GEOTECHNICAL INVESTIGATION
for
COMMERCIAL BUILDING AND TOWN HOMES
DUNSLEE WAY AT SCOTTS VALLEY DRIVE
Scotts Valley, California

Prepared For
Green Valley Corporation

Prepared By
HARO, KASUNICH AND ASSOCIATES, INC.
Geotechnical & Coastal Engineers
Project No. SC10808
March 2015

HARO, KASUNICH AND ASSOCIATES, INC.

CONSULTING GEOTECHNICAL & COASTAL ENGINEERS

Project No. SC10808
16 March 2015

GREEN VALLEY CORPORATION
777 North First Street, 5th Floor
San Jose, California 95112

Attention: Mary Gourlay

Subject: Geotechnical Investigation

Reference: Commercial Building and Town Homes
Dunslee Way at Scotts Valley Drive
Scotts Valley, California

Dear Ms. Gourlay:

The following report presents the results and conclusions of our Geotechnical Investigation for the proposed commercial building and town homes. This report includes design criteria and recommendations addressing the geotechnical aspects of the proposed development.

The results of our investigation indicate the proposed improvements are feasible provided the recommendations presented in this report are followed in the development of project plans and specifications. We have recommended that buildings be supported by conventional spread footings embedded into a mat of engineered fill.

If you have any questions concerning the data or conclusions presented in this report, please call our office.

Respectfully Submitted,

HARO, KASUNICH & ASSOCIATES, INC.

Moses E. Cuprill, P.E.
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Copies: 2 to Addressee
Pdf Mary Gourlay and Corbett Wright

Project No. SC10808
16 March 2015

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GEOTECHNICAL INVESTIGATION

Introduction

This report presents the results of our Geotechnical Investigation for the proposed new commercial building and town homes at Dunslee Way and Scotts Valley Drive in Scotts Valley.

Purpose and Scope

The purpose of our investigation was to explore and evaluate the surface and subsurface conditions at the building site and provide geotechnical criteria for design and construction of the proposed development. The specific scope of our services was as follows:

1. Review the data in our files pertinent to the site.
2. Explore the subsurface conditions at the site with seven (7) continuous flight-augered and hollow stem test bore holes drilled to depths ranging from 4.5 to 31.5 feet below ground surface (bgs).
3. Test selected soil samples to determine their pertinent engineering properties.
4. Evaluate the field and laboratory data to develop geotechnical recommendations for building foundations as well as general recommendations for site grading, slabs-on-grade, and site drainage.
5. Present the results of our investigation in a report.

Site Location and Description

The project site is located on a vacant lot bound by Scotts Valley Drive to the east, Dunslee Way to the south, a new town home subdivision to the north, and a hillside with moderately steep slope gradients to the west. The vacant parcel has a gentle ascending slope gradient from Scotts Valley Drive toward the hillside.

The project site is currently covered with low grasses, coyote brush, pampas grass, and trees. A natural swale runs along the north side of the project site beyond a hedge of brush. The swale appear to convey surface runoff from a portion of the hillside west of the project site to a culvert under Scotts Valley Drive. The condition of the culvert is unknown to HKA and beyond the scope of this study. During the course of our field work for this project the swale remained dry.

HKA developed an understanding of this project scope through conversations with Mr. Corbett Wright and review of the provided conceptual site plan prepared by Ruggeri Jensen-Azar, dated 24 October 2014. Based on the above HKA understands that a 4,000 square foot commercial retail building is proposed on the southeast side of the project site. A parking facility is shown to the west of the commercial building with frontage onto Dunslee Way and Scotts Valley Drive. Twenty four residential town homes are shown in 4 pods stepping up the gentle slope east of the parking facility. Access driveways are shown to provide frontage for the town homes onto Dunslee Way. We understand the town homes

and commercial building will have concrete slab-on-ground floors. Retaining walls on the order of 5 feet tall are shown between two of the town home pods and a 1 to 4 foot tall retaining wall is shown between the commercial parking facility and a pod of town homes.

Field Exploration

Subsurface conditions were investigated on 12 February 2015 and 27 February 2015. The approximate locations of the test bore holes are indicated on the Test Hole Location Map (Figures No. 2). The test borings were advanced using 6-inch diameter continuous flight-auger equipment mounted on a truck or tractor.

Representative soil samples were obtained from the exploratory borings at selected depths, or at major strata changes. These samples were recovered using the 3.0 inch O.D. Modified California Sampler (L) or the Standard Terzaghi Sampler (T).

The penetration resistance blow counts noted on the boring logs were obtained as the sampler was dynamically driven into the in situ soil. The process was performed by dropping a 140-pound hammer a 30-inch free fall distance and driving the sampler 6 to 18 inches and recording the number of blows for each 6-inch penetration interval. The blows recorded on the boring logs represent the accumulated number of blows that were required to drive the last 12 inches.

The soils encountered in the borings were continuously logged in the field and described in accordance with the Unified Soil Classification System (ASTM D2486). The Logs of the Borings are included in the Appendix of this report. The Boring Logs denote subsurface conditions at the locations and time observed, and it is not warranted that they are representative of subsurface conditions at other locations or times.

Laboratory Testing

The laboratory testing program was directed toward determining pertinent engineering and soil properties as follows:

1) The strength parameters of the underlying earth materials were determined from field test values derived from standard penetration blow count measurements of the in situ soil.

2) Atterberg Limits tests were performed to aid is soil classification as well as qualify the soil for expansion potential.

3) Moisture content and density tests were also run on select samples for use in analysis.

4) PH, chlorides, sulfates, and resistivity tests were run on a bulk sample.

The results of the field and laboratory testing appear on the "Logs of Test Boring" opposite the sample tested or in the respective graph attached as part of the appendix of this report.

Subsurface Conditions

In general the upper 1.5 to 6.0 feet from the ground surface consisted of loose to medium dense silty sand and occasionally clayey sand. The loose soils were confined to the upper 2.5 feet from the ground surface. A sandy lean clay was encountered between 1.5 to 5.0 bgs. The sandy clay layers were 5 to 6 feet thick and occasionally less. The predominately clay (sandy clay) soil is potentially expansive with measured Atterberg limits (PI) of 25 and 31. Below the sandy clay soil layers a very stiff to hard silt, sandy silt, and silty clay were encountered. These fine grain soils were interbedded with layers of medium dense to dense silty sand, clayey sand, and sand. A very dense tan white sand was encountered just below a gravel layer at depths of 14 feet bgs in test hole B1, 17 feet bgs in B3, 18 feet bgs in B4, and 30 feet bgs in B5. We interpret this material as Santa Margarita sandstone formation.

Expansive Clays

Sandy clay soil with plasticity index (PI) of 25 and 31 were encountered at the site within

the top 1.5 to 10 feet. Predominately clay soil with a PI greater than 15 and liquid limit less than 50 percent is considered lean and moderately expansive. A consolidation/swell test performed in accordance with ASTM D2435 indicated approximately 1 percent of swell strain with 30 psf applied stress. This could result in heaving pressures on the order of 500 to 1000 psf and movement on the order of 1 inch or more in addition to static settlement estimated at 1 inch or less. The expansion potential of these soils should be considered when designing pools, pavements, slab-on-ground, and landscaping. It is recommended to remove predominately clay soils encountered within the subexcavation below foundations and slab-on-ground.

Soil Corrosivity

Based on review of the documents in our file and results of laboratory tests run on soil samples collected from the site we conclude that on-site soils should be considered moderately corrosive. Measures to protect against corrosion for underground pipes and structures should be considered.

Groundwater

During the field exploration a groundwater table was not encountered within the depths explored. However perched water was encountered within a gravel layer from 6 to 7 feet

bgs in test bore hole B2. It can be anticipated that groundwater conditions may fluctuate based on seasonal factors and other conditions not readily apparent.

Seismicity

The following is a general discussion of seismicity in the project area. Detailed studies of geologic hazards are beyond the scope of this study.

The project site lies about 2¾ miles southwest of the San Andreas Fault zone and 1¼ miles southwest of the Zayante. The San Andreas is a major fault zone of active displacement which extends from the Gulf of California to the vicinity of Point Arena, where the fault leaves the California coastline. Between these points, the fault is about 700 miles long. The fault zone is a break or series of breaks along the earth's crust, where shearing movement has taken place. This fault movement is primarily horizontal.

Historically, the San Andreas Fault has been the site of large earthquakes, and consequently large earthquakes can be expected in the future. The largest of the historic quakes in Northern California occurred on 18 April 1906 (mag. 8.3+). The recent 17 October 1989 earthquake was also associated with the San Andreas Fault system. This event was the second largest earthquake in Northern California this past century.

Other significant faults within the nearby vicinity include the Zayante-Vergales Fault (6.0 mile to the southwest).

Geologic hazards review is beyond the scope of our services. The above information is general in nature and is provided only to illustrate that the property lies within a complex geologic area.

Geotechnical Related Seismicity

The improvements should be designed in conformance with the most current California Building Code (2013 CBC). For seismic design, the soil properties at the site are classified as **Site Class "D"** based on definitions presented in Table 1613.5.2 in the 2013 CBC. The longitude and latitude were determined using a satellite image generated by Google Earth. These coordinates were taken from the approximate middle of the area of the proposed improvements:

Longitude = -121.7714, Latitude = 36.9126

The coordinates listed above were used as inputs in the Java Ground Motion Parameter Calculator created by the USGS to determine the ground motion associated with the maximum considered earthquake (MCE) SM and the reduced ground motion for design SD. The results are as follows:

Site Class D

SM_s= 1.635 g

SM_1= 0.960 g

SD_s= 1.090 g

SD_1= 0.640 g

A maximum considered earthquake geometric mean (MCE_G) peak ground acceleration (PGA) was estimated using the Figure 22-7 of the ASCE Standard 7-10. The mapped PGA was 0.624 g and the site coefficient F_{PGA} for Site Class D is 1.0. The MCE_G peak ground acceleration adjusted for Site Class effects is $PGA_M = F_{PGA} * PGA$

$$PGA_M = 1.0 * 0.624\ g = 0.624\ g$$

Liquefaction Potential

Liquefaction is a phenomenon where the loose or medium dense sand or in some cases firm silt deposited below the groundwater table experience a loss of shear strength while cyclically loaded by the ground shaking during an earthquake. Modern geotechnical engineering practice assumes ground failures can occur from soil deposits liquefying within 50 to 60 feet of the ground surface. Since a groundwater table was not encountered at the project site at the time of our field exploration the potential for liquefaction is low.

Furthermore the site is mapped as "D" low potential for liquefaction on the Map of Geology and Liquefaction Potential of Quaternary Deposits in Santa Cruz County (Dupre' 1975). The loose soils near the surface in their current state could be susceptible to dynamic compaction, however they will be removed and replaced with engineered fill reducing the potential to low. Below this zone the soils encountered within our test bore holes have low potential for dynamic compaction.

DISCUSSIONS AND CONCLUSIONS

Based on the results of our investigation, the proposed development, from a geotechnical standpoint, is feasible so long as the recommendations presented in this report are incorporated into the design and construction of the proposed development. Geotechnical considerations for this site include strong seismic shaking, adequate foundation support of buildings, and predominately clay soils within the wetting zone with a moderate degree of expansion potential.

To minimize the potential for movement and more importantly differential movement and create uniform support the new buildings should be supported by conventional spread footings embedded into the mat of engineered fill. The concrete slab-on-grade floors should also be supported by a uniform mat of engineered fill. Predominately clay soil encountered within the subexcavation for the mat of engineered fill should be removed and replaced with non-expansive fill in accordance with this report.

Change in elevation across the proposed building footprints is shown to be on the order of 2 to 3 feet. Since the new building will have a slab-on-grade floor a level building pad will need to be constructed. This will require either making a cut slope along the inboard side supported by retaining walls or constructing a small embankment on the outboard side or both.

RECOMMENDATIONS

The following recommendations should be used as guidelines for preparing project plans and specifications:

Site Grading

1. We request the opportunity to review project grading and foundation plans during the design phase of the project. We can then provide our opinion regarding geotechnical considerations.

2. Observation and testing services for earthwork performed at the project site should be provided by Haro, Kasunich, and Associates. The observation and testing of earthwork allows for an evaluation of the contractors compliance with our geotechnical recommendations. It also allows us the opportunity to confirm that actual soil conditions encountered during construction are essentially the same as those anticipated based on the subsurface exploration.

3. HKA should be notified **at least four (4) working days** prior to any site clearing or grading so that the work in the field can be coordinated with the grading contractor and arrangements for testing and observation can be made. The recommendations of this

report are based on the assumption that the geotechnical engineer will perform the required testing and observation during grading and construction. It is the owner's responsibility to make the necessary arrangements for these required services.

4. Where referenced in this report, Percent Relative Compaction and Optimum Moisture Content shall be based on ASTM Test Designation D1557.

5. A mat of engineered fill should be constructed to support buildings and concrete slabs. The in-situ soils should be subexcavated to a depth of 18 inches below the bottom of foundation elements, 12 inches below bottom of concrete slabs, moisture conditioned, and replaced as engineered fill. The bottom of the subexcavation should be scarified to a depth of 6 inches, moisture conditioned, and redensified. Where predominately clay soils are encountered within the subexcavation they should be removed and replaced with non-expansive engineered fill. The mat of engineered fill should extend 5 horizontal feet beyond foundation elements in all directions.

6. Areas to be graded or to receive building foundations should be cleared of obstructions including **loose fill**, debris, foundations, trees not designated to remain and their principal roots, or other unsuitable material. Existing depressions or voids created during site clearing should be backfilled with engineered fill.

7. Engineered fill should be placed in thin lifts not exceeding 8 inches in loose thickness, moisture conditioned, and compacted to a minimum of 90 percent relative compaction. Engineered fill placed within 8 inches of rough finished subgrade elevation should be compacted to a minimum of 95 percent relative compaction.

8. Where predominately clay soil is exposed at the base of subexcavations it should be scarified to a depth of 6 inches, moisture conditioned or dried back to a moisture content of 2 to 4 percent over optimum moisture, and compacted to a relative compaction between 87 and 89 percent. Where non clay soils are encountered compact to a minimum 90 percent.

9. Imported fill should meet the following criteria:

   a. Be free of wood, brush, roots, grass, debris and other deleterious materials.
   b. Not contain rocks or clods greater than 2.5 inches in diameter.
   c. Not more than 20 percent passing the #200 sieve.
   d. Have a plasticity index less than 15.
   e. Be evaluated for conformance to the aforementioned requirements by the HKA. Submit to HKA samples of import material or utility trench backfill for compliance testing a minimum of 4 days before it is delivered to the job site.

10. We estimate shrinkage factors of about 15 percent for the recommended imported materials when used in engineered fills.

11. Cut and fill slopes should be placed at a maximum gradient of 2:1 (H:V). Graded and disturbed slopes should be covered with erosion control netting and planted with an approved erosion control mix.

Fill Slopes

12. Minor fill is anticipated to create level building pads. These fills are anticipated to be on the order of 3 feet in height or less. Fill slopes may require periodic maintenance to remove minor soil sloughing.

13. All fill slopes with gradients in excess of 5:1 (horizontal to vertical) must be adequately keyed and benched into competent material. The toe key should be at least 8 feet wide and should extend at least 1 foot into competent native soil. The bottom of the toe key should be sloped downward at about 2 percent toward the back of the key.

14. The bottom of toe keys and subsequent bench keys should be scarified to a depth of 6 inches; moisture conditioned 2 to 4 percent over optimum moisture content, and compacted to a relative compaction of 87 to 89 percent.

15. There should be a minimum of 5 feet horizontal separation between the bottom of all footing elements and the top of a fill slope or the base of a cut slope.

16. In order to maintain stable slopes at the recommended gradients, it is important that seepage forces and accompanying hydrostatic pressure be relieved by adequate drainage. If significant seepage is observed during construction of fill slopes backdrains in keyways and benches should be provided. The locations of backdrains and outlets will be determined by a representative from HKA in the field during grading.

17. After the earthwork operations have been completed and HKA has finished observation of the work, no further earthwork operations shall be performed except with the approval of and under the observation of HKA.

Conventional Spread Foundations

18. Provided the building pads are prepared in accordance with our recommendations, the proposed building should be supported by conventional spread foundations embedded into a mat of engineered fill that extends a minimum of 18 inches below the bottom of foundation elements. The mat of fill should extend a minimum 5 horizontal feet beyond the outer edge of the foundation elements in each direction. The mat of engineered fill should be prepared in accordance with the section of this report titled "Site Grading".

19. Actual footing depths should be determined in accordance with anticipated use and applicable design standards. Conventional footings should be reinforced as required by the structural designer based on the actual loads transmitted to the foundation.

20. Foundations designed in accordance with the above may be designed for an allowable soil bearing pressure of 1,500 psf for dead plus live loads. This value may be increased by one-third to include short-term seismic and wind loads.

21. Lateral load resistance for structures supported on spread footings may be developed in friction between the foundation bottom and the supporting subgrade. A friction coefficient of 0.34 is considered applicable.

22. Footings located adjacent to other footings or utility trenches should have their bearing surfaces founded below an imaginary 2:1 plane projected upward from the bottom edge of the adjacent footings or utility trenches.

23. Total and differential settlements under the proposed light building loads are anticipated to be less than 1 inch and ½ inch respectively.

24. All footing excavations should be thoroughly cleaned and observed by HKA <u>prior to placing forms and steel.</u> Observation of foundation excavations allows anticipated soil

conditions to be correlated to those inferred from our investigation and to verify that the footings are in accordance with our recommendations

Retaining Walls and Lateral Pressures

25. For design of retaining walls up to 8 feet in height and fully drained, the following design criteria may be used:

A. Active earth pressure for walls allowed to yield (up to ½ percent of their height) is that exerted by an equivalent fluid weighing 40 pcf for a level back slope gradient; 50 pcf for a 2:1 backslope gradient. This is assuming a fully drained condition.

B. Where walls are restrained from moving at the top, design for uniform wall pressure of 28H psf/ft for level backfill and 35H psf/ft for 2:1 backfill slope gradient, where H is the height of the wall.

C. Site retaining walls should be supported by conventional spread footings embedded into firm native soils. The excavation for the foundation element should be moisture conditioned 2 to 4 percent over optimum moisture content and the base of the excavation compacted to 87 percent relative compaction. Retaining walls connected to buildings should have foundation elements embedded into a mat of engineered fill as described in the section of this report titled "Conventional Spread Foundations".

D. For seismic design of critical structures, a nominal earthquake load equal to 19 H^2 lbs/horizontal foot of wall may be assumed to act at 0.6H above the heel of the wall base (where H is the height of the wall).

E. In addition, the walls should be designed for a surcharge load from the residence as well as any other adjacent live or dead surcharge loads which will exert a force on the wall (foundation loads and/or vehicle traffic see Figure No. 14).

F. For fully drained conditions as delineated above, we recommend that permeable material meeting the State of California Standard Specifications, Section 68-1.025, Class 1, Type A, or an approved equivalent be placed behind the wall, with a minimum continuous width of 12 inches, and extend the full height of the wall to within 1-foot of the ground surface. A 4-inch diameter perforated drain pipe (with perforations placed downward) should be installed within 4 inches of the bottom of the granular backfill and be discharged to a suitable location.

G. Wall backfill should be compacted to a minimum of 90 percent relative compaction. The backfill material should be approved by HKA

H. HKA should observe foundation excavations during to observe anticipated soil conditions and excavation depths.

Concrete Slab-On-Ground General

26. Concrete slab floors should be supported by a mat of engineered fill that extends a minimum 12 inches below the bottom of the slab. The engineered fill should be prepared in accordance with the section of this report titled "Site Grading". The 1 foot can include the blotter layer and/or gravel under slab section. The blotter layer is considered a 4 inch thick layer of quarry run granular material that is moisture conditioned and compacted over the top of a vapor barrier.

27. To reduce the potential for cracking and curling as well as other undesirable defects the concrete slab-on-grade design, placement, and curing should be done in accordance with the most recent version of ACI 302.1R-04.

28. HKA presumes floor wetness would be unacceptable for the buildings for reasons such as moisture sensitive floor covering and interior humidity control just to name a few. To minimize potential for floor wetness the interior concrete slab floor should be underlain with a vapor barrier. Vapor barriers should be overlapped a minimum of 6 inches at the joints and carefully fitted around service openings. Whether to locate the vapor barrier in direct contact with the slab or beneath a blotter layer of granular fill should be made with careful considerations to many factors directly and indirectly related to concrete construction. Such factors include but are not limited to; whether a water tight roof membrane is in place prior to slab construction, sequence of slab construction in relation to

other construction activities requiring water, and the floor covering manufacturer's recommendations. Proposed installation should be independently evaluated as to the moisture-related sensitivity of subsequent floor finishes, project conditions, schedule, and the potential effects of slab curling and cracking.

29. If a blotter layer of granular fill over the vapor barrier is selected it should be a minimum of 4 inches thick, trimmable, and compactible at low moisture content (4 to 5 percent). The use of cushion or clean sand with uniform particle size is not recommended for use as a blotter layer of granular fill. Crusher run material graded from 3/4 inch down to rock dust is suitable. The blotter layer of granular fill should be compacted to a minimum 95 percent relative compaction in accordance with ASTM D1557. Following compaction the surface should be choked off with a fine graded material and proof rolled to reduce friction between the granular fill and the slab. To prevent the granular fill from becoming a water reservoir (contributing to floor wetness) it will be imperative to keep it dry after preparation has been completed.

30. Although groundwater was not encountered at the time of our field drilling operation, and considering the reduced permeability of the redensified on-site soils, and the possibility of consistent irrigation of landscaping around the subdivision a free draining granular material to act as capillary break is recommended below the slab. The granular material should be comprised of a minimum 4 inch thick layer of a permeable material that meets

the requirements of a Caltrans Class I Type A gradation (Section 68.202F(2) Std. Spec.). A thin layer approximately 1 inch thick of fine graded material should be proof rolled over the permeable material using a drum roller before installation of the vapor barrier to reduce the possibility of puncture.

31. We recommend the specifications for slab-on-grade floors require moisture emission tests be performed on the slab prior to the installation of flooring. No flooring should be installed until safe moisture emission levels are recorded for the type of flooring to be used.

Surface Drainage

32. An engineered drainage plan to handle surface runoff should be developed for this site. Site drainage should be adequately controlled both during and after construction.

33. Due to the impermeable nature of the in-situ clay soils shallow on-site retention is not recommended for this project site.

34. All exposed soil should be landscaped and permanently protected against erosion as soon as possible after grading.

35. We recommend that full gutters be used along all roof down eaves to collect storm runoff water and channel it through closed rigid conduits to a suitable discharge point away from all structural improvements.

36. Surface runoff should **not** be allowed to flow onto graded or natural slopes. Consideration should be given to catch basins, berms, concrete v-ditches, or drainage swales at the top of all slopes to intercept runoff and direct it to a suitable discharge point.

37. Surface drainage should include provisions for positive gradients so that surface runoff is not permitted to pond adjacent to foundations and on pavements. Surface drainage should be directed away from the building foundations, at a minimum gradient of 5 percent for a distance of at least 10 feet to an adequate discharge point. Concentrations of surface water runoff should be handled by providing necessary structures, solid pipes, catch basins, etc.

38. Irrigation activities at the site should be done in a controlled and reasonable manner. Moderate to highly expansive near surface clay should be considered when planning landscape features. Planter areas should not be sited adjacent to walls; otherwise, measures should be implemented to contain irrigation water and prevent it from seeping into walls and under foundations.

39. The migration of water or spread of extensive root systems below foundations, slabs, or pavements may cause undesirable differential movements and subsequent damage to these structures. Landscaping should be planned accordingly.

40. Drainage patterns approved at the time of finished grading should be maintained throughout the life of proposed structures.

Pavement Design

41. To have the selected pavement sections perform to their greatest efficiency, it is very important that the following items be considered:

a. Pavements should be supported by a mat of engineered fill that extends a minimum 12 inches below the bottom of the aggregate baserock layer. The mat of engineered fill should be prepared in accordance with the section of this report titled "Site Grading".

b. Provide sufficient gradient to prevent ponding of water.

c. Use only quality materials of the type and thickness (minimum) specified. All baserock (R=78 minimum) must meet CALTRANS Standard Specifications for Class 2 Untreated Aggregate Base (Section 26). All subbase (R=50 minimum) must meet CALTRANS

Standard Specifications for Class 2 Untreated Aggregate Subbase, (Section 25).

d. Compact the baserock and subbase uniformly to a minimum relative compaction of 95 percent.

e. Place the asphaltic concrete only during periods of fair weather when the free air temperature is within prescribed limits.

f. Maintenance should be undertaken on a routine basis.

Utility Trenches

42. Trenches must be properly shored and braced during construction or laid back at an appropriate angle to prevent sloughing and caving at sidewalls. The project plans and specifications should direct the attention of the contractor to all CAL OSHA and local safety requirements and codes dealing with excavations and trenches.

43. Utility trenches that are parallel to the sides of buildings should be placed so that they do not extend below an imaginary line sloping down and away at a 2:1 (horizontal to vertical) slope from the bottom outside edge of footing elements. The structural design professional should coordinate this requirement with the utility layout plans for the project.

44. Trenches should be backfilled with engineered fill prepared in accordance with this document.

45. We strongly recommend placing a 3 foot concrete plug in each trench where it passes under the exterior foundations. Care should be taken not to damage utility lines.

46. Trenches should be capped with 1.5 feet of relatively impermeable soil.

Plan Review, Construction Observation, and Testing

47. Our firm must be provided the opportunity for a general review of the final project plans prior to construction so that our geotechnical recommendations may be properly interpreted and implemented. If our firm is not accorded the opportunity of making the recommended review, we can assume no responsibility for misinterpretation of our recommendations. We recommend that our office review the project plans prior to submittal to public agencies, to expedite project review. The recommendations presented in this report require our review of final plans and specifications prior to construction and upon our observation and, where necessary, testing of the earthwork and foundation excavations. Observation of grading and foundation excavations allows anticipated soil conditions to be correlated to those actually encountered in the field during construction.

LIMITATIONS AND UNIFORMITY OF CONDITIONS

1. The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed in the borings. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that planned at the time, our firm should be notified so that supplemental recommendations can be given.

2. This report is issued with the understanding that it is the responsibility of the owner, or his representative, to ensure that the information and recommendations contained herein are called to the attention of the Architects and Engineers for the project and incorporated into the plans, and that the necessary steps are taken to ensure that the Contractors and Subcontractors carry out such recommendations in the field. The conclusions and recommendations contained herein are professional opinions derived in accordance with current standards of professional practice. No other warranty expressed or implied is made.

3. The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they be due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated, wholly or partially, by changes outside our control. Therefore, this report should not be relied upon after a period of three years without being reviewed by a geotechnical engineer.

APPENDIX A

Site Vicinity Map

Test Hole Location Map

Key to Logs

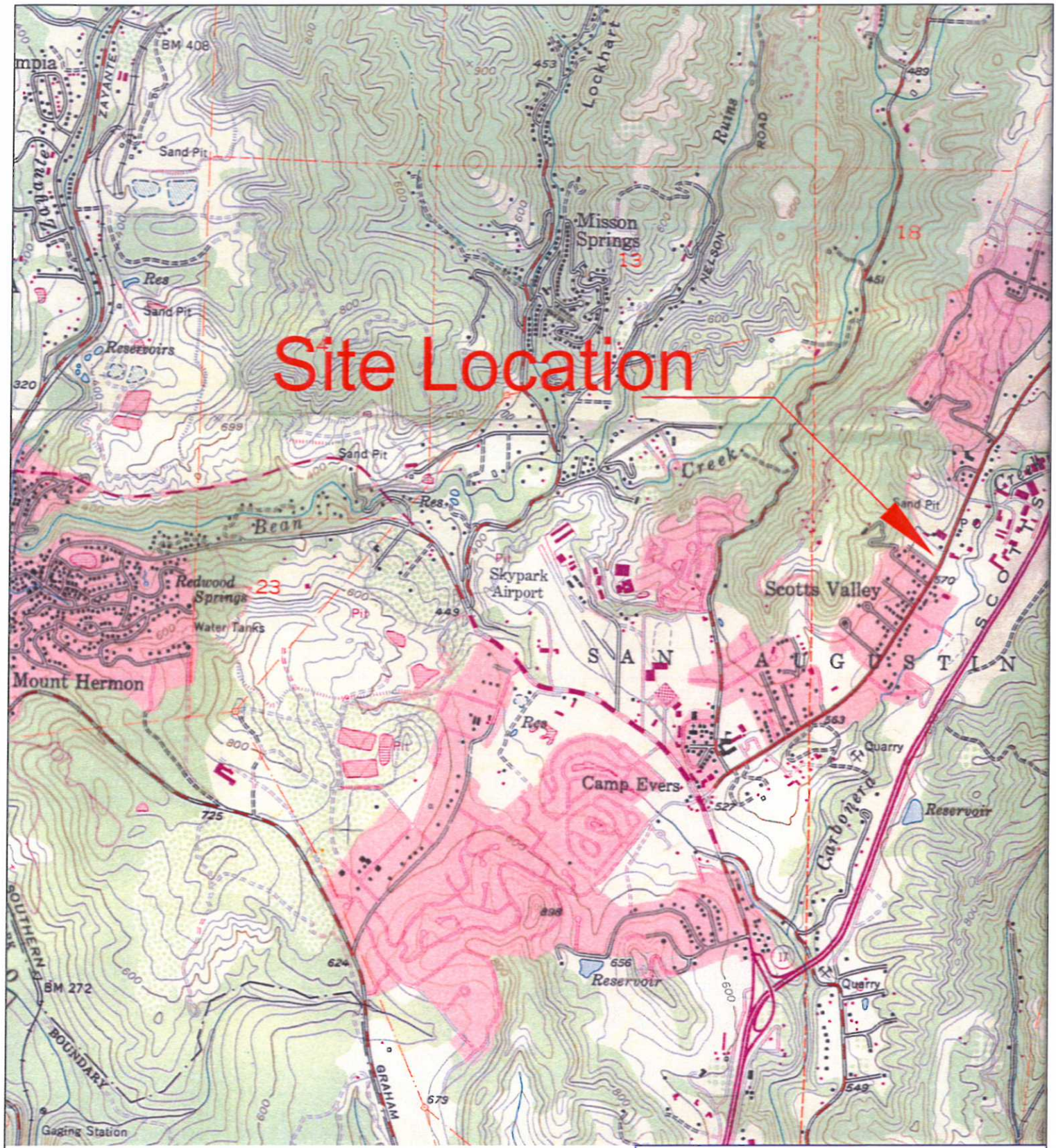
Logs of Test Borings

Atterberg Limits Test Results

Soil Corrosion Test Results

Key and Bench Detail

Retaining Wall Surcharge Diagram



SITE VICINITY MAP
TOWNHOUSE SUBDIVISION
DUNSLEE WAY AT SCOTTS VALLEY DRIVE
SCOTSS VALLEY, CALIFORNIA

SCALE	No Scale
DRAWN BY	MC
DATE	MARCH 2015
REVISED	
JOB NO	SC10808

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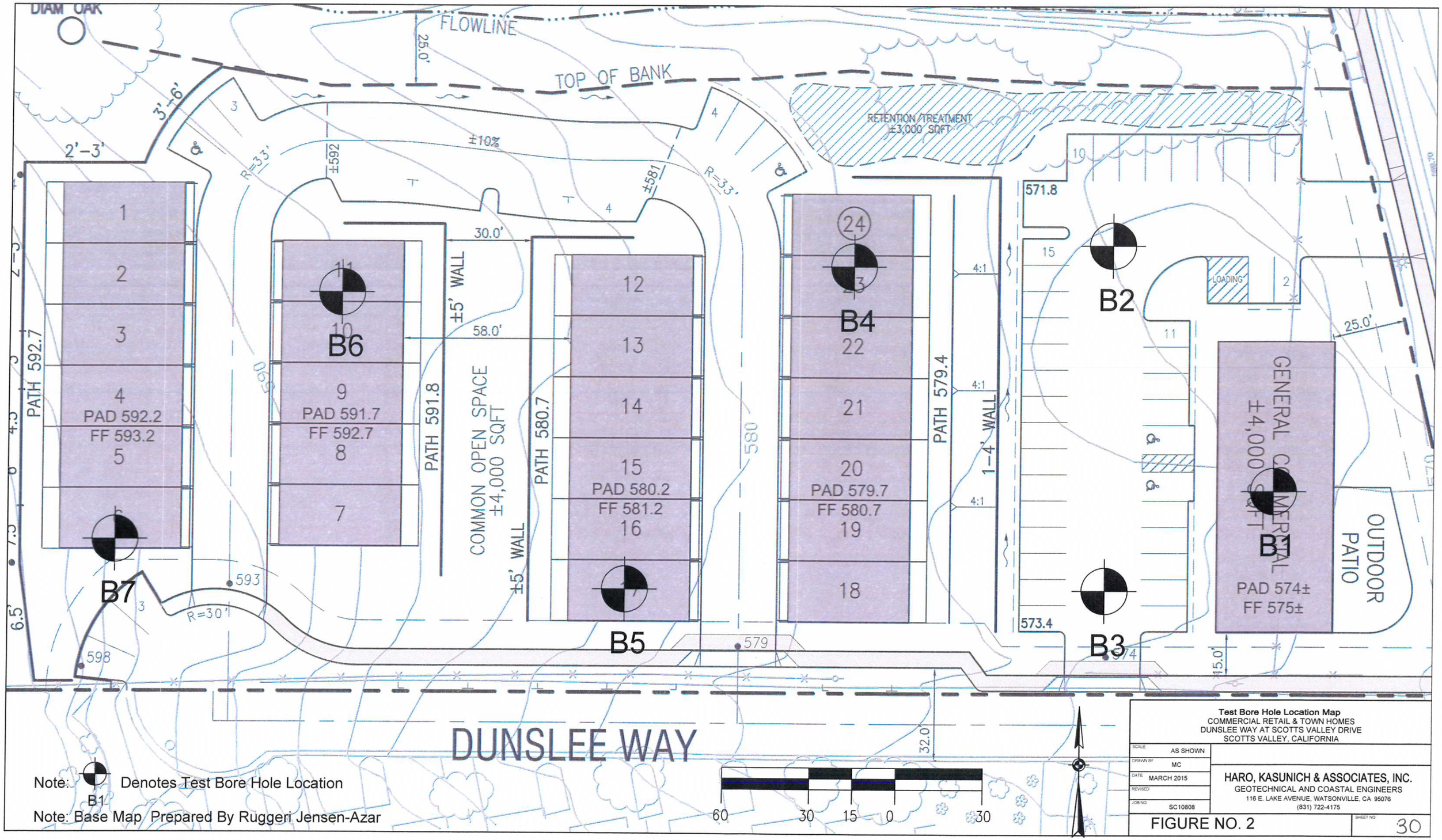
FIGURE NO. 1

SHEET NO 29



Note: B1 Denotes Test Bore Hole Location

Note: Base Map Prepared By Ruggeri Jensen-Azar

Test Bore Hole Location Map
COMMERCIAL RETAIL & TOWN HOMES
DUNSLEE WAY AT SCOTTS VALLEY DRIVE
SCOTTS VALLEY, CALIFORNIA

SCALE	AS SHOWN
DRAWN BY	MC
DATE	MARCH 2015
REVISED	
JOB NO	SC10808

HARO, KASUNICH & ASSOCIATES, INC.
GEOTECHNICAL AND COASTAL ENGINEERS
116 E. LAKE AVENUE, WATSONVILLE, CA 95076
(831) 722-4175

FIGURE NO. 2

SHEET NO 30

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS — MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS — MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands or gravelly sands, little or no fines
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS — LIQUID LIMIT IS LESS THAN 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS — LIQUID LIMIT IS GREATER THAN 50%		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.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.

GRAIN SIZES

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

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

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS PER FOOT*
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH (TSF)**	BLOWS PER FOOT*
VERY SOFT	0 - ¼	0 - 2
SOFT	¼ - ½	2 - 4
FIRM	½ - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

SAMPLING METHOD

STANDARD PENETRATION TEST	T	
MODIFIED CALIFORNIA	L or M	
PITCHER BARREL	P	
SHELBY TUBE	S	
BULK	B	

H_2O

Final	▽
Initial	▼
Water level designation	

*Number of blows of 140 lb hammer falling 30 inches to drive a 2" O.D. (1⅜" I.D.) split spoon sampler (ASTM D-1586)

**Unconfined compressive strength in tons/ft² is determined by laboratory testing or approximated by the Standard Penetration Test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

Haro Kasunich & Associates	KEY TO LOGS Dunslee Way At Scotts Valley Dr. Scotts Valley, California	Project No. SC10808 March 2015	Figure No. 3

Haro, Kasunich & Associates, Inc.
Geotechnical Engineers

Dunslee Way at Scotts Valley Boulevard

PROJECT NO. SC10808

LOGGED BY MC | DATE DRILLED 2-12-15 | BORING DIAMETER 8" | BORING NO. B-1

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Brown Silty SAND fine to medium grain, 1/4 inch subangular gravel, moist, loose	SM					
	1-1-1 (L)		Dark brown Sandy CLAY, fine gravel, moist, very stiff	CL	31			17.6	Atterberg Limits PI = 31 LL = 45.4% Free Swell 1%
	1-2 (T)		Dark brown mottled orange Sandy CLAY, fine to coarse grain, clasts, moist, very stiff		27				
5									
	1-3-1 (L)		Brown sandy SILT, fine grain, moist, very stiff	ML	33		96	28.1	
10	1-4 (T)		Brown orange matrix of Silty CLAY, SAND, gravel, fine to coarse grain, 1/4 inch to 1 inch gravel, moist, dense	ML-SW	46				
			Cobbles and gravels, rough drilling	CL-GW					
			Tan white SAND, fine to medium grain, damp, dense	SW					
15									
	1-5-1 (L)		Same but very dense		50/5"				
20									
25									
	1-6 (T)		Same as above		50/5"				
			Boring terminated at 29 feet						
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr | FIGURE NO. 4

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\SC10808 Dunslee Way at Scotts Valley Boulevard.log Date: 3/17/2015

Haro, Kasunich & Associates, Inc.
Geotechnical Engineers

Dunslee Way at Scotts Valley Boulevard

PROJECT NO. SC10808

LOGGED BY MC | DATE DRILLED 2-12-15 | BORING DIAMETER 8" | BORING NO. B-2

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Dark brown Silty SAND, fine grain, trace of binder, moist, loose	SM					
	2-1- 1 (L)				19				
	2-2 (T)		Interbedded with clasts and gravels, 1/4 inch diameter, moist, medium dense		12				
5			Gravel layer with perched water	GW	13				
	2-3 (T)							25.0	
			Brown Sandy CLAY, very moist, fine grain, stiff	CL					
			Boring terminated at 7.5 feet						
10									
15									
20									
25									
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr | FIGURE NO. 5

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\SC10808 Dunslee Way at Scotts Valley Boulevard.log Date: 3/17/2015

Haro, Kasunich & Associates, Inc.
Geotechnical Engineers

Dunslee Way at Scotts Valley Boulevard

PROJECT NO. SC10808

LOGGED BY MC | DATE DRILLED 2-12-15 | BORING DIAMETER 8" | BORING NO. B-3

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Dark brown, brown Sandy CLAY and Silty SAND	CL					
5			Brown Sandy CLAY and Silty SAND	CL-SM					
10			Gravel layer	GW					
15			SAND	SW					
			Gravel	GW					
	3-1 (T)		Grey white SAND, damp to moist, fine to medium grain, very dense	SW	50/5.5'				
			Boring terminated at 18 feet						
20									
25									
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr | FIGURE NO. 6

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\SC10808 Dunslee Way at Scotts Valley Boulevard.log Date: 3/17/2015

Haro, Kasunich & Associates, Inc.
Geotechnical and Environmental Engineers

Dunslee Way at Scotts Valley Boulevard

PROJECT NO. SC10808

LOGGED BY MC | DATE DRILLED 2-12-15 | BORING DIAMETER 8" | BORING NO. B-4

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Dark brown Silty SAND, damp-moist, fine to medum grain, loose	SM					
	4-1-1 (L)		Dark brown Sandy CLAY, fine grain, moist, very stiff becomes interbedded with clasts at 3 to 4 feet	CL	25				
	4-2 (T)				27				
5	4-3 (T)		Grey Clayey SAND, interbedded with 1 inch clasts, moist, medium dense	SC	26				
10	4-4 (T)		Grey brown matrix of Sandy CLAY and SILT, moist, very stiff to hard	CL-ML	32			18.8	
15	4-5 (T)		Brown grey orange matrix of clayey SAND, SILT, and mudstone gravels 1 inch diameter, damp-moist, very dense	SC-ML	55				
			Greyish white SAND with tan mottling SAND fine to medium grain, moist, very dense	SW					
20	4-6 (T)				50/6"				
			Boring terminated at 21.5 feet						
25									
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr | FIGURE NO. 7

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\SC10808 Dunslee Way at Scotts Valley Boulevard.log Date: 3/17/2015

Haro, Kasunich & Associates, Inc.
Geotechnical Engineers

Dunslee Way at Scotts Valley Boulevard

PROJECT NO. SC10808

LOGGED BY MC | DATE DRILLED 2/27/15 | BORING DIAMETER 6" | BORING NO. B-5

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0	5-1-1 (L)		Dark brown Silty SAND trace of CLAY, fine to medium grain, wet, loose	SM	11				
	5-2 (T)		Brown Clayey SAND, fine grain, moist, medium dense	SC	18				
5	5-3 (T)		Brown sandy lean CLAY, fine to medium grain, moist, very stiff	CL	27				
10	5-4 (T)		Brown Silty SAND with CLAY, moist, fine to medium grain, medium dense	SM	11				
15	5-6 (T)		Brown Silty SAND, fine to medium, grain, medium dense	SM	13				
20	5-7 (T)		Interbedded tan orange brown Silty SAND, fine to medium grain and subrounded gravels, 1 inch, damp, dense		41				
			Boring terminated at 21.5 feet						
25									
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr | FIGURE NO. 8

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\SC10808 Dunslee Way at Scotts Valley Boulevard.log Date: 3/17/2015

Haro, Kasunich & Associates, Inc.
Geotechnical and Environmental Engineers

Dunslee Way at Scotts Valley Boulevard

PROJECT NO. SC10808

LOGGED BY MC | DATE DRILLED 2/27/15 | BORING DIAMETER 6" | BORING NO. B-6

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0	6-1-1 (L)		Brown Silty SAND, wet, fine to medium grain, loose	SM	14				
	6-2 (T)		Brown sandy, lean CLAY, moist, very stiff	CL	20			19.6	Atterberg Limits PI = 25 LL = 37.1%
5									
10	6-3 (T)		Brown orange Silty SAND, trace of CLAY, fine grain, moist, medium dense Harder drilling	SM	21				
15			Brown Clayey SAND with gravels, fine to medium grain, moist	SC					
20									
25	6-4 (T)		Brown orange interbedded SAND, Clayey SAND and Silty SAND fine to medium grain, moist, dense	SC	34				
			Tan SAND, fine to medium grain damp, very dense	SW					
30	6- 5(T)				50/3"				
			Boring terminated at 31.5 feet						
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr | FIGURE NO. 9

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\SC10808 Dunslee Way at Scotts Valley Boulevard.log Date: 3/17/2015

Haro, Kasunich & Associates, Inc.
Geotechnical Engineers

Dunslee Way at Scotts Valley Boulevard

PROJECT NO. SC10808

LOGGED BY MC | DATE DRILLED 2/27/15 | BORING DIAMETER 6" | BORING NO. B-7

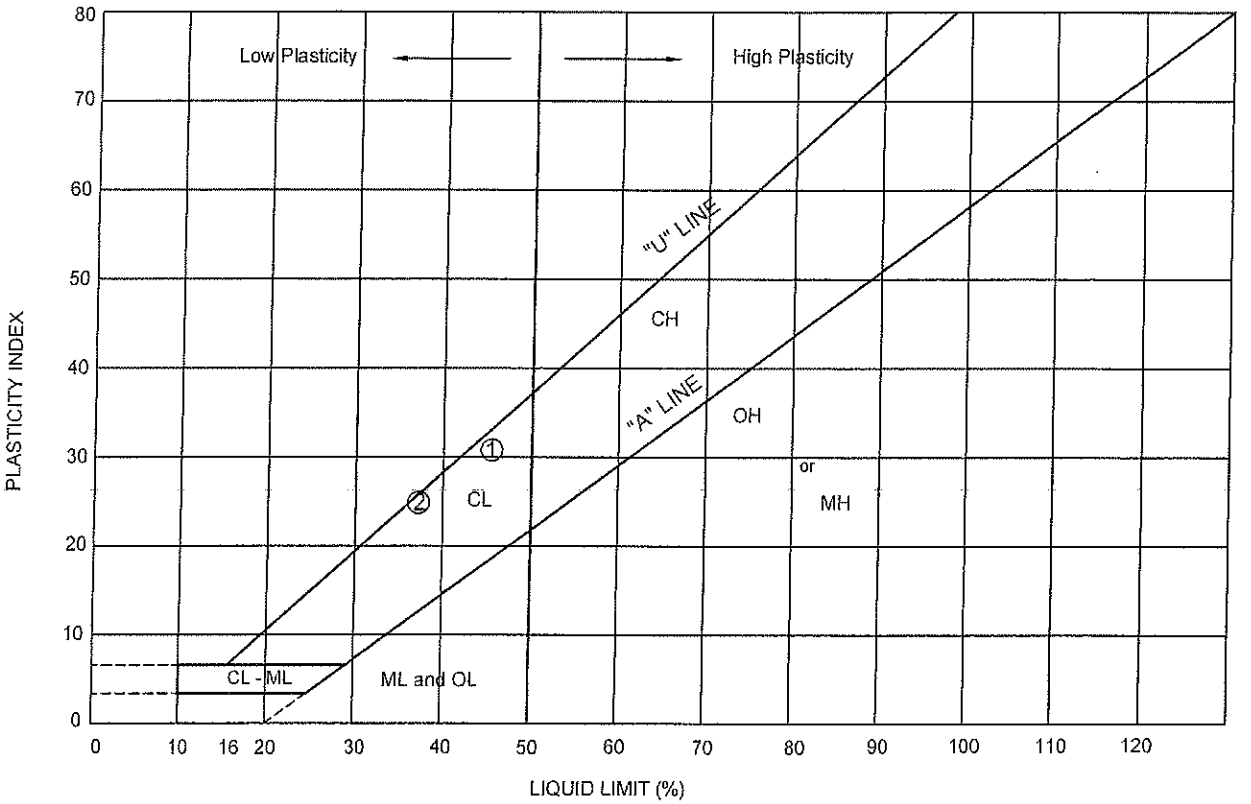
Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Light brown Silty SAND, fine to medium grain, damp, FILL	SM					
			Dark brown Silty SAND, fine to medium grain, moist, loose	SM	26				
	7-1-1 (L)			SC					
	7-2 (T)		Brown orange Clayey SAND, fine to medium grain, moist-wet, medium dense	SM	37				
5			Brown orange Silty SAND, fine to medium grain, clasts, 1/4 inch, damp, dense						
			Boring terminated at 4.5 feet						
10									
15									
20									
25									
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr | FIGURE NO. 10

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\SC10808 Dunslee Way at Scotts Valley Boulevard.log Date: 3/17/2015

PLASTICITY CHART



PLASTICITY DATA

Key Symbol	Sample Number	Depth (feet)	Natural Water Content W(%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index	Liquidity Index $\frac{W - PL}{LL - PL}$	Unified Soil Classification Symbol
①	1-1-1	2.0	17.6	14.5	45.4	31	+0.100	CL
②	6-2	3.5	19.6	12.3	37.1	25	+0.292	CL
③	*	*	*	*	*	*	*	*

ATTERBERG LIMITS TEST RESULTS
COMMERCIAL, RETAIL AND TOWN HOMES
DUNSLEE WAY AT SCOTTS VALLEY DRIVE
SCOTTS VALLEY, CALIFORNIA

SCALE:	No Scale
DRAWN BY:	MC
DATE:	MARCH 2015
REVISED:	
JOB NO.	M10478

HARO, KASUNICH & ASSOCIATES, INC.
GEOTECHNICAL AND COASTAL ENGINEERS
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(831) 722-1475

FIGURE NO. 11

SHEET NO. 39

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Work Order #: 5030258
Account #: 2953
Date Received: 03/06/15
Date Reported: March 13, 2015

Haro - Kasunich and Assoc.
116 East Lake Avenue
Watsonville, CA 95076

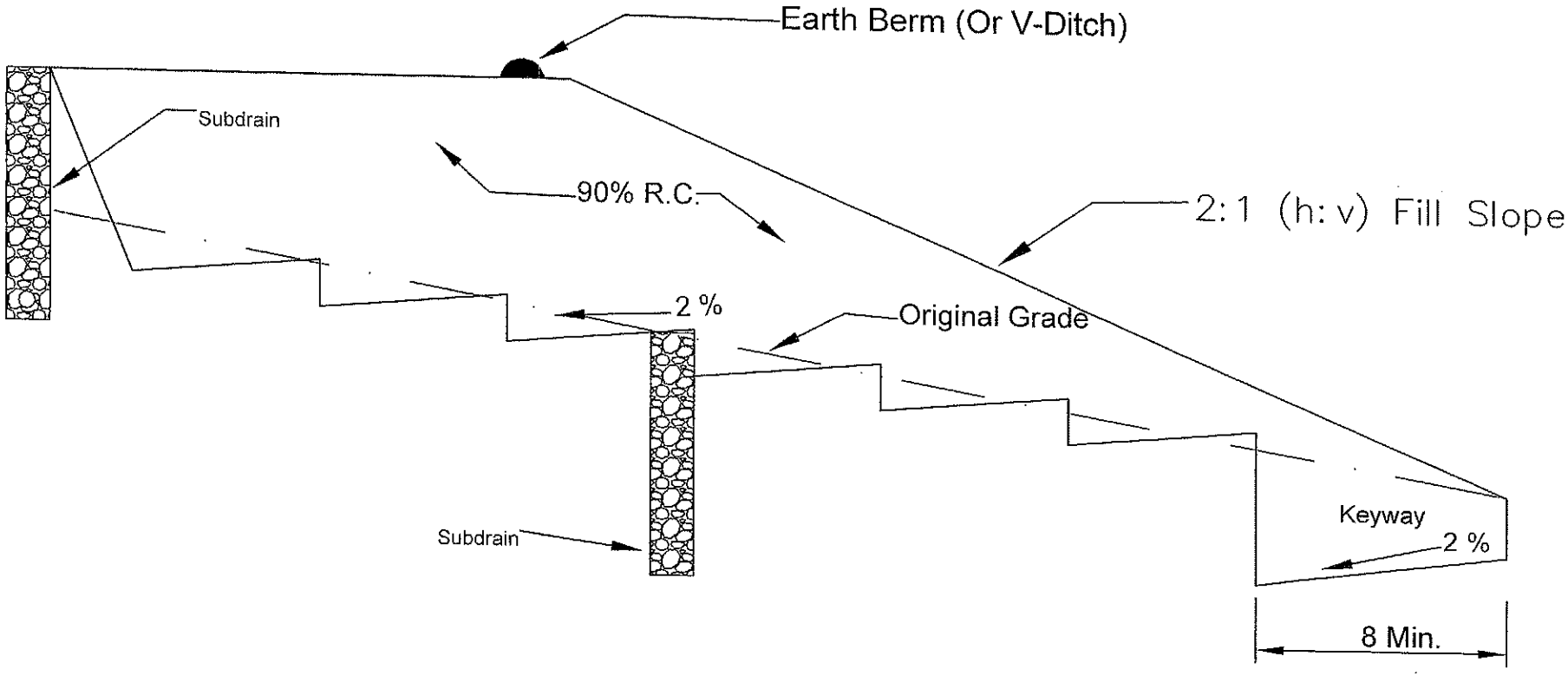
Reporting Date: March 13, 2015

Date Received: 03/06/15
Project#/Name: SC10808 / Dunslee Townhouse Subdivision
Matrix: Soil

Sample Identification	pH (units)	Chloride (mg/Kg)	Sulfate (mg/Kg)	Resistivity (ohms x cm)
SC10808	7.4	24	9.4	2800
	Method	**Method**	**Method**	**Method**
	CalTest 643	CalTest 422	CalTest 417	CalTest 643
	June 2007	April 2000	March 1999	June 2007

Mike Galloway

Figure 12



Notes:

1. For slopes greater than 20' high an intermediate bench at least 8 feet wide shall be constructed
2. Refer to geotechnical report for compaction testing
3. Downslope side of keyway to be at least 2 feet deep below native grade, to be verified by Geotechnical Engineer
4. Drawing is not to scale
5. Refer to Geotechnical Report for subdrain construction requirements
6. Fills Situated on slopes steeper than 5:1 (H:V) should be keyed and benched
7. DRAWING FOR ILLUSTRATIVE PURPOSES ONLY

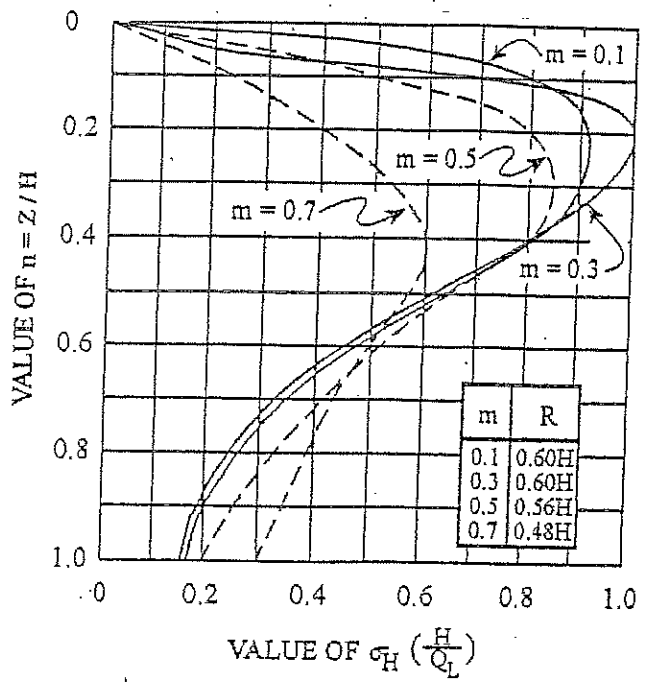
KEY AND BENCH DETAIL
COMMERCIAL RETAIL AND TOWN HOMES
SCOTTS VALLEY DRIVE AND DUNSLEE WAY
SCOTTS VALLEY, CALIFORNIA

SCALE	No Scale
DRAWN BY	MC
DATE	MARCH 2015
REVISED	
JOB NO	SC10808

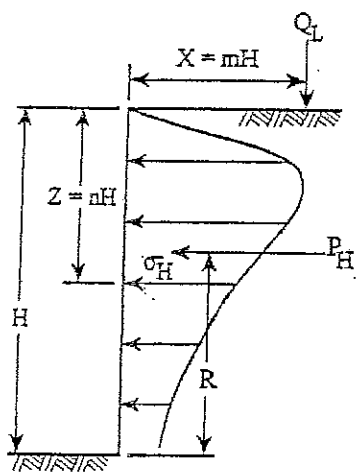
HARO, KASUNICH & ASSOCIATES, INC.
GEOTECHNICAL AND COASTAL ENGINEERS
116 E. LAKE AVENUE, WATSONVILLE, CA 95076
(831) 722-4175

Figure No. 13

LINE LOAD



m	R
0.1	0.60H
0.3	0.60H
0.5	0.56H
0.7	0.48H



FOR m ≦ 0.4:

$$\sigma_H \left(\frac{H}{Q_L}\right) = \frac{0.20\,n}{(0.16 + n^2)^2}$$

$$P_H = 0.55\,Q_L$$

FOR m > 0.4:

$$\sigma_H \left(\frac{H}{Q_L}\right) = \frac{1.28\,m^2 n}{(m^2 + n^2)^2}$$

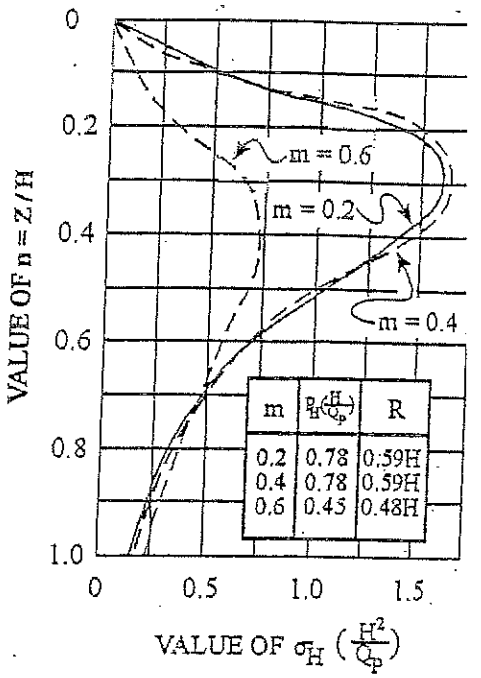
RESULTANT $P_H = \dfrac{0.64\,Q_L}{(m^2 + 1)}$

PRESSURES FROM LINE LOAD Q_L

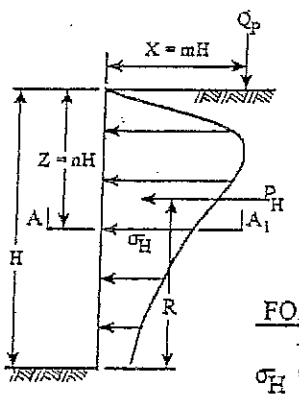
(BOISSINESQ EQUATION MODIFIED BY EXPERMENT)

REFERENCE: Design Manual
NAVFAC DM-7.02
Figure 11
Page 7.2-74

POINT LOAD



m	$P_H\left(\frac{H}{Q_P}\right)$	R
0.2	0.78	0.59H
0.4	0.78	0.59H
0.6	0.45	0.48H



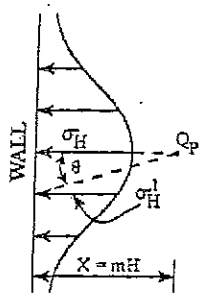
FOR m ≦ 0.4:

$$\sigma_H \left(\frac{H^2}{Q_P}\right) = \frac{0.28\,n^2}{(0.16 + n^2)}$$

FOR m > 0.4:

$$\sigma_H \left(\frac{H^2}{Q_P}\right) = \frac{1.77\,m^2 n^2}{(m^2 + n^2)^3}$$

$$\sigma_H^1 = \sigma_H \cos^2(1.1\,\theta)$$



SECTION A-A_1

PRESSURES FROM POINT LOAD Q_P

(BOISSINESQ EQUATION MODIFIED BY EXPERMENT)

Haro Kasunich & Associates Geotechnical and Coastal Engineers	Surcharge Pressure Diagram NAVFAC 7.2 Figure 11, Page 7.2-74	Project No. SC10808 Town Homes SVD Scotts Valley Drive, CA March 2015	Figure No. 14

Project No. SC10808
16 March 2015

APPENDIX B

Scale of Acceptable Risks From Non-Seismic Geologic Hazards

APPENDIX B SCALE OF ACCEPTABLE RISKS FROM NON-SEISMIC GEOLOGIC HAZARDS*		
RISK LEVEL	**STRUCTURE TYPE**	**RISK CHARACTERISTICS**
EXTREMELY LOW RISKS	Structures whose continued functioning is critical, or whose failure might be catastrophic: nuclear reactors, large dams, power intently systems, plants manufacturing or storing explosive or toxic materials.	Failure affects substantial populations risk equals nearly zero.
VERY LOW RISKS	Structures whose use is critically needed after a disaster: important utility centers: hospitals: fire, police, and emergency communication facilities; fire stations; and critical transportation elements such as bridges and overpasses; also smaller dams.	Failure affects substantial populations.
LOW RISKS	Structures of high occupancy, or whose use after a disaster: important utility centers; hospitals; fire, police, and emergency communication facilities; fire stations; and critical transportation elements such as bridges and overpasses; also smaller dams.	Failure of a single structure would affect primary only the occupants.
"ORDINARY RISKS"	The vast majority of structures: most commercial and industrial buildings; small hotels and apartment buildings, and single-family residences.	Failure only affects owners/occupants of a structure rather than a substantial population. No significant potential for loss of life of serious physical injury. Risk level is similar or comparable to other ordinary risks (including seismic risks) to citizens of coastal California. No collapse of structures; structural damage limited to repairable damage in most cases. This degree of damage is unlikely as a result of storms with a repeat time of 50 years or less.
MODERATE RISKS	fences, driveways, non-habitable structures, detached retaining walls, sanitary landfills, recreation areas and open space.	Structure is not occupied or occupied infrequently. Low probability of physical injury. Moderate probability of collapse.

***Non-seismic geologic hazards include flooding, landslides, erosion, wave run-up and sinkhole collapse.**

APPENDIX B SCALES OF ACCEPTABLE RISKS FROM SEISMIC GEOLOGIC HAZARDS		
LEVEL OF ACCEPTABLE RISK	**KINDS OF STRUCTURES**	**EXTRA PROJECT COST PROBABLY REQUIRED TO REDUCE RISK TO AN ACCEPTABLE LEVEL**
Extremely Low	Structures whose continued functioning is critical, or whose failure might be catastrophic nuclear reactors, large dams, power intently systems, plants manufacturing or storing explosives to toxic materials.	No set percentage (whatever is required for maximum attainable safety).
Slightly higher than under level 1[1]	Structures whose use is critically needed after a disaster; important utility centers; hospitals; fire, police, and emergency communication facilities; fire station; and critical transportation elements such as bridges and overpasses; also smaller dams.	5 to 25 percent of project cost.
Lowest possible risk to occupants of the structure [3]	Structures of high occupancy or whose use after a disaster would be particularly convenient; schools, churches, theaters, large hotels, and other high-rise buildings housing large numbers of people, other places normally attracting large concentrations of people civic buildings such as fire stations, secondary utility structures, extremely large commercial enterprises, most roads,alternative or non-critical bridges and overpasses.	5 to 15 percent of project cost.
An "ordinary" level or risk to occupants of the structure [3,5]	The vast majority of structures; most commercial and industrial buildings, small hotels and apartment buildings and single-family residences.	1 to 2 percent of project cost in most cases (2 to 10 percent of project cost in a minority of cases)[4]

1. Failure of a single structure may affect substantial populations.

2. These additional percentages are based on the assumption that the base cost is the total cost of the building or other facility when ready for occupancy. In addition, it is assumed that the structure would have been designed and built in accordance with current California practice. Moreover, the estimated additional cost presumes that structures in this acceptable-risk category are to embody sufficient safety to remain functional following an earthquake.

3. Failure of single structure would affect primarily only the occupants.

4. These additional percentages are based on the assumption that the base cost is the total cost of the building or facility when ready for occupancy. In addition, it is assumed that the structures would have been designed and built in accordance with current California Practice. Moreover, the estimated additional cost presumes that structures in this acceptable-risk category are to be sufficiently safe to give reasonable assurance of preventing injury or loss of life during and following an earthquake, but otherwise not necessarily to remain functional.

5. "Ordinary Risk": Resist minor earthquakes without damage; resist moderate earthquakes without structural damage but with some non-structural damage; resist major earthquakes of the intensity or severity of the strongest experienced in California, without collapse, but with some structural, as well as non-structural damage. In most structures, it is expected that structural damage, even in a major earthquake, could be limited to repairable damage. (Structural Engineers Association of California).

Source: Meeting The Earthquake Challenge, Joint Committee on Seismic Safety of the California Legislature, January 1974, p.9.