GEOTECHNICAL ENGINEERING REPORT
COASTAL CHRISTIAN SCHOOL
MULTIPURPOSE BUILDING, CLASSROOMS & PLAYFIELDS
ARROYO GRANDE, CALIFORNIA

September 15, 2020
(Revised April 28, 2022)

Prepared for

Coastal Christian School
c/o Oasis Associates, Inc.

Prepared by

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September 15, 2020
(Revised April 28, 2022)

File No.: 304022-001

Coastal Christian School
c/o Oasis Associates, Inc.
Attn.: Ms. Carol Florence
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PROJECT: COASTAL CHRISTIAN SCHOOL
MULTIPURPOSE BUILDING, CLASSROOMS & PLAYFIELDS
1005 NORTH OAK PARK BOULEVARD
ARROYO GRANDE, CALIFORNIA

SUBJECT: *Revised* Geotechnical Engineering Report

CONTRACT REF: Proposal to Provide a Geotechnical Engineering Investigation and Soil Corrosivity Testing, Coastal Christian School – Multipurpose Building, Classrooms and Playfields, 1005 North Oak Park Blvd., Arroyo Grande, California, by Earth Systems Pacific, Doc. No. 2007-061.PRP, dated July 17, 2020

Dear Ms. Florence:

Per your authorization of the referenced proposal, this geotechnical engineering report has been prepared for use in the development of plans and specifications for the proposed project at 1005 North Oak Park Boulevard in Arroyo Grande, California. Preliminary geotechnical engineering recommendations for site preparation, grading, utility trenches, foundations, interior slabs-on-grade and exterior pedestrian flatwork, retaining walls, pavement sections, drainage and maintenance, and observation and testing are presented herein. The soil corrosivity testing program included in the referenced proposal was not authorized. This report has been revised to include the correct boring logs. One electronic and one bound copy of this report have been provided to you.

We appreciate the opportunity to have provided professional services for this project and look forward to working with you again in the future. If there are any questions concerning this report, please do not hesitate to contact the undersigned.

Sincerely,

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1.0 INTRODUCTION

Additional facilities are proposed at the existing Coastal Christian School Campus at 1005 North Oak Park Boulevard in Arroyo Grande, California. Based on the civil plan set prepared by Cannon (2020), we understand that construction of the additional facilities will include grading the vacant land to the north of the existing school into two terraces, with cuts as deep as 35 feet below the existing topography and fills of 6 to 10 feet. Cut slope gradients of 2:1 (horizontal to vertical) are planned, with benches on the slopes as needed. The upper terrace will be a turf playfield, with permanent softball and baseball fields in opposite corners, and an overlying soccer field in the central portion of the terrace. The lower terrace will have a multipurpose building with a footprint of approximately 18,000 square feet, surrounded by a flatwork courtyard and single-story classroom buildings. Vehicle parking will be provided on the southeast and east sides of the lower terrace, and outdoor basketball courts will be in the northeast corner. The existing entry driveway from North Oak Park Boulevard will be realigned at its upper end, to provide access to the new parking areas and to maintain access to the existing facilities. A service road will also be constructed to provide access between the two terraces.

The multipurpose building will likely be of steel frame and masonry construction; the classrooms will be of wood and/or steel frame construction and may be prefabricated (modular) units. All of the structures will be single story. Conventional continuous and spread (pad) footings with concrete slabs-on-grade and/or raised floors are anticipated. Maximum continuous and column loads of 3 kips per linear foot and 75 kips, respectively, have been assumed. The pavement improvements will consist of hot mix asphalt (HMA) and/or Portland cement concrete (PCC) over aggregate base (AB). Retaining walls for sitework, or connected to or forming part of a structure, and a maximum of 10 feet tall, may also be constructed. The site will be served by the existing municipal utility lines in the area. The existing drainage basins or other drainage detention facilities will be used for stormwater control.

2.0 SCOPE OF SERVICES

Our scope of work included a general site reconnaissance by a geotechnical engineer and an engineering geologist, field exploration, laboratory testing, geotechnical and geologic analysis of the data gathered (including analysis of slope stability), and preparation of this report. The analysis and subsequent recommendations were based on our discussions with Ms. Carol Florence of Oasis Associates, Inc., and our review of the plan set prepared by Cannon.

This report and recommendations are intended to comply with the considerations of Sections 1803.1 through 1803.6, J104.3 and J104.4, as applicable, of the 2019 California Building Code

(CBC) and common geotechnical engineering and engineering geology practice in this area under similar conditions at this time. The test procedures were accomplished in general conformance with the standards noted, as modified by common geotechnical engineering and engineering geology practice in this area under similar conditions at this time.

Preliminary geotechnical engineering recommendations for site preparation, grading, utility trenches, foundations, interior slabs-on-grade and exterior pedestrian flatwork, retaining walls, pavement sections, drainage and maintenance, and observation and testing are presented to guide the development of project plans and specifications. As there may be geotechnical issues yet to be resolved, the geotechnical engineer should be retained to provide consultation as the design progresses, and to review project plans as they near completion to assist in verifying that pertinent geotechnical issues have been addressed and to aid in conformance with the intent of this report.

It is our intent that this report be used exclusively by the client to form the geotechnical basis of the design of the project and in the preparation of plans and specifications. Application beyond this intent is strictly at the user's risk.

This report does not address issues in the domain of contractors such as, but not limited to, site safety, loss of volume due to stripping of the site, shrinkage of soils during compaction, excavatability, dewatering, temporary slope angles, construction means and methods, etc. Detailed analyses of aerial or site geology, or of the soil for corrosivity, radioisotopes, asbestos (in man-made products), lead or mold potential, hydrocarbons, or chemical properties is beyond the scope of this report. Any ancillary features such as flag or light poles, temporary access roads, and non-structural fills are not within our scope and are also not addressed. Design, including assessment for infiltration characteristics, of LID features such as retention basins, bio swales, or other improvements is also beyond our scope.

In the event that there are any changes in the nature, design, or location of improvements, or if any assumptions used in the preparation of this report prove to be incorrect, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified by the geotechnical engineer in writing. The criteria presented in this report are considered preliminary until such time as any peer review or review by any jurisdiction has been completed, conditions have been observed by the geotechnical engineer in the field during construction, and the recommendations have been verified as appropriate, or modified by the geotechnical engineer in writing.

3.0 SITE SETTING

The site is located to the north of the existing school and northwest of North Oak Park Boulevard; otherwise, the site is bounded by undeveloped land, as shown in Figure 1 – Site Vicinity Map in Appendix A. The approximate central site coordinates obtained from the Google Earth website (Google Earth 2020) are latitude 35.1382° N and longitude 120.6058° W. Overall, the site slopes moderately to the southeast, with frequent undulations and cut slopes where previous quarry activities have occurred. A temporary unpaved parking lot is located at the southeast corner of the site and unpaved access roads run throughout the property. A water well is located near the middle of the northeast property line, and several water storage tanks are present near the northwest property line. The site is generally covered by low lying wild grasses and sparsely spaced oak trees. The locations and dispositions of utility lines on the site are unknown.

4.0 FIELD INVESTIGATION AND LABORATORY ANALYSIS

Five exploratory borings were drilled at the site on July 24, 2020 to depths ranging from 16 to 41 feet below the existing ground surfaces (bgs). The borings were drilled with a truck-mounted Mobile Drill B-53 rig equipped with 4-inch outside diameter solid stem auger and an automatic hammer for sampling. As the exploratory borings were drilled, soil samples were obtained using a 3-inch outside diameter ring-lined barrel sampler (ASTM D 3550-17 with shoe similar to ASTM D 2937-17). Standard Penetration Tests (SPT) (ASTM D 1586-18) using a 2-inch outside diameter split-spoon sampler were also conducted at selected depths in the borings, and bulk samples were obtained from the auger cuttings. The approximate locations of the borings are shown on Figure 2 - Exploration Location Map in Appendix A.

Soils encountered in the borings were categorized and logged in general accordance with the Unified Soil Classification System and ASTM D 2488-17. Where bedrock was encountered, its properties were described based upon observation of ring and/or standard presentation test samples, observation of the auger cuttings, the effort required to drill into the bedrock, and the effort required to drive samplers into the bedrock. Logs of the borings are presented in Appendix A, along with a Boring Log Legend. In reviewing the boring logs and legend, the reader should recognize that the legend is intended as a guideline only, and there are a number of conditions that may influence the characteristics observed during drilling. These include, but are not limited to, the presence of cobbles or boulders, cementation, variations in soil moisture, presence of groundwater, and other factors. It should also be noted that the descriptions of bedrock must span a much wider range of density and strength characteristics than soil and are relative to other bedrock strata. For example, weathered bedrock may be described as “soft,” yet it will be

considerably harder than almost any type of soil. Conversely, a clay soil may be described as "hard," however, it will not be nearly as hard as even "soft" bedrock. Consequently, the logger must exercise judgment in interpreting soil characteristics, possibly resulting in soil descriptions that vary from the legend. The reader should also consider the sampler type used when reviewing the blow counts.

Selected samples were tested for expansion index (ASTM D 4829-19), maximum density and optimum moisture content (ASTM D 1557-12, modified), direct shear (ASTM D 3080/D 3080M-11, remolded to 90 percent of maximum dry density), point load strength of bedrock (ASTM D 5731-16), bulk density (ASTM D 2937-17, modified for ring liners) and moisture (ASTM D 2216-10). The results of the laboratory tests are presented in Appendix B.

5.0 GENERAL SUBSURFACE PROFILE

Alluvial soils were encountered below the existing ground surface to depths of 1 to 4.5 feet bgs and consisted of loose to dense poorly graded sand and clayey sand; these soils are likely crushed sandstone that were disturbed during previous activities at the site. The alluvium/crushed sandstone was underlain by sandstone bedrock of the Pismo Formation (Squire Member). Clayey sandstone, also of the Pismo Formation (Squire Member), was encountered below the sandstone in Borings 3 and 5. The bedrock was generally soft and moderately weathered. The soils and bedrock were categorized during drilling as being moist and moist to very moist, respectively. Groundwater was not encountered in any of the borings to the maximum depth explored of 41 feet bgs.

6.0 GEOLOGY

Geologic Setting

The site lies at the southeastern tip of the Irish Hills, a northwest-southeast trending range within the Coast Ranges geomorphic province of California (CGS 2002). The Irish Hills, in the vicinity of the site, are bounded between the Pacific Ocean to the southwest, Arroyo Grande Valley to the southeast, the Edna Valley to the northeast (USGS 2020).

According to the Geologic Map of the Arroyo Grande NE Quadrangle by Wiegers (2013), the project site is underlain by sandstone bedrock of the Squire Member of the lower Pliocene to upper Miocene Pismo formation (Tpsq). Our subsurface exploration performed for this site encountered massive (structureless) sandstone with occasional siltstone lenses, which is consistent with the geologic unit mapped by Wiegers.

Faulting

Faults are classified by the State of California based on the likelihood of generating ground motions and surface rupture. The classification system applies to known faults that have been compiled by numerous researchers through various methods of investigation. The State evaluates faults with documented ground rupture during the last 11,700 years and considers them for inclusion in Earthquake Fault Zones requiring investigation (A-P Zones) which encompass traces of *Holocene-active* faults, as defined by the State's Alquist-Priolo Earthquake Fault Zoning Act (California 1972). The State's guidance is intended to prohibit developments and structures for human occupancy across the trace of active faults (CGS 2018). Other active faults capable of generating strong ground motion are present in the region but are not included in A-P Zones because they do not meet the criteria of "sufficiently active and well-defined." The site is not within a State or County Special Studies Zone requiring a fault investigation and there are no faults depicted on the regional geologic map on the site (Wiegers 2013).

Groundwater

Groundwater was not encountered in any of the borings within the maximum depth explored of approximately 41 feet bgs. Limited groundwater data was available in the immediate site area and we do not anticipate that bedrock at the site is water bearing or that groundwater will be a factor in the design of operation of the project (CDWR 2020).

7.0 SEISMICITY

Design Acceleration Parameters

In accordance with the 2019 CBC and ASCE 7-16 (2017), an assessment was made to determine the need for employing "Site-Specific Ground Motion Procedures" to calculate the ground motion parameters for the project.

Results of standard penetration testing (SPT) of the sandstone bedrock at the site indicate that the Seismic Site Class, determined in accordance with Table 20.3-1 of ASCE 7-16 (2017) is "C", therefore in accordance with ASCE 7-16 (2017) Section 11.4.8 a site-specific ground motion analysis is not required. We have provided general procedure seismic design parameters in the "Foundations" Section of this report.

Seismic Design Category

Section 1613A.3.5 of the 2019 CBC indicates that structures will be assigned to Seismic Design Category D unless $S_1 \geq 0.75$. The mapped S_1 for the site is 0.390g, less than 0.75; therefore, the site is classified as Seismic Design Category D

8.0 GEOLOGIC HAZARDS

Surface Ground Rupture

Surface ground rupture generally occurs at sites that are traversed by, or lie very near to, an active fault. The site is not located in any State Earthquake Fault Zones (Bryant and Hart 2007) and there are no mapped faults crossing the site. The closest mapped *Holocene-active* fault to the site is the Irish Hills segment of the Los Osos Fault System, located approximately 10 miles north-northwest. The San Luis Range Faults (San Luis Obispo Bay, Oceano, Wilmar Ave., Olson, and Santa Maria River faults) are considered active but are not included in A-P Zones. The closest strand of the San Luis Range Fault System to the site is the Wilmar Avenue fault located approximately 3,500 feet southwest of the site. Because there are no mapped or observed active faults on the site the potential for surface fault rupture to occur at the site is considered very low.

Seismic Settlement

Liquefaction refers to a phenomenon that tends to occur in saturated soils (soils below the groundwater table) of low density that have grain sizes within a certain range, usually fine- to medium-grained poorly graded sands, silty sands, and silts. A sufficiently strong earthquake is also required to cause liquefaction. During liquefaction, the energy from the earthquake causes the water pressure within the pores of the soil to increase. The increase in water pressure decreases the friction between the soil grains, allowing the soil grains to move relative to one another. During this state, the soil will behave as a viscous liquid, temporarily losing its ability to support foundations and other improvements. The high pressure water will flow through the soil along the path of least resistance. As the pressure is released, the soils typically settle in a process called “liquefaction settlement.” Liquefaction settlement can cause damage to structures and other surface and subsurface improvements.

Seismic settlement may also occur within unsaturated soils during a seismic event. Unsaturated loose to medium dense cohesionless soils above the groundwater table may also settle during seismic shaking.

The site is mapped by the County of San Luis Obispo (2020) as being in an area of low liquefaction potential. The site is generally underlain by a thin layer of alluvium over bedrock and no groundwater was encountered during our explorations at the site. Based on the subsurface

conditions encountered above, we conclude with the County of San Luis Obispo that there is a low potential for liquefaction, as well as a low potential for seismic settlement of unsaturated soils, at the site.

Slope Stability

The site is located in an area mapped by the County of San Luis Obispo (2020) as having low potential for landsliding, but the State has mapped the site in an area ranked as VIII for the potential for deep seated landslides (Wills et al 2011). Because the proposed project includes significant cuts, we evaluated the proposed design grade to calculate the factor of safety of the approximately 35-foot high cut slopes. Groundwater levels were modelled at the proposed surface elevations in most locations and were considered conservative for the analysis. Strength parameters used in our evaluation were assessed through point load testing of the sandstone bedrock. The results of the point load testing are presented in Appendix B.

Slope stability analyses were performed using the computer program Slide (Version 2018) by Rocscience. Static analyses were performed on Cross Sections A-A', which follow Cross Section A from the plans from Cannon (2020) and C-C' (Cannon's plans show a Cross Section B that we did not evaluate), whose limits are shown on Figure 2 – Exploration Location Map in Appendix A, to calculate a factor of safety against failure (FoS). The slope stability analysis methods utilized for our calculations are those recommended by SCEC (2002) and include Bishop and Janbu Simplified methods.

The seismic screening analysis was performed in accordance with the guidance provided by CGS (2008), which indicate that the horizontal destabilizing coefficient (*k*) of 0.10 be used for earthquake scenarios involving magnitude 6.5 events and *k* of 0.15 for earthquake scenarios of magnitude 8.25. Further analysis to develop a site-specific coefficient would be required if the FoS using this method was less than 1.0 to determine the magnitude of slope displacement. Because the site is within a seismically active region and potentially subject to the affects from an earthquake larger than magnitude 6.5, the horizontal destabilizing coefficient of *k*=0.15 was applied.

Cross Section A-A' was analyzed to assess the entire slope, from approximately the location of the water storage tanks through the proposed sports fields and gym/multi-purpose building to the lower parking area and natural slope. Cross Section C-C' was evaluated to assess the highest design slope of the project graded at an inclination of 2:1 (H:V). Both cross-sections indicate a

FoS for the static model greater than 1.5, and the for the pseudostatic model (with seismic force applied) greater than 1.1. Both of these FoS values exceed the generally accepted criteria for safety. The slope stability analysis results and Cross Sections A-A' and C-C' are shown in Appendix C.

Flooding

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map No. 06079C1363H (FEMA 2017), the site is located within Flood Zone X, which indicates areas of minimal flooding outside of any mapped flood zone. The site is not within any mapped downstream inundation zone for dam failure

Tsunami and Seiche Potential

According to the State of California Tsunami Inundation Zone map for the County of San Luis Obispo, and the ASCE Tsunami Design Geodatabase (2020), the project site does not lie within a Tsunami Inundation Zone. Furthermore, the site is located about 2 miles from the Pacific Ocean at an approximate elevation of over 100 feet above sea level; therefore, the potential for a tsunami to flood the site is considered very low.

A seiche is a water wave that can be generated in a reservoir, lake or pond as the result of long-period surface waves generated by strong local earthquakes or larger earthquakes at farther distances. The site is not within proximity to any impounded or natural body of water; therefore, the potential for a seiche to affect the project site is considered very low.

Naturally Occurring Asbestos

There are no naturally occurring asbestos-bearing rock formations (serpentinite or ultramafic rock) known on the site. The site is underlain by sandstone, which is not an asbestos-bearing geologic unit. Therefore, the potential for naturally occurring asbestos on the site is considered very low.

Radon

Radon is a naturally-occurring, colorless, odorless gas present in certain soils and rock, which is derived from the decay of radium atoms. The occurrence of radon correlates with the presence of specific minerals, and its concentrations in soil or rock will vary depending on the mineralogy of the surrounding bedrock, temperature, barometric pressure, moisture and other factors. Prolonged exposure to elevated levels of radon is associated with an increased risk of lung cancer. The route of exposure is via inhalation in an enclosed space, such as a structure.

No rock types associated with elevated radon were observed during our investigation. According to the State of California interactive data viewer, the site is in an area mapped as low radon potential (California Dept. of Conservation 2020).

9.0 CONCLUSIONS

In our opinion, the site is suitable, from a geotechnical engineering standpoint, for the proposed structures and other improvements discussed in the "Introduction and Site Setting" Section of this report, provided the recommendations contained herein are implemented in the design and construction. In our opinion, the primary geotechnical engineering concerns at the site are the potential for strong seismic shaking and differential settlement, and the erosion potential of the near-surface soils and bedrock. The expansion potential of the site soils and bedrock are also discussed.

Strong Seismic Shaking

The site is in a region of high seismic activity, with the potential for large seismic events that could generate strong ground shaking. A seismic analysis was undertaken to provide seismic acceleration design parameters, which are presented in the "Foundations" Section of this report.

Potential for Differential Settlement Due to Non-Uniform Soil Conditions

Unless properly mitigated, differential settlement could occur if foundations cross a cut/fill or a soil/bedrock transition. Differential settlement can stress and damage foundations and slabs-on-grade, often resulting in severe cracks and displacement. To reduce this potential, a program of overexcavation and recompaction is recommended within the building areas per the "Grading" Section of this report, to create sufficiently uniform bearing conditions, and to reduce the potential for destructive differential settlement. Where a building area is excavated entirely below existing grade to expose the underlying bedrock, no remedial earthwork is considered necessary, except as needed to address the expansive soil concerns.

Erosion Potential

The site soils and bedrock are considered to be highly erodible and erosion is evidenced at the site. It is essential that all surface drainage be controlled and directed to appropriate discharge points, away from slopes, and that surface soils and bedrock, particularly those disturbed during construction, are stabilized by vegetation or other means *during and following construction*.

Expansive Soils

An expansion index test performed on a sample of the surficial alluvium/crushed sandstone bedrock produced an expansion index value of 39. Per Section 1803.5.3 of the 2019 CBC, the site soils are considered to be expansive. However, based on the subsurface conditions observed from samples in our exploratory borings and our general reconnaissance of the near surface soils and bedrock, we anticipate the site consists of nonexpansive materials. It is our interpretation that the expansion index value stated above is not representative of the site materials and may be a result of silt build up that occurred at a low point where the sample was collected. Verification that the site soils and bedrock are nonexpansive should be confirmed, however, with additional expansion index tests performed as grading operations near building pad elevations. Where nonexpansive soils or nonexpansive bedrock are exposed, no mitigating measures with respect to expansive soils are considered necessary.

10.0 PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

These recommendations are applicable for the proposed project as described in the "Introduction" Section of this report. If other improvements not previously mentioned are included, the geotechnical engineer should be contacted for revised recommendations.

Unless otherwise noted, the following definitions are used in the recommendations presented below. Where terms are not defined, definitions commonly used in the construction industry are intended.

- **Building Areas:** The building areas are defined as the areas within and extending a minimum of 5 feet beyond the perimeter of the foundations for the proposed structures. The building areas also include the footprint of any improvements which are rigidly connected to the structures and that are expected to perform in a similar manner.
- **Sitework Retaining Wall Areas:** The area within and extending a minimum of 3 feet beyond the footprint of any sitework retaining wall foundation.
- **Flatwork Areas:** The areas within and extending a minimum of 1 foot beyond the limits of exterior pedestrian flatwork.
- **Pavement Areas:** The areas within and extending a minimum of 1 foot beyond the limits of any areas to receive HMA or PCC pavement, such as roadways, parking areas, driveway aprons, and/or trash enclosure pads.

- **Grading Area:** The entire area to be graded, including the building areas, sitework retaining wall areas, flatwork areas, pavement areas, and any areas where surface improvements will be constructed or fill will be placed.
- **Subgrade:** The elevation of the surface upon which a sand cushion/nonexpansive imported material or AB will be placed for flatwork or pavement, respectively.
- **Existing Grade:** Elevations of the site that existed as of the date of this report.
- **Scarified:** Thoroughly plowed or ripped in two orthogonal directions to a depth of not less than 8 inches.
- **Moisture Conditioned:** Soil moisture content adjusted to optimum moisture content, or just above, prior to application of compactive effort**.**
- **Compacted / Recompacted:** Soils placed in level lifts not exceeding 8 inches in loose thickness and compacted to a minimum of 95 percent of maximum dry density, unless specified otherwise. The standard tests used to establish maximum dry density and field density should be ASTM D 1557-12 and ASTM D 6938-17, respectively, or other methods acceptable to the geotechnical engineer and jurisdiction.

Site Preparation

1. The ground surface in the grading area should be prepared for construction by removing all existing improvements, vegetation, debris, and other deleterious materials. Any existing utility lines that will not remain in service should be either removed or abandoned. The appropriate method of utility abandonment will depend upon the type and depth of the utility. Recommendations for abandonment during construction can be made as necessary.

2. Voids created by the removal of materials or utilities described above should be called to the attention of the geotechnical engineer. No fill should be placed unless the underlying soil has been observed by the geotechnical engineer.

Grading

1. Following site preparation, building areas that will be cut entirely below existing grade and into bedrock should be excavated to finish grade. The bedrock exposed should be sampled and tested for expansion index. If the bedrock is found to be nonexpansive, no additional excavation would be necessary. If the bedrock is found to be expansive,

additional excavations to a level plane at a minimum of 12 inches below planned bottom of slab elevation should be made to allow for the placement of nonexpansive material to protect slabs-on-grade. The exact depth of overexcavation should be determined by the geotechnical engineer based on the expansion tests of the bedrock at the time of construction. Excavations should be cut to a level plane neatly into the underlying bedrock; the exposed bedrock need not be scarified.

2. Building areas that will be constructed within bedrock/soil transitions should be overexcavated neatly to a level plane within the bedrock to 75 percent of the soil thickness, as measured from bottom of slab to the alluvium/bedrock contact. This overexcavation depth should continue across the entire building area. The exposed soil should then be scarified, moisture conditioned and recompacted to a minimum of 95 percent of maximum dry density. Exposed bedrock need not be scarified and recompacted.

3. Soil in pavement areas should be cut to subgrade elevation. The exposed surfaces should then be scarified, moisture conditioned and recompacted to a minimum of 95 percent of maximum dry density. If bedrock is exposed at subgrade elevation, the surface should be cut neatly, and no scarifying and recompaction is recommended. If fill is required to bring existing grades up to subgrade elevation, existing grades should be scarified, moisture conditioned, and recompacted.

4. Site soils within flatwork areas should be excavated to subgrade elevation or overexcavated to the bottom of the nonexpansive fill section recommended in the "Interior Slabs-on-Grade and Exterior Pedestrian Flatwork" Section of this report, if the soils are determined to be expansive. The exposed surfaces should then be scarified, moisture conditioned and recompacted to 90 percent of maximum dry density. If bedrock is exposed at subgrade elevation, then the surface should be cut neatly and no scarifying and recompaction is recommended. If fill is required to bring existing grades up to subgrade elevation, existing grades should be scarified, moisture conditioned, and recompacted to 90 percent of maximum dry density.

5. In remaining areas to be graded, the prepared soil surfaces should be scarified, moisture conditioned, and recompacted prior to the placement of any fill. Exposed bedrock need not be scarified and recompacted prior to fill placement.

6. Voids created by dislodging rocks and/or debris during scarification should be backfilled and replaced with appropriate fill material, and the dislodged materials should be removed from the work area.

7. Excavations within building areas should be backfilled in level lifts with moisture conditioned, compacted site or similar soil, up to 12 inches below bottom of slab elevation. The final 12 inches of fill below bottom of slab elevation should consist of moisture conditioned and compacted imported nonexpansive material, as described in Paragraph 8.

8. Nonexpansive materials are defined as materials that fall in the GW, GP, GM, GC, SP, SW, SC and SM categories per ASTM D 2487-17, and that have an expansion index of 10 or less (ASTM D 4829-11). Nonexpansive soils may be imported to the site, or they may be derived from selective grading operations on the site. Proposed nonexpansive materials should be reviewed by the geotechnical engineer before being brought to the site, and on an intermittent basis during placement. The clean sand layer described in the "Interior Slabs-on-Grade and Exterior Pedestrian Flatwork" Section of this report (if utilized) is considered to be part of the minimum recommended depth of nonexpansive material (if applicable, based in expansion index testing), not in addition to it.

9. All materials used as fill should be cleaned of all debris and any rocks larger than 6 inches in maximum dimension. When fill material includes rocks, the rocks should be placed in a sufficient soil matrix to ensure that voids caused by nesting of the rocks will not occur and that the fill can be properly compacted.

10. If the soils become unstable, or if the recommended compaction cannot be readily achieved, drying the site soils to near optimum moisture content may be necessary. Placement of gravel layers or geotextiles may also be necessary to help stabilize unstable soils. Soils that are disturbed in any manner should be removed, moisture conditioned, and recompacted.

11. The recommended soil moisture content should be maintained throughout construction. Failure to maintain the soil moisture content can result in cracks and disturbance, which are an indication of degradation of the soil compaction. If cracks are allowed to develop, or if soils near improvements such as foundations, flatwork, pavement, curbs, etc. are otherwise disturbed, damage to those improvements may result. Soils that have been or are otherwise disturbed should be removed, moisture conditioned, and compacted.

12. Generally, permanent cut and fill slopes should not exceed 2:1 (horizontal:vertical) gradient, unless otherwise recommended by the geotechnical engineer. Permanent cut and fill slopes should not exceed 35 feet tall as planned (Cannon 2020) without further evaluation by the geotechnical engineer.

Utility Trenches

1. Unless otherwise recommended, utility trenches adjacent to foundations should not be excavated within the zone of foundation influence, as shown in Typical Detail A in Appendix D.

2. Utilities that must pass beneath a foundation should be placed with properly compacted utility trench backfill and the foundation should be designed to span the trench.

3. A select, non-corrosive, easily compacted sand should be used as bedding and shading immediately around utilities. The site soils may be used for trench backfill above the select material up to the bottom of the nonexpansive fill sections (if required, based on expansion index test results) within building and flatwork areas.

4. In general, trench backfill should be compacted to a minimum of 95 percent of maximum dry density.

5. Trench backfill should be placed in level lifts, moisture conditioned, and compacted to the minimums noted above.

6. Compaction of trench backfill by jetting or flooding is not recommended except under extraordinary circumstances. However, to aid in *encasing* utility conduits, particularly corrugated drain pipes, and multiple, closely spaced conduits in a single trench, jetting or flooding may be useful. Flooding or jetting should only be attempted with extreme caution, and any jetting operation should be subject to review by the geotechnical engineer.

7. The recommendations of this section are minimums only and may be superseded by the requirements of the architect/engineer, the recommendations of pipe manufacturers or utility companies, or the requirements of the governing jurisdiction based upon soil corrosivity or other factors.

Foundations

1. Continuous and spread footings may be used to support the proposed structures. Pending confirmation from expansion index test results that that site soils and bedrock are nonexpansive, the footings should be constructed at a minimum overall depth of 12 inches below lowest adjacent grade and should bear in excavations cut neat into undisturbed bedrock or compacted fill, as described in the "Grading" Section of this report. If the site soils/bedrock are found to be expansive, minimum overall footing excavation depths should be 18 inches. Footings should be supported by either undisturbed bedrock or engineered fill within the entire building footprint, not by both materials. Footing excavations should be horizontal and stepped as needed to bear in uniform material.

2. Continuous footings and grade beams should be reinforced, at a minimum, by two No. 4 rebar, one at the top and one at the bottom, or as required by the architect/engineer. Spread footings should be reinforced in accordance with the requirements of the architect/engineer.

3. Footings bearing into firm compacted fill may be designed using maximum allowable bearing capacities of 2,000 psf for dead loads and 3,000 psf for dead plus live loads. For footings bearing at least 6 inches into undisturbed bedrock, allowable bearing capacities of 3,500 psf and 5,000 psf may be used for dead loads and dead plus live loads, respectively. Using these criteria, maximum settlement and differential settlement are expected to be on the order of ¾-inch and ½-inch over a horizontal distance of 25 feet for footings supported by engineered fill, respectively; settlement for footings supported directly be undisturbed bedrock will be negligible. Allowable capacities may be increased by one-third when transient loads such as wind or seismicity are included.

4. A seismic analysis was undertaken to provide seismic acceleration design parameters. The ground motions were obtained from the Structural Engineers Association of California (SEAOC) Seismic Design Map Tool website (SEAOC 2020) using the ASCE 7-16 (2017) Standard Analysis Method for Site Class C – Very Dense Soil and Soft Rock. The project is considered a "nonessential" facility from the perspective of risk category. Site coordinates from the "Site Setting" Section of the report were used in the analysis. The results of the seismic hazard analysis are presented in the following table:

TABLE 1: SUMMARY OF DESIGN RESPONSE ACCELERATION PARAMETERS

Mapped Spectral Response Accelerations		**Site Coefficients for Site Class C**		**Adjusted MCE Spectral Response Accelerations for Site Class C**		**Design Spectral Response Accelerations for Site Class C**	
Seismic Parameter	Value (g)	Site Coefficient	Value	Seismic Parameter	Value (g)	Seismic Parameter	Value (g)
S_S	1.069	F_a	1.200	S_{MS}	1.283	S_{DS}	0.855
S_1	0.390	F_v	1.500	S_{M1}	0.585	S_{D1}	0.390
Peak Mean Ground Acceleration (PGA_M): 0.563g							
Seismic Design Category = D							

5. In calculating resistance to lateral loads, an ultimate passive equivalent fluid pressure of 400 pcf and a coefficient of friction of 0.40 may be used for foundations bearing in either compacted fill or undisturbed bedrock. The lateral capacities are based on the assumption that the soil adjacent to the foundations is properly compacted and that the bedrock is undisturbed. Passive and friction resistance components may be combined in the analysis without reduction to either value.

6. Foundation excavations should be observed by the geotechnical engineer during excavation and prior to placement of formwork, reinforcing steel or concrete. Soil in foundation excavations should be moistened to optimum moisture content or just above and no desiccation cracks should be present prior to concrete placement.

Interior Slabs-on-Grade and Exterior Pedestrian Flatwork

Interior Slabs-on-Grade

1. Interior slabs-on-grade should have a minimum thickness of 4 inches. They should be reinforced and doweled to foundations per the specifications of the architect/engineer. At a minimum, interior slabs should be reinforced with No. 4 rebar placed at 18 inches on center each way. All structural slabs should contain minimum rebar meeting the criteria of ACI 318, Section 24.4 (ACI 2014). At a minimum, foundation dowels should be lap spliced to the slab rebar. The size and spacing of the dowels should match the size and spacing of the slab rebar.

Exterior Pedestrian Flatwork

1. Exterior pedestrian flatwork should have a minimum thickness of 4 inches. Minimum reinforcement for exterior pedestrian flatwork should consist of No. 4 rebar placed at 18 inches on-center each way.

2. In conventional construction, it is common to use 4 to 6 inches of imported sand beneath exterior pedestrian flatwork. As the site soils are nonexpansive (to be confirmed by expansion index test results), this common practice would be suitable at this site. If additional cost savings are desired with minimal potential for loss of support, exterior pedestrian flatwork can be constructed directly over compacted site soils.

3. Flatwork should be constructed with frequent joints to allow articulation as the flatwork moves in response to seasonal soil temperature and moisture variations. The soil below flatwork should be moisture conditioned prior to casting the flatwork.

4. Flatwork at doorways, and at other areas where maintaining the elevation of the flatwork is desired, should be doweled to the perimeter foundations, at a minimum, by No. 4 dowels lapped to the flatwork rebar at 18 inches on center. In other areas, the flatwork may be doweled to the foundation or the flatwork may be allowed to "float free," at the discretion of the architect/engineer. Flatwork that is intended to float free should be separated from foundations by a felt joint or other means.

Moisture Vapor Transmission

1. Due to the current use of impermeable floor coverings, water-soluble flooring adhesives, and the speed at which buildings are now constructed, moisture vapor transmission through slabs is a much more common problem than in past years. Where moisture vapor transmitted from the underlying soil would be undesirable, the slabs should be protected from subsurface moisture vapor. A number of options for vapor protection are discussed below; however, the means of vapor protection, including the type and thickness of the vapor retarder, if specified, are left to the discretion of the architect/engineer.

2. Where specified, vapor retarders should conform to ASTM Standard E1745-17. This standard specifies properties for three performance classes, Class "A", "B" and "C". The appropriate class should be selected based on the potential for damage to the vapor retarder during its installation and placement of slab reinforcement and concrete. The

class that is chosen will make a difference in how resistant the vapor retarder is to punctures and tears, but it will not ensure any better permeance values to protect floor coverings.

3. Several recent studies, including those of ACI Committee 302 (ACI 2015), have concluded that excess water above the vapor retarder increases the potential for moisture damage to floor coverings and could increase the potential for mold growth or other microbial contamination. The studies also concluded that it is preferable to eliminate the typical sand layer beneath the slab and place the slab PCC in direct contact with a vapor retarder, particularly during wet weather construction. However, placing the PCC directly on the vapor retarder requires special attention to specifying the proper vapor retarder, a low water-cement ratio in the PCC mix, and special finishing and curing techniques.

4. Another option for vapor protection would be the use of vapor-inhibiting admixtures in the slab PCC mix and/or application of a sealer to the surface of the slab. This would also require special PCC mixes and placement procedures, depending upon the recommendations of the admixture or sealer manufacturer.

5. A third option that may be a reasonable compromise between effectiveness and cost considerations would be the use of a subslab vapor retarder protected by a layer of clean sand. Clean sand is defined as a well or poorly graded sand (ASTM D2487-17) of which less than 3 percent passes the No. 200 sieve. The retarder should be covered with a minimum 4 inches of granular material or clean sand. If a Class “A” vapor retarder is specified, the retarder can be placed directly on the compacted soil material. If a less durable vapor retarder is specified (Class “B” or “C”), a minimum of 1-inch clean sand should be placed over the compacted soil material to reduce the chance of puncturing the vapor retarder. If the soils/bedrock are determined to be expansive, the granular material or clean sand layer is considered to be part of the minimum 12-inch layer of imported nonexpansive material recommended in the “Grading” Section of this report to be placed below slabs-on-grade, not in addition to it.

6. If sand is used between the vapor retarder and the slab, it should be moistened only as necessary to promote concrete curing; saturation of the sand should be avoided, as the moisture would be on top of the vapor retarder, potentially resulting in vapor transmission through the slab for months or years.

7. Regardless of the underslab vapor retarder selected, proper installation of the retarder is critical for optimum performance. Where utilized, the vapor retarder should be placed a minimum of 1-inch above the flow line of the drainage path surrounding the structures, or 1-inch above the area drain grates if area drains are used to collect runoff around the structures. All seams must be properly lapped, and all seams and utility penetrations properly sealed in accordance with the vapor retarder manufacturer's recommendations and ASTM E1643-18a. At the terminating edges of the vapor retarder, the vapor retarder should be effectively sealed with accessories specifically designed to seal the material to new or existing concrete; details for edge sealing of the vapor retarder should be provided by the architect/engineer.

Slabs-on-Grade - General

1. To reduce shrinkage cracks in all slabs-on-grade, the concrete aggregates should be of appropriate size and proportion, the water/cement ratio should be low, the concrete should be properly placed and finished, contraction joints should be installed, and the concrete should be properly cured. This is particularly applicable to slabs that will be cast directly upon a vapor retarder and those that will be protected from transmission of vapor by use of admixtures or surface sealers. Concrete materials, placement, and curing specifications should be at the direction of the architect/engineer; AC 302.1R-15 (ACI 2015) is suggested as a resource for the architect/engineer in preparing such specification.

Retaining Walls

1. Foundation excavations for retaining walls forming part of a structure should be supported by the same material as the structure (i.e., all bedrock or all fill) per the "Foundations" Section of this report. Sitework retaining wall foundations may be supported by either firm compacted fill or undisturbed bedrock, per the "Foundations" Section of this report. If a sitework retaining wall foundation excavation crosses a bedrock/fill transition, a construction joint should be placed in the foundation and the wall at the transition, to reduce the potential for random cracking due to potential differential settlement.

2. Retaining wall footings should be reinforced in accordance with the requirements of the architect/engineer; however, minimum reinforcement should consist of two No. 4 rebars, one at the top and one at the bottom.

3. Retaining wall design may be based on the following parameters:

Table 2: Retaining Wall Design Parameters

Parameter	Backfill Type	Value
Active Equivalent Fluid Pressure	On-Site Soils or Imported Sand/Gravel	35 pcf
At-rest Equivalent Fluid Pressure	On-Site Soils or Imported Sand/Gravel	50 pcf
Passive Equivalent Fluid Pressure	On-Site Soils or Imported Sand/Gravel	400 pcf
Maximum Toe Pressure	Engineered Fill	3,000 psf
	Undisturbed Bedrock	5,000 psf
Coefficient of Sliding Friction	Engineered Fill and Undist. Bedrock	0.40

4. No surcharges are taken into consideration in the values presented in the table above. The maximum toe pressure is an *allowable* value; no factors of safety, load factors or other factors have been applied to the remaining values. With the exception of the maximum toe pressure, these values are ultimate values and will require application of appropriate factors of safety, load factors, and/or other factors as deemed appropriate by the architect/engineer.

5. The active and at-rest pressures presented in Table 2 are applicable to a horizontal retained surface behind the wall. Walls having a retained surface that slopes upward from the wall should be designed for an additional equivalent fluid pressure of 1 pcf for the active case and 1.5 pcf for the at-rest case, for every two degrees of slope inclination.

6. The upper foot of backfill behind all retaining walls should consist of native soil, except in areas where exterior pedestrian flatwork or PCC pavements for vehicle use will abut the top of the wall. In such cases, the backfill soil should extend to the sand, aggregate base, or other material below the improved surface, as appropriate. If gravel backfill is utilized, the gravel should be encased in a permeable synthetic filter fabric conforming to standard specification section 96-1.02B – Class C (Caltrans 2018a).

7. Under the 2019 CBC, the Risk-Targeted Maximum Considered Earthquake (MCE_R) must be used for determining seismic pressures on walls. Further, Section 1807.2.2 of the 2019 CBC requires that dynamic seismic lateral earth pressures be provided by the geotechnical engineer for walls retaining more than 6 feet of backfill. The Structural Engineers Association of California website (SEAOC 2020) was used to determine the MCE_R-based Geometric Mean Peak Ground Acceleration (PGA_M) for a Seismic Design Category "D"

project. The resulting PGA_M was 0.563g. Then, using the methods presented by Lew et al. (2010) and this PGA_M, it was determined that an incremental increase in lateral soil pressure of 10 pcf above the static active equivalent fluid pressure for flexible (cantilevered) walls was required for the native soils and imported sand or gravel backfill. Flexible (cantilevered) walls retaining over 6 feet of backfill should be designed using these incremental seismic pressures. Walls retaining 6 feet or less of backfill need not be designed for seismic pressures.

8. Recent research by Al Atik and Sitar (2010) confirmed that for flexible (cantilevered) walls, particularly those over 12 feet tall, an increase in soil pressure does occur under significant seismic accelerations. Further, they found that the increase is due to the out-of-phase interaction between the soil and the flexible wall. When considering rigid walls (i.e. those designed using at-rest criteria); however, they found that the incremental increase due to seismicity was typically less than 50 percent of the static wall pressure. Consequently, no incremental increase in lateral soil pressure is recommended for the design of walls where the static design utilizes the at-rest equivalent fluid pressure and they are designed with factors of safety and earth load factors of at least 1.5.

9. In typical structural design methods for retaining walls such as those found in Section 1605 of the 2019 CBC, lateral soil pressure is multiplied by a load factor of 1.6. According to Lew et al. (2010), a load factor of 1.6 is too conservative for seismic loads; this paper suggests that the seismic increase in lateral pressure be separated from the static active pressure and that a load factor of 1.0 be used for the seismic increase. Further, Al Atik and Sitar (2010) found that pressure increases due to seismic earth loads were minimal for walls retaining less than 12 feet of backfill. While Al Atik and Sitar's research is generally accepted among geotechnical and structural engineers in California, it is not entirely acknowledged by the CBC, as the CBC sets the height below which seismic loads may be ignored at 6 feet. Given this disparity, it is suggested that caution be used not to over-engineer walls retaining between 6 and 12 feet of backfill.

10. Long-term settlement of properly compacted native soil retaining wall backfill or imported sand/gravel backfill should be assumed to be about 0.25 percent of the depth of the backfill. Improvements that are constructed near the tops of retaining walls should be designed to accommodate long-term settlement.

11. All retaining walls should be designed as drained walls. The wall drainage design may consist of a conventional system that includes perforated pipe encased in a free-draining gravel blanket or of a manufactured synthetic drainage system that consists of drainage panels that direct water flow into an integrated subdrain.

12. For the conventional drainage system, the pipe should be placed with perforations facing downward, and should discharge in a non-erosive manner away from foundations and other improvements. The gravel blanket should have a width of approximately 1 foot and should extend upward to approximately 1 foot below the top of the wall backfill. The upper foot should be backfilled with native soil, except in areas where exterior pedestrian flatwork will abut the top of the wall. In such cases, the gravel should extend to the sand, aggregate base, or other material below the improved surface, as appropriate. To reduce infiltration of the soil into the gravel, a permeable synthetic filter fabric conforming to Standard Specifications Section 96-1.02B – Class C (Caltrans 2018b), should be placed between the two layers.

13. Manufactured synthetic drains, such as Miradrain or Enkadrain are acceptable alternatives to the use of gravel, provided they are installed in accordance with the recommendations of the manufacturer. The integrated subdrain should discharge in a non-erosive manner away from foundations and other improvements. The drainage panels should extend upward to approximately 1 foot below the top of the wall backfill.

14. Where weep hole drainage can be properly discharged, the perforated pipe or integrated subdrain may be omitted in lieu of weep holes on maximum 4-foot centers. A filter fabric as described above should be placed between the weep holes and the drain gravel when applied to a conventional drainage system.

15. If drainage cannot be provided for permanent walls, an additional lateral hydrostatic pressure increment of 40 pcf should be applied over the entire height of the wall.

16. Walls facing areas where moisture transmission through the wall would be undesirable should be *thoroughly* waterproofed in accordance with the specifications of the architect/engineer.

17. The architect/engineer should bear in mind that retaining walls by their nature are flexible structures, and that surface treatments on walls often crack. Where walls are to be

plastered or otherwise have a finish applied, the flexibility should be considered in determining the suitability of the surfacing material, spacing of horizontal and vertical control joints, etc. The flexibility should also be considered where a retaining wall will abut or be connected to a rigid structure, and where the geometry of the wall is such that its flexibility will vary along its length.

Pavement Sections

HMA Pavement

The following HMA pavement sections are based upon an assumed R-value of 40 and assumed Traffic Indices (TIs) of 4.0 through 6.0. Determination of the appropriate TI for specific areas of the project is left to others. The HMA sections were calculated in accordance with the method presented in the "Highway Design Manual" (Caltrans 2018b). The calculated HMA and Class 2 AB thicknesses are for compacted material. Normal Caltrans construction tolerances should apply.

Table 3: HMA Pavement Sections

Traffic Index	HMA (in)	Class 2 AB* (in)
4.0	2.25	4.0
4.5	2.50	4.0
5.0	2.75	4.0
5.5	3.00	5.0
6.0	3.25	6.0

*Per Caltrans (2018a) Section 26

PCC Pavement

1. If unreinforced Portland cement concrete pavement is planned, the following minimum section is recommended:

    - 8 inches plain PCC (4,000 psi minimum)
    - Joint spacing at a maximum of 12 feet on-center each way
    - No. 4 smooth joint dowels at 12-inch centers
    - 8 inches Class 2 AB and subgrade compacted to a minimum of 95 percent of maximum dry density

2. If reinforced concrete pavement is planned, the following minimum section may be used:
    - 6 inches PCC (4,000 psi minimum)
    - Joint spacing at a maximum of 12 feet on-center each way
    - No. 4 rebar at 18-inch centers each way
    - No. 4 smooth joint dowels at 18-inch centers
    - 8 inches Class 2 AB and subgrade compacted to a minimum of 95 percent of maximum dry density

3. Alternately, the pavement may be designed by the architect/engineer for the appropriate loads. Provided that a minimum of 12 inches of AB compacted to a minimum of 95 percent of maximum dry density is provided, the design may be based on a subgrade modulus of 300 pci (psi/in). Specification of concrete properties and reinforcing is left to the architect/engineer.

4. Section design for trash enclosures and similar PCC pavement should follow the minimum recommendations presented above.

<u>Pavement Sections - General</u>

1. HMA and PCC pavement should be constrained by curbs, gutters, flatwork, walls, etc.; free edges to the pavement should be avoided.

2. HMA and PCC pavement should be set back a minimum of 5 feet from any descending slope. Alternately, deepened curbs may be used to constrain the pavement. Where curbs will be deepened in lieu of the recommended setback, the individual situation should be reviewed and specific recommendations prepared by the geotechnical engineer.

3. PCC aprons should be provided in front of all trash enclosures.

4. Subgrade and AB should be firm and unyielding when proof-rolled with heavy, rubber-tired grading equipment prior to continuing construction.

5. Finished pavement surfaces should be sloped to freely drain toward appropriate drainage facilities. Water should not be allowed to stand or pond on or adjacent to pavement, as it could cause premature pavement deterioration or improvement damage.

6. To reduce migration of surface drainage into the subgrade, maintenance of pavement areas is critical. Any cracks that develop in the pavement should be promptly sealed.

7. The local jurisdiction may have additional requirements for pavement or pavers that could take precedence over the above recommendations.

Drainage and Maintenance

1. Unpaved ground surfaces should be graded during construction, and per Section 1804.4 of the 2019 CBC, should be finish graded to direct surface runoff away from foundations, slopes, and other improvements at a minimum 5 percent grade for a minimum distance of 10 feet. If this is not practicable due to the terrain, proximity of property lines, etc., swales with improved surfaces, area drains, or other drainage features should be provided to divert drainage away from these areas.

2. For foundations and surface improvements within 5 horizontal feet of LID areas (such as detention basins and bio-swales) if added to the project, moisture protection should consist of deepened curbs, cut off walls or impermeable membranes that extend to at least the bottoms of detention basins, or at least 2 feet below any footings, or at least 1 foot below subgrade elevation (for pavements). Cut off walls or curbs should be at least 6 inches wide; impermeable membranes should have a minimum thickness of 10 mils and should line the entire sides of the basins nearest the foundation and extend into the basins to at least 10 horizontal feet from the foundations.

3. If LID areas extend to within the zone of foundation influence (see Typical Detail A in Appendix D), the foundations should be deepened so that the LID improvements are above the zone of foundation influence. Loose gravel, mulch, or similar materials should be neglected when determining the depth of the LID feature.

4. Exterior pedestrian flatwork and other paved surfaces should be sloped to freely drain toward appropriate drainage facilities. Water should not be allowed to stand or pond on or adjacent to foundations or other improvements as it could infiltrate into the bearing soils, causing settlement or premature deterioration.

5. Any raised planter boxes constructed adjacent to structures should be installed with drains and sealed sides and bottoms to reduce the potential for planter drainage gaining access to subslab areas. Drains should also be provided in all areas adjacent to foundations that would not otherwise drain freely.

6. All eaves of the structures should be provided with roof gutters. Runoff from roof gutters, downspouts, area drains, etc., should discharge to an appropriate outlet in a non-erosive manner away from foundations and other improvements in accordance with the requirements of the governing agencies. Erosion protection should be placed at drainage outlets unless discharge is to an improved surface.

7. The site soils and bedrock are considered to be highly erodible. Stabilization of surface soils, particularly those disturbed during construction, by vegetation or other means *during and following construction,* should be implemented to protect the site from erosion damage. Care should be taken to establish and maintain vegetation.

8. Maintenance of drainage and other improvements is critical to the long-term stability of slopes and the integrity of the roadway improvements. Site improvements, particularly drainage improvements, should be inspected and maintained on a regular basis. All exterior drains should be maintained to be free-flowing.

9. Vegetation, erosion matting or other forms of erosion protection should be used in all areas disturbed by construction, as required by the architect/engineer. Vegetation, erosion matting, etc., should be maintained or augmented as needed to ensure a high level of erosion protection. Irrigation systems should be maintained so that the soils are not over-watered or allowed to desiccate.

10. To reduce the potential for undermining of foundations, flatwork, and other improvements, all rodent activity should be aggressively controlled and kept to an absolute minimum.

Observation and Testing

1. It must be recognized that the recommendations contained in this report are based on a limited number of borings and rely on continuity of the subsurface conditions encountered. Therefore, the geotechnical engineer should be retained to provide consultation during the design phase, to review plans as they near completion, to interpret this report and verify its recommendations during construction, and to provide construction monitoring in the form of testing and observation.

2. At a minimum, the geotechnical engineer should be retained to provide:
    - Consultation during the design phase
    - Review of the project plans as they near completion
    - Professional observation during grading and backfill
    - Oversight of soil special inspection

3. Special inspection of grading and backfill should be provided as per Section 1705.6 and Table 1705.6 of the 2019 CBC. The special inspector should be under the direction of the geotechnical engineer. It is our opinion that none of the grading construction is of a nature that should warrant continuous special inspection; periodic special inspection should suffice. Subject to approval by the Building Official, the exception to continuous special inspection is described in Section 1704.2 of the 2019 CBC and should be specified by the architect/engineer and periodic special inspection of the following items should be provided by the special inspector.
    - Stripping and clearing of vegetation and unsuitable materials
    - Overexcavation to the recommended depths
    - Scarification, moisture conditioning, and compaction of the soil
    - Fill quality, placement, and compaction
    - Utility trench backfill
    - Foundation excavations
    - Retaining wall backfill
    - Subgrade and AB compaction and proof-rolling

4. A program of quality control should be developed prior to beginning grading. The contractor or project manager should determine any additional inspection items required by the architect/engineer or the governing jurisdiction.

5. Locations and frequency of compaction tests should be as per the recommendation of the geotechnical engineer at the time of construction. The recommended test locations and frequency may be subject to modification by the geotechnical engineer, based upon soil and moisture conditions encountered, size and type of equipment used by the contractor, the general trend of the results of compaction tests, or other factors.

6. A preconstruction conference among the owner, the geotechnical engineer, the governing agency, the special inspector, the architect/engineer, and contractors is recommended to discuss planned construction procedures and quality control requirements.

7. The geotechnical engineer should be notified at least 48 hours prior to beginning construction operations. If Earth Systems Pacific is not retained to provide construction observation and testing services, it shall not be responsible for the interpretation of the information by others or any consequences arising therefrom.

11.0 CLOSURE

Our intent was to perform the investigation in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in the locality of this project and under similar conditions. No representation, warranty, or guarantee is either expressed or implied. This report is intended for the exclusive use by the client as discussed in the "Scope of Services" section. Application beyond the stated intent is strictly at the user's risk.

This report is valid for conditions as they exist at this time for the type of project described herein. The conclusions and recommendations contained in this report could be rendered invalid, either in whole or in part, due to changes in building codes, regulations, standards of geotechnical or construction practice, changes in physical conditions, or the broadening of knowledge. If Earth Systems Pacific is not retained to provide construction observation and testing services, it shall not be responsible for the interpretation of the information by others or any consequences arising there from.

If changes with respect to project type or location become necessary, if items not addressed in this report are incorporated into plans, or if any of the assumptions used in the preparation of this report are not correct, this firm shall be notified for modifications to this report. Any items not specifically addressed in this report should comply with the CBC and the requirements of the governing jurisdiction.

The preliminary recommendations of this geotechnical report are based upon the geotechnical conditions encountered at the site and may be augmented by additional requirements of the architect/engineer, or by additional recommendations provided by the geotechnical engineer based on conditions exposed at the time of construction.

This document, the data, conclusions, and recommendations contained herein are the property of Earth Systems Pacific. This report shall be used in its entirety, with no individual sections reproduced or used out of context. Copies may be made only by Earth Systems Pacific, the client, and the client's authorized agents for use exclusively on the subject project. Any other use is subject to federal copyright laws and the written approval of Earth Systems Pacific.

Thank you for this opportunity to have been of service. If you have any questions, please feel free to contact this office at your convenience.

End of Text.

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APPENDIX A

Figure 1 – Site Vicinity Map
Figure 2 – Exploration Location Map
Boring Log Legend
Boring Logs

BASE MAP PROVIDED BY: GOOGLE EARTH (2020)

NOT TO SCALE

Earth Systems Pacific
4378 Old Santa Fe Road, San Luis Obispo, CA 93401
www.earthsystems.com
(805) 544-3276 ● Fax (805) 544-1786

SITE VICINITY MAP

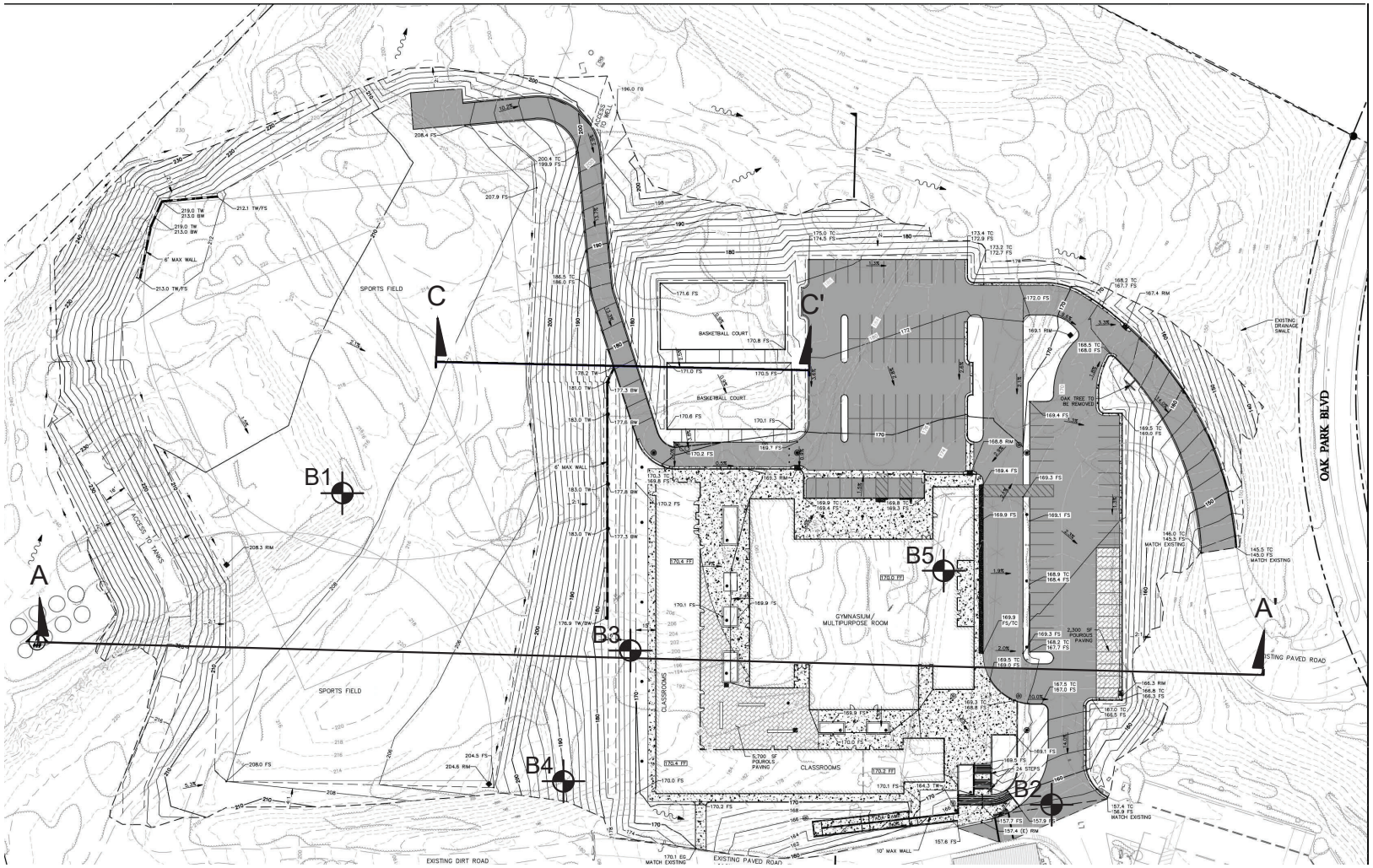
Coastal Christian School
Multipurpose Building, Classrooms and Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

Date
August 2020

Project No.
304022-001

Figure 1

304022-001 CHRISTIANCOASTALSCHOOLmaps



LEGEND

B1 Boring Location (Approx.)

A A' Geologic Cross Section (Approx.)

BASE MAP PROVIDED BY: CANNON (2020)

NOT TO SCALE

Earth Systems Pacific
4378 Old Santa Fe Road, San Luis Obispo, CA 93401
www.earthsystems.com
(805) 544-3276 ● Fax (805) 544-1786

EXPLORATION LOCATION MAP

Coastal Christian School
Multipurpose Building, Classrooms and Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

Date
August 2020

Project No.
304022-001

Figure 2

304022-001 CHRISTIANCOASTALSCHOOLmaps

Earth Systems Pacific

BORING LOG LEGEND

SAMPLE / SUBSURFACE WATER SYMBOLS	GRAPH. SYMBOL
CALIFORNIA MODIFIED	
STANDARD PENETRATION TEST (SPT)	
SHELBY TUBE	
BULK	
SUBSURFACE WATER DURING DRILLING	
SUBSURFACE WATER AFTER DRILLING	

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTIONS	GRAPH. SYMBOL
COARSE GRAINED SOILS	MORE THAN HALF OF MATERIAL IS LARGER THAN #200 SIEVE SIZE	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
		GP	POORLY GRADED GRAVELS, OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, NON-PLASTIC FINES	
		GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, PLASTIC FINES	
		SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
		SP	POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES	
		SM	SILTY SANDS, SAND-SILT MIXTURES, NON-PLASTIC FINES	
		SC	CLAYEY SANDS, SAND-CLAY MIXTURES, PLASTIC FINES	
FINE GRAINED SOILS	HALF OR MORE OF MATERIAL IS SMALLER THAN #200 SIEVE SIZE	ML	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS	
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS	
		PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	

OBSERVED MOISTURE CONDITION

DRY	SLIGHTLY MOIST	MOIST	VERY MOIST	WET (SATURATED)

CONSISTENCY

COARSE GRAINED SOILS			FINE GRAINED SOILS		
BLOWS/FOOT		DESCRIPTIVE TERM	BLOWS/FOOT		DESCRIPTIVE TERM
SPT	CA SAMPLER		SPT	CA SAMPLER	
0-10	0-16	LOOSE	0-2	0-3	VERY SOFT
11-30	17-50	MEDIUM DENSE	3-4	4-7	SOFT
31-50	51-83	DENSE	5-8	8-13	MEDIUM STIFF
OVER 50	OVER 83	VERY DENSE	9-15	14-25	STIFF
			16-30	26-50	VERY STIFF
			OVER 30	OVER 50	HARD

GRAIN SIZES

U.S. STANDARD SERIES SIEVE				CLEAR SQUARE SIEVE OPENING		
# 200	# 40	# 10	# 4	3/4"	3"	12"

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

TYPICAL BEDROCK HARDNESS

MAJOR DIVISIONS	TYPICAL DESCRIPTIONS
EXTREMELY HARD	CORE, FRAGMENT, OR EXPOSURE CANNOT BE SCRATCHED WITH KNIFE OR SHARP PICK; CAN ONLY BE CHIPPED WITH REPEATED HEAVY HAMMER BLOWS
VERY HARD	CANNOT BE SCRATCHED WITH KNIFE OR SHARP PICK; CORE OR FRAGMENT BREAKS WITH REPEATED HEAVY HAMMER BLOWS
HARD	CAN BE SCRATCHED WITH KNIFE OR SHARP PICK WITH DIFFICULTY (HEAVY PRESSURE); HEAVY HAMMER BLOW REQUIRED TO BREAK SPECIMEN
MODERATELY HARD	CAN BE GROOVED 1/16 INCH DEEP BY KNIFE OR SHARP PICK WITH MODERATE OR HEAVY PRESSURE; CORE OR FRAGMENT BREAKS WITH LIGHT HAMMER BLOW OR HEAVY MANUAL PRESSURE
SOFT	CAN BE GROOVED OR GOUGED EASILY BY KNIFE OR SHARP PICK WITH LIGHT PRESSURE, CAN BE SCRATCHED WITH FINGERNAIL; BREAKS WITH LIGHT TO MODERATE MANUAL PRESSURE
VERY SOFT	CAN BE READILY INDENTED, GROOVED OR GOUGED WITH FINGERNAIL, OR CARVED WITH KNIFE; BREAKS WITH LIGHT MANUAL PRESSURE

TYPICAL BEDROCK WEATHERING

MAJOR DIVISIONS	TYPICAL DESCRIPTIONS
UNWEATHERED	NO DISCOLORATION, NOT OXIDIZED
SLIGHTLY WEATHERED	DISCOLORATION OR OXIDATION IS LIMITED TO SURFACE OF, OR SHORT DISTANCE FROM, FRACTURES: SOME FELDSPAR CRYSTALS ARE DULL
MODERATELY WEATHERED	DISCOLORATION OR OXIDATION EXTENDS FROM FRACTURES, USUALLY THROUGHOUT; Fe-Mg MINERALS ARE "RUSTY", FELDSPAR CRYSTALS ARE "CLOUDY"
HIGHLY WEATHERED	DISCOLORATION OR OXIDATION THROUGHOUT; FELDSPAR AND Fe-Mg MINERALS ARE ALTERED TO CLAY TO SOME EXTENT, OR CHEMICAL ALTERATION PRODUCES IN SITU DISAGGREGATION
DECOMPOSED	DISCOLORATION OR OXIDATION THROUGHOUT, BUT RESISTANT MINERALS SUCH AS QUARTZ MAY BE UNALTERED; FELDSPAR AND Fe-Mg MINERALS ARE COMPLETELY ALTERED TO CLAY

Earth Systems Pacific

Boring No. 1

LOGGED BY: R. Mettler
DRILL RIG: Mobile B-53 with Automatic Hammer
AUGER TYPE: 4" Solid Stem Auger

JOB NO.: 304022-001
DATE: 7/24/2020

COASTAL CHRISTIAN SCHOOL
Multipurpose Building, Classrooms, & Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
0	SP		POORLY GRADED SAND: light brown, loose, moist (Alluvium)					
2	SC		CLAYEY SAND: brown, medium dense, moist					
4			SANDSTONE: light brown, soft, moist, moderately weathered (Pismo Formation - Squire Member)					
20				20.0 - 21.0	●		5.6	27 50/5"

LEGEND: ■ Ring Sample ○ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Boring No. 1

LOGGED BY: R. Mettler
DRILL RIG: Mobile B-53 with Automatic Hammer
AUGER TYPE: 4" Solid Stem Auger

JOB NO.: 304022-001
DATE: 7/24/2020

COASTAL CHRISTIAN SCHOOL
Multipurpose Building, Classrooms, & Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
27			same as above					
28				28.5 - 29.5	●		10.7	16
29								50/6"
30			End of Boring @ 29.5' No subsurface water encountered					
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								

LEGEND: ■ Ring Sample ◯ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Boring No. 2

LOGGED BY: R. Mettler
DRILL RIG: Mobile B-53 with Automatic Hammer
AUGER TYPE: 4" Solid Stem Auger

JOB NO.: 304022-001
DATE: 7/24/2020

COASTAL CHRISTIAN SCHOOL
Multipurpose Building, Classrooms, & Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
0	SC		CLAYEY SAND: reddish brown, medium dense, moist (Alluvium)	0.0 - 5.0	Grab			
3			dense					
5			SANDSTONE: light brown, soft, moist, moderately weathered (Pismo Formation - Squire Member)	7.5 - 9.0	Ring			20 38 50/3"
13			light brown to reddish brown	15.0 - 16.5	SPT			14 42 50/4.5"
17			End of Boring @ 16.5' No subsurface water encountered					

LEGEND: Ring Sample Grab Sample Shelby Tube Sample SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Boring No. 3

LOGGED BY: R. Mettler
DRILL RIG: Mobile B-53 with Automatic Hammer
AUGER TYPE: 4" Solid Stem Auger

JOB NO.: 304022-001
DATE: 7/24/2020

COASTAL CHRISTIAN SCHOOL
Multipurpose Building, Classrooms, & Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
0	SP		POORLY GRADED SAND: light brown, loose, moist (Alluvium)					
2			SANDSTONE: light brown, soft, moist, moderately weathered (Pismo Formation - Squire Member)					
5				5.0 - 6.5	●			22 32 47
10				10.0 - 11.5	●			19 36 50/5.5"
15				15.0 - 16.5	●			24 47 50/4"
18			yellowish brown, some clay					
20				20.0 - 21.0	●			11 20 31
23			CLAYEY SANDSTONE: light brown, soft, moist, moderately weathered					
25				25.0 - 26.5	●			32 50/6"

LEGEND: ■ Ring Sample ◯ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Boring No. 3

LOGGED BY: R. Mettler
DRILL RIG: Mobile B-53 with Automatic Hammer
AUGER TYPE: 4" Solid Stem Auger

JOB NO.: 304022-001
DATE: 7/24/2020

COASTAL CHRISTIAN SCHOOL
Multipurpose Building, Classrooms, & Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
27			same as above					
28								
29								
30				30.0 - 31.0	●			16 50/6"
31								
32								
33								
34			with reddish brown mottles					
35				35.0 - 36.0	●		21.9	34 50/4"
36								
37								
38								
39								
40			brown to dark gray	40.0 - 41.0	●		27.6	30 50/4"
41			End of Boring @ 41.0' No subsurface water encountered					
42								
43								
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								

LEGEND: ■ Ring Sample ○ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Boring No. 4

LOGGED BY: R. Mettler
DRILL RIG: Mobile B-53 with Automatic Hammer
AUGER TYPE: 4" Solid Stem Auger

JOB NO.: 304022-001
DATE: 7/24/2020

COASTAL CHRISTIAN SCHOOL
Multipurpose Building, Classrooms, & Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
0	SP		POORLY GRADED SAND: light brown, loose, moist (Alluvium)					
1			SANDSTONE: light brown, soft, moist, moderately weathered (Pismo Formation - Squire Member)					
2								
3								
4								
5								
6								
7								
8			yellow brown					
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19			with reddish brown mottles					
20				20.0 - 21.0	●		20.6	22 50/6"
21								
22								
23								
24								
25								
26								

LEGEND: ■ Ring Sample ◯ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Boring No. 4

LOGGED BY: R. Mettler
DRILL RIG: Mobile B-53 with Automatic Hammer
AUGER TYPE: 4" Solid Stem Auger

JOB NO.: 304022-001
DATE: 7/24/2020

COASTAL CHRISTIAN SCHOOL
Multipurpose Building, Classrooms, & Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
27			SANDSTONE: yellow brown with reddish brown mottles, soft, very moist, moderately weathered (Pismo Formation - Squire Member)	28.5 - 30.0	●		27.1	22 38 50/5"
30			End of Boring @ 30.0' No subsurface water encountered					

LEGEND: ■ Ring Sample ◯ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Boring No. 5

LOGGED BY: R. Mettler
DRILL RIG: Mobile B-53 with Automatic Hammer
AUGER TYPE: 4" Solid Stem Auger

JOB NO.: 304022-001
DATE: 7/24/2020

COASTAL CHRISTIAN SCHOOL
Multipurpose Building, Classrooms, & Playfields
1005 N Oak Park Blvd
Arroyo Grande, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
0	SP		POORLY GRADED SAND: light brown, loose, moist (Alluvium)					
1–5			SANDSTONE: light brown, soft, moist, moderately weathered (Pismo Formation - Squire Member)	0.0 - 5.0	Grab		26.1	
6–16			CLAYEY SANDSTONE: brown with red mottles, soft, very moist, moderately weathered	7.5 - 8.5	Ring		27.8	7 50/6"
				15.0 - 16.0	SPT			19 50/5"
16			End of Boring @ 16.0' No subsurface water encountered					

LEGEND: Ring Sample Grab Sample Shelby Tube Sample SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

APPENDIX B

Laboratory Test Results

Coastal Christian School
Multipurpose Building, Classrooms and Playfields

304022-001

BULK DENSITY TEST RESULTS

ASTM D 2937-17 (modified for ring liners)

August 17, 2020

BORING NO.	DEPTH feet	MOISTURE CONTENT, %	WET DENSITY, pcf	DRY DENSITY, pcf
1	20.0 - 21.0	5.6	---	---
1	28.5 - 29.5	10.7	---	---
3	35.0 - 36.0	21.9	---	---
3	40.0 - 40.5	27.6	---	---
4	20.0 - 21.0	20.6	---	---
4	28.5 - 30.0	27.1	---	---
5	0.0 - 5.0	26.1	---	---
5	7.5 - 8.5	27.8	114.9	89.9

EXPANSION INDEX TEST RESULTS

ASTM D 4829-11

BORING NO.	DEPTH feet	EXPANSION INDEX
5	0.0 - 5.0	39

Coastal Christian School
Multipurpose Building, Classrooms and Playfields

304022-001

MOISTURE-DENSITY COMPACTION TEST

ASTM D 1557-12 (Modified)

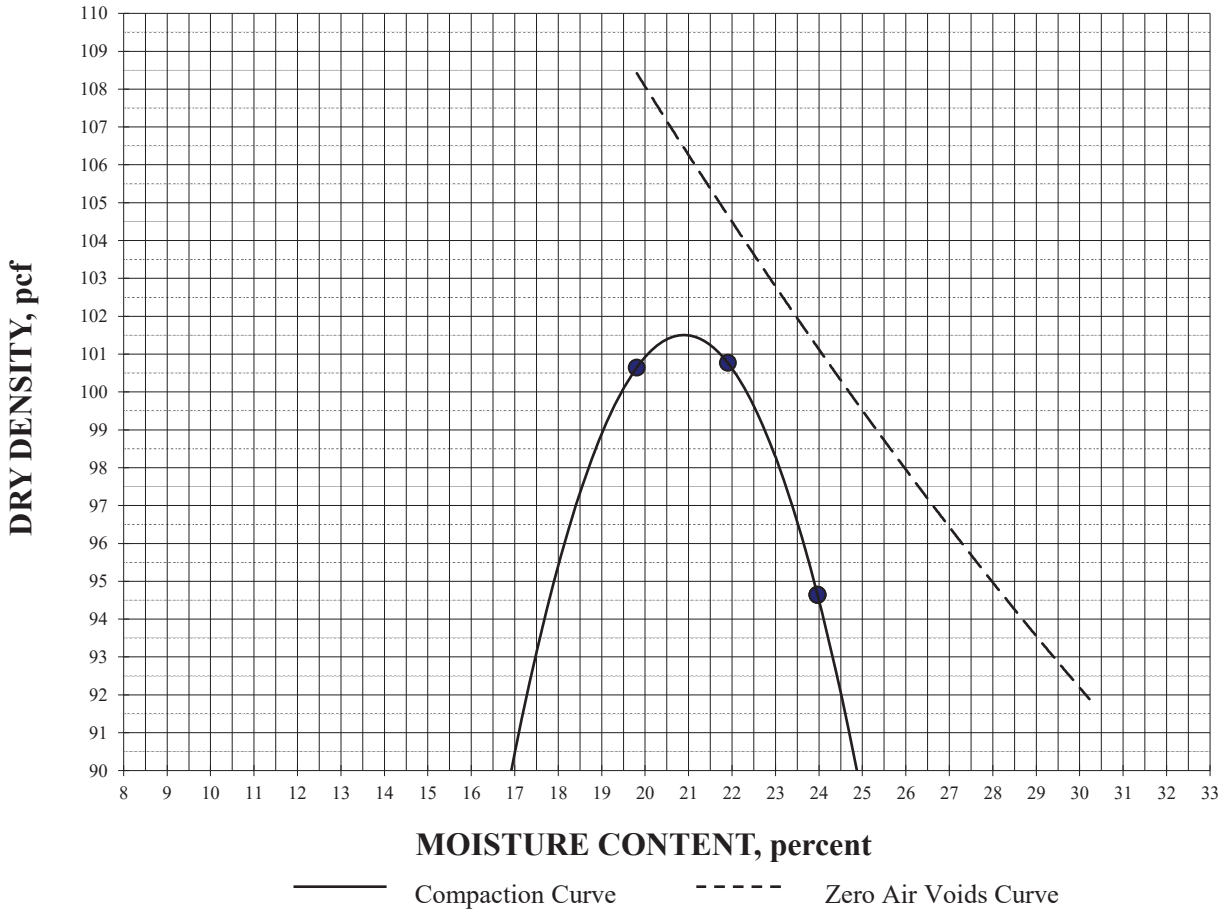
PROCEDURE USED: A
PREPARATION METHOD: Moist
RAMMER TYPE: Mechanical
SPECIFIC GRAVITY: 2.65 (assumed)

August 17, 2020
Boring #5 @ 0.0 - 5.0'
Brown Clayey Sand (SC)
(Sandstone)

SIEVE DATA:

Sieve Size	% Retained (Cumulative)
3/4"	0
3/8"	0
#4	0

MAXIMUM DRY DENSITY: 101.5 pcf
OPTIMUM MOISTURE: 20.9%



Coastal Christian School
Multipurpose Building, Classrooms and Playfields

304022-001

DIRECT SHEAR

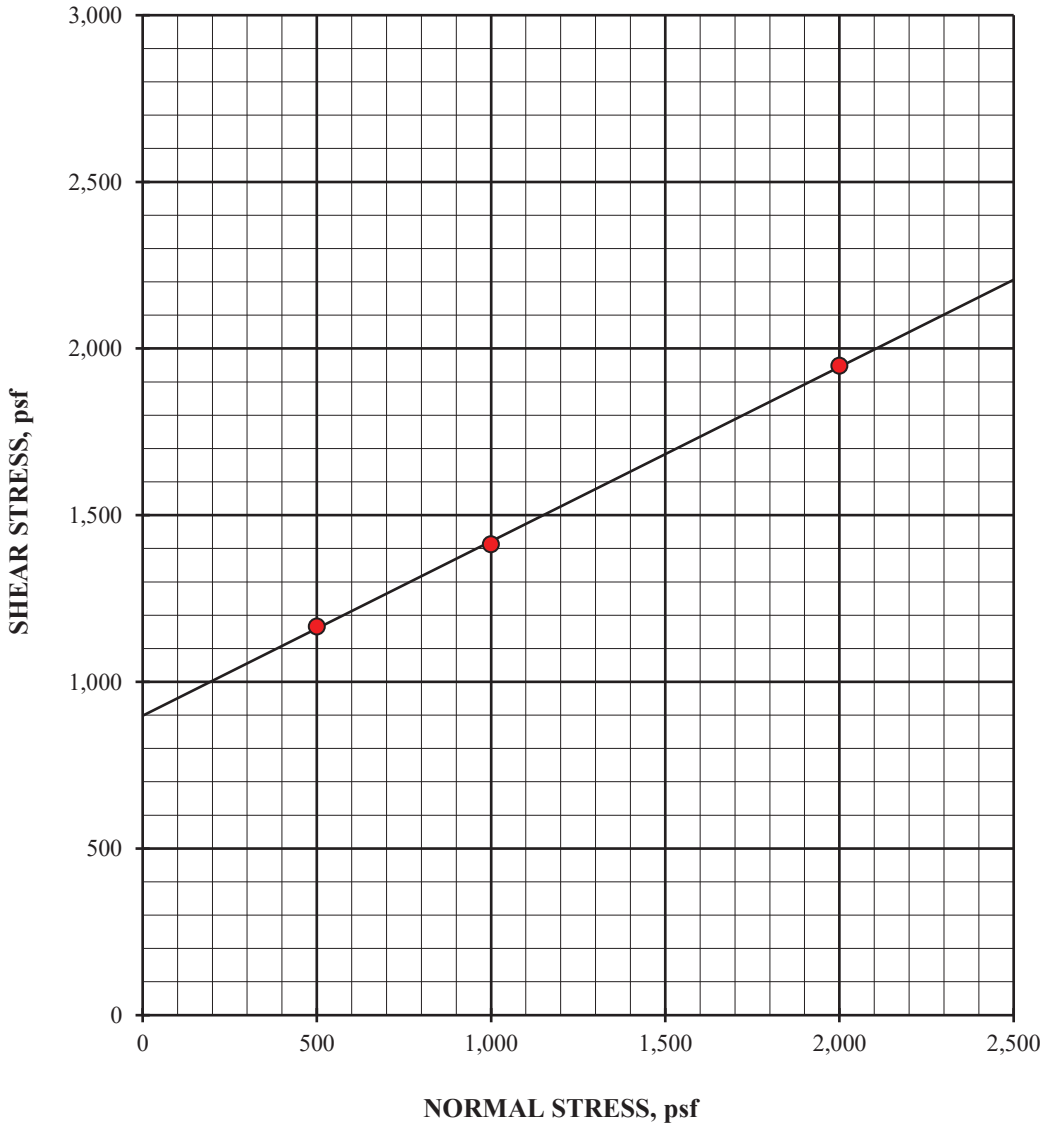
ASTM D 3080/D3080M-11 (modified for consolidated, undrained conditions)

August 17, 2020

Boring #5 @ 0.0 - 5.0'
Clayey Sand (SC)
Compacted to 90% RC, saturated

INITIAL DRY DENSITY: 91.4 pcf
INITIAL MOISTURE CONTENT: 20.9 %
PEAK SHEAR ANGLE (Ø): 28°
COHESION (C): 898 psf

SHEAR vs. NORMAL STRESS



Coastal Christian School 304022-001

Multipurpose Building, Classrooms and Playfields

DIRECT SHEAR continued

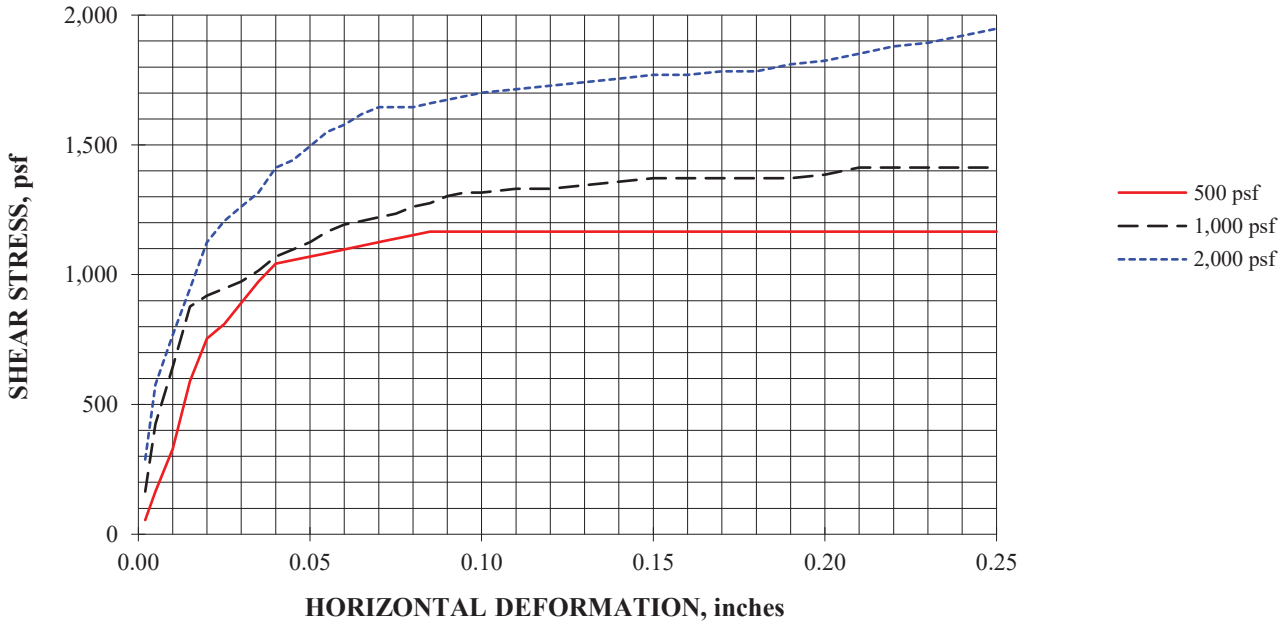
ASTM D 3080/D3080M-11 (modified for consolidated, undrained conditions)

Boring #5 @ 0.0 - 5.0' August 17, 2020

Clayey Sand (SC)

Compacted to 90% RC, saturated SPECIFIC GRAVITY: 2.65 (assumed)

SAMPLE NO.:	1	2	3	AVERAGE
INITIAL				
WATER CONTENT, %	20.9	20.9	20.9	20.9
DRY DENSITY, pcf	91.4	91.4	91.4	91.4
SATURATION, %	68.4	68.4	68.4	68.4
VOID RATIO	0.810	0.810	0.810	0.810
DIAMETER, inches	2.375	2.375	2.375	
HEIGHT, inches	1.00	1.00	1.00	
AT TEST				
WATER CONTENT, %	38.5	36.5	38.4	
DRY DENSITY, pcf	92.7	95.0	97.5	
SATURATION, %	100.0	100.0	100.0	
VOID RATIO	0.785	0.741	0.696	
HEIGHT, inches	0.99	0.96	0.94	



Summary of Point Load Tests

Depth (ft)	Sample	Rock Type[a]	Test Type[b]	Foliation/Joint Dip[c] (degrees)	Moisture Condition[d]	D (mm)	W (mm)	D' (mm)	D_e (mm)	D_e^2 (mm^2)	Failure Load (kN)	I_s (MPa)	$I_{s(50)}$ (MPa)	Failure Mode[e]
Bag 1	A	2	I	N/A	3	60	70	-			-			Invalid
	B	2	I	N/A	3	53	67	49	65	4202	0.328	0.08	0.09	1
	C	2	I	N/A	3	39	52	34	47	2230	0.266	0.12	0.12	1
	D	2	I	N/A	3	44	64	41	58	3336	0.300	0.09	0.10	1
	E	2	I	N/A	3	45	68	42	60	3625	0.490	0.14	0.15	1
	F	2	I	N/A	3	39	57	38	53	2763	0.102	0.04	L	1
	G	2	I	N/A	3	51	57	42	55	3055	0.464	0.15	H	1
	H	2	I	N/A	3	50	63	46	61	3679	0.230	0.06	0.07	1
	I	2	I	N/A	3	44	58	40	54	2944	0.222	0.08	0.08	1
	J	2	I	N/A	3	56	87	-			-			Invalid
	K	2	I	N/A	3	54	110	49	83	6890	0.594	0.09	0.11	1
	L	2	I	N/A	3	53	56	-			-			Invalid
	M	2	I	N/A	3	50	59	48	60	3606	0.206	0.06	0.06	1

results	
$I_{s(50),ave}$ =	0.10
std =	0.03
no. samples =	13
dtop (ft) =	0.0
dbot (ft) =	0.0
rock type =	2

Summary of Point Load Tests

Depth (ft)	Sample	Rock Type[a]	Test Type[b]	Foliation/Joint Dip[c] (degrees)	Moisture Condition[d]	D (mm)	W (mm)	D' (mm)	D_e (mm)	D_e^2 (mm^2)	Failure Load (kN)	I_s (MPa)	$I_{s(50)}$ (MPa)	Failure Mode[e]
Bag 2	A	2	I	N/A	3	42	77	36	60	3547	0.326	0.09	0.10	1
	B	2	I	N/A	3	52	59	46	59	3472	0.374	0.11	H	1
	C	2	I	N/A	3	51	86	47	72	5141	0.452	0.09	0.10	1
	D	2	I	N/A	3	50	72	47	66	4325	0.182	0.04	0.05	1
	E	2	I	N/A	3	55	80	52	73	5277	0.214	0.04	0.05	1
	F	2	I	N/A	3	53	101	46	77	5915	0.380	0.06	0.08	1
	G	2	I	N/A	3	56	94	50	77	5920	0.178	0.03	L	1
	H	2	I	N/A	3	56	85	31	58	3342	0.168	0.05	0.05	1
	I	2	I	N/A	3	55	82	53	74	5488	0.258	0.05	0.06	1
	J	2	I	N/A	3	74	79	69	83	6956	0.390	0.06	0.07	1

results

$I_{s(50),ave}$ =	0.07
std =	0.02
no. samples =	10
dtop (ft) =	0.0
dbot (ft) =	0.0
rock type =	2

Notes:

a. 1 = argillaceous sandstone ; 2 = sandstone; 3 = quartzite w/ sheared and brecciated zones; 4 = argillite; 5 = graywacke; 6 = fault gouge; 7 = quartzite; 8 = argillaceous sandstone/quartzite with occassional layers of graywacke and argillite; 9 = interlayered quartzite and argillaceous sandstone and argillite with intermediate zones of graywacke; 10 = interlayered argillaceous sandstone/quartzite and argillite

b. D = diametral; A = axial; I = irregular lump; B = block

c. Dip measured from plane normal to core axis, F = foliation; B = bedding; J = joint; S = shear; M = massive (no defined discontinuity)

d. 1= air dried; 2 =saturated; 3 = as received

e. 1 = perpendicular to discontinuity; 2 = parallel to discontinuity; 3 = pop out; 4 = broke while seating; load did not register on gauge

INVALID TEST

ASTM recommends the two highest and lowest values are removed for the average point load strength

APPENDIX C

Slope Stability Analysis Results

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Slide Analysis Information

Section_A

Project Summary

File Name:	Section_A.slmd
Slide Modeler Version:	9.008
Project Title:	Coastal Christian Elementary School
Author:	D. Hasham
Company:	Earth Systems Pacific
Date Created:	8/31/2020, 4:08:59 PM

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Group 1	Master Scenario	Bishop Simplified: 4.625800 Janbu Simplified: 4.087090	00h:00m:02.904s
	Seismic	Bishop Simplified: 3.254280 Janbu Simplified: 2.844710	00h:00m:03.623s

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified Janbu simplified
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Seismic Loading

Group 1 - Master Scenario

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Group 1 - Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.15

Loading

All Open Scenarios

Distribution:	Constant
Magnitude [psf]:	550
Orientation:	Vertical

Distribution:	Constant
Magnitude [psf]:	300
Orientation:	Vertical

Distribution:	Constant
Magnitude [psf]:	300
Orientation:	Vertical

Materials

Sandstone	
Color	
Strength Type	Generalized Hoek-Brown
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	125
Unconfined Compressive Strength (intact) [psf]	40000
GSI	75
mi	17
Disturbance	0
Water Surface	Assigned per scenario
Hu Value	1

Materials In Use

Material		Group 1	Seismic
Sandstone		✓	✓

Global Minimums

Group 1 - Master Scenario

Method: bishop simplified

FS	4.625800
Center:	819.059, 203.595
Radius:	78.001
Left Slip Surface Endpoint:	750.085, 167.169
Right Slip Surface Endpoint:	847.463, 130.949
Resisting Moment:	2.32834e+07 lb-ft
Driving Moment:	5.03337e+06 lb-ft
Total Slice Area:	1591.91 ft2
Surface Horizontal Width:	97.3774 ft
Surface Average Height:	16.3479 ft

Method: janbu simplified

FS	4.087090
Center:	814.301, 181.823
Radius:	61.722
Left Slip Surface Endpoint:	754.361, 167.100
Right Slip Surface Endpoint:	848.999, 130.778
Resisting Horizontal Force:	299205 lb
Driving Horizontal Force:	73207.4 lb
Total Slice Area:	1970.92 ft2
Surface Horizontal Width:	94.6388 ft
Surface Average Height:	20.8257 ft

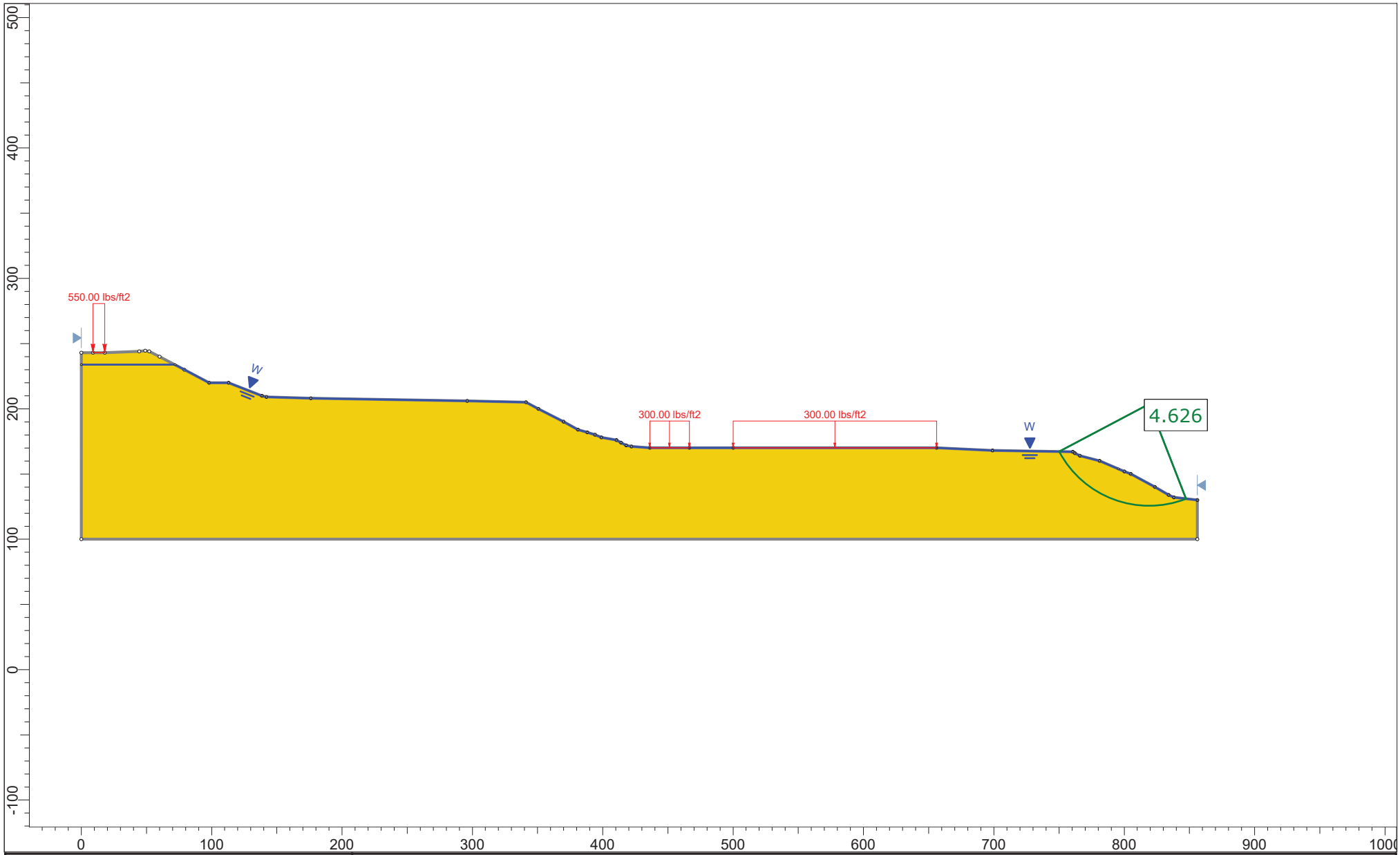
Group 1 - Seismic

Method: bishop simplified

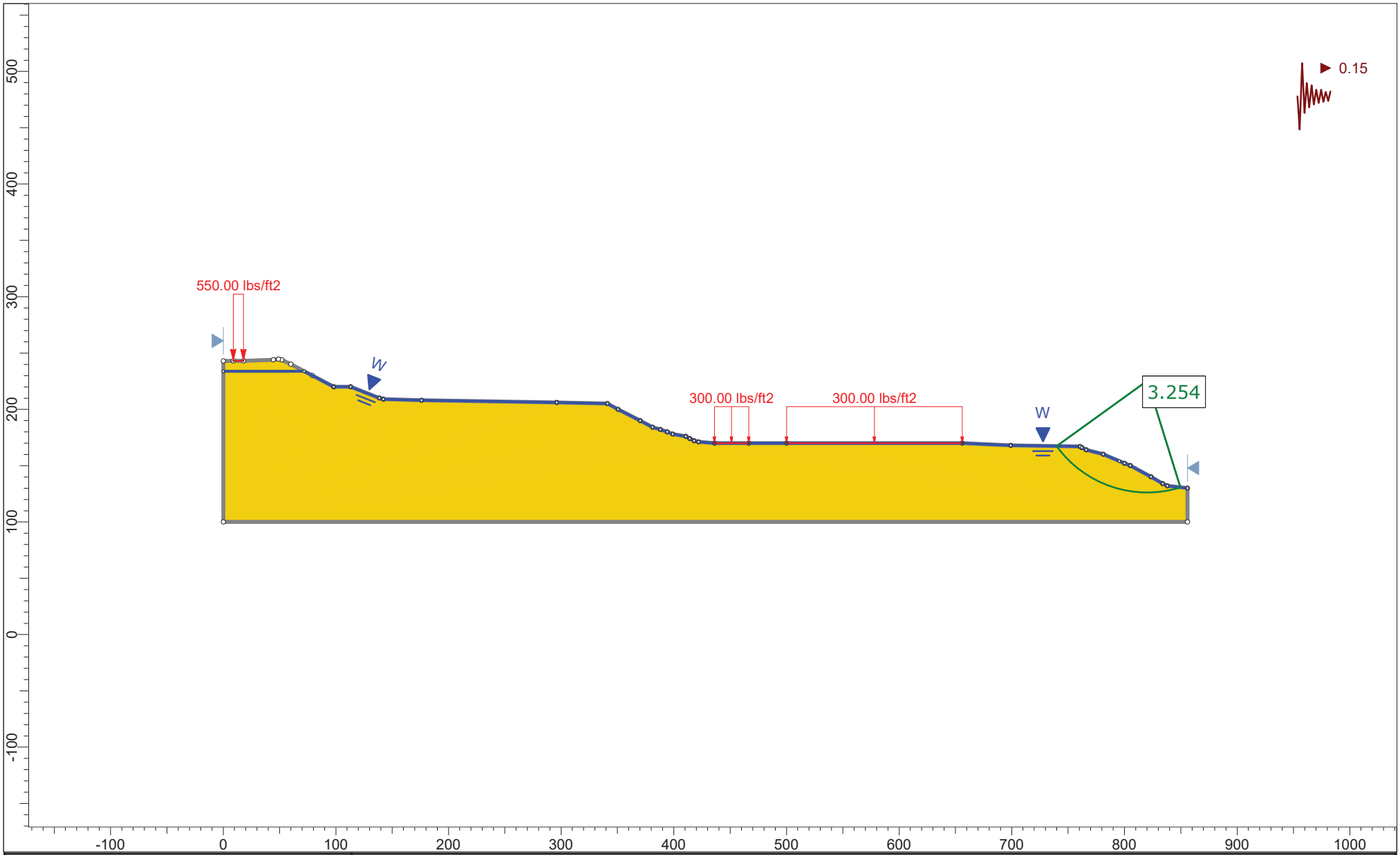
FS	3.254280
Center:	820.129, 225.221
Radius:	99.008
Left Slip Surface Endpoint:	739.804, 167.337
Right Slip Surface Endpoint:	849.625, 130.708
Resisting Moment:	3.15684e+07 lb-ft
Driving Moment:	9.70059e+06 lb-ft
Total Slice Area:	1803.57 ft2
Surface Horizontal Width:	109.821 ft
Surface Average Height:	16.4228 ft

Method: janbu simplified

FS	2.844710
Center:	814.123, 193.067
Radius:	71.757
Left Slip Surface Endpoint:	747.184, 167.217
Right Slip Surface Endpoint:	849.625, 130.708
Resisting Horizontal Force:	310310 lb
Driving Horizontal Force:	109083 lb
Total Slice Area:	2084.72 ft2
Surface Horizontal Width:	102.441 ft
Surface Average Height:	20.3504 ft



rocscience	Project	Coastal Christian Elementary School	
	Group	Group 1	Scenario	Master Scenario
	Drawn By	D. Hasham	Company	Earth Systems Pacific
SLIDEINTERPRET 9.008	Date	8/31/2020, 4:08:59 PM	File Name	Section_A.slmd



rocscience	Project	Coastal Christian Elementary School	
	Group	Group 1	Scenario	Seismic
	Drawn By	D. Hasham	Company	Earth Systems Pacific
SLIDEINTERPRET 9.008	Date	8/31/2020, 4:08:59 PM	File Name	Section_A.slmd

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Method: janbu simplified 6

Slide Analysis Information

Section_B

Project Summary

File Name:	Section_B.slmd
Slide Modeler Version:	9.008
Project Title:	Coastal Christian Elementary School
Author:	D. Hasham
Company:	Earth Systems Pacific
Date Created:	8/31/2020, 4:40:49 PM

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Group 1	Master Scenario	Bishop Simplified: 5.329640 Janbu Simplified: 4.785510	00h:00m:02.435s
	Seismic	Bishop Simplified: 3.743870 Janbu Simplified: 3.307000	00h:00m:02.320s

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified Janbu simplified
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Seismic Loading

Group 1 - Master Scenario

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Group 1 - Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.15

Materials

Sandstone	
Color	
Strength Type	Generalized Hoek-Brown
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	125
Unconfined Compressive Strength (intact) [psf]	40000
GSI	75
mi	17
Disturbance	0
Water Surface	Assigned per scenario
Hu Value	1

Materials In Use

Material		Group 1	Seismic
Sandstone		✓	✓

Global Minimums

Group 1 - Master Scenario

Method: bishop simplified

FS	5.329640
Center:	103.037, 223.452
Radius:	49.269
Left Slip Surface Endpoint:	56.707, 206.692
Right Slip Surface Endpoint:	122.050, 178.000
Resisting Moment:	9.48728e+06 lb-ft
Driving Moment:	1.7801e+06 lb-ft
Total Slice Area:	839.323 ft2
Surface Horizontal Width:	65.3428 ft
Surface Average Height:	12.8449 ft

Method: janbu simplified

FS	4.785510
Center:	101.690, 216.916
Radius:	44.699
Left Slip Surface Endpoint:	58.185, 206.653
Right Slip Surface Endpoint:	123.679, 178.000
Resisting Horizontal Force:	171975 lb
Driving Horizontal Force:	35936.6 lb
Total Slice Area:	934.362 ft2
Surface Horizontal Width:	65.4942 ft
Surface Average Height:	14.2663 ft

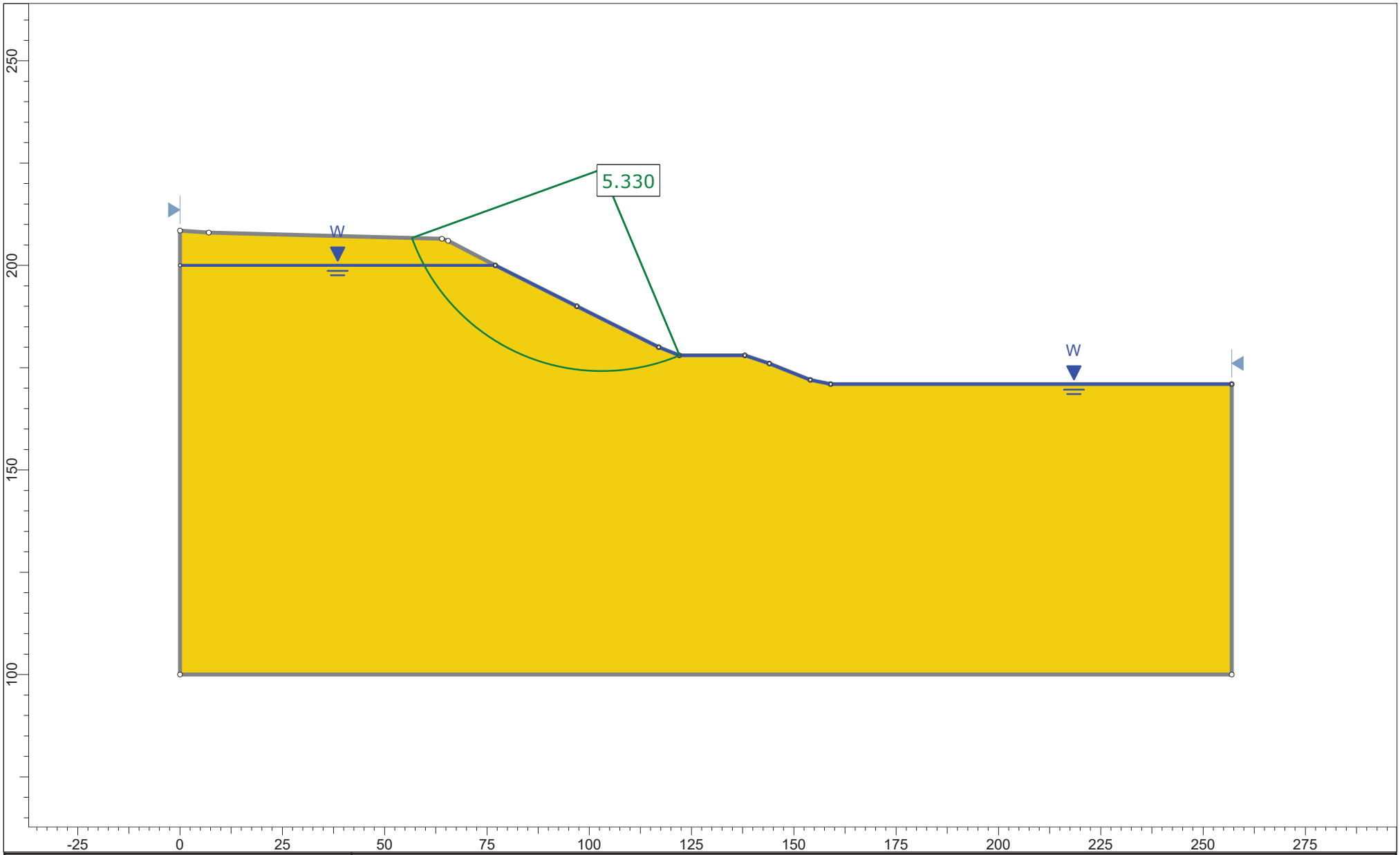
Group 1 - Seismic

Method: bishop simplified

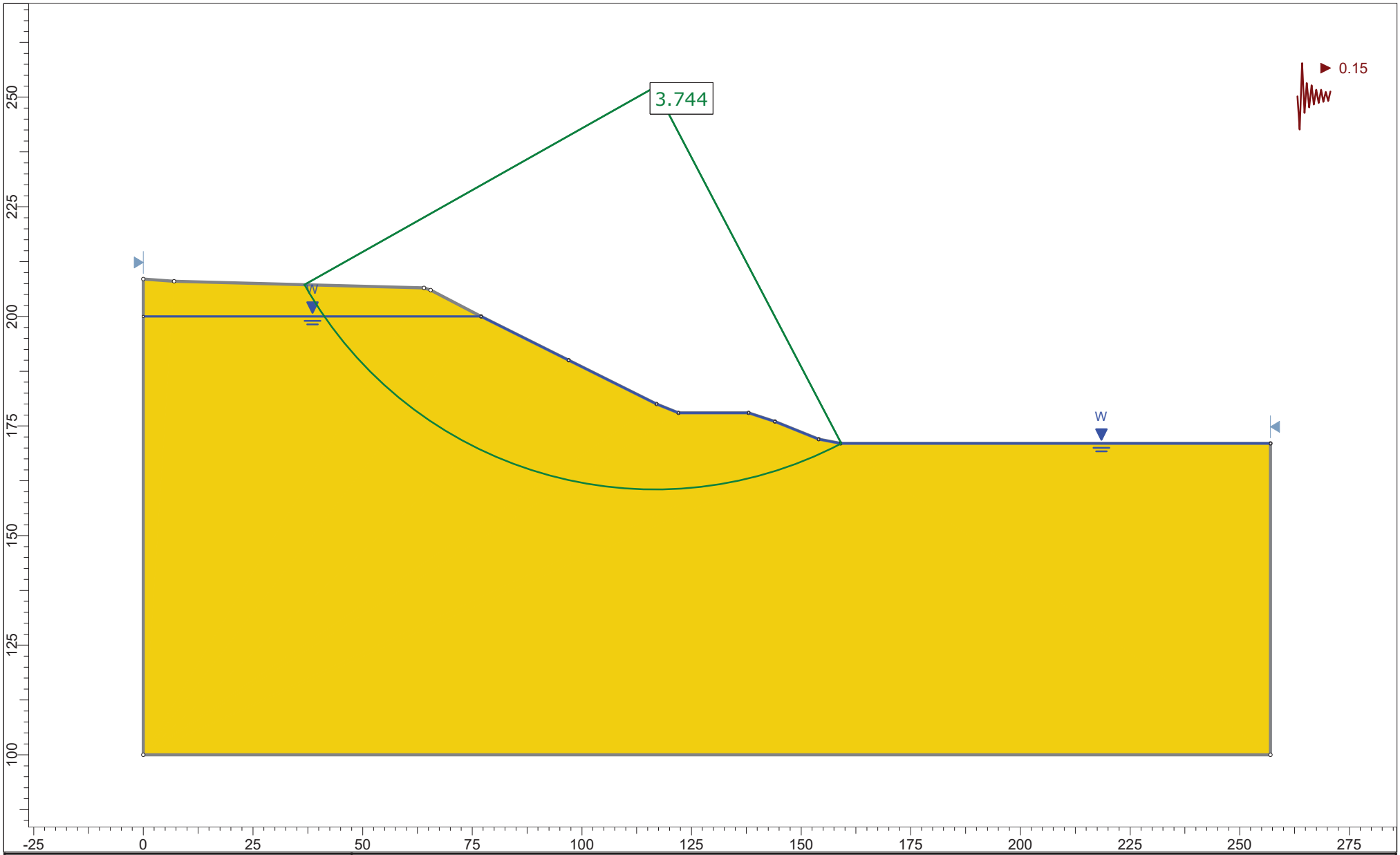
FS	3.743870
Center:	116.600, 252.252
Radius:	91.714
Left Slip Surface Endpoint:	36.705, 207.218
Right Slip Surface Endpoint:	159.138, 171.000
Resisting Moment:	4.03977e+07 lb-ft
Driving Moment:	1.07904e+07 lb-ft
Total Slice Area:	2434.18 ft2
Surface Horizontal Width:	122.433 ft
Surface Average Height:	19.8817 ft

Method: janbu simplified

FS	3.307000
Center:	114.826, 236.612
Radius:	79.174
Left Slip Surface Endpoint:	41.359, 207.096
Right Slip Surface Endpoint:	159.138, 171.000
Resisting Horizontal Force:	400873 lb
Driving Horizontal Force:	121220 lb
Total Slice Area:	2608.09 ft2
Surface Horizontal Width:	117.778 ft
Surface Average Height:	22.144 ft



rocscience	Project	Coastal Christian Elementary School	
	Group	Group 1	Scenario	Master Scenario
	Drawn By	D. Hasham	Company	Earth Systems Pacific
SLIDEINTERPRET 9.008	Date	8/31/2020, 4:40:49 PM	File Name	Section_B.slmd



rocscience	Project	Coastal Christian Elementary School	
	Group	Group 1	Scenario	Seismic
	Drawn By	D. Hasham	Company	Earth Systems Pacific
	Date	8/31/2020, 4:40:49 PM	File Name	Section_B.slmd

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Project Summary

File Name:	Section_C.slmd
Slide Modeler Version:	9.008
Project Title:	Coastal Christian Elementary School
Author:	D. Hasham
Company:	Earth Systems Pacific
Date Created:	8/31/2020, 4:40:49 PM

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Group 1	Master Scenario	Bishop Simplified: 5.329640 Janbu Simplified: 4.785510	00h:00m:02.362s
	Seismic	Bishop Simplified: 3.743870 Janbu Simplified: 3.307000	00h:00m:02.234s

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Seismic Loading

Group 1 - Master Scenario

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Group 1 - Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.15

Materials

Sandstone	
Color	
Strength Type	Generalized Hoek-Brown
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	125
Unconfined Compressive Strength (intact) [psf]	40000
GSI	75
mi	17
Disturbance	0
Water Surface	Assigned per scenario
Hu Value	1

Materials In Use

Material		Group 1	Seismic
Sandstone		✓	✓

Global Minimums

Group 1 - Master Scenario

Method: bishop simplified

FS	5.329640
Center:	103.037, 223.452
Radius:	49.269
Left Slip Surface Endpoint:	56.707, 206.692
Right Slip Surface Endpoint:	122.050, 178.000
Resisting Moment:	9.48728e+06 lb-ft
Driving Moment:	1.7801e+06 lb-ft
Total Slice Area:	839.323 ft2
Surface Horizontal Width:	65.3428 ft
Surface Average Height:	12.8449 ft

Method: janbu simplified

FS	4.785510
Center:	101.690, 216.916
Radius:	44.699
Left Slip Surface Endpoint:	58.185, 206.653
Right Slip Surface Endpoint:	123.679, 178.000
Resisting Horizontal Force:	171975 lb
Driving Horizontal Force:	35936.6 lb
Total Slice Area:	934.362 ft2
Surface Horizontal Width:	65.4942 ft
Surface Average Height:	14.2663 ft

Group 1 - Seismic

Method: bishop simplified

FS	3.743870
Center:	116.600, 252.252
Radius:	91.714
Left Slip Surface Endpoint:	36.705, 207.218
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Resisting Moment:	4.03977e+07 lb-ft
Driving Moment:	1.07904e+07 lb-ft
Total Slice Area:	2434.18 ft2
Surface Horizontal Width:	122.433 ft
Surface Average Height:	19.8817 ft

Method: janbu simplified

FS	3.307000
Center:	114.826, 236.612
Radius:	79.174
Left Slip Surface Endpoint:	41.359, 207.096
Right Slip Surface Endpoint:	159.138, 171.000
Resisting Horizontal Force:	400873 lb
Driving Horizontal Force:	121220 lb
Total Slice Area:	2608.09 ft2
Surface Horizontal Width:	117.778 ft
Surface Average Height:	22.144 ft

Entity Information

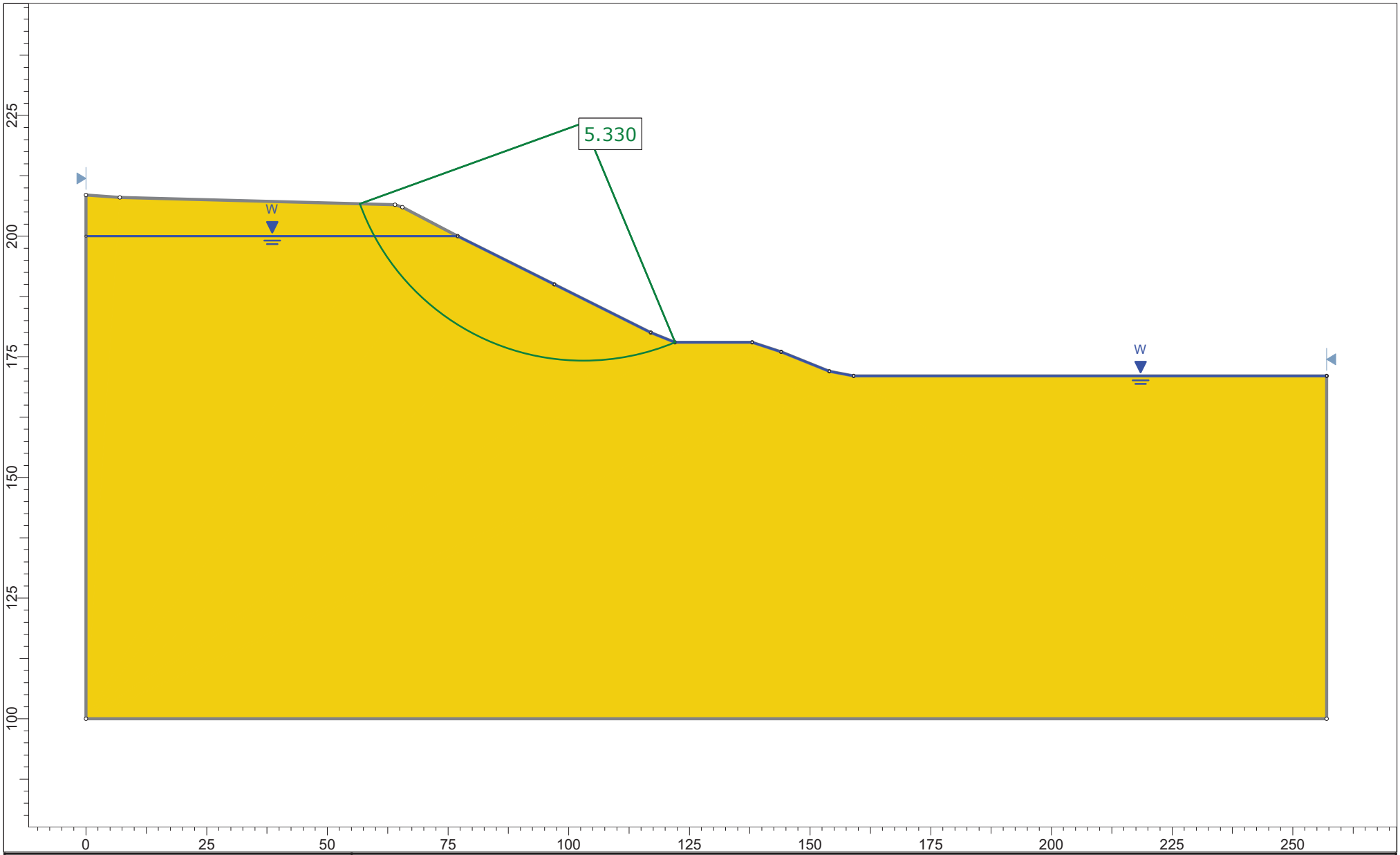
Group 1

Shared Entities

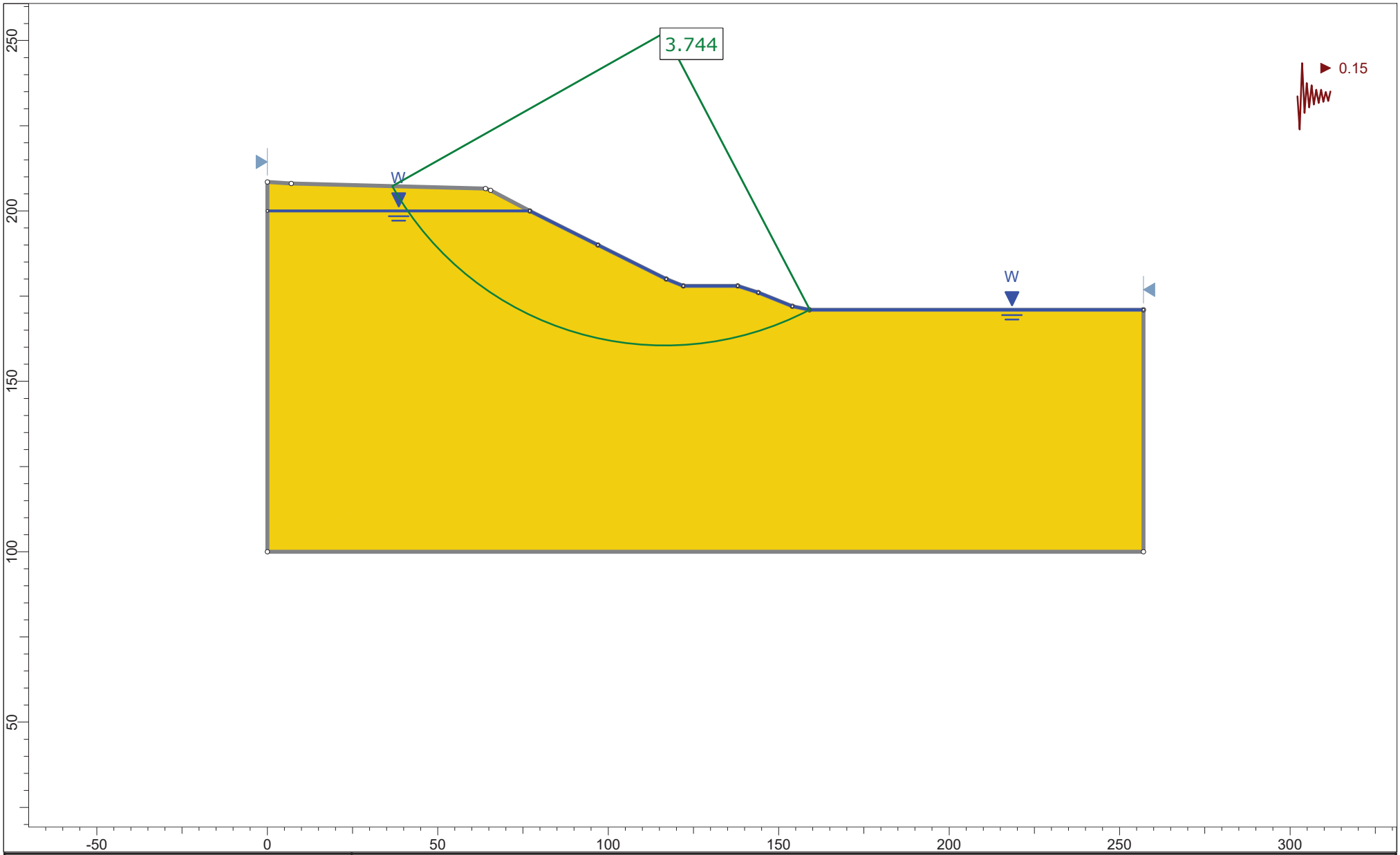
Type	Coordinates (x,y)
External Boundary	257, 100 257, 171 159, 171 154, 172 144, 176 138, 178 122, 178 117, 180 97, 190 77, 200 65.5, 206 64, 206.5 7, 208 0, 208.5 0, 100

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario	Seismic
Water Table	0, 200 77, 200 97, 190 117, 180 122, 178 138, 178 144, 176 154, 172 159, 171 257, 171	Assigned to: Sandstone	Assigned to: Sandstone



rocscience	Project	Coastal Christian Elementary School	
	Group	Group 1	Scenario	Master Scenario
	Drawn By	D. Hasham	Company	Earth Systems Pacific
SLIDEINTERPRET 9.008	Date	8/31/2020, 4:40:49 PM	File Name	Section_C.slmd



rocscience	Project	Coastal Christian Elementary School	
	Group	Group 1	Scenario	Seismic
	Drawn By	D. Hasham	Company	Earth Systems Pacific
	Date	8/31/2020, 4:40:49 PM	File Name	Section_C.slmd

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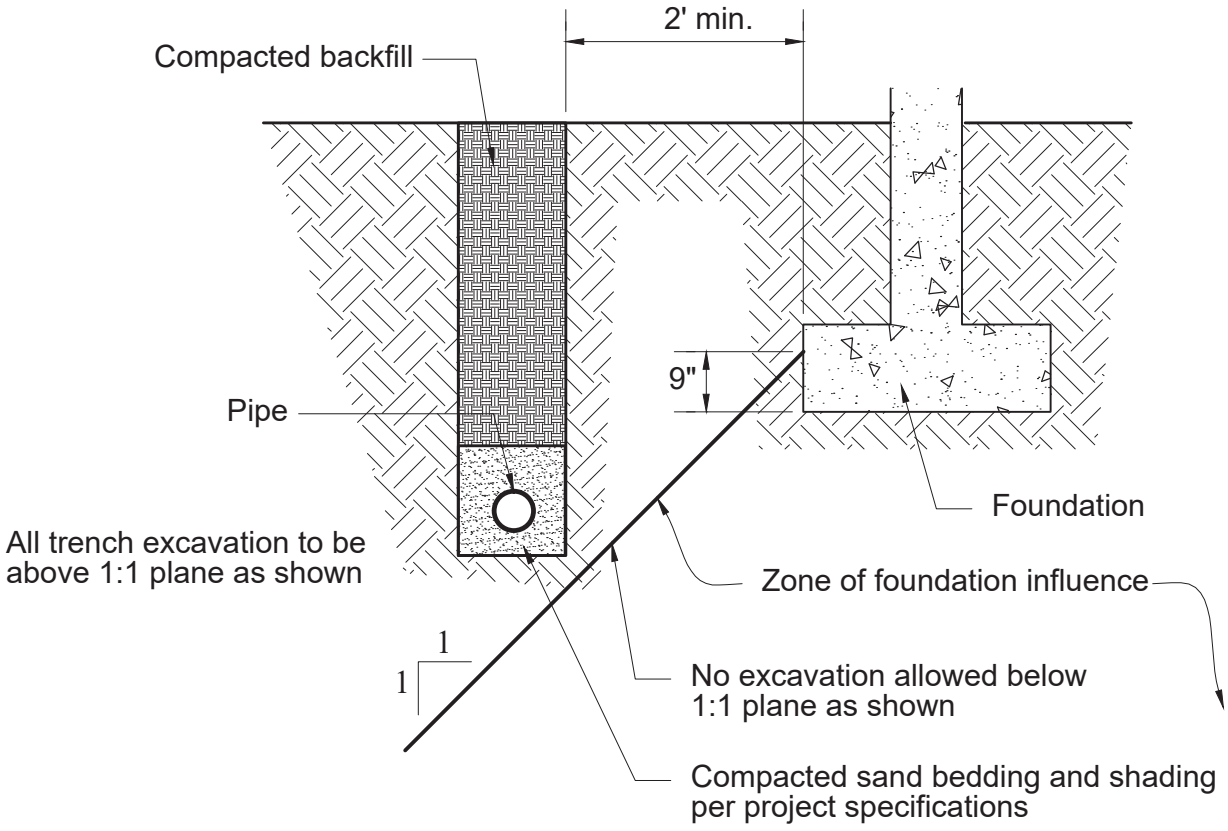
APPENDIX D

Typical Detail A: Pipe Placed Parallel to Foundations

TYPICAL DETAIL A
PIPE PLACED PARALLEL TO FOUNDATIONS



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