHEAR TESTS				
Boring Number	**Sample Depth (feet)**	**Soil Description (U.S.G.S.)**	**Angle of Internal Friction (degrees)**	**Apparent Cohesion (psf)**
B-1	0-3	(SM) Silty Sand	28	200

Sieve Analysis

A quantitative determination of the grain size distribution was performed for selected samples in accordance with the ASTM D 422 laboratory test procedure. The determination is performed by passing the soil through a series of sieves, and recording the weights of retained particles on each screen. The results of the sieve analyses are presented graphically on Enclosure C-1.

Sand Equivalent

The sand equivalent of selected soils were evaluated using the California Sand Equivalent Test Method, Caltrans Number 217. The results of the sand equivalent tests are presented with the grain size distribution analyses on Enclosure C-1.

R-Value Test

Soil samples were obtained at probable pavement subgrade level and was tested to determine its R-value using the California R-Value Test Method, Caltrans Number 301. The results of the R-value test is presented on Enclosure C-1.

Consolidation Tests

The apparatus used for the consolidation tests (odometer) is designed to test a one-inch high portion of the undisturbed soil sample as contained in a sample ring. Porous stones and filler paper are placed in contact with the top and bottom of the specimen to permit the addition or release of water. Loads are applied to the test specimen in specified increments, and the resulting axial deformations are recorded. The results are plotted as log of axial pressure versus consolidation or compression, expressed as strain or sample height.

Samples are tested at field and greater-than field moisture contents. The results are shown on Enclosures C-2 through C-5.

Expansion Index Tests

Remolded samples are tested to determine their expansion potential in accordance with the Expansion Index (EI) test. The test is performed in accordance with the Uniform Building Code Standard 18-2. The test results are presented in the following table:

EXPANSION INDEX TESTS				
Boring Number	**Sample Depth (feet)**	**Soil Description (U.S.C.S.)**	**Expansion Index (EI)**	**Expansion Potential**
B-1	0-3	(SM) Silty Sand	11	Very Low

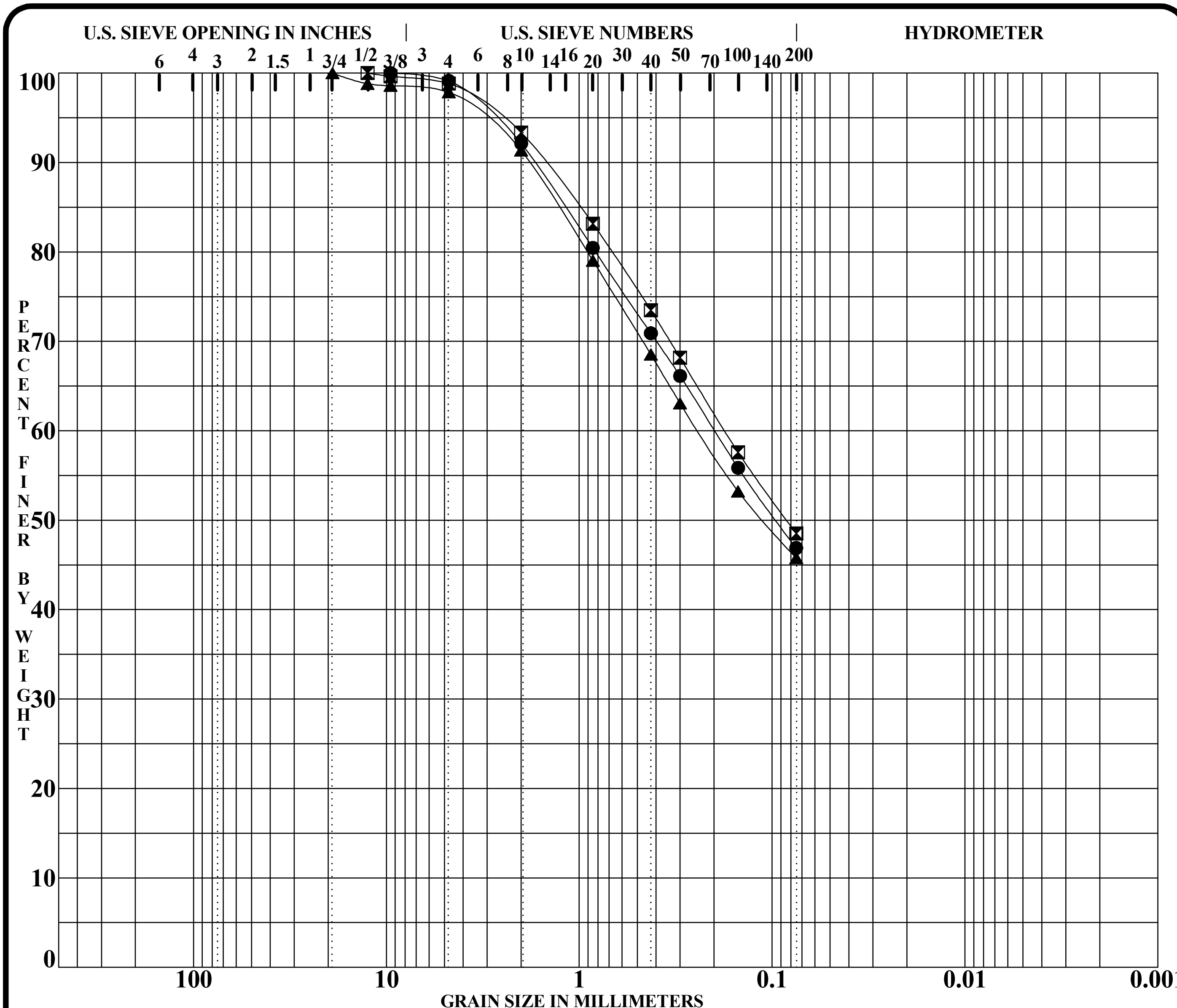
Atterberg Limits

Selected samples of the fine-grained soil units encountered at the site are tested for their Atterberg limits in accordance with ASTM D 4318. The results of these tests are presented on Enclosure C-6.

Soluble Sulfate Content Tests

The soluble sulfate content of selected subgrade soils was evaluated and the concentration of soluble sulfates in the soils was determined by measuring the optical density of a barium sulfate precipitate. The precipitate results from a reaction of barium chloride with water extractions from the soil samples. The measured optical density is correlated with readings on precipitates of known sulfate concentrations. The test results are presented on the following table:

SOLUBLE SULFATE CONTENT TESTS			
Boring Number	**Sample Depth (feet)**	**Soil Description (U.S.G.S.)**	**Sulfate Content (percent by weight)**
B-1	0-3	(SM) Silty Sand	< 0.0085
B-4	0-3	(SM) Silty Sand	< 0.0075
B-5	0-3	(SM) Silty Sand	< 0.0055



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Soil Classification	SE	RV	PL	PI	Cc	Cu
●	B-1	@ 0-3 ft	(SM) Silty Sand	13	--				
⧗	B-4	@ 0-3 ft	(SM) Silty Sand	13	28				
▲	B-5	@ 0-3 ft	(SM) Silty Sand	16	--				

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	@ 0-3 ft	9.50	0.20			0.9	52.2	46.9	
⧗	B-4	@ 0-3 ft	12.50	0.18			1.2	50.3	48.5	
▲	B-5	@ 0-3 ft	19.00	0.24			2.1	52.1	45.8	

PROJECT *Proposed Iris Park Residential Development*

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DATE *11/19/19*

GRADATION CURVES

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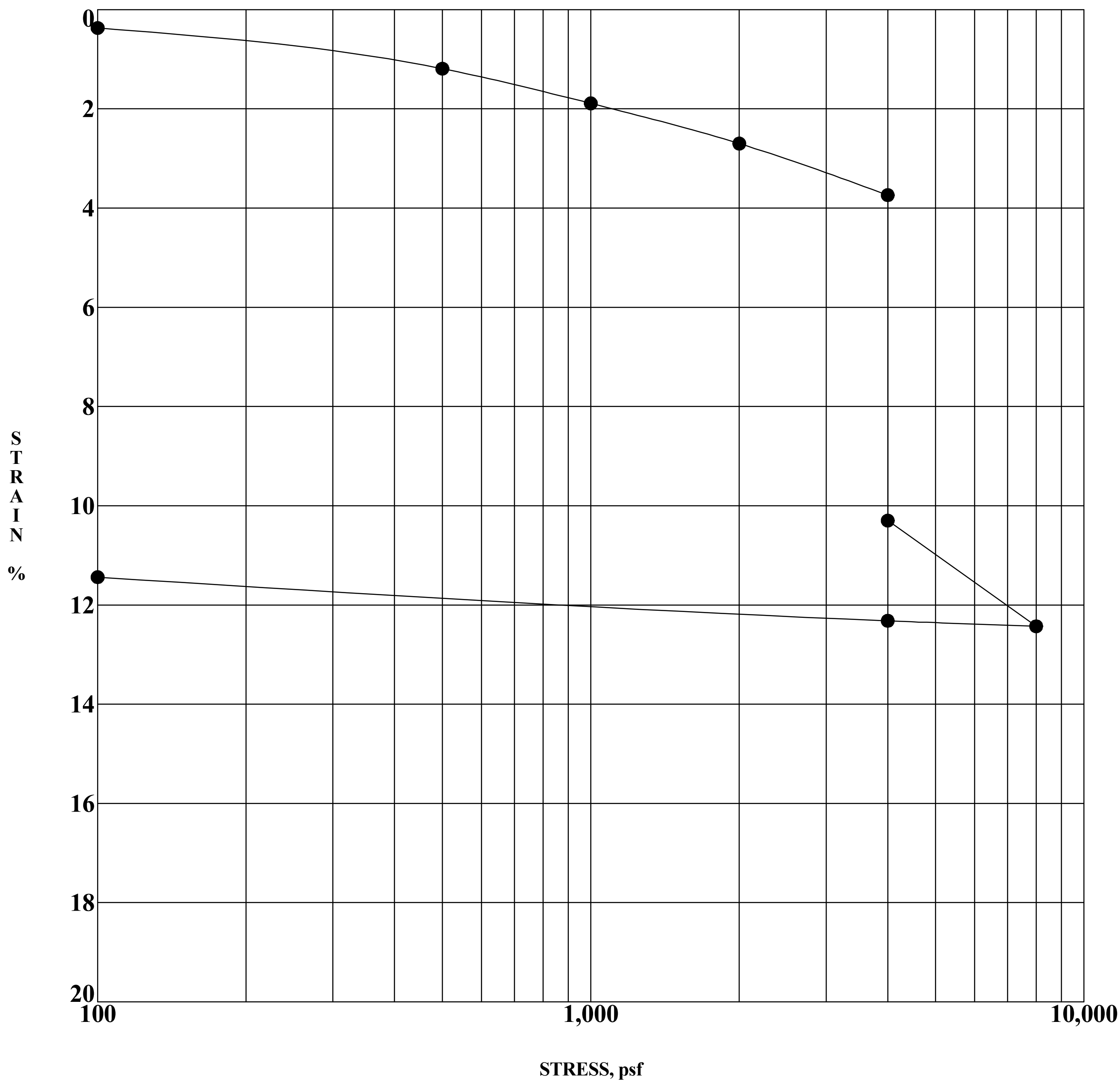
ENCLOSURE C-1



	Specimen I.D.		Classification	DD	MC%
●	B-2	@ 2 ft	**(SM) Silty Sand**	*107*	*4*

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CONSOLIDATION TEST
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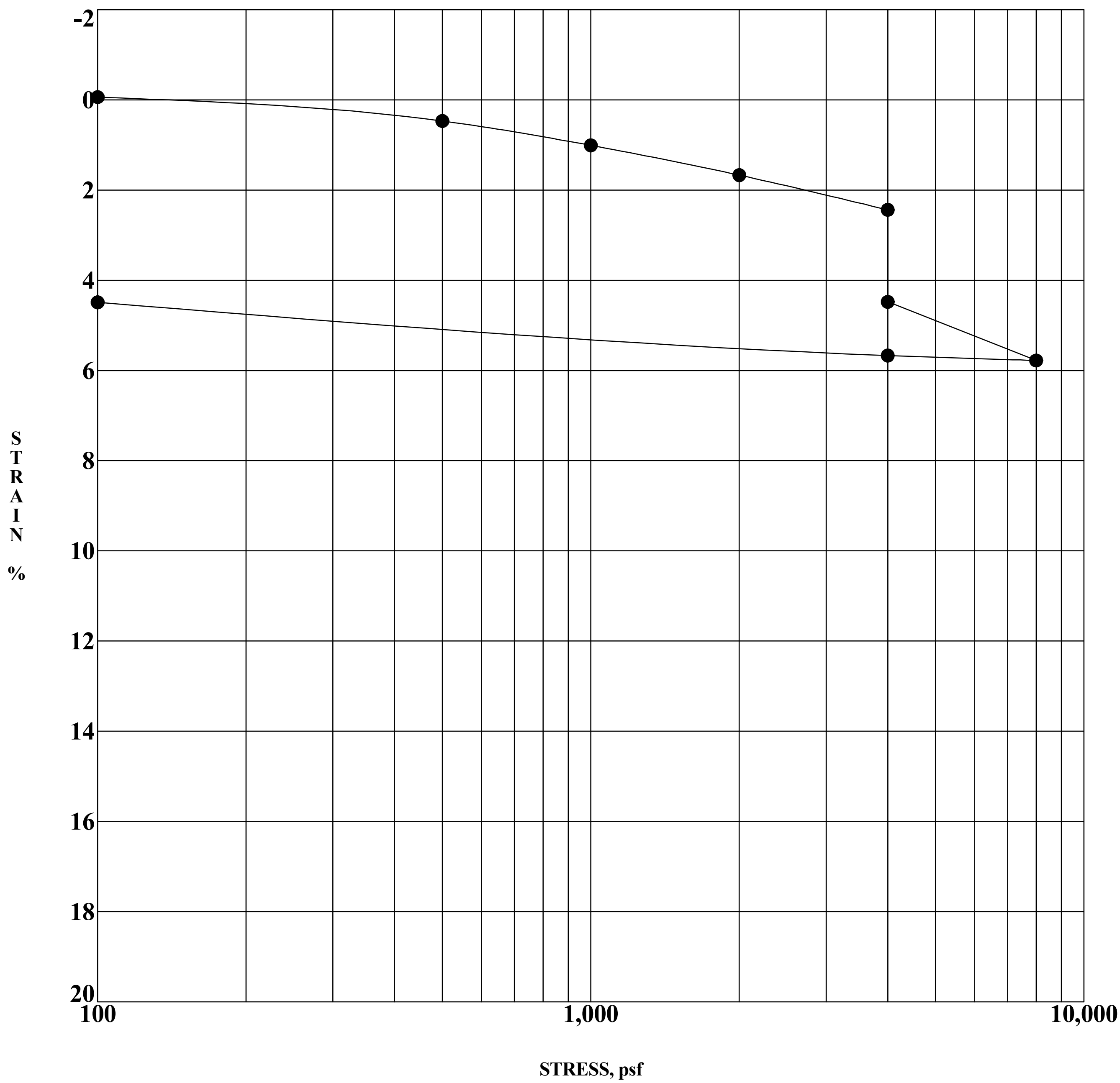
ENCLOSURE C-2



	Specimen I.D.		Classification	DD	MC%
●	B-4	@ 7 ft	**(SM) Silty Sand**	*103*	*3*

PROJECT *Proposed Iris Park Residential Development*

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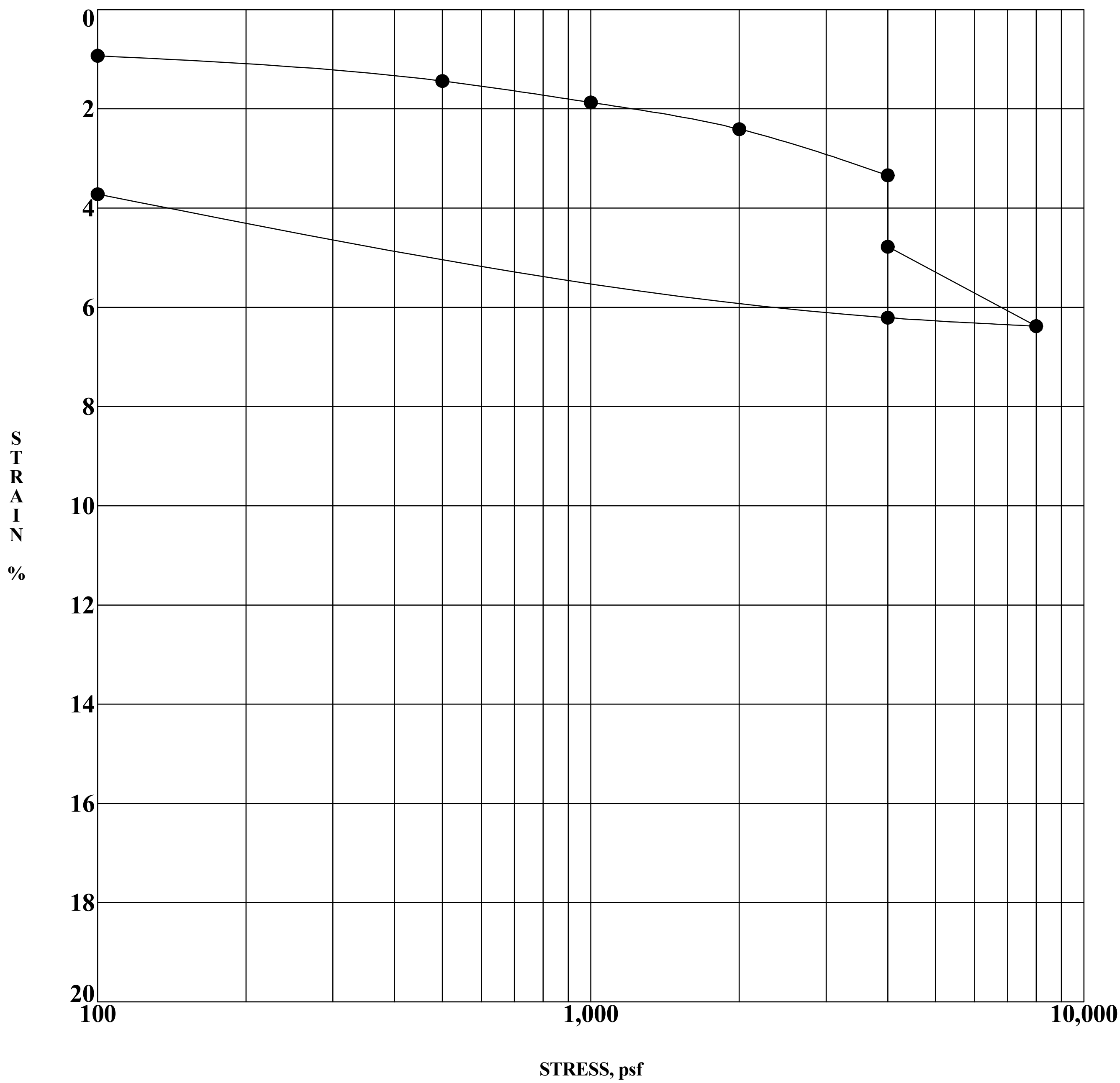
DATE *11/19/19*

CONSOLIDATION TEST
LOR Geotechnical Group, Inc.

ENCLOSURE C-3



	Specimen I.D.		Classification	DD	MC%
●	B-5	@ 7 ft	**(ML) Sandy Silt**	*103*	*7*

PROJECT *Proposed Iris Park Residential Development*

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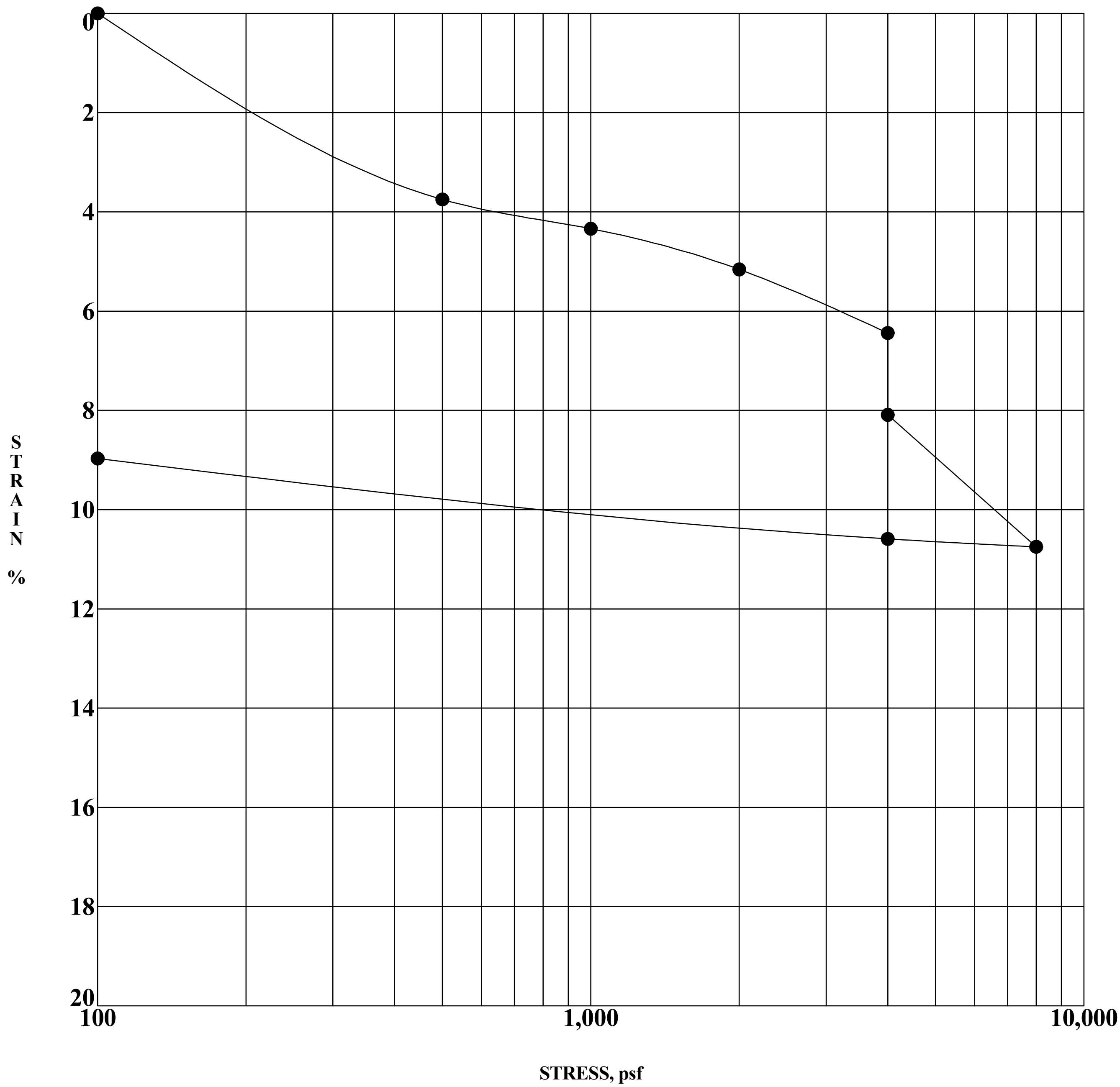
CONSOLIDATION TEST

LOR Geotechnical Group, Inc.

ENCLOSURE C-4



	Specimen I.D.		Classification	DD	MC%
●	B-5	@ 10 ft	**(ML) Sandy Silt**	*106*	*9*

PROJECT *Proposed Iris Park Residential Development*

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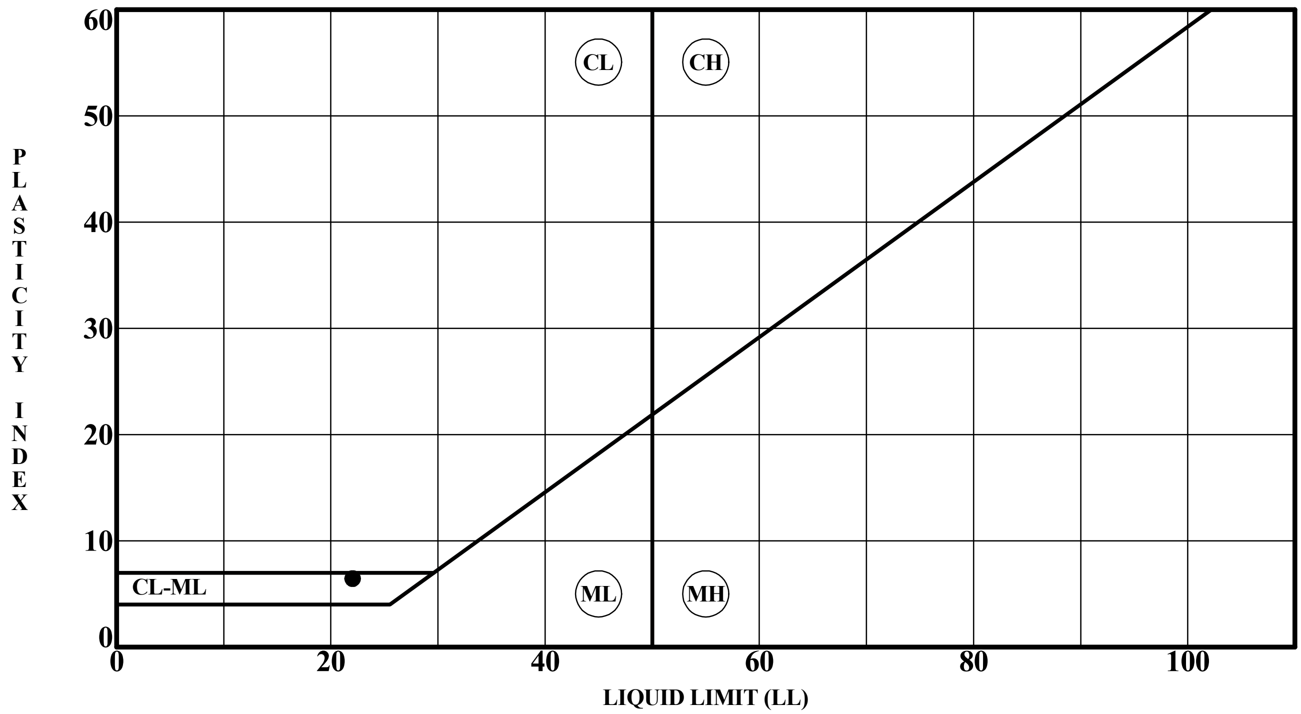
DATE *11/19/19*

CONSOLIDATION TEST
LOR Geotechnical Group, Inc.

ENCLOSURE C-5



	Specimen Identification		LL	PL	PI	Fines	Soil Classification
●	*B-2*	*@ 45 ft*	*22*	*16*	*6*		*(CL) Lean Clay with Sand*

PROJECT *Proposed Iris Park Residential Development*

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DATE *11/19/19*

ATTERBERG LIMITS RESULTS

LOR Geotechnical Group, Inc.

ENCLOSURE C-6

APPENDIX D

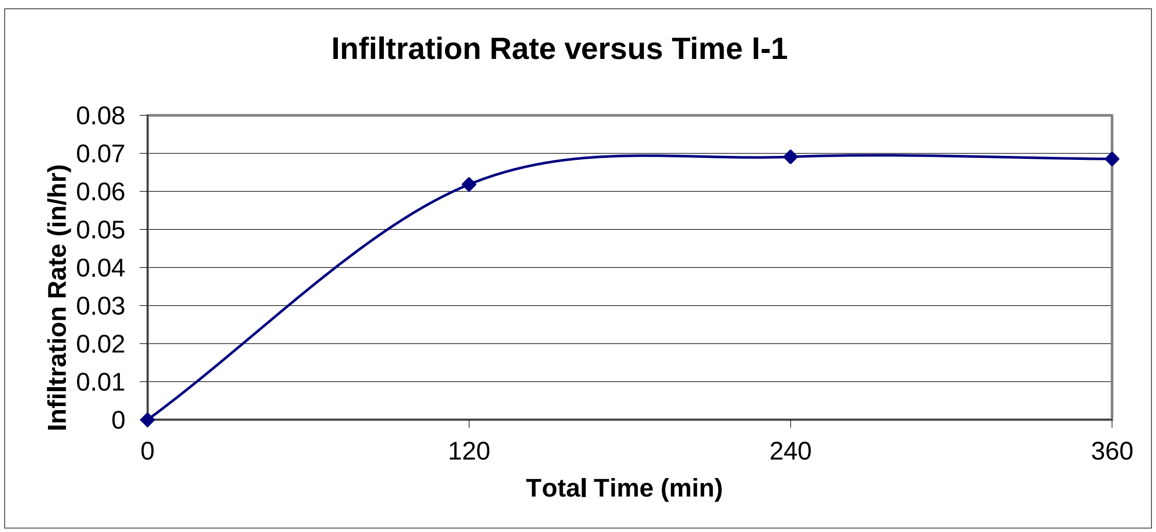
Infiltration Test Results

CONSTANT HEAD INFILTROMETER TEST DATA

Project:	Iris Park	Test Date:	November 7, 2019
Project No.:	33591.1	Test Hole No.:	I-1
Soil Classification:	(ML) Sandy Silt	Test Hole Size:	8" x 8"
Depth of Test Hole:	4 ft.	Date Excavated:	November 7, 2019
Tested By:	A.L.		

TEST PERIOD

TRIAL NO.	TIME		TIME INTERVAL (minutes)	TOTAL ELASPE TIME (minutes)	WATER USED (lbs.)	WATER USED (gal.)	INFILTRATION RATE (gal/sf/day)	INFILTRATION RATE (in/hr)	REMARKS
1	S	8:26	120	120	1.11	0.13	0.9	0.1	
	E	10:26							
2	S	10:26	120	240	1.24	0.15	1.0	0.1	
	E	12:26							
3	S	12:26	120	360	1.23	0.15	1.0	0.1	
	E	14:26							



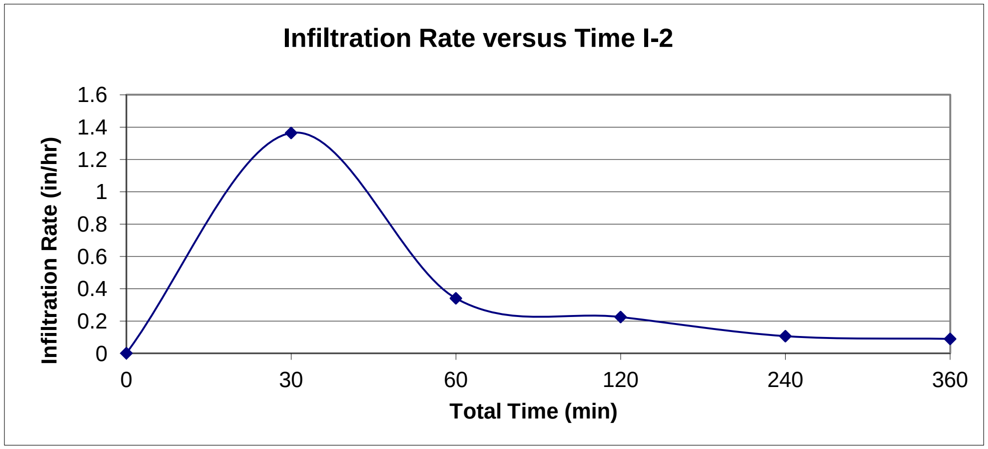
Enclosure D-1

CONSTANT HEAD INFILTROMETER TEST DATA

Project:	Iris Park	Test Date:	November 7, 2019
Project No.:	33591.1	Test Hole No.:	I-2
Soil Classification:	(ML) Sandy Silt	Test Hole Size:	6" x 8"
Depth of Test Hole:	4 ft.	Date Excavated:	November 7, 2019
Tested By:	A.L.		

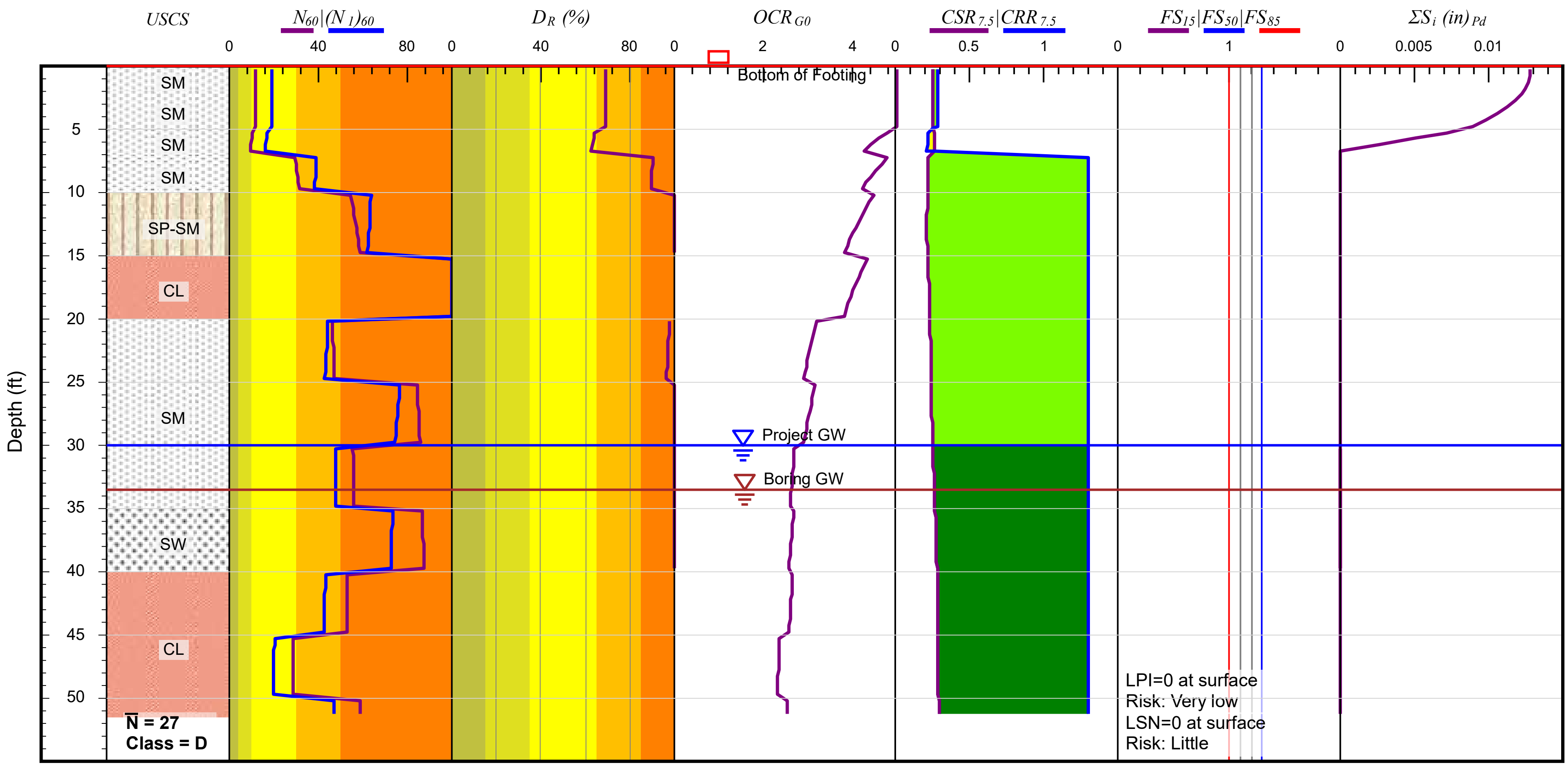
TEST PERIOD

TRIAL NO.	TIME		TIME INTERVAL (minutes)	TOTAL ELASPE TIME (minutes)	WATER USED (lbs.)	WATER USED (gal.)	INFILTRATION RATE (gal/sf/day)	INFILTRATION RATE (in/hr)	REMARKS
1	S	8:20	30	30	4.41	0.53	20.3	1.4	
	E	8:50							
2	S	8:50	30	60	1.10	0.13	5.1	0.3	
	E	9:20							
3	S	9:20	60	120	1.45	0.17	3.3	0.2	
	E	10:20							
4	S	10:20	120	240	1.37	0.16	1.6	0.1	
	E	12:20							
5	S	12:20	120	360	1.15	0.14	1.3	0.1	
	E	14:20							



APPENDIX E

Liquefaction Analysis



SM
SP-SM
CL
SW

Earthquake & Groundwater Information:
Magnitude = 6.5
Max. Acceleration = 0.553 g
Project GW = 30 ft
Maximum Settlement = 0.01 in
Settl. at Bottom of Footing = 0.01 in

Liquefaction: Boulanger & Idriss (2010-16)
Settl.: [dry] Pradel (1998); [sat] Idriss & Boulanger (2008)
Lateral spreading: Idriss & Boulanger (2008)
M correction: [Sand; Clay] Boulanger & Idriss(2004)
σv correction: Idriss & Boulanger (2008)
Stress reduction: Idriss & Boulanger (2008)

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Soil Engineering ▲ Geology ▲ Environmental

Liquefaction Potential - SPT Data			
Project:	Iris Park Residential Development		
Location:	Moreno Valley, California		
Job Number: 33591.1	Boring No.: B-2	Enclosure: E-1	

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