Geotechnical Engineering Report

Starlight Cinema
Garden Grove, Orange County, California
October 25, 2019
Terracon Project No. 60195111

Prepared for:
Valley View Cinema Center, LLC
Orange, California

Prepared by:
Terracon Consultants, Inc.
Tustin, California

October 25, 2019

Terracon GeoReport

Valley View Cinema Center, LLC
Client Address
Orange, California Zip Code

Attn: Mr. Daniel Akarakian
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Re: Geotechnical Engineering Report
Starlight Cinema
12101-12111 Valley View Street
Garden Grove, Orange County, California
Terracon Project No. 60195111

Dear Mr. Akarakian:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P60195111 dated June 3, 2019. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

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REPORT TOPICS

ATTACHMENTS

Geotechnical Engineering Report

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12101-12111 Valley View Street
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INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Starlight Cinema to be located at 12101-12111 Valley View Street in Garden Grove, Orange County, California. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Infiltration Design and Considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per CBC

The geotechnical engineering Scope of Services for this project included the advancement of four (4) test borings to depths ranging from approximately 5 to 51½ feet below existing site grades. Two (2) of these borings were used for percolation testing.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and as separate graphs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at 12101-12111 Valley View Street in Garden Grove, Orange County, California. Approximate coordinates for the center of the site are 33.7862°N, 118.0294°W
Existing Improvements	The site is currently occupied by an existing one-story commercial building with associated paved parking and drive lanes, and concrete hardscapes.

Item	Description
Current Ground Cover	Asphalt pavements and concrete flatwork.
Existing Topography (google earth)	The site is relatively flat with an approximate elevation of 24 feet above mean sea level.

PROJECT DESCRIPTION

Item	Description
Proposed Structures	The project will include the following: ■ Demolition of the first bay of the existing bowling alley structure ■ Construction of four restaurants inside the existing building with approximate footprint areas of 2,000 square feet (SF), 1,401 SF, 1,500 SF, and 2,731 SF. One of the restaurants will have a drive thru area along with the patio for outside seating ■ The construction of 7 new cinemas within the existing bowling alley structure We understand that the new cinemas have no new bearings, walls, or columns. Therefore, this report was prepared to provide the design and recommendations for the new restaurants only.
Finished Floor Elevation	Assume to be 1 foot from existing grade for the new restaurant buildings.
Maximum Loads (assumed)	■ Columns: 40-80 kips ■ Walls: 1 to 2 kips per linear foot (klf) ■ Slabs: 150 pounds per square foot (psf)
Grading	Minimal cut/fill – assumed to be less than one foot
Pavements	It is our understanding that no new pavements will be constructed for this project.

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The following table provides our geotechnical characterization.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/Density
Surface	3.5 to 5 inches	Asphalt	N/A
1	10	Sandy Silty Clay/Lean Clay with Sand	Soft to stiff
2	25	Sandy Silt/Lean Clay with Sand/Silty Clay with Sand	Soft to stiff
3	30	Silty sand	Medium dense
4	40	Lean clay with sand	Stiff
5	50	Silty clayey sand/Silty Sand	Loose to medium dense
6	51½ feet (boring termination)	Lean clay with sand	Very stiff

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Lab Results

Laboratory tests were conducted on selected soil samples and the test results are presented in the **Exploration Results** section and on the boring logs. Atterberg limit test results indicate that the on-site soils generally have low to medium plasticity. A consolidation test indicates that the clayey soils encountered at an approximate depth of 2½ feet bgs have a negligible collapse potential when saturated under normal footing loads of 2,000 psf. Expansion index test indicates that the near surface clay soils have an expansion index of 14.

Groundwater

Groundwater was encountered at approximate depths range between 10 and 22 feet bgs in the borings. Additionally, Terracon's geotechnical explorations performed for the previous 4 Star Cinemas Expansion encountered groundwater at the depths of 5 and 7 feet bgs[2].

In clayey soils with low permeability, the accurate determination of groundwater level may not be possible without long term observation. Long term observation after drilling could not be performed as borings were backfilled immediately upon completion due to safety concerns. Groundwater levels can best be determined by implementation of a groundwater monitoring plan.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Based on ground water data recorded from a monitoring wells located just north of the project site located at a distance of about 500 feet, the highest historical groundwater measurement was approximately 4½ feet bgs.[3]

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7.

Description	Value
2016 California Building Code Site Classification (CBC) [1]	E [2]
Site Latitude	33.7862°N
Site Longitude	118.0294°W

[2] Terracon Consultants, Inc., Geotechnical Engineering Report, 4 Stars Cinemas Expansion and New Restaurants, 12101-12111 Valley View Street,, Terracon Project No. 60175088, June 5, 2017.

[3] Groundwater elevation was obtained from a monitoring wells located at distance of about 500 feet north of the project site (12001 Valley View Street, Garden Grove, California, http://geotracker.waterboards.ca.gov)

Description	Value

1. Seismic site classification in general accordance with the *2016 California Building Code*.
2. The 2016 California Building Code (CBC) requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the required 100-foot soil profile determination. Borings were extended to a maximum depth of 51½ feet, and this seismic site class definition considers that similar or denser soils continue below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

Faulting and Estimated Ground Motions

The site is located in the southern California, which is a seismically active area. The type and magnitude of seismic hazards affecting the site are dependent on the distance to causative faults, the intensity, and the magnitude of the seismic event. As calculated using the USGS Unified Hazard Tool, the Compton fault, which is considered to have the most significant effect at the site from a design standpoint, has a maximum credible earthquake magnitude of 7.31 and is located approximately 8.7 kilometers from the site.

Based on the USGS Design Maps Summary Report, using the American Society of Civil Engineers (ASCE 7-10) standard, the peak ground acceleration (PGA_M) at the project site is expected to be 0.491 g. Based on the USGS Unified Hazard Tool, the project site has a mean magnitude of 6.65. Furthermore, the site is not located within an Alquist-Priolo Earthquake Fault Zone based on our review of the State Fault Hazard Maps.[4]

LIQUEFACTION

Liquefaction is a mode of ground failure that results from the generation of high pore water pressures during earthquake ground shaking, causing loss of shear strength. Liquefaction is typically a hazard where loose sandy soils exist below groundwater. The California Geological Survey (CGS) has designated certain areas as potential liquefaction hazard zones. These are areas considered at a risk of liquefaction-related ground failure during a seismic event, based upon mapped surficial deposits and the presence of a relatively shallow water table.

Subsurface soils encountered at the project site generally consisted of soft to stiff clay soils with variable amounts of sand with interbedded layers of loose to medium dense sand with variable amounts of silt and clay to the maximum depth explored at51½ feet bgs. Groundwater was encountered between the depths of 10 and 22 feet bgs in the current borings and at the depth of 5 and 7 feet in Terracon's previous borings for the 4 Star Cinema expansion project. Based on

[4] California Department of Conservation Division of Mines and Geology (CDMG), *"Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Southern Region"*, CDMG Compact Disc 2000-003, 2000.

the nearby groundwater monitoring well data, the historical high groundwater is at the depth of 4½ feet bgs.

A liquefaction analysis for the site was performed in general accordance with the DMG Special Publication 117. The liquefaction study utilized the software "LiquefyPro" by CivilTech Software. This analysis was based on the soil data from the soil borings. A Peak Ground Acceleration (PGA) of 0.491g and the mean magnitude of 6.65 for the project site were used. Calculations utilized the historical high groundwater depth of 4½ feet. Settlement analysis used the Tokimatsu, M-correction method and the fines percentage were corrected for liquefaction using the Stark/Olson method. To determine the seismically-induced settlement below the foundation level, the liquefaction potential analysis was performed to the depth of 50feet bgs.

Based on calculation results, seismically induced settlement of saturated and unsaturated sands is estimated to be about 2 inches. Differential seismic settlement is anticipated to be between 1 inch to 1.3 inch. The detailed liquefaction potential analysis results are attached to this report in **Supporting Documents** section of the **Appendix**.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary									
Boring	**Sample Depth (ft)**	**Soil Description**	**Soluble Sulfate (%)**	**Sulfides (ppm)**	**Chlorides (ppm)**	**Red-Ox Potential (mV)**	**Electrical Resistivity (Ω-cm)**	**Total Salts (ppm)**	**pH**
B-2	0.4-2.5	Lean Clay with Sand	0.02	Nil	50	+684	2425	1254	8.37

Results of soluble sulfate testing indicate samples of the on-site soils tested possess negligible sulfate concentrations when classified in accordance with Table 19.3.1.1 of the ACI Design Manual. Concrete should be designed in accordance with the exposure class S0 provisions of the ACI Design Manual, Section 318, Chapter 19.

STORMWATER MANAGEMENT

Two (2) in-situ percolation tests were performed to approximate depths of 5 and 10 feet bgs. A 2-inch thick layer of gravel was placed in the bottom of each boring after the borings were drilled to investigate the soil profile. A 3-inch diameter perforated pipe was installed on top of the gravel layer in each boring. Gravel was used to backfill between the perforated pipes and the boring sidewall. The borings were then filled with water for a pre-soak period of 24 hours. Testing began after a pre-soak period. At the beginning of the test, the pipes were refilled with water and readings were taken at standardized time intervals. Percolation rates are provided in the following table:

TEST RESULTS				
Test Location (depth, feet bgs)	**Soil Classification**	**Slowest Measured Percolation Rate (in/hr.)**	**Correlated Infiltration Rate[1] (in/hr.)**	**Water Head (in)**
P-1 (5 to 10 ft)	Sandy Lean Clay	27	2.6	31
P-2 (0 to 5 ft)	Sandy Lean Clay	30	5.8	18

[1]If proposed infiltration system will mainly rely on vertical downward seepage, the correlated infiltration rates should be used. The infiltration rates were correlated using the Porchet method.

Based on the groundwater encountered in the current borings, our previous borings and groundwater monitoring well located near the project site, the highest groundwater is at the depth of about 4½ feet bgs. Based on the County of Orange Technical Guidance Document (TGD) for the Preparation of Conceptual/Preliminary and/or Project Water Quality Management Plans (WQMPs), onsite infiltration is not considered feasible due to the groundwater depths.

With time, the bottoms of infiltration systems tend to plug with organics, sediments, and other debris. Long term maintenance will likely be required to remove these deleterious materials to help reduce decreases in actual percolation rates.

The percolation tests were performed with clear water, whereas the storm water will likely not be clear, but may contain organics, fines, and grease/oil. The presence of these deleterious materials will tend to decrease the rate that water percolates from the infiltration systems. Design of the stormwater infiltration systems should account for the presence of these materials and should incorporate structures/devices to remove these deleterious materials. A safety factor should be applied to these measured rates.

Based on the soils encountered in our borings, we expect the percolation rates of the soils could be different than measured in the field due to variations in fines content. The design elevation and size of the proposed infiltration system should account for this expected variability in infiltration rates.

Infiltration testing should be performed after construction of the infiltration system to verify the design infiltration rates. It should be noted that siltation and vegetation growth along with other factors may affect the infiltration rates of the infiltration areas. The actual infiltration rate may vary from the values reported here. Infiltration systems should be located a minimum of 10 feet from any existing or proposed foundation system.

GEOTECHNICAL OVERVIEW

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

The proposed building modifications/additions for the restaurants may be supported by a shallow foundation system. Due to the anticipated seismically-induced settlement and the low bearing capacity of the near surface soils, the new foundations and floor slabsshould bear on geogrid reinforced engineered fill. Geogrid reinforced engineered fill should extend to a minimum depth of 2½ feet below the bottom of foundations, or 4 feet below existing grades, whichever is greater. Onsite clayey soils may be used as engineered fill materials. Grading for the proposed foundation should incorporate the limits of the foundations plus a lateral distance of 2½ feet beyond the outside edge of perimeter footings.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results** section), engineering analyses, and our current understanding of the proposed project.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

The following recommendations include site preparation, excavation, subgrade preparation and placement of engineered fills on the project. The recommendations presented for design and construction of earth supported elements including foundations and slabs are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

Site Preparation

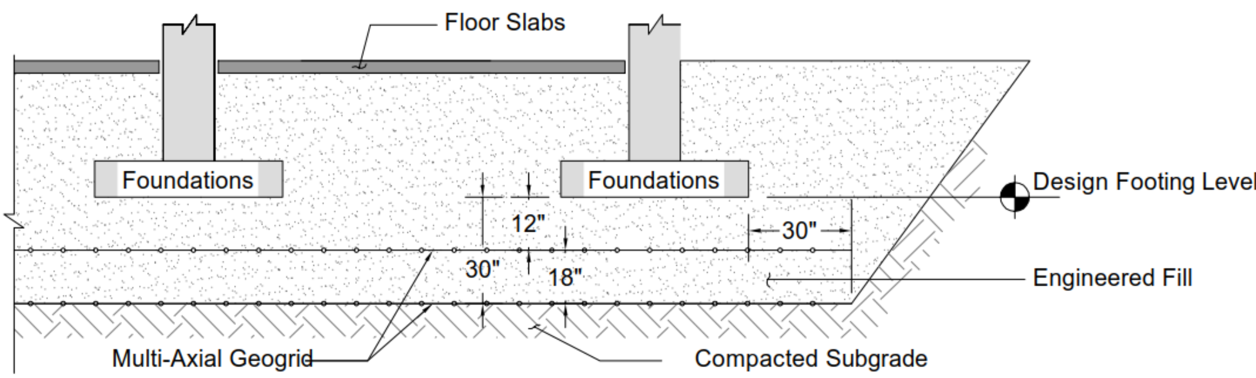
Strip and remove existing vegetation, debris, pavements, and other deleterious materials from proposed building areas. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction. The site should be initially graded to create a relatively level surface to receive fill and provide for a relatively uniform thickness of fill beneath proposed building structures.

Demolition of the first bay of the existing bowling alley structure and any other portion of the existing structure should include complete removal of all the existing foundation systems and remaining underground utilities within the proposed construction area. This should include removal of any loose backfill found adjacent to existing foundations. All materials derived from the demolition of existing structures should be removed from the site and not be allowed for use as on-site fill, unless processed in accordance with the fill requirements included in this report.

Although no evidence of fills or underground facilities such as septic tanks, cesspools, basements, and utilities was observed during the site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Subgrade Preparation

Due to the anticipated seismically-induced settlement and the low bearing capacity of the near surface soils, foundations and floor slabs should bear on geogrid reinforced engineered fill. Geogrid reinforced engineered fill should extend to a minimum depth of 2½ feet below the bottom of foundations, or 4 feet below existing grades, whichever is greater. As shown in the figure below, multi-axial (such as Tensar TX5 or equivalent) geogrid reinforced engineered fill extending to a minimum depth of 2½ feet below the bottom of foundations should be used to support the building foundation systems. Reinforced engineered fill should be placed beneath the entire footprint of the new foundations and floor slabs for the buildings and additions, and should extend horizontally a minimum distance of 2½ feet beyond the outside edge of perimeter footings. Two layers of geogrid should be placed at 18-inch on center with the first geogrid placed on the bottom of the excavation on prepared native soils. This placement schedule will place the top geogrid one-foot below the bottom of the footing.



OVER-EXCAVATION / BACKFILL DETAIL

The over-excavation bottom, once properly cleared, should be scarified to a minimum depth of 10 inches, moisture conditioned, and compacted per the compaction requirements presented in this report. The over-excavation should then be backfilled up to the footing base elevation with engineered fill placed in lifts of 8 inches or less in loose thickness and should be moisture conditioned and compacted following the recommendations presented in this report.

Subgrade soils beneath exterior slabs should be scarified, moisture conditioned, and compacted to a minimum depth of 10 inches. The moisture content and compaction of subgrade soils should be maintained until slab construction.

Exposed areas which will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of 10 inches, moisture conditioned, and compacted per the compaction requirements in this report.

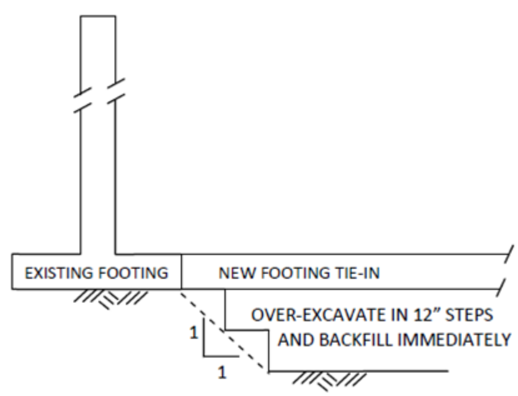
Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable. However, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Excavation

The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Prior to the construction phase of the project, additional evaluation of groundwater and fluctuations in groundwater levels should be performed. Depending upon the depth of excavation and seasonal conditions, groundwater may be encountered within the excavations planned on the site.

If new foundations are constructed adjacent to the existing foundations, there is a risk that the bearing material could become undermined and/or overstressed due to overlapping stresses. Provisions should be made during construction to prevent undermining or disturbing the soils supporting the existing foundations. Excavations should not extend below an imaginary 1H:1V inclined plane projecting below the bottom edge of any adjacent existing foundations as shown in the figure to the right.



Maintaining a sufficient clear distance between new and existing foundations will reduce the potential for increased bearing stresses and additional foundation settlement. Connections between the existing building and the new addition should allow for some differential movement.

Individual contractors are responsible for designing and constructing stable, temporary excavations. Excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

Fill Materials and Placement

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than 6 inches in size. Pea gravel or other similar non-cementitious, poorly-graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.

On-site soils or low volume change imported materials may be used as fill material for the following:

- general site grading
- foundation areas
- interior floor slab areas
- foundation backfill
- exterior slab areas

Imported soils for use as fill material within proposed building and structure areas should conform to low volume change materials as indicated in the following specifications:

Gradation	Percent Finer by Weight (ASTM C 136)
3"	100
No. 4 Sieve	50-100
No. 200 Sieve	10-40
■ Liquid Limit	30 (max)
■ Plasticity Index	15 (max)
■ Maximum expansion index*	20 (max)

*ASTM D 4829

The contractor shall notify the Geotechnical Engineer of import sources sufficiently ahead of their use so that the sources can be observed and approved as to the physical characteristic of the import material. For all import material, the contractor shall also submit current verified reports from a recognized analytical laboratory indicating that the import has a "not applicable" (Class S0) potential for sulfate attack based upon current ACI criteria and is only "mildly corrosive" to ferrous metal and copper. The reports shall be accompanied by a written statement from the contractor that the laboratory test results are representative of all import material that will be brought to the job.

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill lifts should not exceed 10 inches loose thickness.

Compaction Requirements

Recommended compaction and moisture content criteria for engineered fill materials are as follows:

Material Type and Location	Per the Modified Proctor Test (ASTM D 1557)		
	Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction Above Optimum	
		Minimum	Maximum
On-site soils or low volume change imported materials:			
Beneath foundations:	90	0%	+3%
Beneath interior slabs:	90	0%	+3%
Miscellaneous backfill:	90	0%	+3%
Beneath pavements:	95	0%	+3%
Utility Trenches*:	90	0%	+3%
Bottom of excavation receiving fill:	90	0%	+3%
Aggregate base:	95	-1%	+3%

* Upper 12 inches should be compacted to 95% within pavement and structural areas. Low-volume change imported soils should be used in structural areas.

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Planters and other surface features which could retain water in areas adjacent to the building should be sealed or eliminated. In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a minimum grade of approximately 5 percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto pavements or are tied to tight lines that discharge into the on-site storm drain system.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Utility Trenches

It is anticipated that the on-site soils and fill materials will provide suitable support for underground utilities and piping that may be installed. Any soft and/or unsuitable material encountered at the bottom of excavations should be removed and be replaced with an adequate bedding material. A non-expansive granular material with a sand equivalent greater than 30 should be used for bedding and shading of utilities, unless allowed or specified otherwise by the utility manufacturer.

On-site materials are considered suitable for backfill of utility and pipe trenches from one foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

Shrinkage

For balancing grading on-site, estimated shrink factor of granular soils when used as compacted fill following recommendations in this report ranges between 0.90 and 0.95. Shrinkage factors are based on converting materials in its natural state before disturbance to materials after compaction. The range of shrinkage factors are approximate and are based on our experience with similar materials. The contractor should make his own evaluation of potential shrinkage.

Construction Considerations

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed, or these materials should be scarified, moisture conditioned, and recompacted prior to floor slab and pavement construction.

On-site clay soils may pump, and unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. The use of light construction equipment would aid in reducing subgrade disturbance. The use of remotely operated equipment, such as a backhoe, would be beneficial to perform cuts and reduce subgrade disturbance.

Should unstable subgrade conditions develop stabilization measures will need to be employed. Stabilization measures may include placement of aggregate base and multi-axial geogrid. Use of lime, fly ash, kiln dust or cement could also be considered as a stabilization technique. Laboratory evaluation is recommended to determine the effect of chemical stabilization on subgrade soils prior to construction.

We recommend that the earthwork portion of this project be completed during extended periods of dry weather if possible. If earthwork is completed during the wet season (typically November through April) it may be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork operations may require additional mitigative measures beyond that which would be expected during the drier summer and fall months. This could include diversion of surface runoff around exposed soils and draining of ponded water on the site. Once subgrades are established, it may be necessary to protect the exposed subgrade soils from construction traffic.

Construction Observation and Testing

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proof-rolling, placement and compaction of controlled compacted fills, backfilling of excavations to the completed subgrade.

The exposed subgrade and each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas. One density and water content test should be performed for every 12-inch thick lift for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. In the event that unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Shallow Foundation Design Recommendations

DESCRIPTION	RECOMENDATION
Foundation Type	Conventional shallow spread footing foundations
Bearing Material	Geogrid reinforced engineered fill extending to a minimum depth of 2½ feet below the bottom of the proposed foundations or 4 feet below the existing ground, whichever is greater.
Allowable Bearing Pressure*	2,000 psf for a maximum footing width of 6 feet 1,500 psf for a maximum footing width of 8 feet
Minimum Dimensions	Walls: 18 inches; Columns: 24 inches
Minimum Embedment Depth Below Finished Grade	18 inches
Total Estimated Settlement	1 inch
Estimated Differential Settlement	½ inch across 40 feet

*Due to the potential soft clay soils encountered onsite, bearing capacity was based on an allowable settlement value of 1-inch. Terracon should be contacted if larger width foundations are planned onsite or if different design criteria will be used in the design of foundations.

Finished grade is defined as the lowest adjacent grade within five feet of the foundation for perimeter (or exterior) footings.

The allowable foundation bearing pressure applies to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

Foundations should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

FLOOR SLABS

DESCRIPTION	RECOMMENDATION
Interior floor system	Slab-on-grade concrete
Floor slab support	Geogrid reinforced engineered fill extending to a minimum depth of 2½ feet below the bottom of the proposed foundations or 4 feet below the existing ground, whichever is greater.
Subbase	Minimum 4-inches of Aggregate Base
Modulus of subgrade reaction	200 pounds per square inch per inch (psi/in) (The modulus was obtained based on estimates obtained from NAVFAC 7.1 design charts). This value is for a small loaded area (1 Sq. ft or less) such as for forklift wheel loads or point loads and should be adjusted for larger loaded areas.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

LATERAL EARTH PRESSURES

Design Parameters

For engineered fill comprised of on-site soils above any free water surface, recommended equivalent fluid pressures for unrestrained foundation elements are:

ITEM	VALUE[a, b]
Active Case	43 psf/ft
Passive Case	300 psf/ft
At-Rest Case	64 psf/ft
Coefficient of Friction	0.30

[a]Note: The values are based on on-site soils used as backfill.
[b]Note: Uniform, horizontal backfill, compacted to at least 90% of the ASTM D 1557 maximum dry density, rendering a maximum unit weight of 125 pcf.

The lateral earth pressures herein do not include any factor of safety and are not applicable for submerged soils/hydrostatic loading. Additional recommendations may be necessary if such conditions are to be included in the design.

Fill against foundation and retaining walls should be compacted to densities specified in the **Earthwork** section of this report. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. For the low volume change engineered fill materials values to be valid, the backfill must extend out and up from the base of the wall and at an angle of at least 45 and 60 degrees from vertical for the active and passive cases respectively.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
2	21½ to 51½	Building area
2	5 to 10	Pavement/utilities area

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted drill rig using continuous hollow stem flight augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Soil sampling was performed using split-barrel sampling procedures. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. A 2.5-inch O.D. split-barrel Modified California sampling spoon with 2.0-inch I.D. tube lined sampler was also used for sampling. The Modified California split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. Tube-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are not equivalent to the SPT blow counts. The values provided on our boring logs are uncorrected. The samples were placed in appropriate containers, taken to our soil laboratory for testing, and classified by a geotechnical engineer. In addition, we observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D7263 Standard Test Methods for Laboratory Determination of Dry Density (Unit Weight) of Soil Specimens
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D1140 Standard Test Method for Determining the Amount of Material Finer than No. 200 Sieve by Soil Washing
- ASTM D4546 Standard Test Methods for One-Dimensional Swell or Collapse of Soils
- ASTM D4829 Standard Test Method for Expansion Index of Soils
- ASTM D7263 Standard Test Methods for Laboratory Determination of Density (Unit Weight) of Soil Specimens
- Corrosivity Testing will include pH, chlorides, sulfates, sulfides, Redox potential, and electrical lab resistivity

The laboratory testing program included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

SITE LOCATION

Starlight Cinema ■ Garden Grove, CA

October 25, 2019 ■ Terracon Project No. 60195111

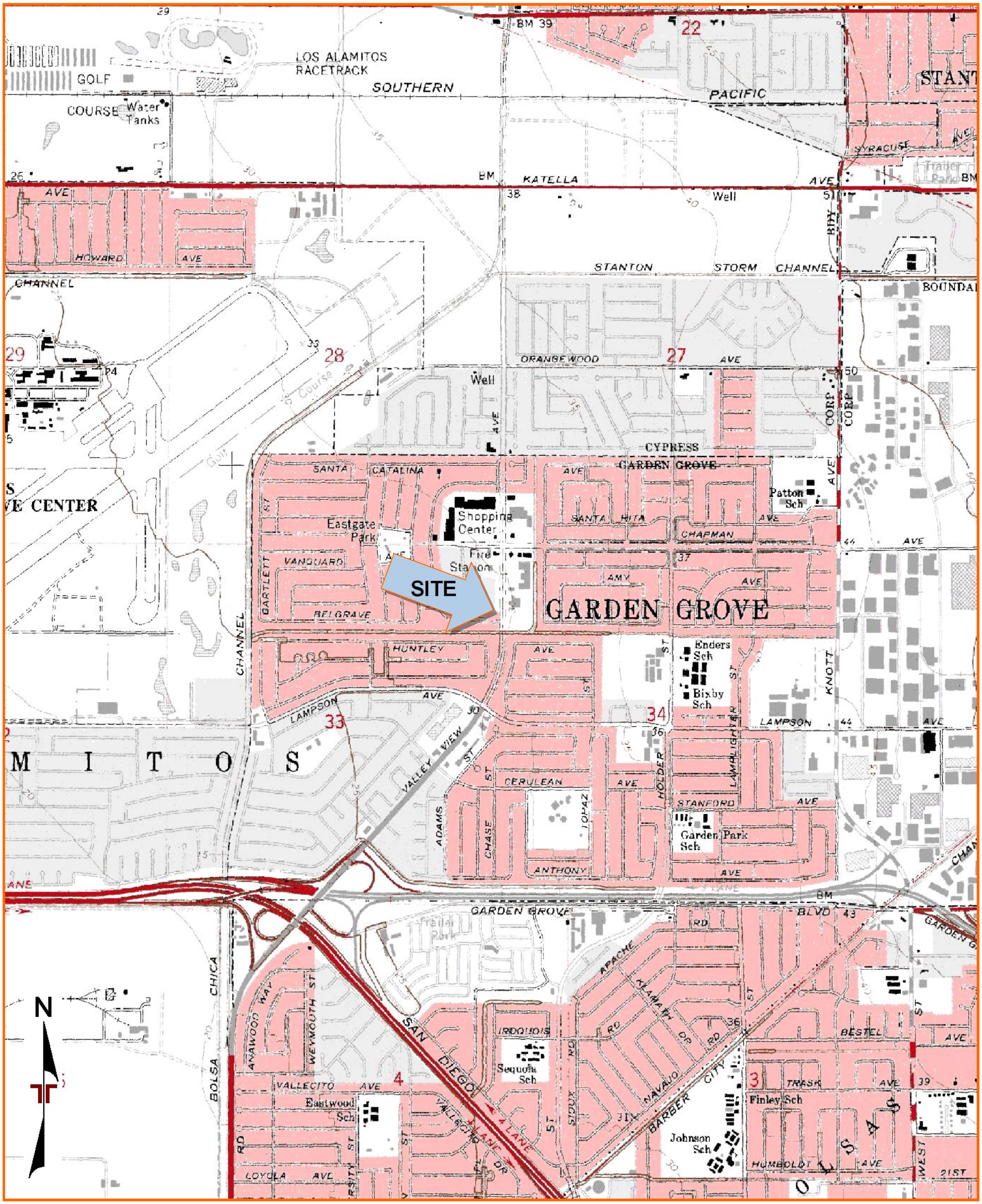


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: LOS ALAMITOS, CA (1/1/1981).

EXPLORATION PLAN

Starlight Cinema ■ Garden Grove, CA

October 25, 2019 ■ Terracon Project No. 60195111

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

BORING LOG NO. B-1

PROJECT: Proposed Starlight Cinema (West Grove Center)

CLIENT: Cinemas Management Inc, Playa Del Rey, CA

SITE: 12101-12111 Valley View Street, Garden Grove, CA

LOCATION See Exploration Plan

Latitude: 33.7865° Longitude: -118.0291°

DEPTH	Material Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	EXPANSION INDEX	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.4	**ASPHALT**, 5" thickness									
	SANDY SILTY CLAY (CL-ML), brown					14				
	medium stiff				4-3-3		14	106		
	soft	5			1-1-2 N=3				25-18-7	51
10.0	with silt, dark brown, stiff				5-7-8		28	94		
15.0	**SANDY SILT (ML)**, dark brown, very soft	10			1-1-3 N=4				27-22-5	68
	LEAN CLAY WITH SAND (CL), dark brown, medium stiff	15	▽		3-3-5		32	89		
21.5		20			1-2-4 N=6				41-20-21	75

Boring Terminated at 21.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 09-16-2019	Boring Completed: 09-16-2019
Drill Rig: B-61	Driller: CalPac
Project No.: 60195111	

BORING LOG NO. B-2

PROJECT: Proposed Starlight Cinema (West Grove Center)

CLIENT: Cinemas Management Inc, Playa Del Rey, CA

SITE: 12101-12111 Valley View Street, Garden Grove, CA

LOCATION See Exploration Plan

Latitude: 33.7862° Longitude: -118.0291°

DEPTH	Material Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	FIELD TEST RESULTS	EXPANSION INDEX	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.4	**ASPHALT**, 4.5" thickness								
	LEAN CLAY WITH SAND (CL), dark brown, stiff			6-8-9		22	93		
	brown, soft	5		5-6-9		7	94		
	dark brown			1-2-2 N=4				46-25-21	84
10.0	**SILTY CLAY WITH SAND (CL-ML)**, brown, soft	10		3-4-7		23	101		
	dark brown	15		1-3-5 N=8				29-22-7	73
	stiff	20	▽	5-7-13		23	103		
25.0	**SILTY SAND (SM)**, gray to brown, medium dense	25		2-3-9					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 09-16-2019	Boring Completed: 09-16-2019
Drill Rig: B-61	Driller: CalPac
Project No.: 60195111	

BORING LOG NO. B-2

PROJECT: Proposed Starlight Cinema (West Grove Center)

CLIENT: Cinemas Management Inc
Playa Del Rey, CA

SITE: 12101-12111 Valley View Street
Garden Grove, CA

LOCATION See Exploration Plan

Latitude: 33.7862° Longitude: -118.0291°

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	EXPANSION INDEX	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND (SM), gray to brown, medium dense *(continued)*				N=12					
30.0	**LEAN CLAY WITH SAND (CL)**, dark gray, stiff	30			8-10-10		30	93		
		35			2-4-7 N=11					
40.0	**SILTY CLAYEY SAND (SC-SM)**, dark brown, medium dense	40			10-10-11		22	107		
45.0	**SILTY SAND (SM)**, dark brown, loose	45			1-3-6 N=9					
50.0	**LEAN CLAY WITH SAND (CL)**, dark gray, very stiff	50			6-7-13		40	86		
51.5	***Boring Terminated at 51.5 Feet***									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 09-16-2019	Boring Completed: 09-16-2019
Drill Rig: B-61	Driller: CalPac
Project No.: 60195111	

BORING LOG NO. Perc-1

PROJECT: **Proposed Starlight Cinema (West Grove Center)**

SITE: **12101-12111 Valley View Street Garden Grove, CA**

CLIENT: **Cinemas Management Inc Playa Del Rey, CA**

LOCATION See Exploration Plan

Latitude: 33.786° Longitude: -118.0293°

GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	EXPANSION INDEX	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3	**ASPHALT**, 3.5" thickness									
		SANDY LEAN CLAY (CL), brown	5								
	10.0		10	▽							
		Boring Terminated at 10 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 09-16-2019	Boring Completed: 09-16-2019
Drill Rig: B-61	Driller: CalPac
Project No.: 60195111	

BORING LOG NO. Perc-2

PROJECT: Proposed Starlight Cinema (West Grove Center)

CLIENT: Cinemas Management Inc, Playa Del Rey, CA

SITE: 12101-12111 Valley View Street, Garden Grove, CA

LOCATION See Exploration Plan

Latitude: 33.7859° Longitude: -118.0292°

GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	EXPANSION INDEX	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3	**ASPHALT**, 4" thickness									
	5.0	**SANDY LEAN CLAY (CL)**, brown	5							31-22-9	68
		Boring Terminated at 5 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

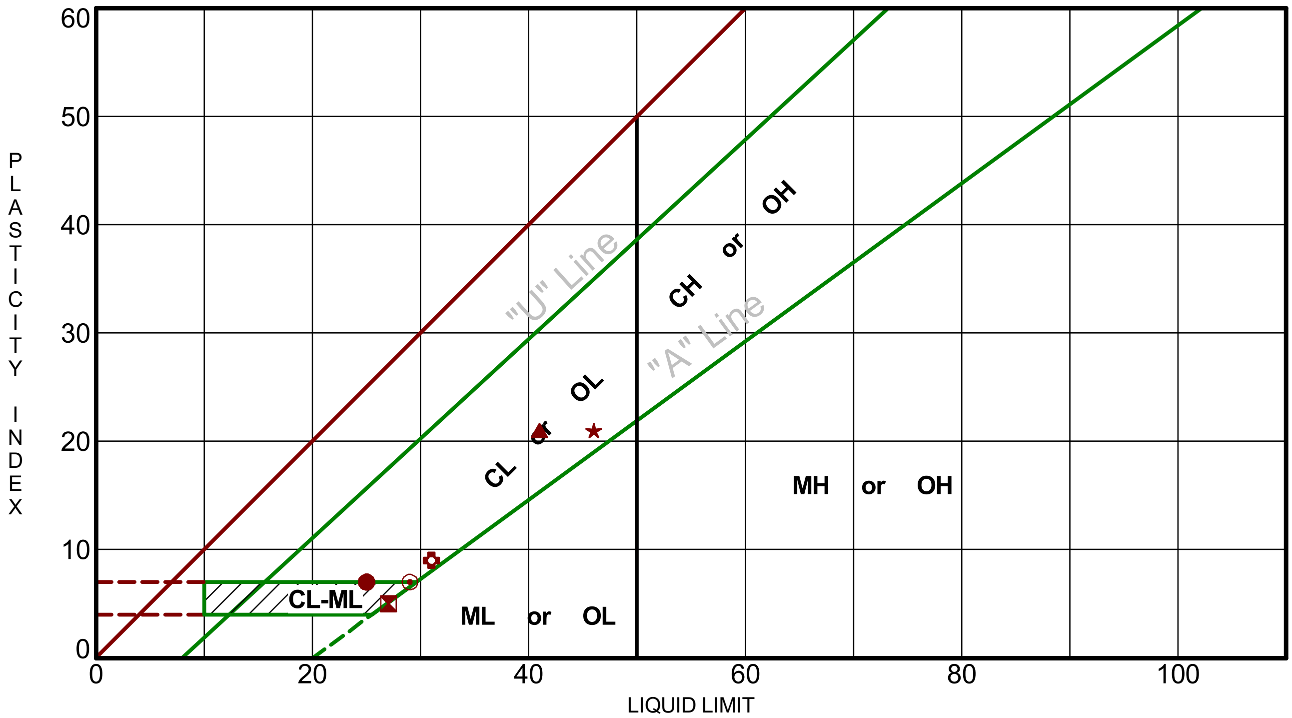
Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 09-16-2019	Boring Completed: 09-16-2019
Drill Rig: B-61	Driller: CalPac
Project No.: 60195111	

ATTERBERG LIMITS RESULTS

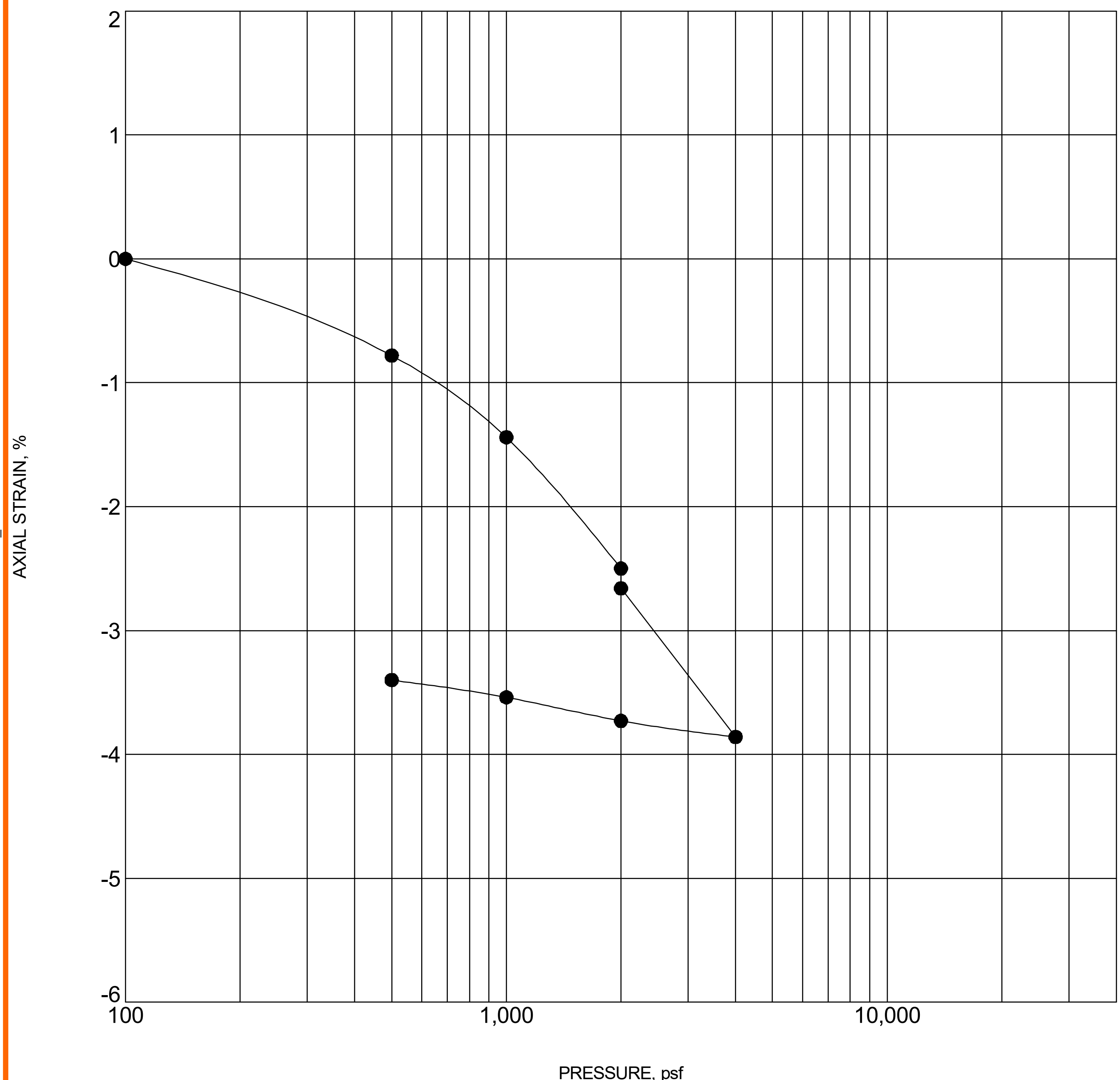
ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	B-1	5 - 6.5	25	18	7	50.6	CL-ML	SANDY SILTY CLAY
⊠	B-1	10 - 11.5	27	22	5	67.7	ML	SANDY SILT
▲	B-1	20 - 21.5	41	20	21	75.0	CL	LEAN CLAY with SAND
★	B-2	7.5 - 9	46	25	21	84.1	CL	LEAN CLAY with SAND
⊙	B-2	15 - 16.5	29	22	7	72.7	CL-ML	SILTY CLAY with SAND
✿	Perc-2	0.3 - 5	31	22	9	68.1	CL	SANDY LEAN CLAY

SWELL CONSOLIDATION TEST

ASTM D2435



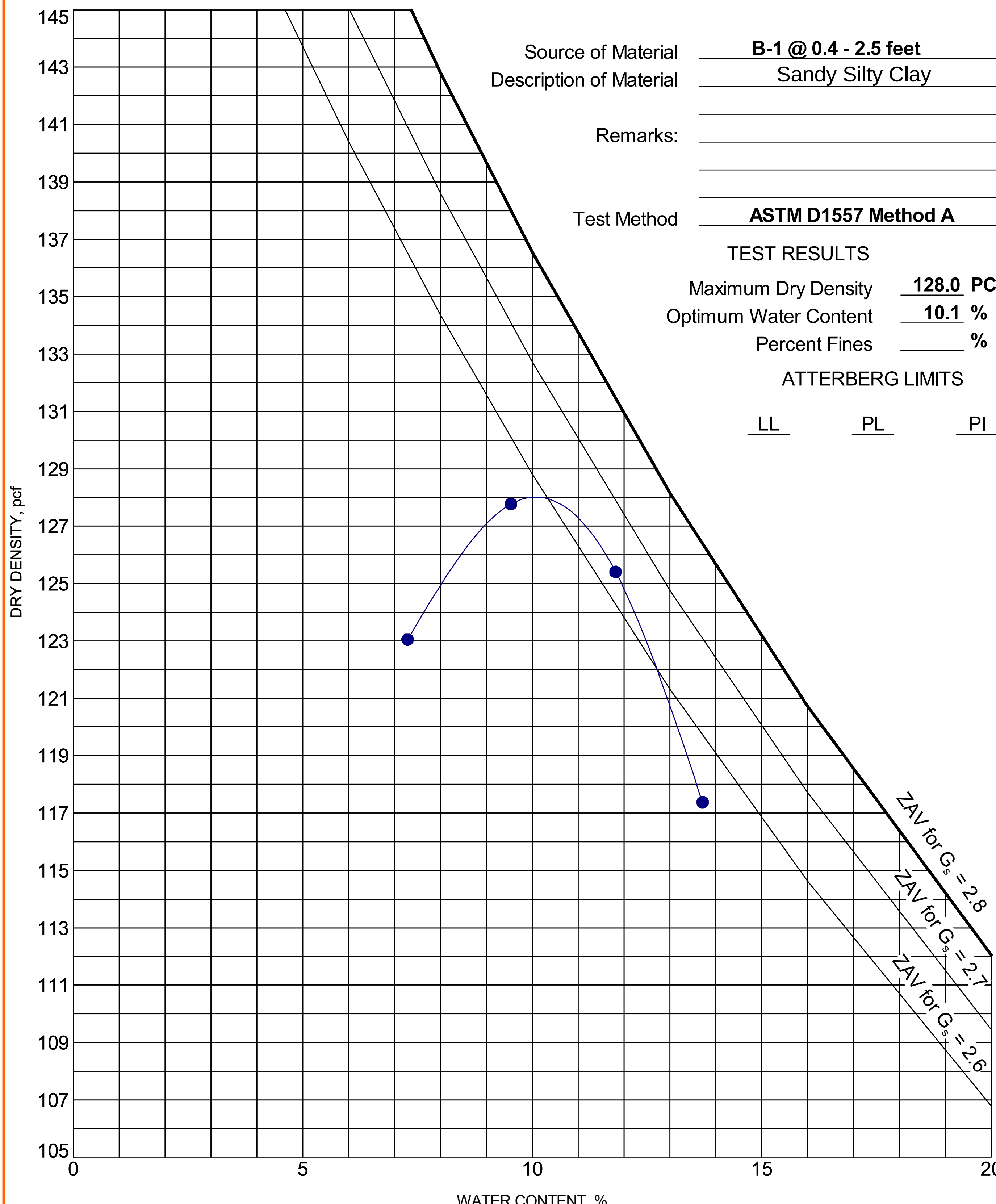
Specimen Identification		Classification	γ_d, pcf	WC, %
●	B-1 2.5 - 4 ft	SANDY SILTY CLAY	106	14

NOTES: Water added at 2,000 psf.

PROJECT: Proposed Starlight Cinema (West Grove Center)	Terracon 1421 Edinger Ave, Ste C Tustin, CA	PROJECT NUMBER: 60195111
SITE: 12101-12111 Valley View Street Garden Grove, CA		CLIENT: Cinemas Management Inc Playa Del Rey, CA
		EXHIBIT: B-1

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material	**B-1 @ 0.4 - 2.5 feet**
Description of Material	Sandy Silty Clay
Remarks:	
Test Method	**ASTM D1557 Method A**

TEST RESULTS

Maximum Dry Density	**128.0**	**PCF**
Optimum Water Content	**10.1**	**%**
Percent Fines		**%**

ATTERBERG LIMITS

LL	PL	PI

PROJECT: Proposed Starlight Cinema (West Grove Center)	Terracon 1421 Edinger Ave, Ste C Tustin, CA	PROJECT NUMBER: 60195111
SITE: 12101-12111 Valley View Street Garden Grove, CA		CLIENT: Cinemas Management Inc Playa Del Rey, CA

CHEMICAL LABORATORY TEST REPORT

Project Number: 60195111
Service Date: 09/20/19
Report Date: 09/25/19
Task:

Terracon
750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Client

Cinemas Management Inc
Playa Del Rey, CA

Project

Proposed Starlight Cinema (West Grove Center)

Sample Submitted By: Terracon (60) **Date Received:** 9/19/2019 **Lab No.: 19-1049**

Results of Corrosion Analysis

Sample Number	
Sample Location	B-2
Sample Depth (ft.)	0.4-2.5
pH Analysis, AWWA 4500 H	8.37
Water Soluble Sulfate (SO4), AWWA 4500 E (percent %)	0.02
Sulfides, AWWA 4500-S D, (mg/kg)	Nil
Chlorides, ASTM D 512, (mg/kg)	50
Red-Ox, AWWA 2580, (mV)	+684
Total Salts, AWWA 2540, (mg/kg)	1254
Resistivity, ASTM G 57, (ohm-cm)	2425

Analyzed By: Trisha Campo

Trisha Campo
Chemist

SUPPORTING INFORMATION

GENERAL NOTES
DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Proposed Starlight Cinema (West Grove Center) ■ Garden Grove, CA
Terracon Project No. 60195111

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Auger Cuttings Modified Dames & Moore Ring Sampler Standard Penetration Test	**Water Initially Encountered** **Water Level After a Specified Period of Time** **Water Level After a Specified Period of Time** Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**N** Standard Penetration Test Resistance (Blows/Ft.) **(HP)** Hand Penetrometer **(T)** Torvane **(DCP)** Dynamic Cone Penetrometer **UC** Unconfined Compressive Strength **(PID)** Photo-Ionization Detector **(OVA)** Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 0.25	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	0.25 to 0.50	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	0.50 to 1.00	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	1.00 to 2.00	8 - 15	10 - 18
Very Dense	> 50	> 99	Very Stiff	2.00 to 4.00	15 - 30	19 - 42
			Hard	> 4.00	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL		RELATIVE PROPORTIONS OF FINES	
Descriptive Term(s) of other constituents	Percent of Dry Weight	**Descriptive Term(s) of other constituents**	**Percent of Dry Weight**
Trace	<15	Trace	<5
With	15-29	With	5-12
Modifier	>30	Modifier	>12

GRAIN SIZE TERMINOLOGY		PLASTICITY DESCRIPTION	
Major Component of Sample	**Particle Size**	**Term**	**Plasticity Index**
Boulders	Over 12 in. (300 mm)	Non-plastic	0
Cobbles	12 in. to 3 in. (300mm to 75mm)	Low	1 - 10
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)	Medium	11 - 30
Sand	#4 to #200 sieve (4.75mm to 0.075mm	High	> 30
Silt or Clay	Passing #200 sieve (0.075mm)		

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]	GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]	SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above “A” line	CL	Lean clay [K, L, M]
			PI < 4 or plots below “A” line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above “A” line	CH	Fat clay [K, L, M]
			PI plots below “A” line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ≥ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add “sandy” to group name.

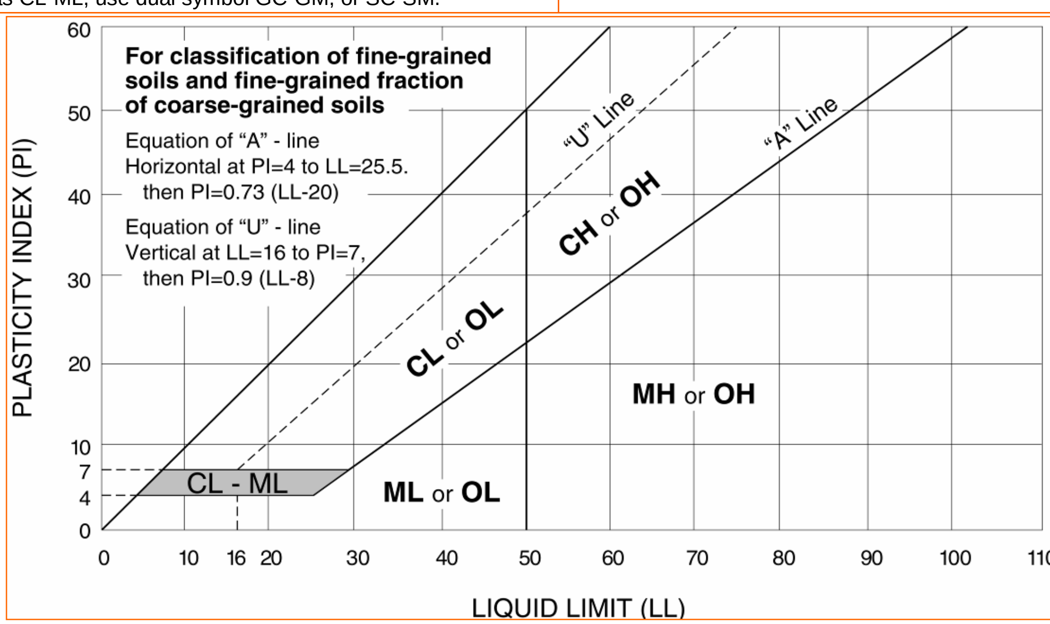
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.

[N] PI ≥ 4 and plots on or above “A” line.

[O] PI < 4 or plots below “A” line.

[P] PI plots on or above “A” line.

[Q] PI plots below “A” line.



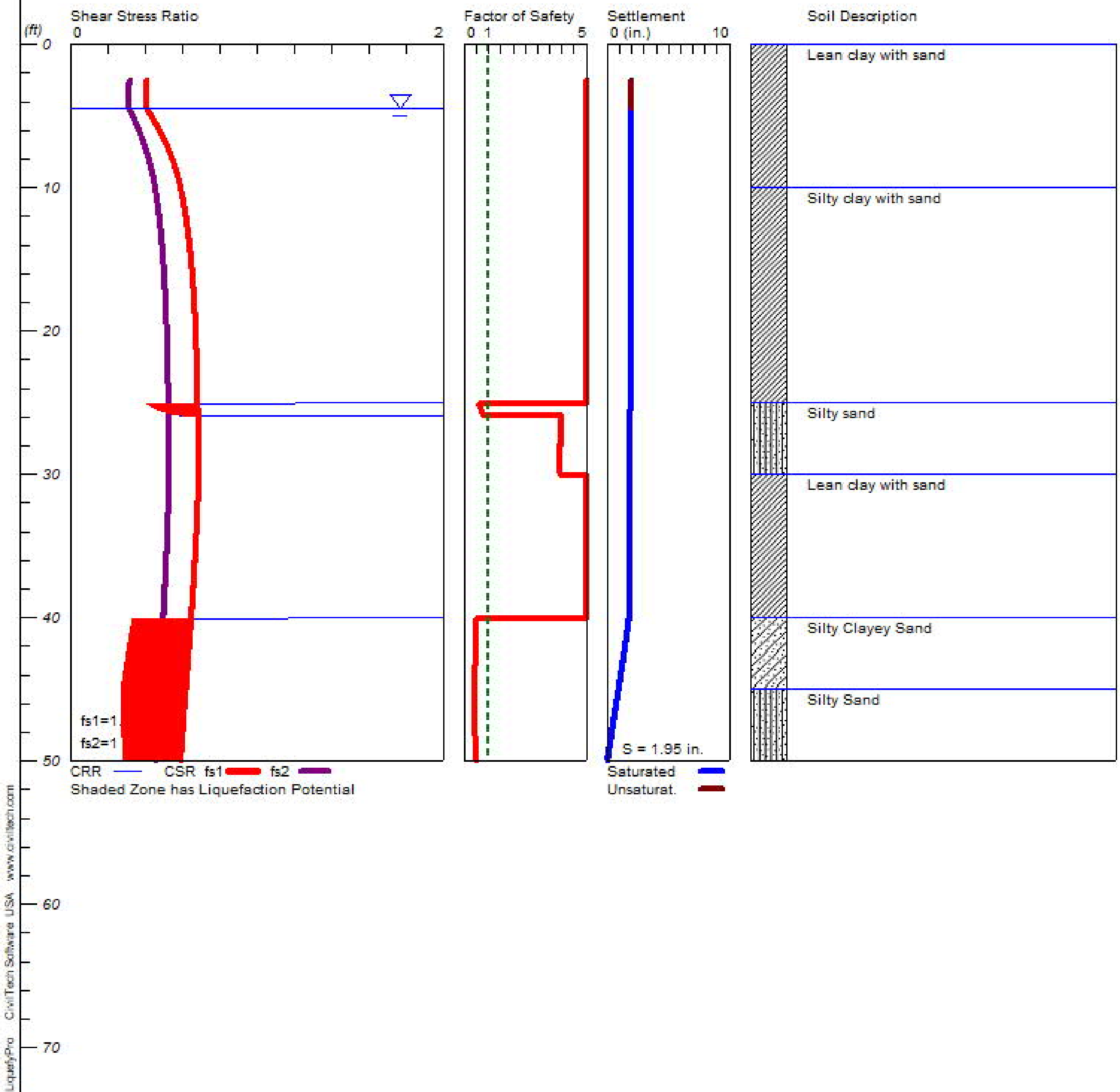
LIQUEFACTION ANALYSIS

LIQUEFACTION ANALYSIS

Starlight Cinema

Hole No.=B-2   Water Depth=4.5 ft   Surface Elev.=24

Magnitude=6.65
Acceleration=0.49g



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LIQUEFACTION ANALYSIS SUMMARY

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Input File Name: N:\Projects\2019\60195111\Working Files\Calculations-Analyses\Liquefy Pro File.liq
Title: Starlight Cinema
Subtitle: 60195111

Surface Elev.=24
Hole No.=B-2
Depth of Hole= 50.00 ft
Water Table during Earthquake= 4.50 ft
Water Table during In-Situ Testing= 22.00 ft
Max. Acceleration= 0.49 g
Earthquake Magnitude= 6.65

Input Data:
Surface Elev.=24
Hole No.=B-2
Depth of Hole=50.00 ft
Water Table during Earthquake= 4.50 ft
Water Table during In-Situ Testing= 22.00 ft
Max. Acceleration=0.49 g
Earthquake Magnitude=6.65
No-Liquefiable Soils: CL, OL are Non-Liq. Soil

1. SPT or BPT Calculation.
2. Settlement Analysis Method: Tokimatsu, M-correction
3. Fines Correction for Liquefaction: Modify Stark/Olson
4. Fine Correction for Settlement: During Liquefaction*
5. Settlement Calculation in: All zones*
6. Hammer Energy Ratio, Ce = 1.45
7. Borehole Diameter, Cb= 1.15
8. Sampling Method, Cs= 1.2
9. User request factor of safety (apply to CSR) , User= 1.3
   Plot two CSR (fs1=User, fs2=1)
10. Use Curve Smoothing: Yes*
* Recommended Options

In-Situ Test Data:

Depth ft	SPT	gamma pcf	Fines %
2.50	15.00	114.00	NoLiq
5.00	13.00	100.00	NoLiq
7.50	4.00	100.00	NoLiq
10.00	9.00	125.00	NoLiq
15.00	8.00	125.00	NoLiq
20.00	16.00	127.00	NoLiq
25.00	12.00	127.00	30.00
30.00	16.00	121.00	NoLiq
35.00	11.00	121.00	NoLiq
40.00	11.00	131.00	30.00
45.00	9.00	131.00	30.00
50.00	10.00	120.00	30.00

Output Results:

Settlement of Saturated Sands=1.95 in.
Settlement of Unsaturated Sands=0.00 in.
Total Settlement of Saturated and Unsaturated Sands=1.95 in.
Differential Settlement=0.974 to 1.286 in.

Depth ft	CRRm	CSRfs	F.S.	S_sat. in.	S_dry in.	S_all in.
2.50	2.00	0.41	5.00	1.95	0.00	1.95
3.50	2.00	0.41	5.00	1.95	0.00	1.95
4.50	2.00	0.41	5.00	1.95	0.00	1.95
5.50	2.00	0.46	5.00	1.95	0.00	1.95
6.50	2.00	0.50	5.00	1.95	0.00	1.95
7.50	2.00	0.53	5.00	1.95	0.00	1.95
8.50	2.00	0.56	5.00	1.95	0.00	1.95
9.50	2.00	0.58	5.00	1.95	0.00	1.95
10.50	2.00	0.60	5.00	1.95	0.00	1.95
11.50	2.00	0.61	5.00	1.95	0.00	1.95
12.50	2.00	0.63	5.00	1.95	0.00	1.95
13.50	2.00	0.64	5.00	1.95	0.00	1.95
14.50	2.00	0.64	5.00	1.95	0.00	1.95
15.50	2.00	0.65	5.00	1.95	0.00	1.95
16.50	2.00	0.66	5.00	1.95	0.00	1.95
17.50	2.00	0.66	5.00	1.95	0.00	1.95
18.50	2.00	0.67	5.00	1.95	0.00	1.95
19.50	2.00	0.67	5.00	1.95	0.00	1.95
20.50	2.00	0.67	5.00	1.95	0.00	1.95
21.50	2.00	0.68	5.00	1.95	0.00	1.95
22.50	2.00	0.68	5.00	1.95	0.00	1.95

23.50	2.00	0.68	5.00	1.95	0.00	1.95
24.50	2.00	0.68	5.00	1.95	0.00	1.95
25.50	0.47	0.69	0.69*	1.89	0.00	1.89
26.50	2.72	0.69	3.96	1.80	0.00	1.80
27.50	2.72	0.69	3.96	1.78	0.00	1.78
28.50	2.72	0.69	3.95	1.78	0.00	1.78
29.50	2.72	0.69	3.94	1.78	0.00	1.78
30.50	2.00	0.69	5.00	1.78	0.00	1.78
31.50	2.00	0.69	5.00	1.78	0.00	1.78
32.50	2.00	0.68	5.00	1.78	0.00	1.78
33.50	2.00	0.68	5.00	1.78	0.00	1.78
34.50	2.00	0.68	5.00	1.78	0.00	1.78
35.50	2.00	0.67	5.00	1.78	0.00	1.78
36.50	2.00	0.67	5.00	1.78	0.00	1.78
37.50	2.00	0.66	5.00	1.78	0.00	1.78
38.50	2.00	0.66	5.00	1.78	0.00	1.78
39.50	2.00	0.65	5.00	1.78	0.00	1.78
40.50	0.33	0.65	0.50*	1.71	0.00	1.71
41.50	0.31	0.64	0.49*	1.55	0.00	1.55
42.50	0.30	0.63	0.47*	1.38	0.00	1.38
43.50	0.29	0.63	0.46*	1.20	0.00	1.20
44.50	0.28	0.62	0.44*	1.02	0.00	1.02
45.50	0.27	0.62	0.44*	0.83	0.00	0.83
46.50	0.27	0.61	0.45*	0.64	0.00	0.64
47.50	0.27	0.61	0.45*	0.46	0.00	0.46
48.50	0.28	0.60	0.46*	0.27	0.00	0.27
49.50	0.28	0.60	0.47*	0.09	0.00	0.09

* F.S.<1, Liquefaction Potential Zone
(F.S. is limited to 5, CRR is limited to 2, CSR is limited to 2)

Units: Unit: qc, fs, Stress or Pressure = atm (1.0581tsf); Unit Weight = pcf; Depth = ft; Settlement = in.

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1 atm (atmosphere) = 1 tsf (ton/ft2)

CRRm	Cyclic resistance ratio from soils
CSRsf	Cyclic stress ratio induced by a given earthquake (with user request factor of safety)
F.S.	Factor of Safety against liquefaction, F.S.=CRRm/CSRsf
S_sat	Settlement from saturated sands
S_dry	Settlement from Unsaturated Sands
S_all	Total Settlement from Saturated and Unsaturated Sands
NoLiq	No-Liquefy Soils