PARTNER

PRELIMINARY GEOTECHNICAL REPORT

Student Housing Building – 2128 Oxford Street
2128 Oxford Street
Berkeley, California 94704

April 30, 2021
Partner Project Number: 20-297761.1

Prepared for:

Core Campus Manager, LLC
1643 N. Milwaukee Avenue, 5th Floor
Chicago, Illinois 60647

Engineers who understand your business

PARTNER

Mark Goehausen
Core Campus Manager, LLC
1643 N. Milwaukee Avenue, 5th Floor
Chicago, Illinois 60647

Subject: **Preliminary Geotechnical Report**
Student Housing Building
2128 Oxford Street
Berkely, California 94704
Partner Project No. 20-297761.1

Dear Mark Goehausen:

Partner Assessment Corporation (Partner) presents the following general opinion regarding the geotechnical conditions at the subject site, based on the information contained within this geotechnical report and our general experience with construction practices and geotechnical conditions on other sites. This statement does not constitute an engineering recommendation.

- *The geotechnical conditions on the site related to the planned construction are expected to be similar to more difficult in comparison with other similar sites*; given challenges associated with relatively shallow historic high groundwater, and possible deep excavations which will require shoring systems and possible dewatering.*

The descriptions and findings of our geotechnical report are presented for your use in this electronic format, for your use as shown in the hyperlinked outline below. To return to this page after clicking a hyperlink, hold “alt” and press the “left arrow key” on your keyboard.

We appreciate the opportunity to be of service during this phase of the work.

Sincerely,

PROFESSIONAL ENGINEER
MATTHEW MARCUS
GE 3156
EXP. 04/30/2021
GEOTECHNICAL
STATE OF CALIFORNIA

Matthew Marcus, PE, PG
Principal Geotechnical Engineer

Chris Landau
Senior Engineer

Yuri Kawashima, GIT
Project Geologist

** “similar sites” refers to sites with similar planned and current use, where we have recently performed similar work, and is a general statement not based on statistical analysis.*

1. GEOTECHNICAL EXECUTIVE SUMMARY

The executive summary is meant to consolidate information provided in more detail in the body of this report. This summary in no way replaces or overrides the detailed sections of the report.

Geologic Zones and Site Hazards

The site is located in the City of Berkeley within the Coast Ranges geomorphic province of California. Surficial geology at the site is mapped as older Quaternary alluvium and marine deposits. The site grades are relatively flat, gently sloping down towards the west. The site is currently occupied by a mixed-use residential and commercial property consisting of two abutting two-story buildings with associated asphalt parking lots in the rear. The site may be impacted by existing buried foundations, utility lines, undocumented fills as well as other remnants of previous construction. This portion of the state is prone to strong ground shaking and the site is mapped less than 1 mile from the Hayward Fault Zone. No other hazards were known or suspected on the site.

Excavation Conditions

We anticipate that support of excavation shoring will be needed to establish foundation bearing elevations on the site given basement levels ranging from 10 to 35 feet may be considered. Such a system could consist of soldier piles with lagging and require heavy construction equipment as described in Section 5. As previously mentioned, undocumented fills and remnants of previous construction are present on the site and could cave or be difficult to remove and require additional planning and equipment. According to the Harza borings, groundwater was encountered at 18 and 17 feet in borings EB-2 and EB-3, respectively. Groundwater may impact the site as levels fluctuate over time and may be different at the time of foundation excavation and during the project life depending on the final finished floor elevation. The contractor should be prepared to manage groundwater during excavation, which will require special planning and equipment, that could include the use of sumps, pumps, trench drains, or other measures.

Foundation/Slab Support

We anticipate that the new building will be supported on mat foundation at basement levels or a deep foundation system, with grade beams. We recommend that the mat foundation (if used) be supported on 24 inches of aggregate base (to provide a capillary break) over competent, approved native subgrade soils. The base of excavation for new foundations and slabs on grade should be evaluated by the engineer, with additional removal of soft or deleterious material if needed and should then be compacted in-place prior to the placement of new fills or foundations. Areas for new slabs on grade should be evaluated by proofrolling with soft, unstable areas removed and replaced with compacted fill. Additional exploration will be needed as the design progresses to obtain seismic spectral analysis and deeper soil information to provide deep foundation capacities and/or total mat slab settlements.

Soil Reuse

Based on the Harza borings, site soils will generally be suitable for re-use as structural fill given the soils are free of deleterious material. However, for this project we anticipate significant export of onsite material will be needed. We recommend structural fill for the site be moisture conditioned and compacted to at least 95% of the maximum dry density as determined by ASTM D 698 and in accordance with Appendix C of this report.

2. REPORT OVERVIEW & LIMITATIONS

2.1 Report Overview

To develop this report, Partner accessed existing information and obtained site specific data from our exploration program. Partner also used standard industry practices and our experience on previous projects to perform engineering analysis and provide recommendations for construction along with construction considerations to guide the methods of site development. The opinions on the cover letter of this report do not constitute engineering recommendations, and are only general, based on our recent anecdotal experiences and not statistical analysis. Section 1.0, Executive Geotechnical Summary, compiles data from each of the report sections, while each of sections in the report presents a detailed description of our work. The detailed descriptions in Section 5.0 and Appendix C constitute our engineering recommendations for the project, and they supersede the Executive Geotechnical Summary.

The report overview, including a description of the planned construction and a list of references, as well as an explanation of the report limitations is provided in Section 2.0. The findings of Partner's geologic review are included in Section 3.0 Geologic Conditions and Hazards. The descriptions of our methods of exploration and testing, as well as our findings are included in Section 4.0 Geotechnical Exploration and Laboratory Results. In addition, logs of our exploration excavations are included in Appendix A of the report, and laboratory testing is included in Appendix B of the report. Site Location and Site Plan maps are included as Figures in the report.

2.2 Assumed Construction

Partner's understanding of the planned construction was based on information provided by the project team. The proposed site plan is included as Figure 2 to this report. Partner's assumptions regarding the new construction are presented in the below table.

Property Data	
Property Use:	Student Housing Building
Building footprint/height	Approximately 294,373 sf, seventeen-stories with partial basement and potentially two to three levels of underground parking
Land Acreage (Ac):	Approximately 0.83 acres
Expected Cuts and Fills	Deep excavations of 10 to 35 feet to establish foundation subgrade elevation
Type of Construction:	Assumed mat slab-on-grade with lightweight wood framing or pre-engineered metal and/or concrete masonry unit facade
Foundations Type	Assumed mat foundations and/or conventional spread foundations and slabs on grade supported by deep foundation elements
Anticipated Loads	Maximum column loads on the order of 2,000 kips
Traffic Loading	Primarily frequent vehicular traffic with occasional heavy truck traffic
Site Information Sources:	Google Earth Pro and Site Plan, HUB, Berkeley, California, prepared by Kimley Horn dated March 25, 2021

2.3 References

The following references were used to generate this report:

California Dept. of Transportation, ARS Online, accessed 04/28/2021

California Geological Survey, Note 36*, California Geomorphic Provinces*, 2002.

Federal Emergency Management Agency, FEMA Flood Map Service Center, accessed 04/28/2021

Google Earth Pro (Online), accessed 04/28/2021

Rockridge Geotechnical, *Geotechnical Consultation Proposed Extended Stay Hotel, 2136 Center Street, Berkeley, California*. Report dated February 5, 2015.

Historic Aerials by NETR Online, accessed 04/28/2021

OSHPD Seismic Design Maps, accessed online 04/28/2021

Partner Engineering and Science, Inc., Phase 1 Environmental Assessment Report – *2128 Oxford Street, Berkeley*, *California*, Report dated 04/21/2021.

Temblor Online, accessed 04/28/2021

United States Department of Agriculture, Web Soil Survey, accessed online 04/28/2021

United States Geological Survey, California Interactive Geologic Map accessed 04/28/2021

United States Geological Survey, Lower 48 States 2014 Seismic Hazard Map, accessed online 04/28/2021

United States Geologic Survey, Earthquake Hazards Program (Online), accessed 04/28/2021

2.4 Limitations

The conclusions, recommendations, and opinions in this report are based upon soil samples and data obtained in widely spaced locations that were accessible at the time of exploration and collected based on project information available at that time. Our findings are subject to field confirmation that the samples we obtained were representative of site conditions. If conditions on the site are different than what was encountered in our borings, the report recommendations should be reviewed by our office, and new recommendations should be provided based on the new information and possible additional exploration if needed. It should be noted that geotechnical subsurface evaluations are not capable of predicting all subsurface conditions, and that our evaluation was performed to industry standards at the time of the study, no other warranty or guarantee is made.

Likewise, our document review and geologic research study made a good-faith effort to review readily available documents that we could access and were aware of at the time, as listed in this letter. We are not able to guarantee that we have discovered, observed, and reviewed all relevant site documents and conditions. If new documents or studies are available following the completion of the report, the recommendations herein should be reviewed by our office, and new recommendations should be provided based on the new information and possible additional exploration if needed.

This report is intended for the use of the client in its entirety for the proposed project as described in the text. Information from this report is not to be used for other projects or for other sites. All of the report must be reviewed and applied to the project or else the report recommendations may no longer apply. If pertinent changes are made in the project plans or conditions are encountered during construction that appear to be different than indicated by this report, please contact this office for review. Significant variations may necessitate a re-evaluation of the recommendations presented in this report. The findings in this report are valid for one year from the date of the report. This report has been completed under specific Terms and Conditions relating to scope, relying parties, limitations of liability, indemnification, dispute resolution, and other factors relevant to any reliance on this report.

If parties other than Partner are engaged to provide construction geotechnical services, they must be notified that they will be required to assume complete responsibility for the geotechnical phase of the project by concurring with the findings and recommendations in this report or providing alternate recommendations.

3. GEOLOGIC CONDITIONS & HAZARDS

This section presents the results of a geologic review performed by Partner, for the proposed new construction on site. The general location of the project is shown on Figure 1.

3.1 Site Location and Project Information

The planned construction will be situated on an occupied parcel within a residential/commercial area of Berkeley, California. The subject property is currently occupied by mixed-commercial and residential buildings. The project site is bordered by Oxford Lane to the south, Oxford Street to the east, Center Street to the north, and a residential building to the west. Figure 2 presents the project site and the locations of our site exploration. Based on our review of available documents, the site has had the following previous uses:

Historical Use Information		
Period/Date	**Source**	**Description/Use**
1890 –1904	Sanborn Maps, Topographic Maps	School, commercial and residential uses
1911 –1993	Sanborn Maps, Aerial Photographs, Topographic Maps, City Directories	Mixed-commercial, and residential, and parking lot uses
1995 – 1996	Municipal Records	Construction of the present day 2128 building
1996 – Present	Municipal Records, City Directories, Topographic Maps, Aerial Photographs, Sanborn Maps, Interviews	Mixed-commercial and residential, and parking lot uses

3.2 Geologic Setting

The site is located in the City of Berkeley within the Coast Ranges geomorphic province of California. Surficial geology at the site is mapped as older Quaternary alluvium and marine deposits. The site grades are relatively flat, gently sloping down towards the west. The site is currently occupied by a mixed-use residential and commercial property consisting of two abutting two-story buildings with associated asphalt parking lots in the rear. The site may be impacted by existing buried foundations, utility lines, undocumented fills as well as other remnants of previous construction. This portion of the state is prone to strong ground shaking and the site is mapped less than 1 mile from the Hayward Fault Zone. No other hazards were known or suspected on the site.

Based on information obtained from the USDA Natural Resources Conservation Service Web Soil Survey online database, the subject property is mapped as 146- Urban land. Urban land complex soils are those soils in which the soil's original structure and content have been so altered by human activities it has lost its original characteristics and is therefore unidentifiable. Urban soils consist of nearly level to moderately steep areas where the soils have been altered or obscured by urban development and structures. Included in the mapping unit are many small areas where the original soil material has been disturbed by construction and areas where fill materials have been added. As such the soil properties and characteristics vary. A general summary of the geologic data compiled for this project is provided in the below table.

Geologic Data		
Parameter	**Value**	**Source**
Geomorphic Zone	Coast Ranges	CGS
Ground Elevation	Approx. 201 feet above MSL	USGS
Flood Elevation	Flood Hazard Zone X	FEMA
Seismic Hazard Zone	High	USGS
Geologic Hazards	Ground shaking, liquefaction	CGS
Surface Cover	Asphalt cover	Onsite Observations
Surficial Geology	Older Quaternary Alluvium and Marine Deposits	USGS
Depth to Bedrock	Unknown	-
Groundwater Depth	15 feet	Partner Phase 1
Historical Groundwater Depth	Approximately 10 feet bgs	CGS GeoTracker

3.3 Geologic Hazards

California is tectonically active and contains numerous large, active faults. As a result, geologic hazards with the greatest potential to affect California include earthquakes and related hazards such as tsunamis, landslides, liquefaction, and ground shaking. According to the California Geological Survey (CGS) Fault Activity Map tool, the three faults most relevant to the site are the Hayward Fault Zone (0.73 miles from the site), Mount Diablo Thrust Fault (12.40 miles from the site), and the Green Valley Connected Fault (14.42 miles from the site). The site is not mapped within a zone of seismically included hazard for landslide or tsunami. The site is partially mapped within a liquefaction hazard zone per the CGS Earthquake Zones of Required Investigation Map.

3.4 Seismic Design Parameters

The site latitude and longitude are 32.870269 degrees N and -122.266579 degrees W respectively.

Seismic design parameters are pending given the results of our future geotechnical investigation planned at the site.

4. GEOTECHNICAL EXPLORATION & LABORATORY RESULTS

Our preliminary evaluation of soils on the site included review of Harza's field exploration and laboratory testing. The field exploration and laboratory testing programs are briefly described below. Harza's boring logs and laboratory testing results are provided in Appendix A.

4.1 Soil Borings

The soil boring program was conducted by Harza on October 16, 2000. Three (3) borings designated EB-1, EB-2 and EB-3, were advanced by the use of a truck-mounted Mobile B-61 drill rig using hollow-stem auger drilling techniques. The borings were advanced to depths of 30 feet. The approximate locations of the exploratory borings are shown on Figure 2. Logs of subsurface conditions encountered in the borings are presented in Appendix A. A summary table description is provided below:

Surficial Geology		
Strata	**Depth to Bottom of Layer (bgs*)**	**Description**
Surface Cover	Approximately 11 –18 inches	Asphalt Pavement / Crushed Rock Base Course
Native Stratum 1	30 feet +	Interbedded Clay, Gravel, and Sand
Groundwater	Approx. 17 – 18 feet	Harza Borings EB-2 and EB-3
Bedrock	Not Encountered	Not Encountered

4.2 Groundwater

Groundwater was encountered on the site in Harza's Borings EB-2 and EB-3 at depths of approximately 18 and 17 feet, respectively. However, groundwater levels fluctuate over time and may be different at the time of construction and during the project life.

4.3 Laboratory Evaluation

Limited laboratory testing results conducted by Harza are presented in Appendix A. Additional laboratory testing will be part of our final geotechnical report for this project.

4.4 Infiltration Test Results

One infiltration test designated P-1 was performed at the location shown on Figure 2. The test was performed at a depth of 5 feet. The test was performed using the borehole percolation test method. The measured infiltration rate reported below is the unfactored rate. The rate was calculated using the Porchet method. The civil engineer should apply the proper reduction factors or factors of safety based on the type of system used. Data is shown in Appendix D, and is summarized below:

Parameter	P-1
Location	Near EB-1
Elevation of Tested Area	5 ft
Pre-soak Depth (from top of pipe)	1.0 ft
Test Start Depth (from top of pipe)	41 in.
Water Drop During Test	19.0 in.
Unfactored Infiltration Rate	**13.05 in./hr**

5. PRELIMINARAY GEOTECHNICAL RECOMMENDATIONS

The following discussion of findings for the site is based on the assumed construction, geologic review, results of the field exploration, and laboratory testing programs. The recommendations of this report are contingent upon adherence to Appendix C of this report, General Geotechnical Design and Construction Considerations. For additional details on the below recommendations, please see Appendix C.

5.1 Preliminary Geotechnical Recommendations

The proposed construction is generally feasible from a geotechnical perspective provided the recommendations and assumptions of this report are followed.

Geologic/General Site Considerations

- The site is located in the City of Berkeley within the Coast Ranges geomorphic province of California. Surficial geology at the site is mapped as older Quaternary alluvium and marine deposits. The site grades are relatively flat, gently sloping down towards the west. The site is currently occupied by a mixed-use residential and commercial property consisting of two abutting two-story buildings with associated asphalt parking lots in the rear. The site may be impacted by existing buried foundations, utility lines, undocumented fills as well as other remnants of previous construction. This portion of the state is prone to strong ground shaking and the site is mapped less than 1 mile from the Hayward Fault Zone. No other hazards were known or suspected on the site.
- Given the presence of the site in a seismically active area, ground shaking during earthquakes should be anticipate during the project life. State, County, City, and other jurisdictions in seismically active areas update seismic standards on a regular basis. The design team should carefully evaluate all of the building requirements for the project.

Excavation Considerations

- At the time of this report we understand finished floor elevations are still being decided. Depending on what is decided, we anticipate deep excavations on the site to depths of 10-35 feet for building foundations and/or structural slabs on grade, and up to 35 feet for utility lines. Drilled foundations if any could be much deeper and would likely need to be socketed into bedrock. Based on Harza's boring data, heavy-duty construction equipment in good working condition should be able to perform the planned excavations. As previously mentioned, undocumented fills and remnants of previous construction may be present on the site and could cave or be difficult to remove and require additional planning and equipment.
- Given the depth of the anticipated planned excavation and the presence of nearby structures, a specially designed shored excavation will be needed to establish foundation subgrade levels. Such a system could consist of a drilled soldier pile wall with lagging and soil anchors, but other systems may also be acceptable. The design of this system should be performed by the contractor performing the work, and should consider the impacts of installing anchors, deflection of the soil behind the walls, and drawdown of groundwater caused by dewatering of the excavation. All of

these factors could result in damage to surrounding properties. The design can use soil data from section 5.2 of this report. The groundwater levels used in the design can be adjusted based on the monitoring data obtained as well as engineering judgement. Appendix C of this report contains a section regarding additional Excavation and Dewatering considerations for the site. Nearby properties should be protected during demolition and excavation, and pre- and post-construction surveys of the nearby properties are recommended, as is site monitoring during construction.

- At the time of our study, multiple existing structures were located on the site and are slated to be demolished. Given the proximity to neighboring properties and roadways sloping, shoring, and/or supported excavations will be called for on the site during building removal. Excavation safety should comply with OSHA requirements.
- According to the Harza borings, groundwater was encountered at 18 and 17 feet in borings EB-2 and EB-3, respectively. However, historic high groundwater levels may be as high as 10 feet. The contractor should be prepared to manage groundwater during excavation, which will require special planning and equipment, that could include the use of sumps, pumps, trench drains, or other measures. As previously mentioned, the contractor could monitor the groundwater on the project site prior to construction to evaluate if groundwater is likely to be encountered during temporary excavations. This should be done at multiple locations on the site, and based on the contractor's judgement, temporary excavations could be designed based on real time monitoring data. It should be noted that groundwater levels can change quickly.
- Excavations should be sloped and/or shored to protect worker safety and adjacent properties, per OSHA and local guidelines and the presence of existing utilities should be thoroughly and carefully checked prior to digging. Appendix C further discusses excavation recommendations in the following sections, which can be accessed by clicking hyperlinks: Earthwork, Underground Pipeline, Excavation De-Watering.

Shallow Foundations

- Based on the maximum column loads provided, we anticipate that the new building may be supported on mat foundations at basement levels. We recommend that mat foundations be supported on 24 inches of aggregate base (to provide a capillary break) over competent, approved native subgrade soils. The base of excavation for new foundations should be evaluated by the engineer, with additional removal of soft or deleterious material if needed and should then be compacted in-place prior to the placement of new fills or foundations. Areas for new slabs on grade should be evaluated by proofrolling with soft, unstable areas removed and replaced with compacted fill.
- Partner provided preliminary estimates of mat foundation settlements given approximate load and foundation shape information from the structural engineer and the limited soil boring data from Harza. The settlement estimates are provided in Section 5.2.
- Where auxiliary structures, such as site walls require foundations, shallow spread foundations can be used as described in Section 5.2. The base of excavation for new foundations should be

evaluated by the engineer, with additional removal of soft or deleterious material if needed and should then be compacted in-place prior to the placement of new fills or foundations. Areas for new slabs on grade should be evaluated by proofrolling with soft, unstable areas removed and replaced with compacted fill. Slabs and auxiliary foundations should be supported on 12 inches of reworked granular soil (PI < 15 or fines % < 35), which may call for removal and replacement of existing site soil.

- Section 5.2 of this report provides a table outlining the embedment depth, bearing capacity, settlement and other parameters for foundation design and construction.

Deep Foundation Considerations

- Alternatively, the new building foundations and floor slabs may be supported on one of or a combination of the following foundation types: Auger-cast-in-place piles, drilled shafts, or driven piles. Based on our review of Harza's soil borings and knowledge of local geologic conditions at the site and in the area, we anticipate deep foundation elements will need to extend into competent bedrock, which is likely to be encountered between 60 and 100 feet below site grades. Coring into bedrock will be needed in order to provide appropriate design parameters for the new building.
- In order to design the deep foundations accordingly, our final geotechnical report for this project will include subsurface explorations to aid in the design of deep foundation support.

On-Grade Construction Considerations

- In new structural areas of the site, all remnants of previous construction, vegetation and/or deleterious materials should be completely removed to exposed clean subgrade soil. In new fill, structural, and pavement areas, cleaned subgrade should be proofrolled and evaluated by the engineer with a loaded water truck (4,000 gallon) or equivalent rubber-tired equipment. In locations where proofrolling is not feasible, probing, dynamic cone penetration testing or other methods may be employed. Soft or unstable areas should be repaired per the direction of the engineer. Once approved, the subgrade soil should be scarified to a depth of 12 inches, moisture conditioned, and compacted as engineered fill. Improvements in these areas should extend laterally beyond the new structure limits 2 feet or a distance equal to or greater than the layer thickness, whichever is greater. This zone should extend vertically from the bearing grade elevation to the base of the fill. The thicknesses of the layer, settlement estimates, and modulus values are provided on the design tables in the next section.
- Based on the Harza borings, we anticipate that some over-excavation may result from proofrolling operations. In areas where deep instability is encountered, we recommend test pits be excavated and an engineer be called to perform an evaluation of the issue and to propose a resolution. Such resolutions may include but are not limited to the use of geotextiles, chemical treatments (soil cement, hydrated lime, etc.) thickened slabs or pavements sections, lime-treated aggregate base, or others. Pavement sections provided in Section 5.2 are based on approved, compacted in-place

soils being used in the subgrade. If subgrade conditions in the upper 3 feet of pavement areas vary or are improved, the pavement sections may be modified.

- Appendix C provides additional recommendations for foundations in the following sections: Cast-in-place Concrete, Foundations, Earthwork, Paving, Subgrade Preparation which can be accessed by clicking the hyperlinks.

Soil Reuse Considerations

- Based on the Harza borings, site soils will generally be suitable for re-use as structural fill given the soils are free of deleterious material. However, for this project we anticipate significant export of onsite material will be needed. We recommend structural fill for the site be moisture conditioned and compacted to at least 95% of the maximum dry density as determined by ASTM D 698 and in accordance with Appendix C of this report.
- Appendix C provides additional recommendations for foundations in the following sections: EARTHWORK, SUBGRADE PREPARATION which can be accessed by clicking the hyperlinks.

Geotechnical Concrete and Steel Construction Considerations

- Soil/rock may be corrosive to concrete. We recommend using corrosion resistant concrete (*e.g.* Type II/V Portland Cement, a fly ash mixture of 25 percent cement replacement, and a water/cement ratio of 0.45 or less) as directed by the producer, engineer or other qualified party based on their knowledge of the materials and site conditions. Concrete exposed to freezing weather should be air-entrained. Mix designs should be well-established and reviewed by the project engineers prior to placement, to verify the design is appropriate to meet the project needs and parameters provided in this report. Quality control testing should be performed to verify appropriate mixes are used and are properly handled and placed. Please refer to Appendix C, Cast In-Place Concrete for more details.
- Soil/rock may be corrosive to un-protected metallic elements such as pipes, poles, rebar, etc. We recommend the use of coatings and/or cathodic protection for metals in contact with the ground, as directed by the product manufacturer, engineer or other qualified party based on their knowledge of the materials to be used and site soil conditions.

Site Storm Water Considerations

- Testing indicated near surface soils are not conducive to storm water infiltration. Surface drainage and landscaping design should be carefully planned to protect the new structures from erosion/undermining, and to maintain the site earthwork and structure subgrades in a relatively consistent moisture condition. Water should not flow towards or pond near to new structures, and high water-demand plants should not be planned near to structures. Appendix C provides additional recommendations for foundations in the following sections: SITE GRADING AND DRAINAGE, WATER PROOFING which can be accessed by clicking the hyperlinks.

- We recommend consulting with the landscape designer and civil engineer regarding management of site storm water and irrigation water, as changes in moisture content below the site after construction will lead to soil movement and potential distress to the building.

5.2 Preliminary Geotechnical Parameters

Based on the findings of our field and laboratory testing, we recommend that design and construction proceed per industry accepted practices and procedures, as described in Appendix C, General Geotechnical Design and Construction Considerations (Considerations).

Preliminary Prepared Subgrade Parameters – (hyperlink to Construction Considerations)

Prepared Subgrade Parameters				
Structure	**Design Values**	**Cover Depth**	**Bearing Surface [a]**	**Static Settlement [d]**
Auxiliary Spread Foundations	q_{all} = 2.5 ksf[c] μ = 0.35	18 inches	12 inches of reworked compacted native soil subgrade	<1 inch
Mat Foundations++	k=90 pci [b] q_{all} = 2.5 ksf[c] μ = 0.35	10 feet	24 inches aggregate capillary break material over 12 inches of approved competent native subgrade	Approx. 2.9 inches
Mat Foundations++	k=90 pci [b] q_{all} = 2.5 ksf[c] μ = 0.35	20 feet	24 inches aggregate capillary break material over 12 inches of approved competent native subgrade	Approx. 1.2 inches
Mat Foundations++	k=90 pci [b] q_{all} = 2.5 ksf[c] μ = 0.35	30 feet	24 inches aggregate capillary break material over 12 inches of approved competent native subgrade	<1 inch
Deep Foundations	1,919 kips	To be determined	Socketed into bedrock. Depth to be determined by future testing	<1 inch

[a] Repairs in bearing *surface areas should be structural fill per the recommendation of the* Earthwork *section of Appendix C that is moisture conditioned to within 3 percent below to optimum moisture content and compacted to 95 percent or more of the soil maximum dry density per ASTM D1557. Expansive material should not be located within the upper* 3 feet of the soil subgrade.

[b] *Subgrade modulus value "k", assuming the grade slab is supported by aggregate layer roughly equal to slab thickness (minimum 4 inches), as required for capillary break*

[c] *Can be increased by 1/3 for temporary loading such as seismic and wind, allowable parameters, estimated FS of 2.5*

[d] *Differential settlement is expected to be half to ¾ of total settlement*

++Mat foundations are subject to a subgrade modulus reduction factor based on the size of the foundation as shown in the bellow equation:

$$K_R = K\left[\frac{B+1}{2B}\right]^2$$

Where:

K = Unit subgrade Modulus
K_R = Reduced Subgrade Modulus
B = Equivalent Foundation width

Laterally Loaded Structures Preliminary Parameters– (hyperlink to Construction Considerations)

Lateral Earth Pressures[a]				
Soil Type	**Coefficient of Friction (µ)**	**Static Fluid Pressure (pcf)**	**Active Fluid Pressure (pcf)**	**Passive Fluid Pressure (pcf)**
Site Soil (Upper 15 feet)	0.38	55	35	300
Dense/Hard Soil (N = 50+/ft)	0.46	40	30	375
Very Dense/Hard Soil (below GW Table)	0.46	40+62.4[b]	30+62.4[b]	400

[a] *These values are unfactored, "raw" numbers and appropriate safety factors should be applied by the wall designer. Assumed GW table at rock surface, for underground structures where water is only on one side, the hydrostatic pressure of 62.4 psf should be added*

[b] *This applies to cases where free standing water is located on only one side of the wall.*

Lateral Loading Considerations

For shoring or permanent retaining walls surcharges from traffic and adjacent buildings should be considered as shown in the below equations. The distribution of soil pressures on retaining structures will depend on the type of systems used, and whether or not they are braced or anchored. The shoring and retaining wall designer should be familiar with the appropriate distribution diagrams to be used and use care in the selection of the appropriate model. The walls should be designed to dissipate nuisance water to the sump system, through an interconnected series of drains. In general, this will not result in lowering of the groundwater table. As such, walls deeper than 10 feet should be designed to withstand hydrostatic pressures.

Traffic Surcharge Loading Equation

Table 1*

Equivalent Height of Soil for Vehicular Loading on Retaining Wall and Shoring Parallel to Traffic

Excavation/Wall Height (ft)	Distance from the edge of excavation (ft)	
	0.0 ft	1.0 ft or further
5.0	5.0	2.0
10.0	3.5	2.0
≥20.0	2.0	2.0

* From Table 3.11.6.4-2 of the AASHTO document referenced above.

γ_s = total unit weight of soil (pcf)

H_{eq} = equivalent height of soil from "Table 1" above

Building Foundation Surcharge Loading Equation

Resultant lateral force:

$$R = \frac{0.3Ph^2}{x^2 + h^2}$$

Location lateral resultant:

$$d = x\left[\left(\frac{x^2}{h^2}+1\right)\left(\tan^{-1}\frac{h}{x}\right)-\left(\frac{x}{h}\right)\right]$$

WHERE:

R = resultant lateral force measured in pounds per foot (N/m) of wall width.

P = resultant surcharge loads of continuous or isolated footings measured in pounds per foot (N/m) of length parallel to the wall.

X = distance of resultant load from back face of wall measured in feet (mm).

h = depth below point of application of surcharge loading to top of wall footing measured in feet (mm).

d = depth of lateral resultant below point of application of surcharge loading measured in feet (mm).

$\tan^{-1} h/x$ = The angle in radians whose tangent is equal to *h/x*.

Loads applied within a horizontal distance equal to the wall stem height, measured from the back face of the wall, shall be considered as surcharge.

For isolated footings having a width parallel to the wall less than 3 feet (914 mm), "*R*" may be reduced to one-sixth the calculated value.

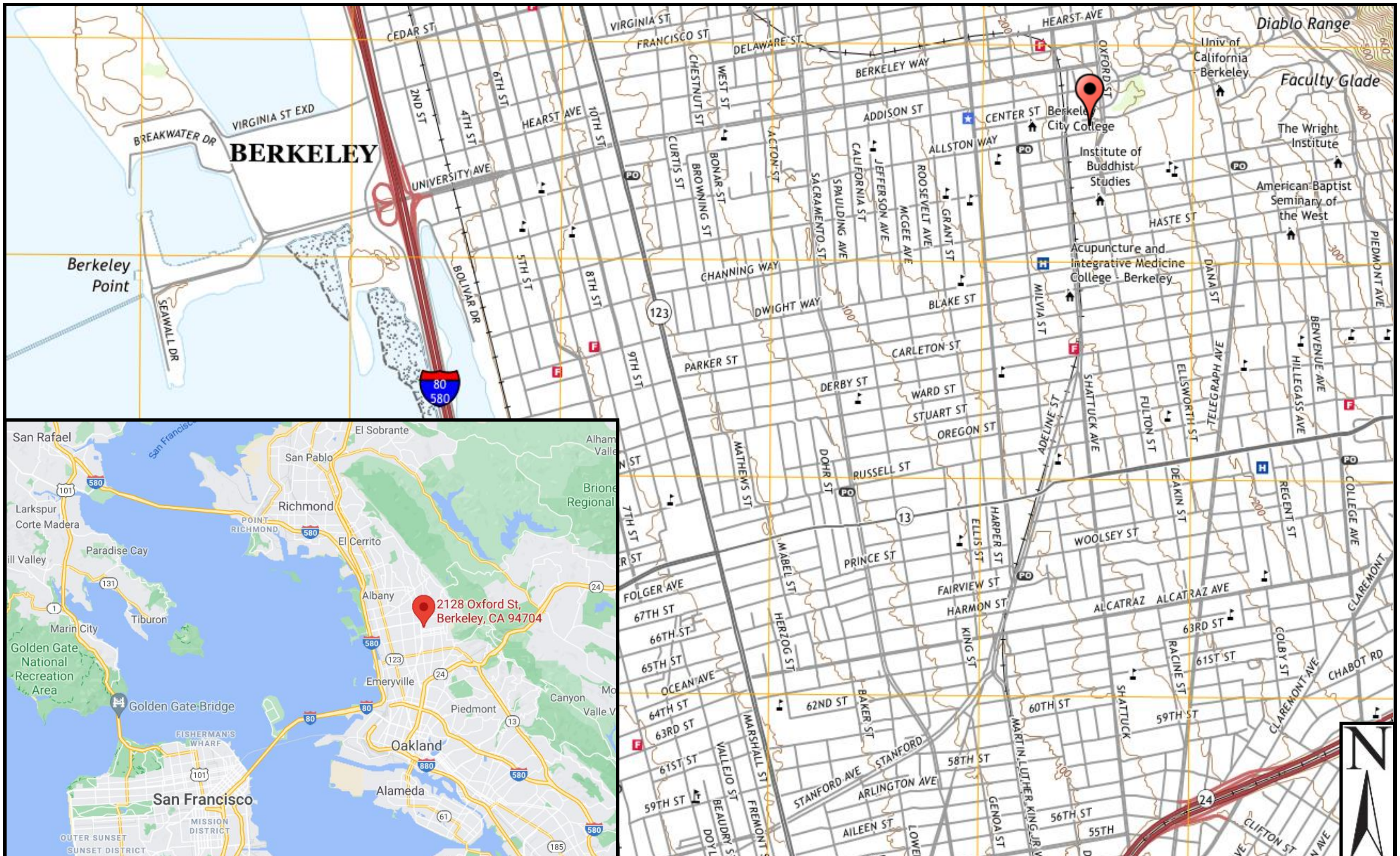
The resultant lateral force "*R*" shall be assumed to be uniform for the length of footing parallel to the wall and to diminish uniformly to zero at the distance "*x*" beyond the ends of the footing.

Vertical pressure due to surcharge applied to the top of the wall footing may be considered to spread uniformly within the limits of the stem and planes making an angle of 45 degrees with the vertical.

FIGURES

- Site Vicinity Plan
- Boring Location Plan
- Geologic Map
- Liquefaction Hazard Map
- Fault Hazard Map

PARTNER



Source: U.S. Geological Survey, USGS US Topo 7.5-minute map for Oakland West, California 2018: USGS - National Geospatial Technical Operations Center (NGTOC)

FIGURE 1 – SITE VICINITY PLAN

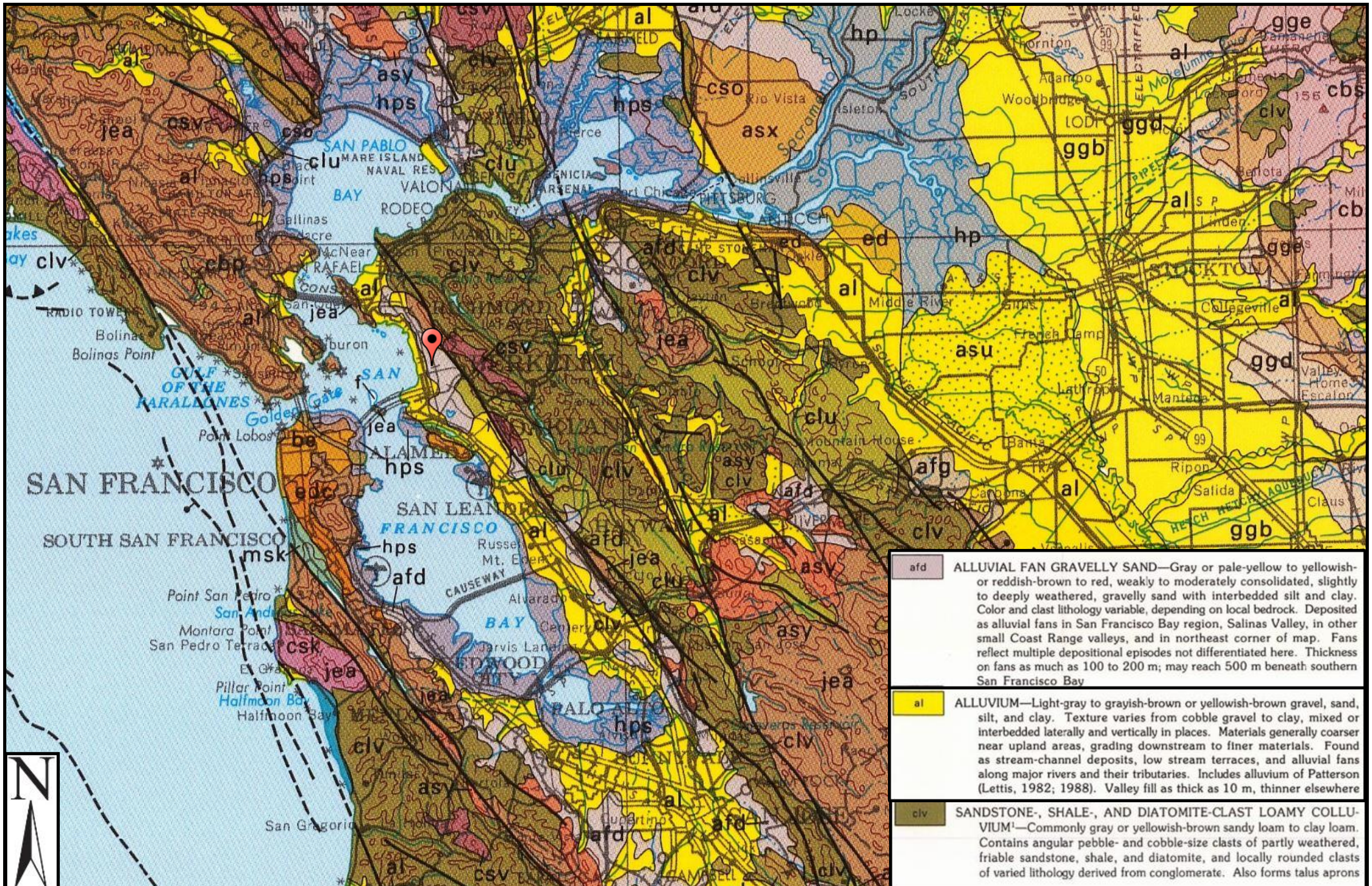
KEY

Approximate Site Location

Source: Google Earth Pro and Client Provided Site Plan

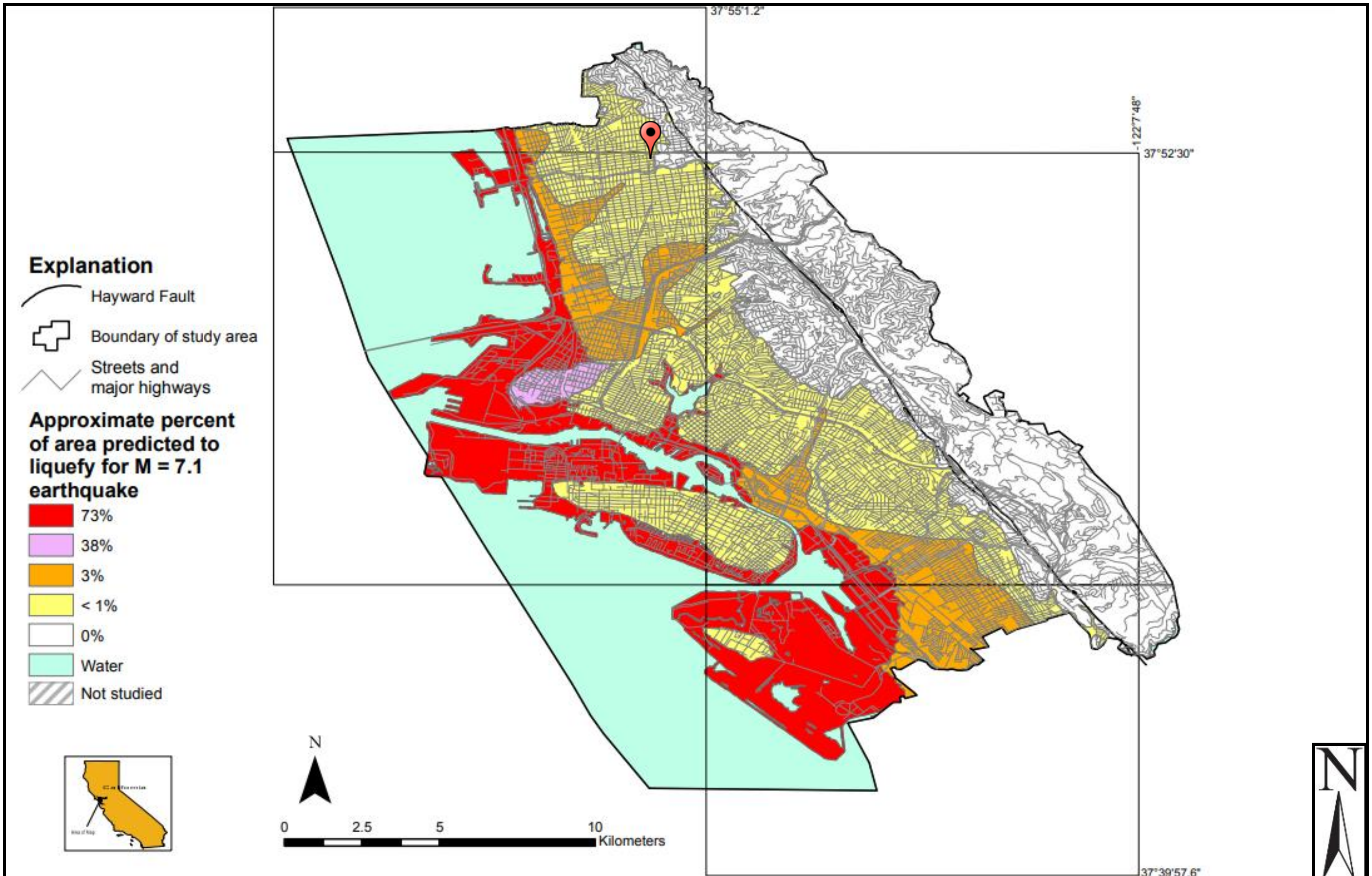
FIGURE 2 – BORING LOCATION PLAN

KEY Approximate Boring Location (Hazra) Approximate Percolation Test Location Approximate Project Limits



Source: Quaternary Geologic Map of the San Francisco Bay Quadrangle, 1993, N. King Huber, scale 1:1,000,000.	**FIGURE 3 – GEOLOGIC MAP**

KEY 📍 Approximate Site Location



Source: Liquefaction Hazard Map of Alameda, Berkeley, Emeryville, Oakland, and Piedmont, California: A Digital Database by Thomas L. Holzer, Michael J. Bennett, Thomas E. Noce, Amy C. Padovani and John C. Tinsley, III

FIGURE 4 – LIQUEFACTION HAZARD MAP

KEY Approximate Site Location

Source: By Thomas M. Brocher, Jack Boatwright, James J. Lienkaemper, Carol S. Prentice, David P. Schwartz, and Howard Bundock

FIGURE 5 – FAULT HAZARD MAP

KEY Approximate Site Location

APPENDIX A

Boring Logs and Laboratory work by Harza Consulting Engineers and Scientists

PARTNER

DRILL RIG	Mobile B-61, HSA	SURFACE ELEVATION	—	LOGGED BY	JND
DEPTH TO GROUND WATER	Not Encountered	BORING DIAMETER	8-inch	DATE DRILLED	10/16/00

DESCRIPTION AND CLASSIFICATION: DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT(%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
PAVEMENT: 3 inches AC over 8 inches AB									
FILL: SAND (SM/SC), brown, fine- to coarse-grained, some silt and clay, wet	Medium Dense				24	22	105		
CLAY (CL), black, silty, some sand (fine- to medium-grained), damp to moist	Firm				4				
			5		6	27	95		
SAND (SC), brown, fine- to coarse-grained, with gravel (fine to coarse, angular to rounded), some clay, moist to wet	Dense		10		66				
GRAVEL (GC), brown, fine to coarse, with sand (fine- to coarse-grained), trace clay, damp	Very Dense				50/5"				
			15						
CLAY (CL), brown, with silt, trace sand (medium- to coarse-grained), trace gravel (fine, subangular to subrounded), damp	Hard				49				
			20						
(grades moist, no gravel)					43				
			25						
	Stiff				19				
			30						

Bottom of Boring = 30 Feet
Notes:
1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.
2. For an explanation of penetration resistance values, see the first page of Appendix A.
3. Samplers were driven with an automatic wire trip hammer falling 30 inches.
4. The boring was backfilled with neat cement after completion.

HARZA
Engineering Company

EXPLORATORY BORING LOG

EASTMAN BUILDING
Berkeley, California

PROJECT NO.	DATE	BORING NO.
18292-CA	November 2000	EB-1

File Name: G:\ENGINEER\GINTW\PROJECTS\18292CA.GPJ Report Template: H Output Date: 11/2/00

DRILL RIG	Mobile B-61, HSA	SURFACE ELEVATION	—	LOGGED BY	JND
DEPTH TO GROUND WATER	18 feet	BORING DIAMETER	8-inch	DATE DRILLED	10/16/00

DESCRIPTION AND CLASSIFICATION: DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT(%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
PAVEMENT: 3½ inches AC over 9 inches AB									
FILL: CLAY (CL), dark brown, silty, some sand (fine-grained), moist	Very Stiff				28	19	104		LL = 37, PI = 20, Passing No. 200 Sieve = 63%
(brick fragments, trace fine and subangular gravel)	Stiff				11				
CLAY (CL), dark brown, silty, some sand (fine-grained), trace gravel (fine, subangular), moist	Very Stiff		5		28	21	103		LL = 37, PI = 20, Passing No. 200 Sieve = 67%
					30				
SAND (SC), brown, fine- to coarse-grained, some clay, some silt, some gravel (fine, subangular), moist	Medium Dense		10						
CLAY (CL), brown, with silt, with sand (fine-grained), moist	Stiff				63				
GRAVEL (GC), brown, fine to coarse, subangular to subrounded, some clay, some sand (fine- to coarse-grained), moist	Very Dense		15						
CLAY (CL), brown, with silt, trace gravel (fine, subangular to subrounded), moist	Hard				49				
			20						
(grades silty, trace fine- to coarse-grained sand, damp)					67	32	91	9.3	
			25						
CLAY (CL/CH), brown, silty, trace sand (fine- to coarse-grained), damp	Hard				33				
			30						

Bottom of Boring = 30 Feet

Notes:

1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.
2. For an explanation of penetration resistance values, see the first page of Appendix A.
3. Samplers were driven with an automatic wire trip hammer falling 30 inches.
4. The boring was backfilled with neat cement after completion.

HARZA
Engineering Company

EXPLORATORY BORING LOG

EASTMAN BUILDING
Berkeley, California

PROJECT NO.	DATE	BORING NO.
18292-CA	November 2000	EB-2

DRILL RIG	Mobile B-61, HSA	SURFACE ELEVATION	—	LOGGED BY	JND
DEPTH TO GROUND WATER	17 feet	BORING DIAMETER	8-inch	DATE DRILLED	10/16/00

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT(%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
PAVEMENT: 3½ inches AC over 14½ inches AB									
FILL: CLAY (CL), dark brown, silty, trace sand (fine- to coarse-grained), damp, trace gravel (fine, subangular to subrounded), trace brick fragmants, damp	Stiff				22	21	98		LL = 38, PI = 22, Passing No. 200 Sieve = 74%
	Hard				49				
GRAVEL (GP/GC), brown, fine to coarse, subangular to subrounded, with sand (fine- to coarse-graiend), trace clay and silt, damp	Dense		5		51	8	101		
SAND (SP/SC), brown, fine- to coarse-grained, some gravel (fine, subangular to subrounded), trace clay and silt, damp	Dense		10		40				
CLAY (CL), brown, silty, some sand (fine-grained), wet	Very Stiff		15		21				
GRAVEL (GC), brown, fine to coarse, subangular to subrounded, some sand (fine- to coarse-grained), some clay, saturated	Very Dense		20		50/5"				
CLAY (CL), brown, silty, trace sand (fine- to coarse-grained), damp to moist	Hard		25		68				
			30		40				

Bottom of Boring = 30 Feet

Notes:

1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.
2. For an explanation of penetration resistance values, see the first page of Appendix A.
3. Samplers were driven with an automatic wire trip hammer falling 30 inches.
4. The boring was backfilled with neat cement after completion.

HARZA Engineering Company

EXPLORATORY BORING LOG

EASTMAN BUILDING
Berkeley, California

PROJECT NO.	DATE	BORING NO.
18292-CA	November 2000	EB-3

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		grf	ltr	Description
Coarse Grained Soils	Gravel And Gravelly Soils		GW	Well-graded gravels or gravel sand mixtures, little or no fines
			GP	Poorly-graded gravels or gravel sand mixture, little or no fines
			GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sand And Sandy Soils		SW	Well-graded sands or gravelly sands, little or no fines
			SP	Poorly-graded sands or gravelly sands, little or no fines
			SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, and-clay mixtures

Major Divisions		grf	ltr	Description
Fine Grained Soils	Silts And Clays LL < 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 silt-clays of low plasticity
	Silts And Clays LL > 50		MH	Inorganic silts, micaceous or diatomaceous fine or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat and other highly organic soils

GRAIN SIZES

U.S. STANDARD SERIES SIEVE: 200, 40, 10, 4

CLEAR SQUARE SIEVE OPENINGS: 3/4", 3", 12"

Silts and Clays	Sand			Gravel		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

RELATIVE DENSITY

Sands and Gravels	Blows/Foot*
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

CONSISTENCY

Silts and Clays	Blows/Foot*	Strength (tsf)**
Very Soft	0 - 2	0 - 1/4
Soft	2 - 4	1/4 - 1/2
Firm	4 - 8	1/2 - 1
Stiff	8 - 16	1 - 2
Very Stiff	16 - 32	2 - 4
Hard	Over 32	Over 4

*Number of Blows for a 140-pound hammer falling 30 inches, driving a 2-inch O.D. (1-3/8" I.D.) split spoon sampler.

**Unconfined compressive strength.

SYMBOLS

- Standard Penetration sample
- Modified California sample
- Shelby Tube sample
- ▽ Ground Water level during drilling
- ▼ Stabilized Ground Water level

Increasing Visual Moisture Content

Dry
Damp
Moist
Wet
Saturated

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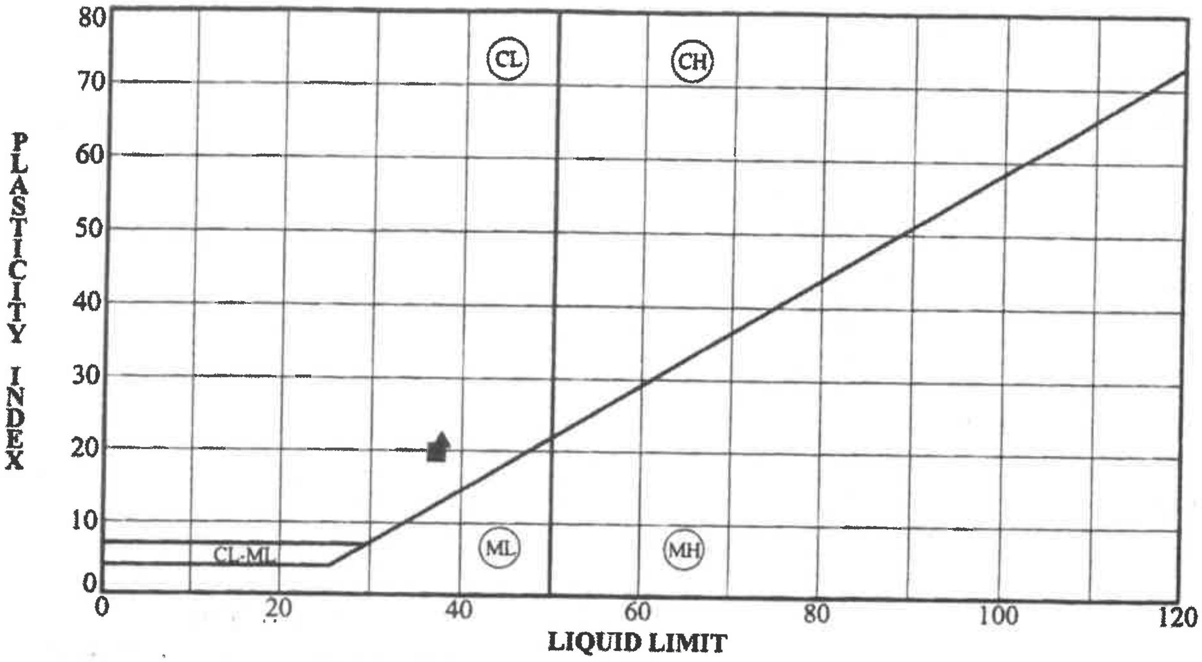
Engineering Company

KEY TO EXPLORATORY BORING LOGS

EASTMAN BUILDING
Berkeley, California

PROJECT NO.	DATE	FIGURE NO.
18292-CA	November 2000	A-1



Key Symbol	Boring No.	Depth (Feet)	Liquid Limit	Plasticity Index	Liquidity Index	Water Content (%)	% Passing #200 Sieve	USCS
●	EB-2	0.5	37	20	---	---	63	CL
⊠	EB-2	2.0	37	20	0.054	19	67	CL
▲	EB-3	2.0	38	22	0.205	21	74	CL

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PREP'D BY
APP'D BY
DATE 11/2/00
DWG FILE 18292-CA.GPJ

PLASTICITY CHART AND DATA

EASTMAN BUILDING
Berkeley, California

FIGURE
B-1

PROJECT No.
18292-CA

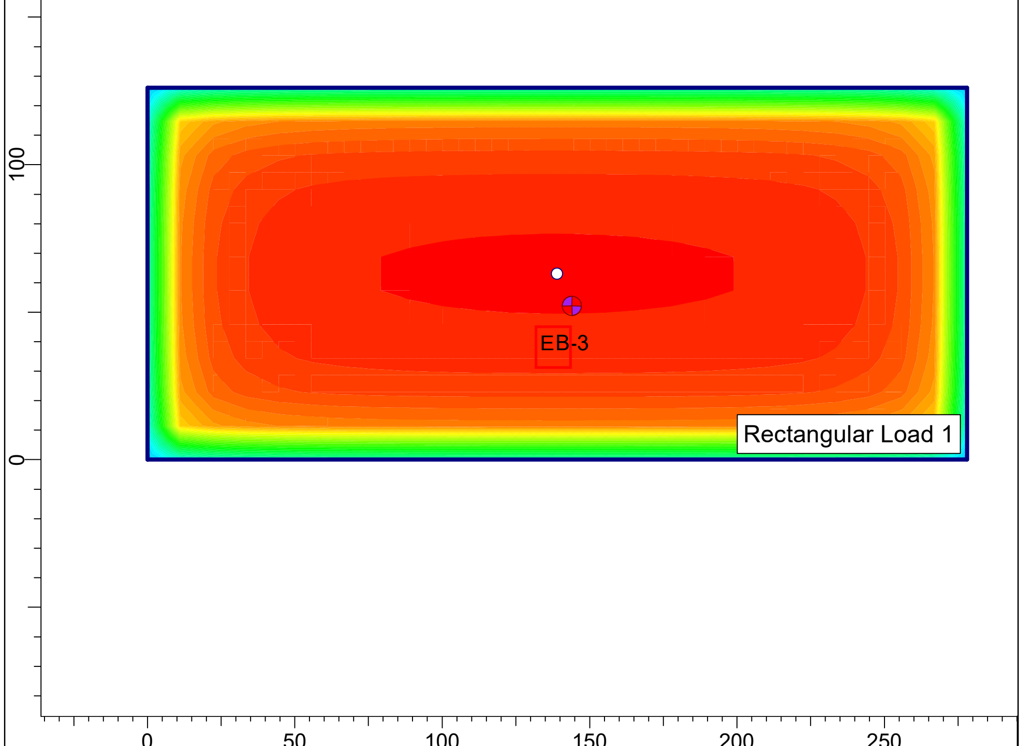
APPENDIX B

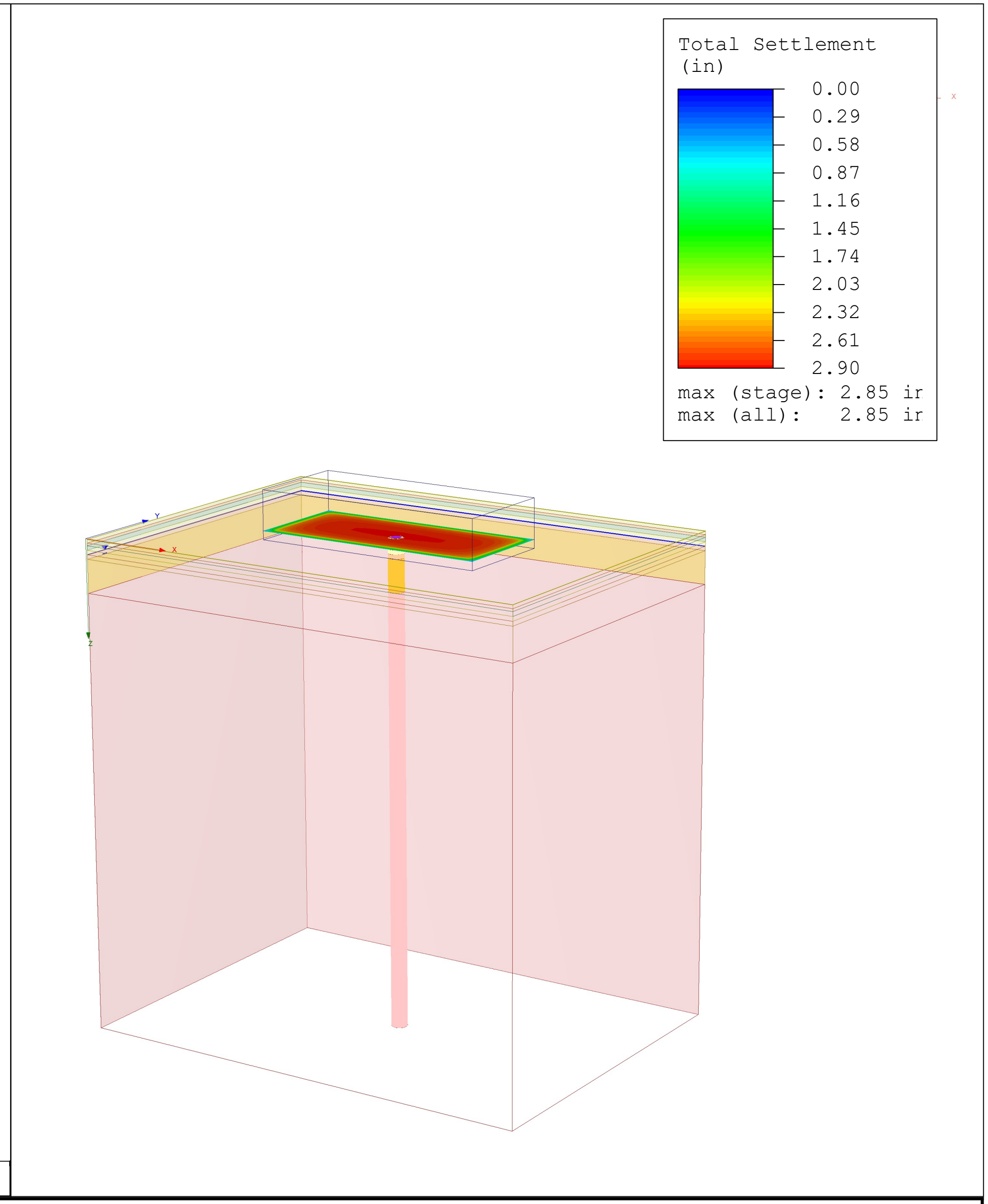
Settlement Analysis (Settle 3D)

PARTNER

Mat Foundation placed 1-story below grade (Approx. 10 feet below grade)

Material Name	Color	Unit Weight (kips/ft3)	Es (ksf)	Cc/Cce	Cr/Cre	OCR
Stiff Clay		0.125	-	0.252	0.019	2
Clayey SAND / SAND		0.115	1305.34	-	-	-
Gravel		0.13	2819.53	-	-	-
Hard Clay		0.13	-	0.15	0.01125	2
Rock		0.14	120000	-	-	-





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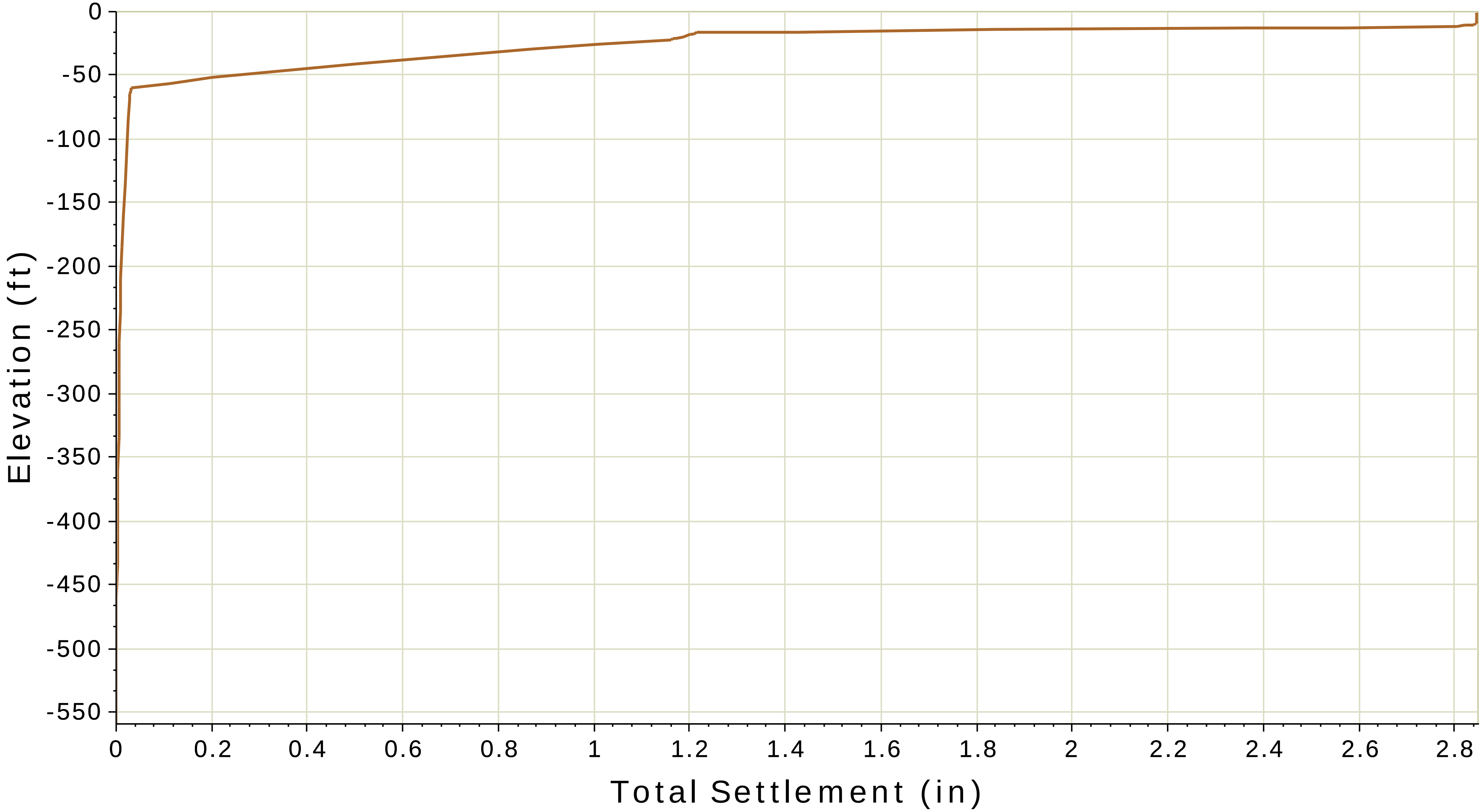
Drawn By	Siamak Koochak
Company	Partner Engineering and Science, Inc.
Date	4/20/2021, 4:36:19 PM
File Name	20-297761.1 - Settle 3 Analysis - Berkeley Hub.s3z

SETTLE3 5.009

Total Settlement vs. Elevation



Reference Stage: None

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Drawn By	Siamak Koochak	Company	Partner Engineering and Science, Inc.
Date	4/20/2021, 4:36:19 PM	File Name	20-297761.1 - Settle 3 Analysis - Berkeley Hub.s3z

SETTLE3 5.010

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Settle3 Analysis Information

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Author	Siamak Koochak
Company	Partner Engineering and Science, Inc.
Date Created	4/20/2021, 4:36:19 PM
Comments	
Check by: Chris Landau	
Stress Computation Method	Boussinesq
Minimum settlement ratio for subgrade modulus	0.9
Use average properties to calculate layered stresses	
Improve consolidation accuracy	
Ignore negative effective stresses in settlement calculations	

Loads

1. Rectangular Load: "Rectangular Load 1"

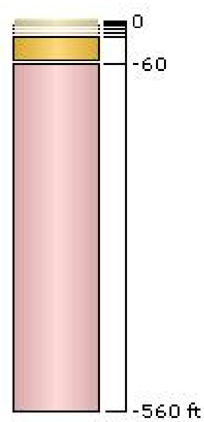
Length	278 ft
Width	126 ft
Rotation angle	0 degrees
Load Type	Flexible
Area of Load	35028 ft2
Load	2.5 ksf
Elevation	-10 ft
Installation Stage	Stage 1

Coordinates

X [ft]	Y [ft]
0	2.84217e-14
278	2.84217e-14
278	126
0	126

Soil Layers

Layer #	Type	Thickness [ft]	Elevation [ft]
1	Stiff Clay	4	-0
2	Gravel	3	-4
3	Clayey SAND / SAND	5	-7
4	Stiff Clay	5	-12
5	Gravel	5	-17
6	Hard Clay	38	-22
7	Rock	500	-60



Soil Properties

Property	Stiff Clay	Clayey SAND / SAND	Gravel	Hard Clay
Color				
Unit Weight [kips/ft3]	0.125	0.115	0.13	0.13
Saturated Unit Weight [kips/ft3]	0.125	0.115	0.13	0.13
K0	1	1	1	1
Immediate Settlement	Disabled	Enabled	Enabled	Disabled
Es [ksf]	-	1305.34	2819.53	-
Esur [ksf]	-	1305.34	2819	-
Primary Consolidation	Enabled	Disabled	Disabled	Enabled
Material Type	Non-Linear			Non-Linear
Cce	0.252	-	-	0.15
Cre	0.019	-	-	0.01125
e0	0.6	-	-	0.4
OCR	2	-	-	2
Undrained Su A [kips/ft2]	0	0	0	0
Undrained Su S	0.2	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8	0.8
Piezo Line ID	1	1	1	1

Property	Rock
Color	
Unit Weight [kips/ft3]	0.14
Saturated Unit Weight [kips/ft3]	0.14
K0	1
Immediate Settlement	Enabled
Es [ksf]	120000
Esur [ksf]	120000
Undrained Su A [kips/ft2]	0
Undrained Su S	0.2
Undrained Su m	0.8
Piezo Line ID	1

Groundwater

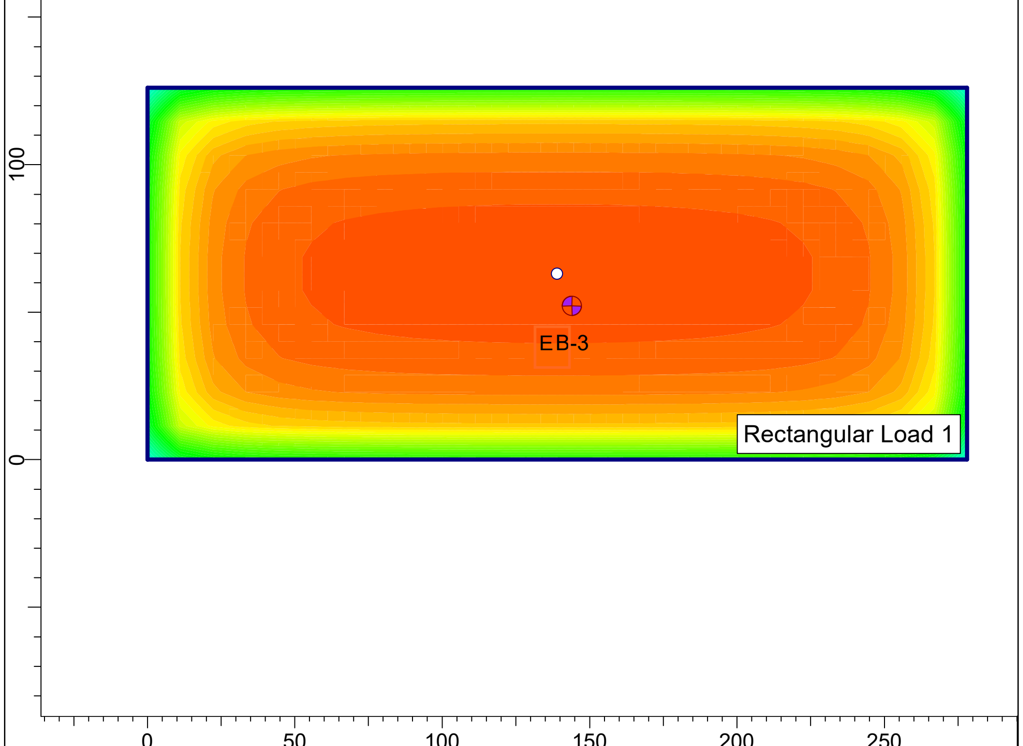
Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft3

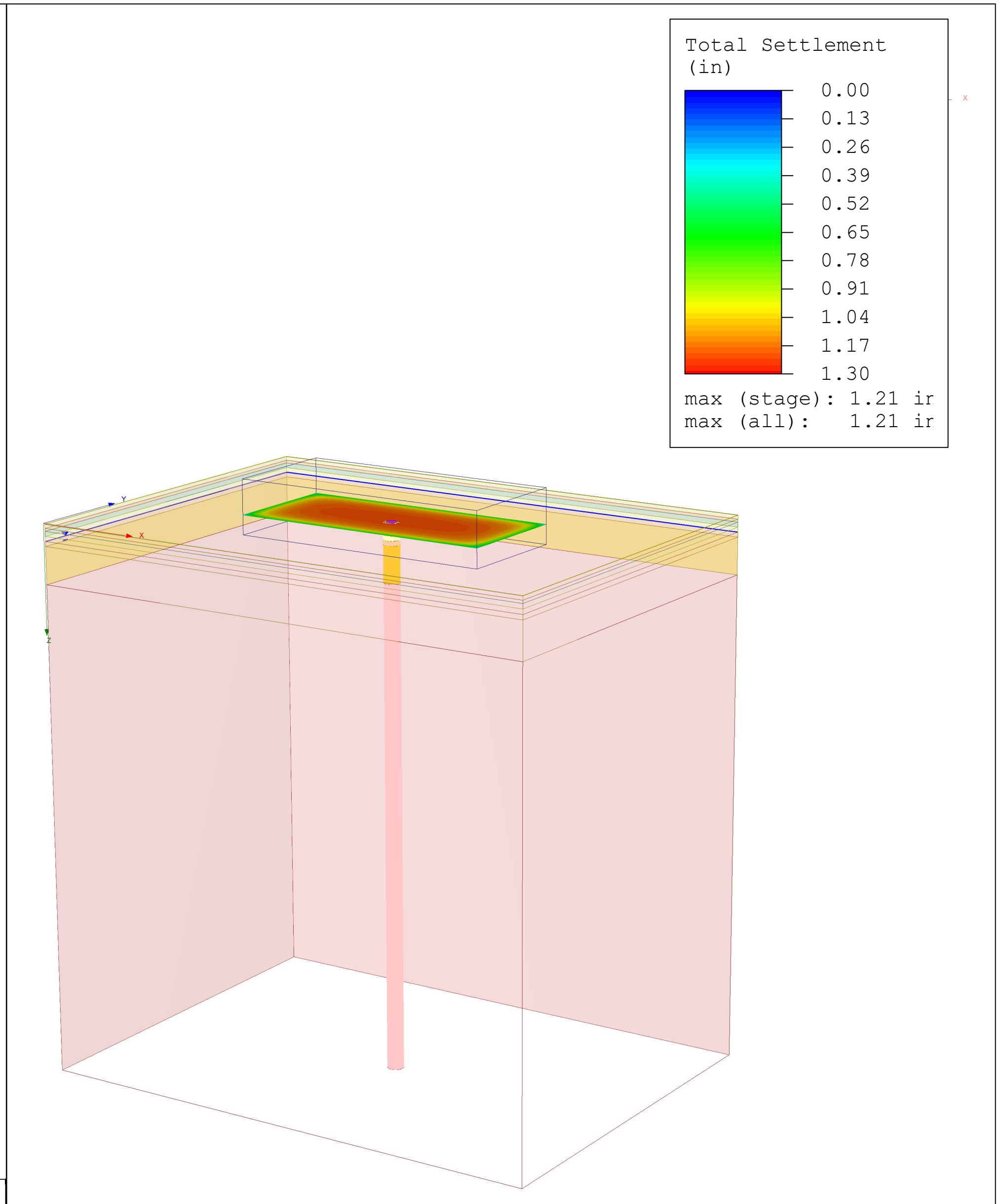
Piezometric Line Entities

ID	Elevation (ft)
1	-17 ft

Mat Foundation placed 2-stories below grade (Approx. 20 feet below grade)

Material Name	Color	Unit Weight (kips/ft3)	Es (ksf)	Cc/Cce	Cr/Cre	OCR
Stiff Clay		0.125	-	0.252	0.019	2
Clayey SAND / SAND		0.115	1305.34	-	-	-
Gravel		0.13	2819.53	-	-	-
Hard Clay		0.13	-	0.15	0.01125	2
Rock		0.14	120000	-	-	-





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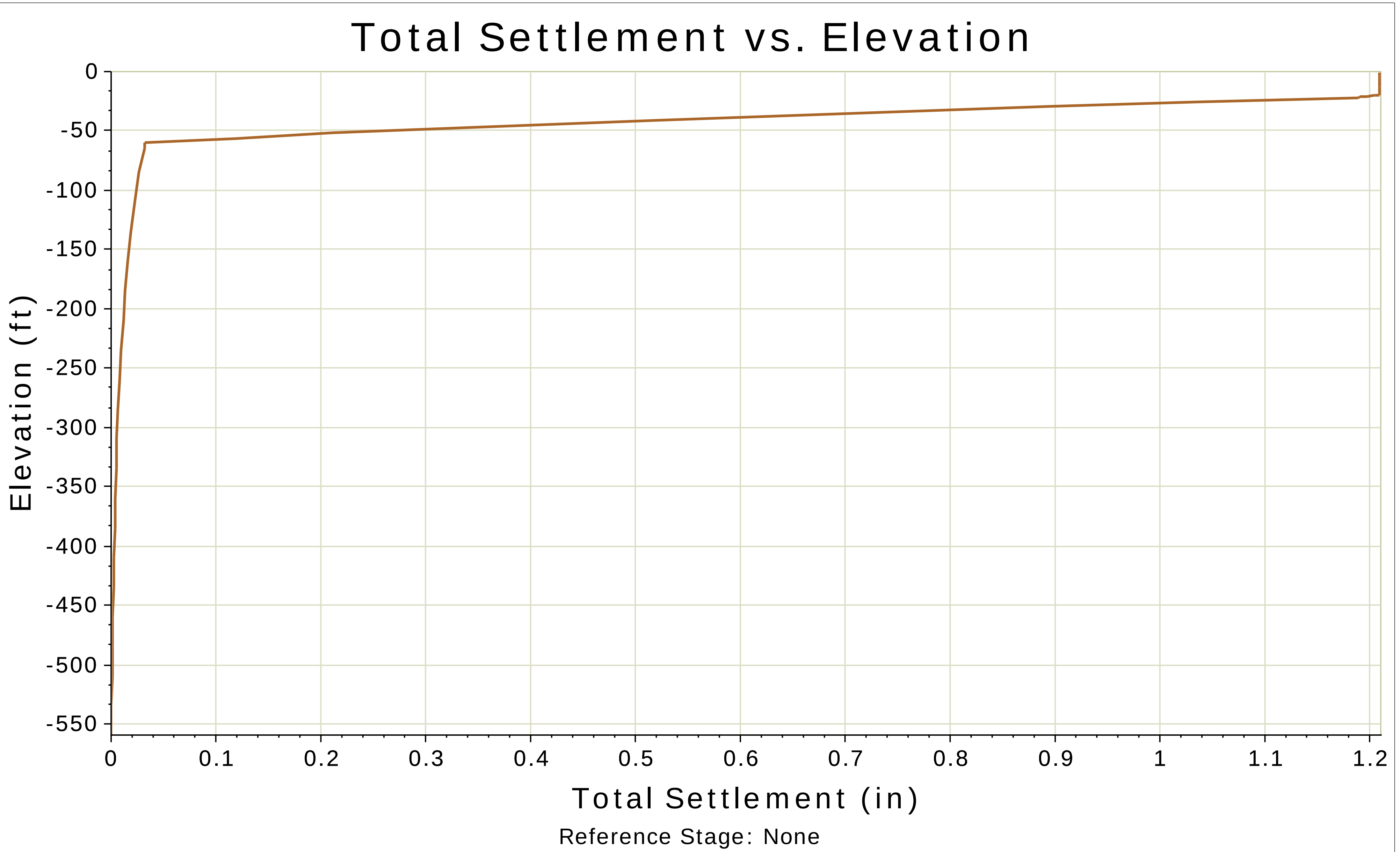

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Date Created	4/20/2021, 4:36:19 PM
Comments	
Check by: Chris Landau	
Stress Computation Method	Boussinesq
Minimum settlement ratio for subgrade modulus	0.9
Use average properties to calculate layered stresses	
Improve consolidation accuracy	
Ignore negative effective stresses in settlement calculations	

Loads

1. Rectangular Load: "Rectangular Load 1"

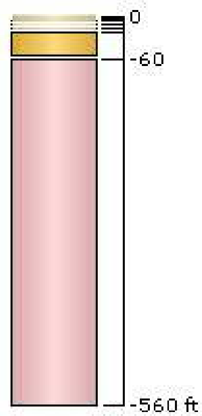
Length	278 ft
Width	126 ft
Rotation angle	0 degrees
Load Type	Flexible
Area of Load	35028 ft2
Load	2.5 ksf
Elevation	-20 ft
Installation Stage	Stage 1

Coordinates

X [ft]	Y [ft]
0	2.84217e-14
278	2.84217e-14
278	126
0	126

Soil Layers

Layer #	Type	Thickness [ft]	Elevation [ft]
1	Stiff Clay	4	-0
2	Gravel	3	-4
3	Clayey SAND / SAND	5	-7
4	Stiff Clay	5	-12
5	Gravel	5	-17
6	Hard Clay	38	-22
7	Rock	500	-60



Soil Properties

Property	Stiff Clay	Clayey SAND / SAND	Gravel	Hard Clay
Color				
Unit Weight [kips/ft3]	0.125	0.115	0.13	0.13
Saturated Unit Weight [kips/ft3]	0.125	0.115	0.13	0.13
K0	1	1	1	1
Immediate Settlement	Disabled	Enabled	Enabled	Disabled
Es [ksf]	-	1305.34	2819.53	-
Esur [ksf]	-	1305.34	2819	-
Primary Consolidation	Enabled	Disabled	Disabled	Enabled
Material Type	Non-Linear			Non-Linear
Cce	0.252	-	-	0.15
Cre	0.019	-	-	0.01125
e0	0.6	-	-	0.4
OCR	2	-	-	2
Undrained Su A [kips/ft2]	0	0	0	0
Undrained Su S	0.2	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8	0.8
Piezo Line ID	1	1	1	1

Property	Rock
Color	
Unit Weight [kips/ft3]	0.14
Saturated Unit Weight [kips/ft3]	0.14
K0	1
Immediate Settlement	Enabled
Es [ksf]	120000
Esur [ksf]	120000
Undrained Su A [kips/ft2]	0
Undrained Su S	0.2
Undrained Su m	0.8
Piezo Line ID	1

Groundwater

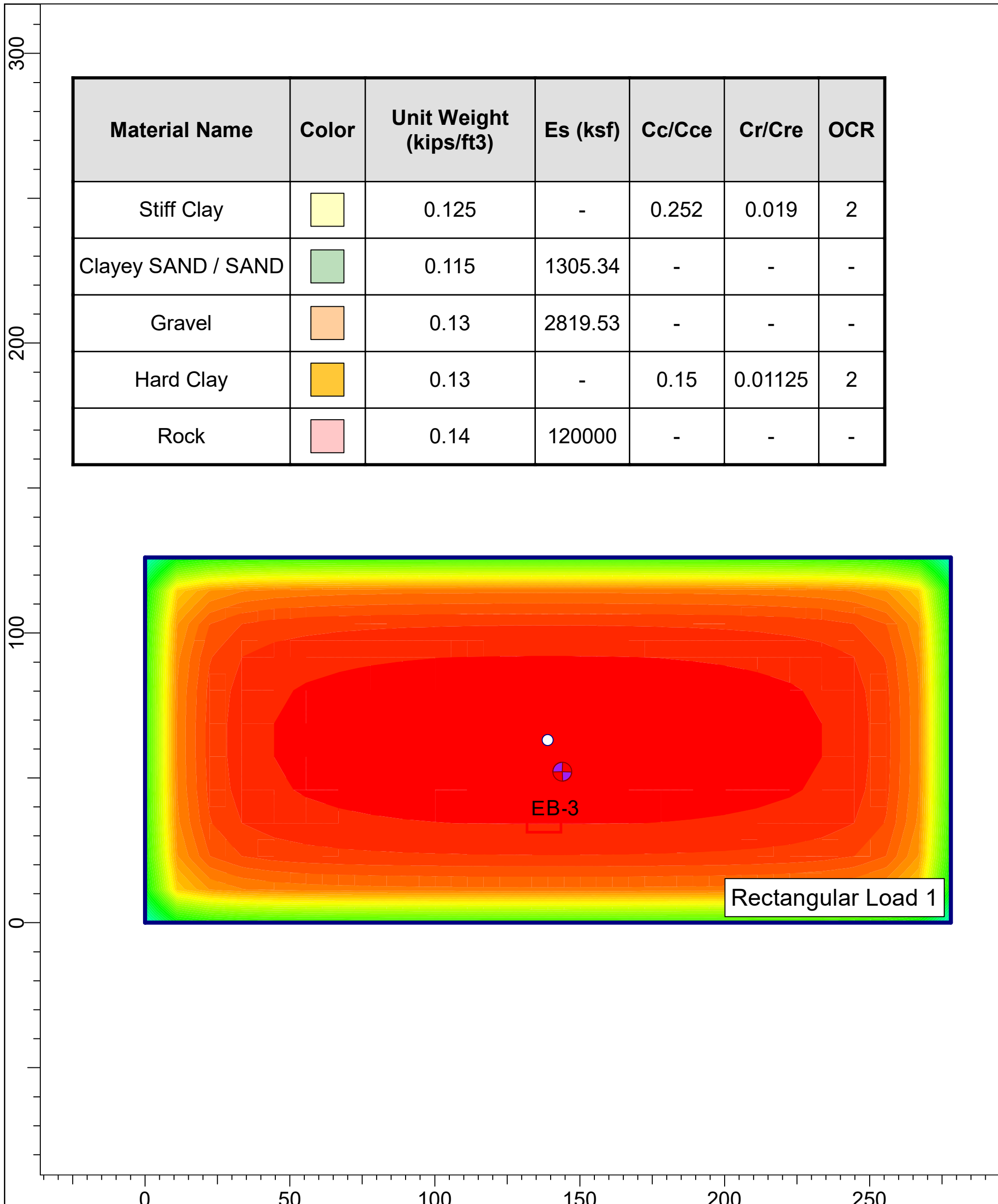
Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft3

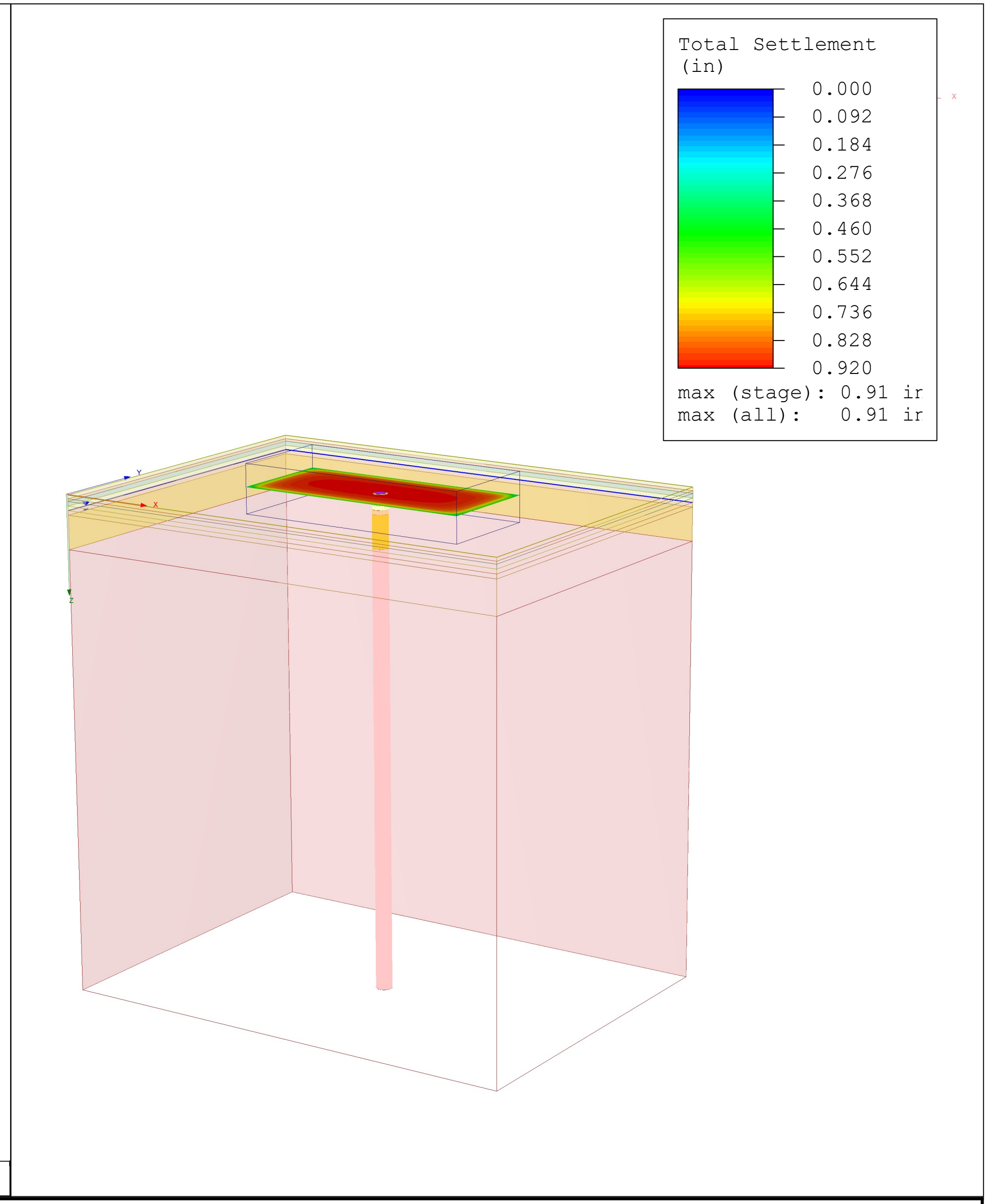
Piezometric Line Entities

ID	Elevation (ft)
1	-17 ft

Mat Foundation placed 3-stories below grade (Approx. 30 feet below grade)

Material Name	Color	Unit Weight (kips/ft3)	Es (ksf)	Cc/Cce	Cr/Cre	OCR
Stiff Clay		0.125	-	0.252	0.019	2
Clayey SAND / SAND		0.115	1305.34	-	-	-
Gravel		0.13	2819.53	-	-	-
Hard Clay		0.13	-	0.15	0.01125	2
Rock		0.14	120000	-	-	-





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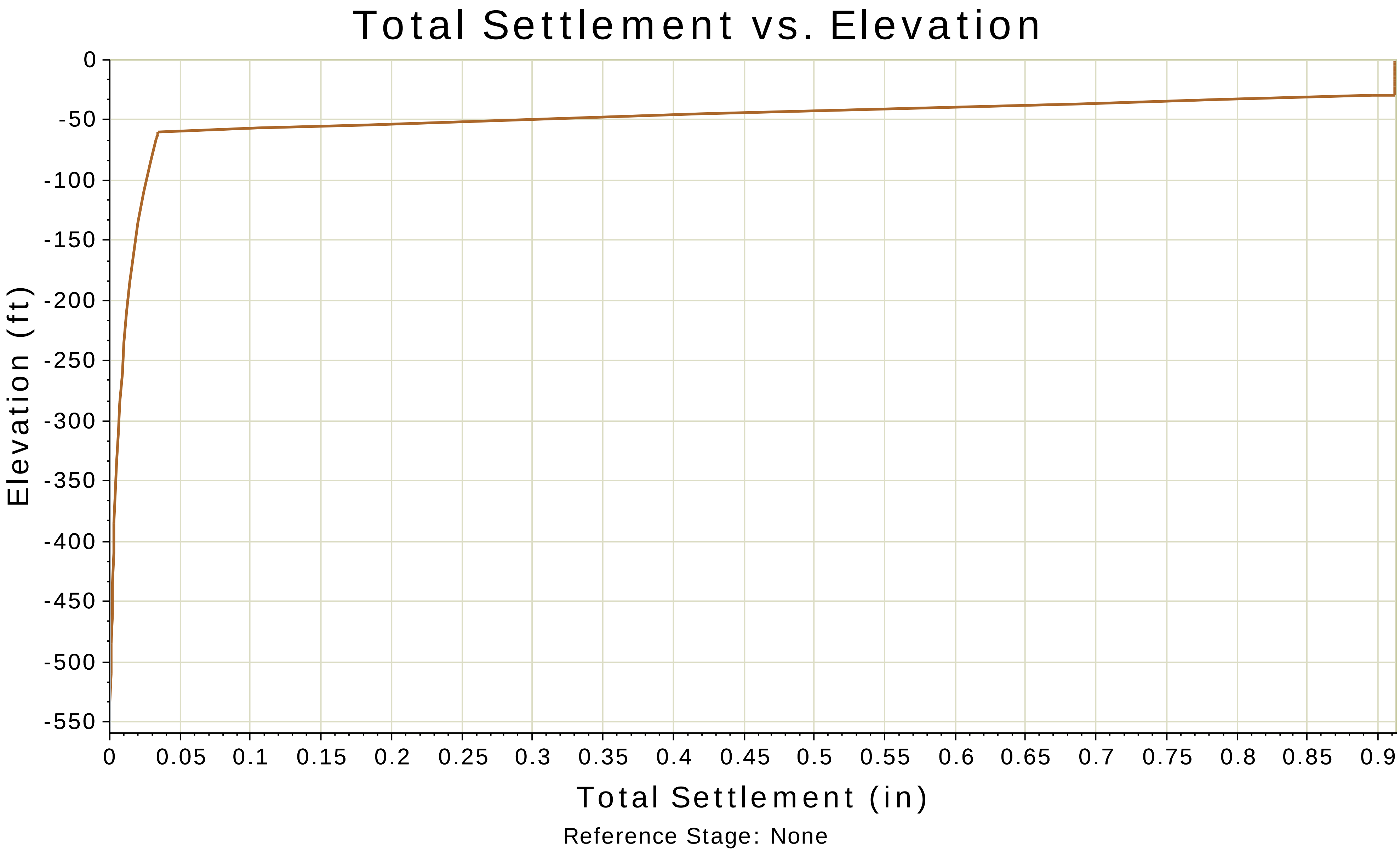

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Project Settings

Document Name	20-297761.1 - Settle 3 Analysis - Berkeley Hub
Project Title	2128 Oxford Street (20-297761.1)
Author	Siamak Koochak
Company	Partner Engineering and Science, Inc.
Date Created	4/20/2021, 4:36:19 PM
Comments	
Check by: Chris Landau	
Stress Computation Method	Boussinesq
Minimum settlement ratio for subgrade modulus	0.9
Use average properties to calculate layered stresses	
Improve consolidation accuracy	
Ignore negative effective stresses in settlement calculations	

Loads

1. Rectangular Load: "Rectangular Load 1"

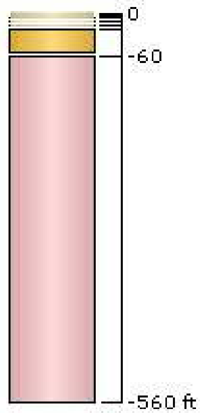
Length	278 ft
Width	126 ft
Rotation angle	0 degrees
Load Type	Flexible
Area of Load	35028 ft2
Load	2.5 ksf
Elevation	-30 ft
Installation Stage	Stage 1

Coordinates

X [ft]	Y [ft]
0	2.84217e-14
278	2.84217e-14
278	126
0	126

Soil Layers

Layer #	Type	Thickness [ft]	Elevation [ft]
1	Stiff Clay	4	-0
2	Gravel	3	-4
3	Clayey SAND / SAND	5	-7
4	Stiff Clay	5	-12
5	Gravel	5	-17
6	Hard Clay	38	-22
7	Rock	500	-60



Soil Properties

Property	Stiff Clay	Clayey SAND / SAND	Gravel	Hard Clay
Color				
Unit Weight [kips/ft3]	0.125	0.115	0.13	0.13
Saturated Unit Weight [kips/ft3]	0.125	0.115	0.13	0.13
K0	1	1	1	1
Immediate Settlement	Disabled	Enabled	Enabled	Disabled
Es [ksf]	-	1305.34	2819.53	-
Esur [ksf]	-	1305.34	2819	-
Primary Consolidation	Enabled	Disabled	Disabled	Enabled
Material Type	Non-Linear			Non-Linear
Cce	0.252	-	-	0.15
Cre	0.019	-	-	0.01125
e0	0.6	-	-	0.4
OCR	2	-	-	2
Undrained Su A [kips/ft2]	0	0	0	0
Undrained Su S	0.2	0.2	0.2	0.2
Undrained Su m	0.8	0.8	0.8	0.8
Piezo Line ID	1	1	1	1

Property	Rock
Color	
Unit Weight [kips/ft3]	0.14
Saturated Unit Weight [kips/ft3]	0.14
K0	1
Immediate Settlement	Enabled
Es [ksf]	120000
Esur [ksf]	120000
Undrained Su A [kips/ft2]	0
Undrained Su S	0.2
Undrained Su m	0.8
Piezo Line ID	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft3

Piezometric Line Entities

ID	Elevation (ft)
1	-17 ft

APPENDIX C

General Geotechnical Design and Construction Considerations

Subgrade Preparation

Earthwork – Structural Fill/Excavations

Underground Pipeline Installation – Structural Backfill

Cast-in-Place Concrete

Foundations

Laterally Loaded Structures

Excavations and Dewatering

Waterproofing and Drainage

Chemical Treatment of Soils

Paving

Site Grading and Drainage

PARTNER

SUBGRADE PREPARATION

1. In general, construction should proceed per the project specifications and contract documents, as well as governing jurisdictional guidelines for the project site, including but not limited to the applicable State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Subgrade preparation in this section is considered to apply to the initial modifications to existing site conditions to prepare for new planned construction.
3. Prior to the start of subgrade preparation, a detailed conflict study including as-builts, utility locating, and potholing should be conducted. Existing features that are to be demolished should also be identified and the geotechnical study should be referenced to determine the need for subgrade preparation, such as over-excavation, scarification and compaction, moisture conditioning, and/or other activities below planned new structural fills, slabs on grade, pavements, foundations, and other structures.
4. The site conflicts, planned demolitions, and subgrade preparation requirements should be discussed in a pre-construction meeting with the pertinent parties, including the geotechnical engineer, inspector, contractors, testing laboratory, surveyor, and others.
5. In the event of preparations that will require work near to existing structures to remain in-place, protection of the existing structures should be considered. This also includes a geotechnical review of excavations near to existing structures and utilities and other concerns discussed in General Geotechnical Design and Construction Considerations, EARTHWORK and UNDERGROUND PIPELINE INSTALLATION.
6. Features to be demolished should be completely removed and disposed of per jurisdictional requirements and/or other conditions set forth as a part of the project. Resulting excavations or voids should be backfilled per the recommendations in the General Geotechnical Design and Construction Considerations, EARTHWORK section.
7. Vegetation, roots, soils containing organic materials, debris and/or other deleterious materials on the site should be removed from structural areas and should be disposed of as above. Replacement of such materials should be in accordance with the recommendations in the General Geotechnical Design and Construction Considerations, EARTHWORK section
8. Subgrade preparation required by the geotechnical report may also call for as over-excavation, scarification and compaction, moisture conditioning, and/or other activities below planned structural fills, slabs on grade, pavements, foundations, and other structures. These requirements should be provided within the geotechnical report. The execution of this work should be observed by the geotechnical engineering representative or inspector for the site. Testing of the subgrade preparation should be performed per the recommendations in the General Geotechnical Design and Construction Considerations, EARTHWORK section.

9. Subgrade Preparation cannot be completed on frozen ground or on ground that is not at a proper moisture condition. Wet subgrades may be dried under favorable weather if they are disked and/or actively worked during hot, dry, weather, when exposed to wind and sunlight. Frozen ground or wet material can be removed and replaced with suitable material. Dry material can be pre-soaked or can have water added and worked in with appropriate equipment. The soil conditions should be monitored by the geotechnical engineer prior to compaction. Following this type of work, approved subgrades should be protected by direction of surface water, covering, or other methods, otherwise, re-work may be needed.

EARTHWORK – STRUCTURAL FILL

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Earthwork in this section is considered to apply to the re-shaping and grading of soil, rock, and aggregate materials for the purpose of supporting man-made structures. Where earthwork is needed to raise the elevation of the site for the purpose of supporting structures or forming slopes, this is referred to as the placement of structural fill. Where lowering of site elevations is needed prior to the installation of new structures, this is referred to as earthwork excavations.
3. Prior to the start of earthwork operations, the geotechnical study should be referenced to determine the need for subgrade preparation, such as over-excavation or scarification and compaction of unsuitable soils below planned structural fills, slabs on grade, pavements, foundations, and other structures. These required preparations should be discussed in a pre-construction meeting with the pertinent parties, including the geotechnical engineer, inspector, contractors, testing laboratory, surveyor, and others. The preparations should be observed by the inspector or geotechnical engineer representative, and following such subgrade preparation, the geotechnical engineer should observe the prepared subgrade to approve it for the placement of earthwork fills or new structures.
4. Structural fill materials should be relatively free of organic materials, man-made debris, environmentally hazardous materials, and brittle, non-durable aggregate, frozen soil, soil clods or rocks and/or any other materials that can break down and degrade over time.
5. In deeper structural fill zones, expansive soils (greater than 1.5 percent swell at 100 pounds per square foot surcharge) and rock fills (fills containing particles larger than 4 inches and/or containing more than 35 percent gravel larger than ¾-inch diameter or more than 50 percent gravel) may be used with the approval and guidance of the geotechnical report or geotechnical engineer. This may require the placement of geotextiles or other added costs and/or conditions. These conditions may also apply to corrosive soils (less than 2,000 ohm-cm resistivity, more than 50 ppm chloride content, more than 0.1 percent sulfates)
6. For structural fill zones that are closer in depth below planed structures, low expansive materials, and materials with smaller particle size are generally recommended, as directed by the geotechnical report (see criteria above in 5). This may also apply to corrosive soils.
7. For structural fill materials, in general the compaction equipment should be appropriate for the thickness of the loose lift being placed, and the thickness of the loose lift being placed should be at least two times the maximum particle size incorporated in the fill.
8. Fill lift thickness (including bedding) should generally be proportioned to achieve 95 percent or more of a standard proctor (ASTM D689) maximum dry density (MDD) or 90 percent or more of a

modified proctor (ASTM D1557) MDD, depending on the state practices. For subgrades below roadways, the general requirement for soil compaction is usually increased to 100 percent or more of the standard proctor MDD and 95 percent or more of the modified proctor MDD.

9. Soil compaction should be performed at a moisture content generally near optimum moisture content determined by either standard or modified proctor, and ideally within 3 percent below to 1 percent over the optimum for a standard proctor, and from 2 percent below to 2 percent above optimum for a modified proctor.
10. In some instances, fill areas are difficult to access. In such cases a low-strength soil-cement slurry can be used in the place of compacted fill soil. In general, such fills should be rated to have a 28-day strength of 75 to 125 psi, which in some areas is referred to as a "1-sack" slurry. It should be noted that these materials are wet during placement and require a period of 2 days (24 hours) to cure before additional fill can be placed above them. Testing of this material can be done using concrete cylinder compression strength testing equipment, but care is needed in removing the test specimens from the molds. Field testing using the ball method and spread, or flow testing is also acceptable.
11. For fills to be placed on slopes, benching of fill lifts is recommended, which may require cutting into existing slopes to create a bench perpendicular to the slope where soil can be placed in a relatively horizontal orientation. For the construction of slopes, the slopes should be over-built and cut back to grade, as the material in the outer portion of the slope may not be well compacted.
12. For subgrade below roadways, runways, railways or other areas to receive dynamic loading, a proofroll of the finished, compacted subgrade should be performed by the geotechnical engineer or inspector prior to the placement of structural aggregate, asphalt or concrete. Proofrolling consists of observing the performance of the subgrade under heavy-loaded equipment, such as full, 4,000 Gallon water truck, loaded tandem-axel dump truck or similar. Areas that exhibit instability during proofroll should be marked for additional work prior to approval of the subgrade for the next stage of construction.
13. Quality control testing should be provided on earthwork. Proctor testing should be performed on each soil type, and one-point field proctors should be used to verify the soil types during compaction testing. If compaction testing is performed with a nuclear density gauge, it should be periodically correlated with a sand cone test for each soil type. Density testing should be performed per project specifications and or jurisdictional requirements, but not less than once per 12 inches elevation of any fill area, with additional tests per 12-inch fill area for each additional 7,500 square-foot section or portion thereof.
14. For earthwork excavations, OSHA guidelines should be referenced for sloping and shoring. Excavations over a depth of 20 feet require a shoring design. In the event excavations are planned near to existing structures, the geotechnical engineer should be consulted to evaluate whether such excavation will call for shoring or underpinning the adjacent structure. Pre-construction and post-construction condition surveys and vibration monitoring might also be helpful to evaluate any potential damage to surrounding structures.

15. Excavations into rock, partially weathered rock, cemented soils, boulders and cobbles, and other hard soil or "hard-pan" materials, may result in slower excavation rates, larger equipment with specialized digging tools, and even blasting. It is also not unusual in these situations for screening and or crushing of rock to be called for. Blasting, hard excavating, and material processing equipment have special safety concerns and are more costly than the use of soil excavation equipment. Additionally, this type of excavation, especially blasting, is known to cause vibrations that should be monitored at nearby structures. As above, a pre-blast and post-blast conditions assessment might also be warranted.

UNDERGROUND PIPELINE – STRUCTURAL BACKFILL

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable State Department of Transportation, the State Department of Environmental Quality, the US Environmental Protection Agency, City and/or County Public Works, Occupational Safety and Health Administration (OSHA), Private Utility Companies, and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered, and in some cases, work may take place to multiple different standards. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Underground pipeline in this section is considered to apply to the installation of underground conduits for water, storm water, irrigation water, sewage, electricity, telecommunications, gas, etc. Structural backfill refers to the activity of restoring the grade or establishing a new grade in the area where excavations were needed for the underground pipeline installation.
3. Prior to the start of underground pipeline installation, a detailed conflict study including as-builts, utility locating, and potholing should be conducted. The geotechnical study should be referenced to determine subsurface conditions such as caving soils, unsuitable soils, shallow groundwater, shallow rock and others. In addition, the utility company responsible for the line also will have requirements for pipe bedding and support as well as other special requirements. Also, if the underground pipeline traverses other properties, rights-of-way, and/or easements etc. (for roads, waterways, dams, railways, other utility corridors, etc.) those owners may have additional requirements for construction.
4. The required preparations above should be discussed in a pre-construction meeting with the pertinent parties, including the geotechnical engineer, inspector, contractors, testing laboratory, surveyor, and other stake holders.
5. For pipeline excavations, OSHA guidelines should be referenced for sloping and shoring. Excavations over a depth of 20 feet require a shoring design. In the event excavations are planned near to existing structures or pipelines, the geotechnical engineer should be consulted to evaluate whether such excavation will call for shoring or supporting the adjacent structure or pipeline. A pre-construction and post-construction condition survey and vibration monitoring might also be helpful to evaluate any potential damage to surrounding structures.
6. Excavations into rock, partially weathered rock, cemented soils, boulders and cobbles, and other hard soil or "hard-pan" materials, may result in slower excavation rates, larger equipment with specialized digging tools, and even blasting. It is also not unusual in these situations for screening and or crushing of rock to be called for. Blasting, hard excavating and material processing equipment have special safety concerns and are more costly than the use soil excavation equipment. Additionally, this type of excavation, especially blasting, is known to cause vibrations that should be monitored at nearby structures. As above, a pre-blast and post-blast conditions assessment might also be warranted.

7. Bedding material requirements vary between utility companies and might depend of the type of pipe material and availability of different types of aggregates in different locations. In general, bedding refers to the material that supports the bottom of the pipe and extends to 1 foot above the top of the pipe. In general, the use of aggregate base for larger diameter pipes (6-inch diameter or more) is recommended lacking a jurisdictionally specified bedding material. Gas lines and smaller diameter lines are often backfilled with fine aggregate meeting the ASTM requirements for concrete sand. In all cases bedding with less than 2,000 ohm-cm resistivity, more than 50 ppm chloride content or more than 0.1 percent sulfates should not be used.
8. Structural backfill materials above the bedding should be relatively free of organic materials, man-made debris, environmentally hazardous materials, frozen material, and brittle, non-durable aggregate, soil clods or rocks and/or any other materials that can break down and degrade over time.
9. In general, the backfill soil requirements will depend on the future use of the land above the buried line, but in most cases, excessive settlement of the pipe trench is not considered advisable or acceptable. As such, the structural backfill compaction equipment should be appropriate for the thickness of the loose lift being placed. The thickness of the loose lift being placed should be at least two times the maximum particle size incorporated in the fill. Care should be taken not to damage the pipe during compaction or compaction testing.
10. Fill lift thickness (including bedding) should generally be proportioned to achieve 95 percent or more of a standard proctor (ASTM D689) maximum dry density (MDD) or 90 percent or more of a modified proctor (ASTM D1557) MDD, depending on the state practices (in general the modified proctor is required in California and for projects in the jurisdiction of the Army Corps of Engineers). For backfills within the upper portions of roadway subgrades, the general requirement for soil compaction is usually increased to 100 percent or more of the standard proctor MDD and 95 percent or more of the modified proctor MDD.
11. Soil compaction should be performed at a moisture content generally near optimum moisture content determined by either standard or modified proctor, and ideally within 3 percent below to 1 percent over the optimum for a standard proctor, and from 2 percent below to 2 percent above optimum for a modified proctor.
12. In some instances, fill areas are difficult to access. In such cases a low-strength soil-cement slurry can be used in the place of compacted fill soil. In general, such fills should be rated to have a 28-day strength of 75 to 125 psi, which in some areas is referred to as a "1-sack" slurry. It should be noted that these materials are wet and require a period of 2 days (24 hours) to cure before additional fill can be placed above it. Testing of this material can be done using concrete cylinder compression strength testing equipment, but care is needed in removing the test specimens from the molds. Field testing using the ball method and spread, or flow testing is also acceptable.
13. Quality control testing should be provided on structural backfill to assist the contractor in meeting project specifications. Proctor testing should be performed on each soil type, and one-point field proctors should be used to verify the soil types during compaction testing. If compaction testing is

performed with a nuclear density gauge, it should be periodically correlated with a sand cone test for each soil type.

14. Density testing should be performed on structural backfill per project specifications and or jurisdictional requirements, but not less than once per 12 inches elevation in each area, and additional tests for each additional 500 linear-foot section or portion thereof.

CAST-IN-PLACE CONCRETE

SLABS-ON-GRADE/STRUCTURES/PAVEMENTS

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Cast-in-place concrete (concrete) in this section is considered to apply to the installation of cast-in-place concrete slabs on grade, including reinforced and non-reinforced slabs, structures, and pavements.
3. In areas where concrete is bearing on prepared subgrade or structural fill soils, testing and approval of this work should be completed prior to the beginning of concrete construction.
4. In locations where a concrete is approved to bear on in-place (native) soil or in locations where approved documented fills have been exposed to weather conditions after approval, a concrete subgrade evaluation should be performed prior to the placement of reinforcing steel and or concrete. This can consist of probing with a "t"-handled rod, borings, penetrometer testing, dynamic cone penetration testing and/or other methods requested by the geotechnical engineer and/or inspector. Where unsuitable, wet, or frozen bearing material is encountered, the geotechnical engineer should be consulted for additional recommendations.
5. Slabs on grade should be placed on a 4-inch thick or more capillary barrier consisting of non-corrosive (more than 2,000 ohm-cm resistivity, less than 50 ppm chloride content and less than 0.1 percent sulfates) aggregate base or open-graded aggregate material. This material should be compacted or consolidated per the recommendations of the structural engineer or otherwise would be covered by the General Considerations for <u>EARTHWORK</u>.
6. Depending on the site conditions and climate, vapor barriers may be required below in-door grade-slabs to receive flooring. This reduces the opportunity for moisture vapor to accumulate in the slab, which could degrade flooring adhesive and result in mold or other problems. Vapor barriers should be specified by the structural engineer and/or architect. The installation of the barrier should be inspected to evaluate the correct product and thickness is used, and that it has not been damaged or degraded.
7. At times when rainfall is predicted during construction, a mud-mat or a thin concrete layer can be placed on prepared and approved subgrades prior to the placement of reinforcing steel or tendons. This serves the purpose of protecting the subgrades from damage once the reinforcement placement has begun.
8. Prior to the placement of concrete, exposed subgrade or base material and forms should be wetted, and form release compounds should be applied. Reinforcement support stands or ties should be

checked. Concrete bases or subgrades should not be so wet that they are softened or have standing water.

9. For a cast-in-place concrete, the form dimensions, reinforcement placement and cover, concrete mix design, and other code requirements should be carefully checked by an inspector before and during placement. The reinforcement should be specified by the structural engineering drawings and calculations.
10. For post-tension concrete, an additional check of the tendons is needed, and a tensioning inspection form should be prepared prior to placement of concrete.
11. For Portland cement pavements, forms an additional check of reinforcing dowels should performed per the design drawings.
12. During placement, concrete should be tested, and should meet the ACI and jurisdictional requirements and mix design targets for slump, air entrainment, unit weight, compressive strength, flexural strength (pavements), and any other specified properties. In general concrete should be placed within 90 minutes of batching at a temperature of less than 90 degrees Fahrenheit. Adding of water to the truck on the jobsite is generally not encouraged.
13. Concrete mix designs should be created by the accredited and jurisdictionally approved supplier to meet the requirements of the structural engineer. In general, a water/cement ratio of 0.45 or less is advisable, and aggregates, cement, fly ash, and other constituents should be tested to meet ASTM C-33 standards, including Alkali Silica Reaction (ASR). To further mitigate the possibility of concrete degradation from corrosion and ASR, Type II or V Portland Cement should be used, and fly ash replacement of 25 percent is also recommended. Air entrained concrete should be used in areas where concrete will be exposed to frozen ground or ambient temperatures below freezing.
14. Control joints are recommended to improve the aesthetics of the finished concrete by allowing for cracking within partially cut or grooved joints. The control joints are generally made to depths of about 1/4 of the slab thickness and are generally completed within the first day of construction. The spacing should be laid out by the structural engineer and is often in a square pattern. Joint spacing is generally 5 to 15 feet on-center but this can vary and should be decided by the structural engineer. For pavements, construction joints are generally considered to function as control joints. Post-tensioned slabs generally do not have control joints.
15. Some slabs are expected to meet flatness and levelness requirements. In those cases, testing for flatness and levelness should be completed as soon as possible, usually the same day as concrete placement, and before cutting of control joints if possible. Roadway smoothness can also be measured and is usually specified by the jurisdictional owner if is required.
16. Prior to tensioning of post-tension structures, placement of soil backfills or continuation of building on newly placed concrete, a strength requirement is generally required, which should be specified by the structural engineer. The strength progress can be evaluated by the use of concrete compressive strength cylinders or maturity monitoring in some jurisdictions. Advancing with backfill, additional concrete work or post-tensioning without reaching strength benchmarks could result in damage and failure of the concrete, which could result in danger and harm to nearby people and property.

17. In general, concrete should not be exposed to freezing temperatures in the first 7 days after placement, which may require insulation or heating. Additionally, in hot or dry, windy weather, misting, covering with wet burlap or the use of curing compounds may be called for to reduce shrinkage cracking and curling during the first 7 days.

FOUNDATIONS

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Foundations in this section are considered to apply to the construction of structural supports which directly transfer loads from man-made structures into the earth. In general, these include shallow foundations and deep foundations. Shallow foundations are generally constructed for the purpose of distributing the structural loads horizontally over a larger area of earth. Some types of shallow foundations (or footings) are spread footings, continuous footings, mat foundations, and reinforced slabs-on-grade. Deep foundations are generally designed for the purpose of distributing the structural loads vertically deeper into the soil by the use of end bearing and side friction. Some types of deep foundations are driven piles, auger-cast piles, drilled shafts, caissons, helical piers, and micro-piles.
3. For shallow foundations, the minimum bearing depth considered should be greater than the maximum design frost depth for the location of construction. This can be found on frost depth maps (ICC), but the standard of practice in the city and/or county should also be consulted. In general, the bearing depth should never be less than 18 inches below planned finished grades.
4. Shallow continuous foundations should be sized with a minimum width of 18 inches and isolated spread footings should be a minimum of 24 inches in each direction. Foundation sizing, spacing, and reinforcing steel design should be performed by a qualified structural engineer.
5. The geotechnical engineer will provide an estimated bearing capacity and settlement values for the project based on soil conditions and estimated loads provided by the structural engineer. It is assumed that appropriate safety factors will be applied by the structural engineer.
6. In areas where shallow foundations are bearing on prepared subgrade or structural fill soils, testing and approval of this work should be completed prior to the beginning of foundation construction.
7. In locations where the shallow foundations are approved to bear on in-place (native) soil or in locations where approved documented fills have been exposed to weather conditions after approval, a foundation subgrade evaluation should be performed prior to the placement of reinforcing steel. This can consist of probing with a "t"-handled rod, borings, penetrometer testing, dynamic cone penetration testing and/or other methods requested by the geotechnical engineer and/or inspector. Where unsuitable foundation bearing material is encountered, the geotechnical engineer should be consulted for additional recommendations.
8. For shallow foundations to bear on rock, partially weathered rock, hard cemented soils, and/or boulders, the entire foundation system should bear directly on such material. In this case, the rock surface should be prepared so that it is clean, competent, and formed into a roughly horizontal,

stepped base. If that is not possible, then the entire structure should be underlain by a zone of structural fill. This may require the over-excavation in areas of rock removal and/or hard dig. In general, this zone can vary in thickness, but it should be a minimum of 1 foot thick. The geotechnical engineer should be consulted in this instance.

9. At times when rainfall is predicted during construction, a mud-mat or a thin concrete layer can be placed on prepared and approved subgrades prior to the placement of reinforcing steel. This serves the purpose of protecting the subgrades from damage once the reinforcing steel placement has begun.
10. For cast-in-place concrete foundations, the excavations dimensions, reinforcing steel placement and cover, structural fill compaction, concrete mix design, and other code requirements should be carefully checked by an inspector before and during placement.

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11. For deep foundations, the geotechnical engineer will generally provide design charts that provide foundations axial capacity and uplift resistance at various depths given certain-sized foundations. These charts may be based on blow count data from drilling and or laboratory testing. In general safety factors are included in these design charts by the geotechnical engineer.
12. In addition, the geotechnical engineer may provide other soil parameters for use in the lateral resistance analysis. These parameters are usually raw data, and safety factors should be provided by the shaft designer. Sometimes, direct shear and or tri-axial testing is performed for this analysis.
13. In general, the spacing of deep foundations is expected to be 6 shaft diameters or more. If that spacing is reduced, a group reduction factor should be applied by the structural engineer to the foundation capacities per FHWA guidelines. The spacing should not be less than 2.5 shaft diameters.
14. For deep foundations, a representative of the geotechnical engineer should be on-site to observe the excavations (if any) to evaluate that the soil conditions are consistent with the findings of the geotechnical report. Soil/rock stratigraphy will vary at times, and this may result in a change in the planned construction. This may require the use of fall protection equipment to perform observations close to an open excavation.
15. For driven foundations, a representative of the geotechnical engineer should be on-site to observe the driving process and to evaluate that the resistance of driving is consistent with the design assumptions. Soil/rock stratigraphy will vary at times and may this may result in a change in the planned construction.
16. For deep foundations, the size, depth, and ground conditions should be verified during construction by the geotechnical engineer and/or inspector responsible. Open excavations should be clean, with any areas of caving and groundwater seepage noted. In areas below the groundwater table, or areas where slurry is used to keep the trench open, non-destructive testing techniques should be used as outlined below.
17. Steel members including structural steel piles, reinforcing steel, bolts, threaded steel rods, etc. should be evaluated for design and code compliance prior to pick-up and placement in the foundation. This includes verification of size, weight, layout, cleanliness, lap-splices, etc. In addition, if non-destructive testing such as crosshole sonic logging or gamma-gamma logging is required,

access tubes should be attached to the steel reinforcement prior to placement, and should be relatively straight, capped at the bottom, and generally kept in-round. These tubes must be filled with water prior to the placement of concrete.

18. In cases where steel welding is required, this should be observed by a certified welding inspector.
19. In many cases, a crane will be used to lower steel members into the deep foundations. Crane picks should be carefully planned, including the ground conditions at placement of outriggers, wind conditions, and other factors. These are not generally provided in the geotechnical report but can usually be provided upon request.
20. Cast-in-place concrete, grout or other cementations materials should be pumped or distributed to the bottom of the excavation using a tremie pipe or hollow stem auger pipe. Depending on the construction type, different mix slumps will be used. This should be carefully checked in the field during placement, and consolidation of the material should be considered. Use of a vibrator may be called for.
21. For work in a wet excavation (slurry), the concrete placed at the bottom of the excavation will displace the slurry as it comes up. The upper layer of concrete that has interacted with the slurry should be removed and not be a part of the final product.
22. Bolts or other connections to be set in the top after the placement is complete should be done immediately after final concrete placement, and prior to the on-set of curing.
23. For shafts requiring crosshole sonic logging or gamma-gamma testing, this should be performed within the first week after placement, but not before a 2-day curing period. The testing company and equipment manufacturer should provide more details on the requirements of the testing.
24. Load testing of deep foundations is recommended, and it is often a project requirement. In some cases, if test piles are constructed and tested, it can result in a significant reduction of the amount of needed foundations. The load testing frame and equipment should be sized appropriately for the test to be performed and should be observed by the geotechnical engineer or inspector as it is performed. The results are provided to the structural engineer for approval.

LATERALLY LOADED STRUCTURES - RETAINING WALLS/SLOPES/DEEP FOUNDATIONS/MISCELLANEOUS

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Laterally loaded structures for this section are generally meant to describe structures that are subjected to loading roughly horizontal to the ground surface. Such structures include retaining walls, slopes, deep foundations, tall buildings, box culverts, and other buried or partially buried structures.
3. The recommendations put forth in General Geotechnical Design and Construction Considerations for <u>FOUNDATIONS</u>, <u>CAST-IN-PLACE CONCRETE</u>, <u>EARTHWORK</u>, and <u>SUBGRADE PREPARATION</u> should be reviewed, as they are not all repeated in this section, but many of them will apply to the work. Those recommendations are incorporated by reference herein.
4. Laterally loaded structures are generally affected by overburden pressure, water pressure, surcharges, and other static loads, as well as traffic, seismic, wind, and other dynamic loads. The structural engineer must account for these loads. In addition, eccentric loading of the foundation should be evaluated and accounted for by the structural engineer. The structural engineer is also responsible for applying the appropriate factors of safety to the raw data provided by the geotechnical engineer.
5. The geotechnical report should provide data regarding soil lateral earth pressures, seismic design parameters, and groundwater levels. In the report the pressures are usually reported as raw data in the form of equivalent fluid pressures for three cases. 1. Static is for soil pressure against a structure that is fixed at top and bottom, like a basement wall or box culvert. 2. Active is for soil pressure against a wall that is free to move at the top, like a retaining wall. 3. Passive is for soil that is resisting the movement of the structure, usually at the toe of the wall where the foundation and embedded section are located. The structural engineer is responsible for deciding on safety factors for design parameters and groundwater elevations based on the raw data in the geotechnical report.
6. Generally speaking, direct shear or tri-axial shear testing should be performed for this evaluation in cases of soil slopes or unrestrained soil retaining walls over 6 feet in height or in lower walls in some cases based on the engineer’s judgment. For deep foundations and completely buried structures, this testing will be required per the discretion of the structural engineer.
7. For non-confined retaining walls (walls that are not attached at the top) and slopes, a geotechnical engineer should perform overall stability analysis for sliding, overturning, and global stability. For walls that are structurally restrained at the top, the geotechnical engineer does not generally perform this analysis. Internal wall stability should be designed by the structural engineer.

8. Cut slopes into rock should be evaluated by an engineering geologist, and rock coring to identify the orientation of fracture plans, faults, bedding planes, and other features should be performed. An analysis of this data will be provided by the engineering geologist to identify modes of failure including sliding, wedge, and overturning, and to provide design and construction recommendations.
9. For laterally loaded deep foundations that support towers, bridges or other structures with high lateral loads, geotechnical reports generally provide parameters for design analysis which is performed by the structural engineer. The structural engineer is responsible for applying appropriate safety factors to the raw data from the geotechnical engineer.
10. Construction recommendations for deep foundations can be found in the General Geotechnical Design and Construction Considerations-FOUNDATIONS section.
11. Construction of retaining walls often requires temporary slope excavations and shoring, including soil nails, soldier piles and lagging or laid-back slopes. This should be done per OSHA requirements and may require specialty design and contracting.
12. In general, surface water should not be directed over a slope or retaining wall but should be captured in a drainage feature trending parallel to the slope, with an erosion protected outlet to the base of the wall or slope.
13. Waterproofing for retaining walls is generally required on the backfilled side, and they should be backfilled with an 18-inch zone of open graded aggregate wrapped in filter fabric or a synthetic draining product, which outlets to weep holes or a drain at the base of the wall. The purpose of this zone, which is immediately behind the wall is to relieve water pressures from building behind the wall.
14. Backfill compaction around retaining walls and slopes requires special care. Lighter equipment should be considered, and consideration to curing of cementitious materials used during construction will be called for. Additionally, if mechanically stabilized earth walls are being constructed, or if tie-backs are being utilized, additional care will be necessary to avoid damaging or displacing the materials. Use of heavy or large equipment, and/or beginning of backfill prior to concrete strength verification can create dangers to construction and human safety. Please refer to the General Geotechnical Design and Construction Considerations-CAST-IN-PLACE CONCRETE section. These concerns will also apply to the curing of cell grouting within reinforced masonry walls.
15. Usually safety features such as handrails are designed to be installed at the top of retaining walls and slopes. Prior to their installation, workers in those areas will need to be equipped with appropriate fall protection equipment.

EXCAVATION AND DEWATERING

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Excavation and Dewatering for this section are generally meant to describe structures that are intended to create stable, excavations for the construction of infrastructure near to existing development and below the groundwater table.
3. The recommendations put forth in General Geotechnical Design and Construction Considerations for LATERALLY LOADED STRUCTURES, FOUNDATIONS, CAST-IN-PLACE CONCRETE, EARTHWORK, and SUBGRADE PREPARATION should be reviewed, as they are not all repeated in this section, but many of them will apply to the work. Those recommendations are incorporated by reference herein.
4. The site excavations will generally be affected by overburden pressure, water pressure, surcharges, and other static loads, as well as traffic, seismic, wind, and other dynamic loads. The structural engineer must account for these loads as described in Section 5.2 of this report. In addition, eccentric loading of the foundation should be evaluated and accounted for by the structural engineer. The structural engineer is also responsible for applying the appropriate factors of safety to the raw data provided by the geotechnical engineer.
5. The geotechnical report should provide data regarding soil lateral earth pressures, seismic design parameters, and groundwater levels. In the report the pressures are usually reported as raw data in the form of equivalent fluid pressures for three cases. 1. Static is for soil pressure against a structure that is fixed at top and bottom, like a basement wall or box culvert. 2. Active is for soil pressure against a wall that is free to move at the top, like a retaining wall. 3. Passive is for soil that is resisting the movement of the structure, usually at the toe of the wall where the foundation and embedded section are located. The structural engineer is responsible for deciding on safety factors for design parameters and groundwater elevations based on the raw data in the geotechnical report.
6. The parameters provided above are based on laboratory testing and engineering judgement. Since numerous soil layers with different properties will be encountered in a large excavation, assumptions and judgement are used to generate the equivalent fluid pressures to be used in design. Factors of safety are not included in those numbers and should be evaluated prior to design.
7. Groundwater, if encountered will dramatically change the stability of the excavation. In addition, pumping of groundwater from the bottom of the excavation can be difficult and costly, and it can result in potential damage to nearby structures if groundwater drawdown occurs. As such, we recommend that groundwater monitoring be performed across the site during design and prior to construction to assist in the excavation design and planning.

8. Groundwater pumping tests should be performed if groundwater pumping will be needed during construction. The pumping tests can be used to estimate drawdown at nearby properties, and also will be needed to determine the hydraulic conductivity of the soil for the design of the dewatering system.
9. For excavation stabilization in granular and dense soil, the use of soldier piles and lagging is recommended. The soldier pile spacing, and size should be determined by the structural engineer based on the lateral loads provided in the report. In general, the spacing should be more than two pile diameters, and less than 8 feet. Soldier piles should be advanced 5 feet or more below the base of the excavation. Passive pressures from Section 5.2 can be used in the design of soldier piles for the portions of the piles below the excavation.
10. If the piles are drilled, they should be grouted in-place. If below the groundwater table, the grouting should be accomplished by tremie pipe, and the concrete should be a mix intended for placement below the groundwater table. For work in a wet excavation, the concrete placed at the bottom of the excavation will displace the water as it comes up. The upper layer of concrete that has interacted with the water should be removed and not be a part of the final product. Lagging should be specially designed timber or other lagging. The temporary excavation will need to account for seepage pressures at the toe of the wall as well as hydrostatic forces behind the wall.
11. Depending on the loading, tie back anchors and/or soil nails may be needed. These should be installed beyond the failure envelope of the wall. This would be a plane that is rotated upward 55 degrees from horizontal. The strength of the anchors behind this plane should be considered, and bond strength inside the plane should be ignored. If friction anchors are used, they should extend 10 feet or more beyond the failure envelope. Evaluation of the anchor length and encroachment onto other properties, and possible conflicts with underground utilities should be carefully considered. Anchors are typically installed 25 to 40 degrees below horizontal. The capacity of the anchors should be checked on 10% of locations by loading to 200% of the design strength. All should be loaded to 120% of design strength, and should be locked off at 80%
12. The shoring and tie backs should be designed to allow less than ½ inch of deflection at the top of the excavation wall, where the wall is within an imaginary 1:1 line extending downward from the base of surrounding structures. This can be expanded to 1 inch of deflection if there is no nearby structure inside that plane. An analysis of nearby structures to locate their depth and horizontal position should be conducted prior to shored excavation design.
13. Assuming that the excavations will encroach below the groundwater table, allowances for drainage behind and through the lagging should be made. The drainage can be accomplished by using an open-graded gravel material that is wrapped in geotextile fabric. The lagging should allow for the collected water to pass through the wall at select locations into drainage trenches below the excavation base. These trenches should be considered as sump areas where groundwater can be pumped out of the excavation.
14. The pumped groundwater needs to be handled properly per jurisdictional guidelines.

15. In general, surface water should not be directed over a slope or retaining wall but should be captured in a drainage feature trending parallel to the slope, with an erosion protected outlet to the base of the wall or slope.
16. Safety features such as handrails or barriers are to be designed to be installed at the top of retaining walls and slopes. Prior to their installation, workers in those areas will need to be equipped with appropriate fall protection equipment.

Waterproofing and Back Drainage

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Waterproofing and Back drainage structures for this section are generally meant to describe permanent subgrade structures that are planned to be below the historic high groundwater elevation of 20 feet below existing grades.
3. The recommendations put forth in General Geotechnical Design and Construction Considerations for FOUNDATIONS, CAST-IN-PLACE CONCRETE, EARTHWORK, and SUBGRADE PREPARATION should be reviewed, as they are not all repeated in this section, but many of them will apply to the work. Those recommendations are incorporated by reference herein.
4. In general, surface water should not be directed over a slope or retaining wall but should be captured in a drainage feature trending parallel to the slope, with an erosion protected outlet to the base of the wall or slope.
5. Waterproofing for retaining walls is generally required on the backfilled side, and they should be backfilled with an 18-inch zone of open graded aggregate wrapped in filter fabric or a synthetic draining product, which outlets to weep holes or a drain at the base of the wall. The purpose of this zone, which is immediately behind the wall is to relieve water pressures from building behind the wall.
6. For the basement walls on this site, sump pumps will be needed to reduce the build-up of water in the basement. The design should be for a historic high groundwater level of 20 feet bgs. The pumping system should be designed to keep the slab and walls relatively dry so that mold, efflorescence, and other detrimental effects to the concrete structure will not result.
7. Backfill compaction around retaining walls and slopes requires special care. Lighter equipment should be considered, and consideration to curing of cementitious materials used during construction will be called for. Additionally, if mechanically stabilized earth walls are being constructed, or if tie-backs are being utilized, additional care will be necessary to avoid damaging or displacing the materials. Use of heavy or large equipment, and/or beginning of backfill prior to concrete strength verification can create dangers to construction and human safety. Please refer to the General Geotechnical Design and Construction Considerations-CAST-IN-PLACE CONCRETE section. These concerns will also apply to the curing of cell grouting within reinforced masonry walls.

CHEMICAL TREATMENT OF SOIL

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, State Department of Environmental Quality, the US Environmental Protection Agency, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Chemical treatment of soil for this section is generally meant to describe the process of improving soil properties for a specific purpose, using cement or chemical lime.
3. A mix design should be performed by the geotechnical engineer to help it meet the specific strength, plasticity index, durability, and/or other desired properties. The mix design should be performed using the proposed chemical lime or cement proposed for use by the contractor, along with samples of the site soil that are taken from the material to be used in the process.
4. For the mix design the geotechnical engineer should perform proctor testing to determine optimum moisture content of the soil, and then mix samples of the soil at 3 percent above optimum moisture content with varying concentrations of lime or cement. The samples will be prepared and cured per ASTM standards, and then after 7-days for curing, they will be tested for compression strength. Durability testing goes on for 28 days.
5. Following this testing, the geotechnical engineer will provide a recommended mix ratio of cement or chemical lime in the geotechnical report for use by the contractor. The geotechnical engineer will generally specify a design ratio of 2 percent more than the minimum to account for some error during construction.
6. Prior to treatment, the in-place soil moisture should be measured so that the correct amount of water can be used during construction. Work should not be performed on frozen ground.
7. During construction, special considerations for construction of treated soils should be followed. The application process should be conducted to prevent the loss of the treatment material to wind which might transport the materials off site, and workers should be provided with personal protective equipment for dust generated in the process.
8. The treatment should be applied evenly over the surface, and this can be monitored by use of a pan placed on the subgrade. This can also be tested by preparing test specimens from the in-place mixture for laboratory testing.
9. Often, after or during the chemical application, additional water may be needed to activate the chemical reaction. In general, it should be maintained at about 3 percent or more above optimum moisture. Following this, mixing of the applied material is generally performed using specialized equipment.

10. The total amount of chemical provided can be verified by collecting batch tickets from the delivery trucks, and the depth of the treatment can be verified by digging of test pits, and the use of reagents that react with lime and or cement.
11. For the use of lime treatment, compaction should be performed after a specified amount of time has passed following mixing and re-grading. For concrete, compaction should be performed immediately after mixing and re-grading. In both cases, some swelling of the surface should be expected. Final grading should be performed the following day of the initial work for lime treatment, and within 2 to 4 hours for soil cement.
12. Quality control testing of compacted treated subgrades should be performed per the recommendations of the geotechnical report, and generally in accordance with General Geotechnical Design and Construction Considerations - EARTHWORK

PAVING

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Paving for this section is generally meant to describe the placement of surface treatments on travel-ways to be used by rubber-tired vehicles, such as roadways, runways, parking lots, etc.
3. The geotechnical engineer is generally responsible for providing structural analysis to recommend the thickness of pavement sections, which can include asphalt, concrete pavements, aggregate base, cement or lime treated aggregate base, and cement or lime treated subgrades.
4. The civil engineer is generally responsible for determining which surface finishes and mixes are appropriate, and often the owner, general contractor and/or other party will decide on lift thickness, the use of tack coats and surface treatments, etc.
5. The geotechnical engineer will generally be provided with the planned traffic loading, as well as reliability, design life, and serviceability factors by the jurisdiction, traffic engineer, designer, and/or owner. The geotechnical study will provide data regarding soil resiliency and strength. A pavement modeling software is generally used to perform the analysis for design, however, jurisdictional minimum sections also must be considered, as well as construction considerations and other factors.
6. The geotechnical report will generally provide pavement section thicknesses if requested.
7. For construction of overlays, where new pavement is being placed on old pavement, an evaluation of the existing pavement is needed, which should include coring the pavement, evaluation of the overall condition and thickness of the pavement, and evaluation of the pavement base and subgrade materials.
8. In general, the existing pavement is milled and treated with a tack coat prior to the placement of new pavement for the purpose of creating a stronger bond between the old and new material. This is also a way of removing aged asphalt and helping to maintain finished grades closer to existing conditions grading and drainage considerations.
9. If milling is performed, a minimum of 2 inches of existing asphalt should be left in-place to reduce the likelihood of equipment breaking through the asphalt layer and destroying its integrity. After milling and before the placement of tack coat, the surface should be evaluated for cracking or degradation. Cracked or degraded asphalt should be removed, spanned with geosynthetic reinforcement, or be otherwise repaired per the direction of the civil and or geotechnical engineer prior to continuing construction. Proofrolling may be requested.

10. For pavements to be placed on subgrade or base materials, the subgrade and base materials should be prepared per the General Geotechnical Design and Construction Considerations – EARTHWORK section.
11. Following the proofrolling as described in the General Geotechnical Design and Construction Considerations – EARTHWORK section, the application of subgrade treatment, base material, and paving materials can proceed per the recommendations in the geotechnical report and/or project plans. The placement of pavement materials or structural fills cannot take place on frozen ground.
12. The placement of aggregate base material should conform to the jurisdictional guidelines. In general, the materials should be provided by an accredited supplier, and the material should meet the standards of ASTM C-33. Material that has been stockpiled and exposed to weather including wind and rain should be retested for compliance since fines could be lost. Frozen material cannot be used.
13. The placement of asphalt material should conform to the jurisdictional guidelines. In general, the materials should be provided by an accredited supplier, and the material should meet the standards of ASTM C-33. The material can be placed in a screed by end-dumping, or it can be placed directly on the paving surface. The temperature of the mix at placement should generally be on the order of 300 degrees Fahrenheit at time of placement and screeding.
14. Compaction of the screeded asphalt should begin as soon as practical after placement, and initial rolling should be performed before the asphalt has cooled significantly. Compaction equipment should have vibratory capabilities and should be of appropriate size and weight given the thickness of the lift being placed and the sloping of the ground surface.
15. In cold and/or windy weather, the cooling of the screeded asphalt is a quality issue, so preparations should be made to perform screeding immediately after placement, and compaction immediately after screeding.
16. Quality control testing of the asphalt should be performed during placement to verify compaction and mix design properties are being met and that delivery temperatures are correct. Results of testing data from asphalt laboratory testing should be provided within 24 hours of the paving.

SITE GRADING AND DRAINAGE

1. In general, construction should proceed per the governing jurisdictional guidelines for the project site, including but not limited to the applicable American Concrete Institute (ACI), International Code Council (ICC), State Department of Transportation, State Department of Environmental Quality, the US Environmental Protection Agency, City and/or County, Army Corps of Engineers, Federal Aviation, Occupational Safety and Health Administration (OSHA), and any other governing standard details and specifications. In areas where multiple standards are applicable the more stringent should be considered. Work should be performed by qualified, licensed contractors with experience in the specific type of work in the area of the site.
2. Site grading and drainage for this section is generally meant to describe the effect of new construction on surface hydrology, which impacts the flow of rainfall or other water running across, onto or off-of, a newly constructed or modified development.
3. This section does not apply to the construction of site grading and drainage features. Recommendations for the construction of such features are covered in General Geotechnical Design and Construction Considerations for Earthwork – Structural Fills section and Underground Pipeline Installation – Backfill section.
4. In general, surface water flows should be directed towards storm drains, natural channels, retention or detention basins, swales, and/or other features specifically designed to capture, store, and or transmit them to specific off-site outfalls.
5. The surface water flow design is generally performed by a site civil engineer, and it can be impacted by hydrology, roof lines, and other site structures that do not allow for water to infiltrate into the soil, and that modify the topography of the site.
6. Soil permeability, density, and strength properties are relevant to the design of storm drain systems, including dry wells, retention basins, swales, and others. These properties are usually only provided in a geotechnical report if specifically requested, and recommendations will be provided in the geotechnical report in those cases.
7. Structures or site features that are not a part of the surface water drainage system should not be exposed to surface water flows, standing water or water infiltration. In general, roof drains and scuppers, exterior slabs, pavements, landscaping, etc. should be constructed to drain water away from structures and foundations. The purpose of this is to reduce the opportunity for water damage, erosion, and/or altering of structural soil properties by wetting. In general, a 5 percent or more slope away from foundations, structural fills, slopes, structures, etc. should be maintained.
8. Special considerations should be used for slopes and retaining walls, as described in the General Geotechnical Design and Construction Considerations - LATERALLY LOADED STRUCTURES section.
9. Additionally, landscaping features including irrigation emitters and plants that require large amounts of water should not be placed near to new structures, as they have the potential to alter soil moisture states. Changing of the moisture state of soil that provides structural support can lead to damage to the supported structures.