Services	Geotechnical Engineering Study
Project	Proposed Rovina Apartments
Location	Petaluma, California
Client	Pacific West Communities, Inc.
Project No.	05-23040G
Date	September 22, 2023

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GEOTECHNICAL ENGINEERING STUDY
PROPOSED ROVINA APARTMENTS
2 ROVINA LANE
PETALUMA, CALIFORNIA 94952

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September 22, 2023
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INTRODUCTION

PURPOSE AND SCOPE OF STUDY

This report presents the results of our Geotechnical Engineering Study for the proposed improvements to be designed and constructed on the above referenced subject site (refer to the Location Plan, Figure 1, Appendix A). The purpose of the study is to evaluate the general conditions of the earth materials at the site to provide conclusions and recommendations related to the geotechnical and geological aspects of the project as discussed in ACG's proposal / agreement of June 23, 2023, and executed on July 17, 2023. The scope of our work included a site reconnaissance, review of client provided and readily available published documents (including aerial images, topographic maps, and nearby groundwater levels), exploring and sampling the general subsurface earth conditions, checking for groundwater, performing percolation testing, performing soil mechanics laboratory tests, preliminarily assessing potential for geological hazards (including liquefaction and expansive soil conditions), performing geotechnical analysis, and making recommendations for earthwork, foundation design, lateral resistance, floor slab-on-grade support, and on-site pavements.

The attached Appendices contain further information including graphic presentations (Site Vicinity Map and Map of Explorations - Appendix A); field exploration procedures and logs of subsurface explorations (Appendix B); laboratory testing, and procedures used (Appendix C); Guide Specifications for Earthwork (Appendix D); and SEAOC/OSHPD U.S. Seismic Design Maps (Appendix E).

PROJECT LOCATION

The project is proposed on a 1.00+/- acre parcel (APN: 019-210-009) in the City of Petaluma, Sonoma County, California. The project site is located at the northeastern corner of the intersection between

Rovina Lane and Jacquelyn Lane. The subject site is bounded by vacant land to the north, residential property to the east, Jacquelyn Lane to the south, and Rovina Lane to the west.

PROPOSED PROJECT INFORMATION

In preparing this report we reviewed the architectural site plan by SDG Architects, Inc., May 22, 2023, "TPC Rovina Lane - Site Plan Option D" (Sheet A01.D); preliminary grading plan by Atlas Civil Design, August 24, 2023, "2 Rovina Lane"; and Google Earth aerial photography (5/13/2023) related to the subject site. Based on the referenced plans, the proposed project will consist of the design and construction of two (2) three-story apartment buildings. Site improvements also include a dog run, paved access lanes and parking spaces, sidewalks, and landscaping. Based on the preliminary grading plan. overall finished grade elevation changes are expected to be in order of up to approximately 9 feet cut and up to approximately 7 feet fill, but the final grading plans were not available for review at the time of this report preparation.

FINDINGS

SITE HISTORICAL BACKGROUND

A Google Earth aerial image of July 1993 indicates the site was occupied by a building in the northern portion and a radio antenna in the central portion of the site. Rovina and Jacquelyn Lanes were not yet constructed. A June 2007 Google Earth aerial image shows Rovina Lane was constructed and the residential developments to the east, south, and west of the site and Jacquelyn Lane are under construction. A Google Earth aerial image of October 2017 shows the site and surrounding areas appeared similar to the current configurations as indicted in the Project Location and Site Description sections.

SITE DESCRIPTION

During our site visit on August 29, 2023, access to the site was through Rovina Lane in the northwestern corner of the site. The subject site was vacant and covered with grasses and weeds. The ground surface in the southeastern portion of the site sloped down toward the northwest with an approximate slope gradient of 7 horizontal to 1 vertical (7H:1V). s\Slightly sloped ground was in the northwestern portion of the site. The building in the northern portion and the radio antenna in the central portion of the site were razed. Footings trenches were noted at the location of the razed building. Some trees were scattered along the boundaries of the site. Overall drainage of the subject site trended generally northwesterly.

GEOLOGY

Based on our review of readily available published geologic literature/maps (CGS "Geologic map and map database of parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California", 2000; scale 1:75,000) the site is mapped to be underlain by Cretaceous and Jurassic Metamorphic Rock (Map Symbol: KJfm). The total thickness of the formation was not determined and is beyond the scope of this study. ACG considers the native earth materials discovered in the subsurface explorations are consistent with the mapped earth materials.

EARTH MATERIAL CONDITIONS

As shown on the Exploratory Logs (Appendix B), the subsurface earth material conditions varied somewhat. The uppermost soil encountered in borings B-3, B-4, B-6, and B-7 consisted of stiff to hard, moist, brown and dark brown, Sandy CLAY and Sandy CLAY with variable Gravel (Unified Soil Classifications: CL) to refusal in hard rock at depths varying between approximately 1½ to 11½ feet below existing ground surface (begs).

The uppermost soil discovered in Borings B-1, B-2 and B-5 was undocumented fill that consisted of stiff, moist, brown and dark brown, Sandy CLAY with Gravel (CL or CH) to depths varying between approximately 3½ to 4 feet begs to refusal on hard rock was encountered. Below the uppermost undocumented fill in boring B-5 was encountered hard, moist, light brown with orange, Sandy SILT (ML) to a depth of approximately 10½ feet begs that was underlain by a layer of very dense, moist, light brown with orange mottled, Silty SAND (SM) to a depth of approximately 12 feet begs. The earth materials encountered below the Silty Sand layer consisted of medium stiff to very stiff, moist, brown and light brown with orange mottled, Sandy SILT (ML) and dense, moist, gray, Silty SAND with Rock Fragments (SM) to the maximum explored depth of approximately 21½ feet begs.

Since the earth material profile is generalized, the reader is advised to consult the Explorations Logs contained in Appendix B, if the earth material conditions at a specific depth and location are desired. The logs contain a more detailed earth material description regarding color, earth material type, and Unified Soil Classification System (USCS) symbol.

Earth material conditions cannot be fully determined by surface and subsurface explorations and earth material sampling. Hence, unexpected earth material conditions might be encountered during construction. If earth material conditions are encountered during construction which vary from earth materials encountered during the investigation, then appropriate recommendations will be needed during construction. Therefore, we suggest a contingency fund for additional expenditures that might have to be made due to unforeseen conditions.

INFILTRATION TEST RESULTS

Three (3) percolation test borings (P-1, P-2 and P-2) were drilled on August 29, 2023, to approximate depths of 2 to 4½ feet begs as shown in Table 1 below. Refusal in hard Rock was encountered in Percolation Borings P-1 and P-3 at depths indicated in Table 1, below. The percolation test locations and depths were determined per the Civil Engineer for the proposed infiltration basin's locations. Please refer the attached "Explorations Location Map" in Appendix A for approximate locations of the percolation test holes.

The soils encountered in the percolation test borings are consistent with the conditions found in the exploratory borings. The sidewalls of each boring were scored along the outer walls to reduce the effects of smearing. Approximately six (6)-inches of clean pea gravel was added to the bottom of each test hole. In each test hole a 2-inch inner diameter (ID) slotted PVC pipe was installed on top of the gravel. Pea gravel was placed in the annular space between the boring wall and pipe.

Each hole was filled with water to let the soils presoak before performing the tests. Following the presoak time each test boring was filled with water to at least 12 inches above the bottom of the boring. The drop in water level was measured at specific time intervals until a steady rate of drop in water level was obtained when at least three consecutive readings were within 10 percent from each other. Pre-adjusted percolation rates were determined by dividing the drop in water level over the time required for the drop in water level. The infiltration rates were estimated using the percolation rate divided by a Conversion Factor for non-vertical flow. The test results are shown on Table 1, below.

TABLE 1. RESULTS OF PERCOLATION TESTS

TEST NO.	DEPTH (ft)	CALCULATED INFILTRATION RATE (in/hr)	SOIL CLASS	Refusal Depth, if encountered (ft)
P-1	2	0.15	Sandy CLAY	2
P-2	4.5	0.04	Sandy CLAY	Not Encountered
P-3	2.5	0.09	Sandy CLAY	2.5

The infiltration rates of water into near surface soils (per the test method referenced and results on Table 1, above) could be used by the General Civil Engineer as a preliminary infiltration rate at the locations indicated. A safety factor was not applied to these values. During construction of the infiltration basins ACG recommends confirmation infiltration testing at the bottom of the basin be performed (e.g., with a double ring infiltrometer).

GROUNDWATER CONDITIONS

Observations of groundwater conditions were made during and just after drilling the exploratory borings. Free groundwater was not encountered during our subsurface investigation.

SOIL CORROSION SCREENING

A representative bulk sample of the near surface soil was collected and transported to Sunland Analytical in Rancho Cordova, California for testing soil corrosivity potential. The test methods for pH, minimum resistivity (CA DOT Test #643), sulfate content (CA DOT Test #417), and chloride content (CA DOT Test #422m) are shown in the following Table.

TABLE 2. CORROSIVITY TEST RESULTS	
Sample ID	B4@0-2’
Soil pH	5.93
Minimum Resistivity (ohm-cm)	1.93
Chloride Content (ppm)	4.0
Sulfate Content (ppm)	13.6

Allerion is not a corrosion engineering firm. We recommend a licensed Corrosion Engineer be consulted to evaluate the above test results, assess the soil corrosion potential, and design resistant materials.

CONCLUSIONS AND DISCUSSIONS

SITE SUITABILITY AND GEOTECHNICAL CONSIDERATIONS

From a geotechnical standpoint, the site is considered suitable for the proposed construction provided the conclusions and recommendations presented in this report are incorporated into the design and construction of the project. Geotechnical considerations that were evaluated by our office include disturbed soils and loose topsoil, which are discussed in the following sections of this report.

BEARING CAPABILITY

Field and laboratory tests show that the affirmed undisturbed, native earth materials encountered at the exploration locations are considered competent for support of the proposed construction. The upper loose / soft soils and any disturbed soils (includes undocumented fill) that are present at the time of construction are not considered stable and should not be utilized to directly support new structural elements. Mitigation measures for unsuitable soil conditions are discussed in the Recommendations section of this report. Mitigation measures considered include removal and replacing the disturbed and/or loose soils with engineered fill; or, foundation elements designed to extend through the unsuitable soils.

Engineered fill, composed of approved materials placed and compacted according to the following recommendations, are considered competent for support of low to moderate loading increases.

COMPRESSIBLE AND EXPANSIVE SOILS

Compressible materials consisting of surficial disturbed material, loose soils, undocumented fills, debris, rubble, rubbish, etc., are considered unsuitable materials for support of the proposed structures. Such materials can differentially settle. We consider that any undocumented fill encountered and disturbed soft and/or loose soil materials in the construction areas should be removed and replaced with engineered fill, or special foundation mitigation measures designed. Overexcavated earth materials deemed suitable for re-use as engineered fill could be stockpiled. If the unsuitable materials are not removed, then special foundation systems should be designed to account for the potential settlements. In areas where unsuitable or soft/loose, wet soils are encountered, remedial grading should be undertaken to remove the soft/loose soils and ensure the removal of the entire disturbed soils.

Engineered fill, composed of approved granular materials placed and compacted according to those discussed in the recommendations section, below, are considered competent for support of low to moderate loading increases anticipated for this project.

Based on visual observation and on laboratory test results performed on representative soil samples, (plasticity index (PI) of 30 and fines percent of 51 to 67; and Expansion Index (EI) of 44), the expansion potential of the uppermost soils is considered to be moderate. Thus, the potentially expansive clays are considered capable of developing expansive pressures that could be detrimental to the completed construction -- the amount of ground movement could be enough to cause heaving and cracking of concrete flatwork (sidewalks, driveways, floor slabs, etc.), as well as foundation and floor slab differential movement. Mitigation measures for the potentially expansive clay soils are presented in the Recommendations section of this report.

GROUNDWATER AND SEASONAL MOISTURE

As previously mentioned, free groundwater was not encountered in our subsurface explorations. Groundwater levels could be seasonal – varying between the winter and summer months. It is our opinion that perched groundwater might have an impact on the proposed design or construction depending on the foundation system selected by designers and depths of underground structures. If wet-season construction is undertaken, then groundwater seepage into excavations is expected to be generally controllable by pumping/diversion; likewise, inflow from surface (dependent on quantity and duration of storm intensity/rainfall) is expected to be similarly controllable as temporarily necessary. **If the uppermost soils should become saturated, then this condition would likely impede or delay grading operations**.

Groundwater levels can fluctuate on a seasonal basis due to changes in precipitation, irrigation, pumping, etc. We consider groundwater levels might change based on site topography and the time our investigation was performed. Excavations below perched groundwater (if encountered) might be impacted by seepage; therefore, we recommend grading and utility excavations be performed during dry season when groundwater levels are lowest.

SEISMIC HAZARDS

Seismic ground shaking of the earth materials underlying the site can cause ground failures, including fault rupture, liquefaction and densification, lateral spreading, landsliding, and tsunamis / seiches. The following sections discuss our conclusions / opinions regarding these conditions based on our findings and literature review.

Fault Rupture

Fault rupture hazards are important near active faults and tend to reoccur along the surface traces of previous fault movements. The site is not located within an Alquist-Priolo Special Studies Zone. We consider the potential for fault rupture, damage from fault displacement, or fault movement directly below the site to be very low. However, the site is located within an area where shaking from earthquake generated ground motion waves should be considered likely.

Seismic Ground Shaking

The mapped and design spectral response accelerations (refer to Appendix E) presents seismic design criteria for the subject project site obtained from the SEAOC/OSHPD Seismic Design Maps (https://seismicmaps.org) that are based on data provided by ASCE 7-16 and are for use with the 2022 California Building Code (CBC). The values for spectral response accelerations with a Risk Category of II are summarized on the following table.

Table 3. Mapped and Design Spectral Accelerations	
Description	**Value**
Site Soil Classification[1]	C
Site Latitude, Longitude	38.22554, -122.62004
S_S - Spectral Acceleration for a Short Period	1.5 g
S_1 - Spectral Acceleration for a 1-Second Period	0.6 g
S_{MS} - MCE_R, 5% damped Spectral Acceleration for a Short Period	1.8 g
S_{M1} - MCE_R, Spectral Acceleration for a 1-Second Period[1]	0.84 g
S_{DS} - design, 5% damped, Spectral Acceleration for a Short Period	1.2 g
S_{D1} - design, 5% damped, Spectral Accel. for a 1-Second Period[1]	0.56 g
Seismic Design Category[2]	D
T_L	16
PGA	0.623 g
PGA_M	0.747 g
F_{PGA}	1.2

[1] The *2022 CBC* requires an earth material profile determination extending to a depth of 100 feet for site soil classification. ACG's explorations extended to depth of about 21½ feet begs, and Site Soil Class C is selected based on soils conditions encountered in our borings. [2]In general accordance with the 2022 CBC (refers to ASCE 7-16) Seismic Design Category is based on spectral acceleration for a 1-sec Period, short & 1-sec period response acceleration parameters (S1, SDS & SD1, respectively) and corresponding Risk Category. Please refer to Appendix E for the U.S. Seismic Design Maps printout.

Liquefaction and Seismic Settlement Evaluation

Liquefaction occurs when saturated fine-grained sands and/or silts lose their physical strength temporarily during earthquake induced shaking and behave as a liquid. This is due to loss of point-to-point grain contact and transfer of normal stress to the pore water. Liquefaction potential varies with water level, soil type, material gradation, relative density, and probable intensity and duration of ground shaking. Dynamic settlement of the soils that experience liquefaction may occur after earthquake shaking has ceased.

The California Geological Survey (CGS) has designated certain areas within California as potential liquefaction hazard zones. These are areas considered at risk of liquefaction-related ground failure during a seismic event based upon mapped surficial deposits and the depth to the areal groundwater table. The project site is not currently mapped for potential liquefaction hazard by the CGS (refer to CGS website: https://www.conservation.ca.gov/cgs/earthquakes).

Subsurface information indicates the site is predominately underlain by generally stiff to hard sandy clay and sandy silt dense to very dense silty sand soils, and hard Rock to the maximum depth explored of approximately 21½ feet begs at the time of our investigation. Based on the information discussed above, it is our opinion that the potential for liquefaction at the site is low if a seismic event should occur that might impact the site.

Ground Lurching

Ground lurching is a result of the rolling motion imparted to the ground surface due to seismic waves released by an earthquake that can cause cracks in weaker soils. The potential for cracking at this site is considered low due to the generally hard soil consistencies and dense relative densities.

Earthquake Induced Landsliding

Based on information available on the California Geological Survey (CGS) website the subject site is not currently within a State of California Seismic Hazard Zone for seismically induced landsliding. In addition, the site has slopes with approximate gradient of 7H:1V and there are no steep slopes on or adjacent to the subject site. Therefore, seismically induced and/or other landslides are not considered a significant hazard at the site.

Tsunamis and Seiche Evaluation

The site is not located near large bodies of water and the site is located at varying elevations between approximately 35 and 60 feet above MSL. Based on the geometry of the site, the potential for tsunami damage or damage caused by oscillatory waves (Seiche) is considered unlikely at the site.

ON-SITE EARTH MATERIALS SUITABILITY

On-site clay soils like those encountered in the test borings are generally considered unsuitable for re-use as engineered fill. Rubble, rubbish, oversize materials, significant organic matter, highly plastic soil, or any other substance deemed unsuitable should not be used as engineered fill. Import granular, low to non-expansive granular soils and/or lime-treated clay soils could be used for engineered fill.

EXCAVATION CONDITIONS

It is anticipated that the soil materials encountered to depths varying between approximately 1½ to 21½ at the site can be readily moved by conventional earth moving equipment. The underlying hard bedrock is expected to require moderate to severe ripping by large excavation equipment to effect removal.

POTENTIAL SLOPE STABILITY

No landslides, slumps, or other indications of slope instabilities were observed in the site area during our field investigation. Based on the soils conditions encountered during our subsurface investigation, we consider the potential for slope instability to be low if the proposed improvements are designed and constructed per the recommendations of this report.

RECOMMENDATIONS

Recommendations for earthwork and the design and construction of the proposed structure(s) and associated improvements follow. All recommendations could require modifications based on conditions encountered during earthworks and general construction. In addition, changes in the locations of the proposed structures and pavements could also necessitate modifications to the recommendations provided herein.

EARTHWORK

Earthwork specifications which may be used as a guide in the preparation of contract documents for site preparation / grading are included in Appendix D. However, recommendations in the text of this report supersede those presented in Appendix D. **The conclusions and recommendations contained in this report should be incorporated into the guide specifications.**

Site Clearing and Stripping

Each building pad is considered to extend laterally away from (outside of) all perimeter foundation/building edges at least five (5) feet in plan view, or to edges of any adjacent features restricting this width. We recommend the construction areas be cleared of all obstructions or unsuitable materials, including all loose, wet, or disturbed soil, undocumented fill, rubble, rubbish, vegetation, structural elements (includes pavements) to be razed, and any buried utility lines to be removed. Any foundations, pavements, cisterns, septic tanks, leach fields, water wells, etcetera that might be encountered and are to be abandoned should be removed. **Any undocumented fill and loose/soft soils overlying the underlying firm earth materials should be overexcavated and, if deemed suitable (expansive clay soil would need to be lime treated or removed and replaced with engineered fill), be re-processed as engineered fill or off-hauled.** In addition, in areas where trees have been or will be cleared, remedial grading is recommended to remove the loose soils and to ensure the removal of the entire tree root systems. The resulting subgrades of excavation(s) should be prepared and filled to planned project subgrade level with engineered fill as discussed in the following sections.

Excavations resulting from the removal of unsuitable materials and/or soft/loose soils should be cleared to expose firm, stable material. The surface of the resulting excavations should be scarified to a depth of 8 inches and backfilled with approved earth materials compacted to the requirements given below under subgrade preparation. Intact rock should not be scarified. Utilities that extend into the construction area and are scheduled to be abandoned should be properly capped or plugged with grout at the perimeter of the construction zone or moved as directed in the plans. It may be feasible to abandon on-site utilities in-place by filling them with grout, provided they will not interfere with future utilities or affect building foundations. The utility lines should be addressed on a case-by-case basis.

In conjunction with clearing, the improvement areas should be stripped to sufficient depth to remove all organic laden topsoil. The actual stripping depth should be determined by our representative at the time of construction. The cleared and stripped materials should be removed from the site or stockpiled for possible use as landscape materials.

Over-excavation Recommendations

Due to differential movement considerations and due to the variable depth of the bedrock across the site, we recommend building foundations, slabs-on-grade, concrete flatwork, and structural pavements bear on engineered fill. We recommend the earth materials be

overexcavated to estimated depth of at least three (3) feet below existing ground surface (begs), or at least 24 inches below the bottom of the structure's foundation, whichever is deeper. The resulting overexcavation should be backfilled with engineered fill comprised of low to non-expansive granular soils meeting the "*Material for Fill*" section of this report.

The overexcavation limits should extend laterally to at least 5 feet beyond the proposed buildings footprint, or to where practical, as affirmed by ACG's representative.

We recommend concrete slabs-on-ground, flatwork and structural pavements bear on at least 12 inches of engineered fill comprised of low to non-expansive granular soils and/or lime treated native clay soil.

Soils to be used for engineered backfill should be per the criteria in the following recommendations *"Material for Fill"* section. Lime treated soils, if used, should be per the criteria in the following recommendations "Clay Treatment Option". All materials should be placed and compacted per the *"Fill Placement and Compaction"* section.

<u>Subgrade Preparation</u>

Once the construction areas have been cleared, any unsuitable soils over-excavated, and any other excavations made, then subgrades that will receive engineered fill, that are to be left at existing grade, or that represent final subgrades in soil achieved by excavation should be scarified to at least 8 inches. Suitability of soils exposed in the bottoms of all subgrades should be verified by an ACG special inspector during site grading. Upon favorable review, exposed soil subgrades should be scarified and recompacted (in-place) an additional 8 inches and/or prior to placing engineered fill materials to planned rough pad grade. The scarified soils should be uniformly moisture conditioned as determined by ACG's field representative based upon the compaction characteristics of the earth material (typically 1 to 3 percent over optimum for granular soils and 2 to 4 percent over optimum for fine grained, clayey soils) and compacted to at least 90 percent relative compaction per ASTM D 1557. The geotechnical engineer's special inspector should observe the recompacted subgrades be proof-rolled with very heavy construction equipment (e.g., loaded water truck) in order to verify subgrade earth material stability. Inability to achieve the stated moisture content, compaction, or instability of the subgrade materials unsuitable conditions and would be used as criteria for the removal of loose, wet, or soft soils, or for the need of special stabilizing measures.

Construction equipment on saturated soils could destabilize the earth materials, sometimes to several feet of depth, which might necessitate further over excavation and/or special stabilization measures.

An ACG special inspector should observe and approve the bottom of all overexcavations to confirm adequate conditions have been reached and should observe and approve the scarification, moisture conditioning and recompaction of the excavated surfaces.

Clay Treatment Option

On-site expansive clay soils should be lime-treated or removed and replaced with engineered fill. For lime treatment and for preliminary planning purposes only, we suggest three to four percent (3 to 4%) lime to be mixed with the on-site clayey soils. We recommend that representative samples of the actual subgrade soils be obtained just after completion of the clearing and stripping, and tests run to confirm lime quantity needed. If guide specifications for lime treatment are desired, then please contact our office.

Material for Fill

All fill materials should be inorganic, granular soils free of vegetation, debris, and fragments larger than three inches in size. Pea gravel or other similar non-cementitious, poorly graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer. Imported earth materials and or earth materials from onsite borrow areas may be used as engineered fill material for general site grading, foundation backfill, foundation areas, trench backfill, slab areas, and pavement areas, provided they meet the following criteria. All fill materials from any source (on-site or off-site) to be used for engineered fill should be pre-approved by ACG and should be observed by our representative and samples obtained for laboratory testing (if required) at least four days prior to any materials being used for engineered fill.

Gradation (ASTM C 136)	**Percent Finer by Weight**
3”	100
No. 4 Sieve	25 - 100
No. 200 Sieve	10 – 35

- Liquid Limit .... 35 (max)
- Plasticity Index .... 15 (max)
- Maximum expansive index (ASTM D 4829) .... 40 (max)

Fill Placement and Compaction

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Materials for engineered fill should be spread and compacted in lifts not exceeding 8 inches in uncompacted thickness. Engineered fill placed at the site and subgrades requiring recompaction should be uniformly compacted to at least 90 percent relative compaction in building areas, and to at least 95 percent relative compaction in the upper 12-inches of pavement and flatwork areas, as determined by ASTM Test Designation D 1557, or to the method as might be determined by an ACG special inspector. The moisture content of engineered fill materials should be determined by ACG’s field representative based upon the compaction characteristics of the earth material (typically 1 to 4 percent over optimum). ACG should continuously observe and test the grading and earthwork operations. Such observations and tests are essential to identify field conditions that differ from those predicted by this investigation, to adjust these recommendations to actual field conditions encountered, and to verify that the grading is in overall accordance with the recommendations presented in this report and the 2022 CBC.

If construction proceeds during or shortly after the wet winter months, it may require time to dry the on-site soils since their moisture content would probably be appreciably above the optimum. In addition, if subgrade soils are wet at the time of construction, they could be rutted, loosened, or otherwise disturbed to several feet of depth by the construction equipment and require additional over-excavation and/or stabilization.

Construction occurring in later summer or early fall (after on-site earth materials becoming dry) may require substantial amounts of water to be added during earthwork operations to enable the appropriate moisture content and compaction to be achieved.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of foundations, exterior flatwork/slabs, and pavements. Construction traffic over the completed subgrade should be avoided to prevent disturbance of subgrade soils. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade consisting of engineered fill should become desiccated, saturated, or disturbed, the affected material should be removed, or these materials should be scarified, moisture conditioned, and recompacted prior to construction.

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

Utility Trench Backfill

Generally, utility trenches should be backfilled with mechanically compacted fill placed in lifts not exceeding 6 inches in uncompacted thickness. Water content of the fill material should be adjusted (typically 1 to 4 percent over optimum) during the trench backfilling operations to obtain compaction. If granular on-site soil or import fill material is used, then the material should be compacted to at least 90 percent relative compaction. Imported sand could also be used for bedding and shading backfill in trenches provided the sand is compacted to at least 95 percent relative compaction. **Public and private utility companies' standard plans and specifications should be adhered to when backfilling their utility trenches.**

Utility trenches should be plugged with lean concrete wherever the utility line passes beneath the perimeters of the structure. The plug should be at least one foot on either side of the perimeter of the building perimeter foundation and extend from the bottom of the building foundation to the bottom of the trench.

Finish Grading and Site Drainage

We consider on-site soils to be slightly susceptible to erosion where drainage concentrations occur. Concentrated flowing water should be either dissipated or channeled to appropriate discharge facilities. Appropriate erosion control measures should be provided, where applicable, by the general civil engineer on his grading and/or winterization plan.

Positive surface gradients should be provided adjacent to the building and pavement areas (includes flatwork) to direct surface water away from the building and pavements for at least ten feet and toward suitable discharge facilities. Ponding of surface water should not be allowed adjacent to the building or pavements or on top of pavement. Positive drainage should be provided during construction and maintained throughout the life of the project. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Backfill against foundations, exterior walls, and in utility and sprinkler line trenches should be well compacted as previously recommended and free of all construction debris to reduce the possibility of moisture infiltration. We recommend a horizontal setback distance of at least 10 feet from the perimeter of any building and the high-water elevation of the nearest storm-water retention.

Downspouts, roof drains or scuppers should discharge into splash blocks or extensions when the ground surface beneath such features is not protected by exterior slabs or paving. Sprinkler systems should not be installed within 5 feet of foundation walls. Landscaped irrigation adjacent to the foundation system should be minimized or eliminated.

All grades must provide effective drainage away from the building during and after construction. Water permitted to pond next to a building can result in greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential floor slab movements, cracked slabs and walls, vapor transmission issues in interior slabs, and roof leaks. Estimated movements described in this report are based on effective drainage for the life of the structures and cannot be relied upon if effective drainage is not maintained.

Per 2022 CBC Section 1804.4, the soil ground surface should be sloped at least 5 percent (2 percent for pavement) down and away from the building for at least of 10 feet beyond the perimeter of the building or pavement. After building construction and landscaping, we recommend the Civil Engineer and/or surveyor verify final grades to document that effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary, as part of the structure's maintenance program.

Cut and Fill Slopes

The permanent excavation and embankment slopes up to 10 feet of height in soil should be graded at an inclination of 2 horizontal to 1 vertical (2H: 1V) or flatter. The crowns of all slopes should be constructed so that surface run-off water is not allowed to flow over the faces of the slopes. All cut slopes should be observed during grading by the Geotechnical Engineer and/or Engineering Geologist to determine if any adverse defects are present. If defects are observed, then additional study and/or recommendations would be made at that time.

For temporary excavations, the individual contractor(s) is/are responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

Earthwork Construction Considerations

At the time of our study, moisture contents of the surface and near-surface native soils were low. Based on these moisture contents, some moisture conditioning will likely be needed for the project to make the soil compactible and suitable for use as engineered fill. The soils may need to be dried by aeration during wet weather conditions, or a chemical treatment, such as cement, lime, or kiln dust, may be needed to stabilize the soil. The soils may need more moisture and water during the dry season to make the soil compactible and suitable. Subgrade conditions may require a rock protective mat covering of exposed subgrades to limit disturbance of the site soils as well as provide a stable base for construction equipment.

Although the exposed subgrades are anticipated to be relatively stable upon initial exposure, on site soils may pump and unstable subgrade conditions could develop during general construction operations, particularly if the soils are wet and/or subjected to repetitive construction traffic. The use of light construction equipment would aid in reducing subgrade disturbance. The use of remotely operated equipment, such as a backhoe, would be beneficial to perform cuts and reduce subgrade disturbance. If unstable subgrade conditions develop, then stabilization measures will need to be employed. Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content just prior to construction of the floor slabs and pavements. Construction traffic over the completed subgrades should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed, or these materials should be scarified, moisture conditioned, and recompacted prior to floor slab and pavement construction.

We anticipate that site grading for concrete foundations, slab construction, pavements and shallow utility trenches could be performed with conventional earthmoving equipment.

We emphasize the contractor is responsible for designing and constructing stable, temporary excavations (including utility trenches) as required to maintain stability of both the excavation sides and bottom and should be in accordance with OSHA excavation and trench safety standards.

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

Geotechnical Engineering Earthwork Construction Observation

As previously discussed, variations in subsurface conditions are possible and may be encountered during construction. In order to permit correlation between the preliminary subsurface data obtained during this investigation and the actual subsurface conditions encountered during construction, as well as affirm substantial conformance with the plans and specifications, a representative of this firm should be present during all phases of the site earthwork to make tests and observations of the site preparation, selection of satisfactory fill materials, proof rolling, placement and compaction of controlled compacted fills, backfilling of excavations to the completed subgrade, etc. Additionally, if lime or cement treatment is needed to stabilize or dry the soil, then our representative should perform observations during mixing, remixing, and compaction.

Any site earthwork performed without the presence of our representative will be entirely at the grading contractor's and/or owner's risk and no responsibility for such operations will be accepted by our firm. Sufficient notification **(at least two working days)** is necessary so that our special inspections and testing will coincide with the construction schedule.

We emphasize the importance of ACG's presence during the observation and testing of the grading operations. ACG's observation of the subsurface soil conditions, especially under the loads imposed by construction equipment, is considered an extension of our investigation, particularly within those areas away from the subsurface explorations.

Guide Specifications

Earthwork guide specifications which may be used as a guide in the preparation of contract documents for site grading are included in Appendix D. **The conclusions and recommendations contained in this report should be incorporated into the guide specifications.**

CRITERIA FOR FOUNDATION DESIGN

Based on the field and laboratory information for this study, we recommend that the proposed 3-story building be supported upon isolated and/or continuous spread footings that penetrate into approved bearing earth materials at least 18-inches below the lowest adjacent building pad soil grade. Foundation dimensions and reinforcement should be based on allowable dead plus live soil bearing values of 2,000 pounds per square foot (psf) for continuous footings of at least 15 inches in width and isolated footings at least 24 inches wide (both directions). The foundations should be supported on at least 24 inches of engineered fill per the "Overexcavation Recommendations" section, above. The design bearing pressure may be increased by one-third when considering total loads that include short duration wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations. Total settlement is estimated at about 1-inch for static compression and is expected to occur as the structure is built. We recommend that all footings be reinforced as designed by the structural engineer to provide structural continuity, to permit strong spanning of local irregularities and to be rigid enough to accommodate potential differential movements. Foundations should be proportioned to reduce differential foundation movement estimated at ½-inch over 20 linear feet.

Total vertical ground surface settlement of foundations due to earthquake shaking (i.e., dynamic induced settlements) is estimated at about ½-inch and an additional differential dynamic settlement of ¼-inch over a horizontal distance of approximately 20 feet should be considered in design and construction.

Proportioning based on equal total settlement is recommended; however, proportioning to relative constant dead-load pressure would reduce differential settlement between adjacent foundations.

Lateral Resistance

Foundations placed in approved soil bearing materials (engineered fill) could be designed using a coefficient of friction of 0.29 for engineered fill comprised of approved soil. A design passive resistance value of 250 pounds per square foot per foot (psf/ft) of depth (with a maximum value of 2,500 pounds per square foot) is recommended for engineered fill comprised of approved soil. If both friction and passive pressures are combined, then the smaller value should be halved.

The sides of the excavations for the foundations should be nearly vertical and the concrete should be placed neat against the vertical faces for the passive earth pressure values to be valid. If the loaded side is sloped or benched in the soil, and then backfilled with engineered fill, then the nominal passive pressure should be reduced to the soil frictional resistance.

General Foundation Considerations

ACG's geotechnical engineer or his representative should observe earth material conditions exposed in foundation excavations to confirm the adequacy for structural foundation bearing, confirm the appropriateness of these recommendations, and to allow for an opportunity to provide additional recommendations if deemed necessary. If the earth material conditions encountered differ significantly from those presented in this report, then supplemental recommendations will be required.

An important factor in soils supporting structural improvements is a change in moisture content. The recommendations herein are predicated on the soil moisture beneath and within five feet of the building perimeters, slabs and pavements being maintained in a uniform condition during and after construction. Please be advised that over watering or under watering, types of plants (trees should be at least the distance away from the improvement equal to their maximum height), altering design site drainage, etc., might be detrimental to the foundation, slabs, and/or pavements. We suggest that automatic timing devices be utilized on irrigation systems; however, provision should be made to interrupt the normal watering cycle during and following periods of rainfall. Additional foundation movements could occur if water, from any source, saturates the foundation soils; therefore, proper drainage should be provided during in the final design, during construction, and maintained for the life of the development.

Static and seismic settlement could affect various aspects of the planned development, including utilities, building entrances, sidewalks, footings, and grade beams. Design of these elements should incorporate features to mitigate the effects of the predicted settlements. Because of the anticipated settlements during an earthquake, it may be necessary to replace esthetic features, sheetrock, glazing, exterior flatwork, etc., after a major earthquake.

The foundation excavations should be clean (i.e., free of all loose slough) and maintained in a moist condition between 1 to 4 percent over optimum just prior to placing steel and concrete. The concrete for the foundation should not be placed against a dry excavation surface.

The base of all foundation excavations should be free of water, loose soil, and gravel prior to placing concrete. Concrete should be placed soon after excavating and placement of engineered fill (and lime treatment, if needed) to reduce bearing soil disturbance. Should the soils at bearing level become excessively dry, disturbed, or saturated, the affected soil should be removed prior to placing concrete. In addition, as previously described, unsuitable soils should be completely removed from any proposed construction areas prior to construction. Concrete should not be chuted against the excavation sidewalls. Concrete should be pumped or placed by means of a tremie or elephant's trunk to avoid aggregate segregation and earth contamination. Rebar reinforcement should be properly supported with proper clearances maintained during concrete placement. The concrete should be properly vibrated to mitigate formation of voids and to promote bonding of the concrete to steel reinforcing. These recommendations are predicated upon ACG's representative observing the bearing materials as well as the manner of concrete placement.

Foundation Setback

The bottoms of utility trenches placed along the perimeter of the foundation should be above an imaginary plane that projects at a 2H:1V angle projected down from 9-inches above the bottom edge of the lowest outermost edge of the foundation per 2022 CBC Section 1809.14. Where trenches pass through the plane, the trench should be installed perpendicular to the face of the foundation for at least the distance of the depth of the foundation. Alternatively, the foundation could be deepened to attain the recommended setback. Foundation details under the influence of this recommendation should be forwarded along with the structural load information to the geotechnical engineer for review.

INTERIOR FLOOR SLAB-ON-GROUND SUPPORT

On most project sites, the site mass grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade soils may be disturbed due to utility excavations, construction traffic, desiccation, rainfall, etc. As a result, the floor slab subgrade soils may not be suitable for placement of base rock and concrete and corrective action would be recommended.

We recommend the engineered fill underlying the floor slab be rough graded and then thoroughly proof rolled with a loaded tandem axle dump truck or water truck prior to final grading and placement of base rock. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the affected material as engineered fill.

A building pad comprised of engineered fill (constructed in accordance with the criteria contained within the above "Earthwork" section) is considered suitable for support of the slabs-on-ground of the building. We suggest the moisture for upper 18 inches of the subgrade to be maintained within 2 to 4 percent above the optimum moisture. In all cases the floor slab should not be placed on a dry subgrade.

Building floor slab design, thickness and reinforcement should be designed by the structural designer for the anticipated loadings based on a modulus of subgrade soil reaction (k) estimated at 75 pounds per square inch per inch (psi/in) for engineered fill. The concrete slabs should be at least 4 inches thick. The slabs should be supported on at least 4-inches thick crushed rock (or at least 4-inches of Class II Aggregate Base compacted to at least 95% relative compaction) underlain by approved engineered fill subgrade soils prepared per the recommendations of this report.

The exterior ground surface should be at least 6 inches below the top of the floor slab. We emphasize that all surfaces should slope to drain away from all sides of the building. Slabs subjected to heavier loads may require thicker slab sections and/or increased reinforcement per the structural engineer's design.

Slabs-on-grade subject to low frequency, light to medium vehicle traffic should be at least five inches thick, or as per the project structural engineer, and have at least a five-inch-thick layer of Class 2 aggregate base (compacted to at least 95 percent relative compaction) placed beneath the slabs. If elastic design is utilized for designing slabs-on-grade founded on at least a six-inch thick layer of Class 2 aggregate base compacted to at least 95 percent relative compaction, the design k value may be increased to 125 pci. The modulus was provided based on the slab being supported on 6 inches or more of compacted aggregate base and estimates obtained from NAVFAC 7.1 design charts. This value is for a small, loaded area (1 sq. foot or less) such as for small truck wheel loads or point loads. Slabs subjected to heavier loads (e.g., forklifts) would require thicker slab sections and/or increased reinforcement. The slabs could be separated from the foundations supporting the structure to allow for differential movements between the two elements unless the structural designer designs the slab - footing to be monolithic. We suggest the structural designer consider slab reinforcement consist of at least #4 reinforcing bars placed on maximum 18-inch centers at mid-slab height.

Floor Slab Moisture Penetration Resistance

We are not experts regarding measures for mitigating (or preventing) moisture intrusion into building's first floor slab(s)-on-grade. If such should be desired, then an expert regarding moisture intrusion should be consulted.

We suggest the following measures for mitigating (not preventing) moisture intrusion into moisture sensitive interior floor slab(s). The floor slabs should be underlain by at least a 6-inch-thick layer of crushed washed rock or compacted aggregate base which is intended to serve as a capillary mitigating moisture break and to provide uniform slab support. Gradation of the crushed rock material should be such that 100 percent will pass a 1-inch sieve and 0 to 5 percent passes the No. 4 sieve. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder. At a minimum, we recommend in areas where it is desired to reduce floor dampness where moisture-sensitive coverings are anticipated, construction should have a suitable waterproof vapor retarder (at least 15 mils thick polyethylene vapor retarder sheeting, Raven Industries "VaporBlock 15, Stego Industries 15 mil "StegoWrap" or W.R. Meadows Sealtight 15 mil "Perminator") incorporated into the floor slab design. The water vapor retarder should be decay resistant material complying with ASTM E96 not exceeding 0.04 perms, ASTM E154 and ASTM E1745 Class A. The vapor barrier should be placed between the concrete slab and the compacted granular aggregate subbase material. The water vapor retarder (vapor barrier) should be installed in accordance with ASTM Specification E 1643-94 or the manufacturer's recommendations, whichever is more stringent. If maximum two inches of clean sand should be placed above the vapor retarder (not recommended), then we recommend a moisture barrier be placed against the outer face of the perimeter foundation. Please note that the sand can be a conduit for water beneath the slab. In addition, the sand can form boils/pockets in the slab concrete. If proposed floor areas or coverings are considered especially sensitive to moisture emissions, additional recommendations from a specialty consultant should be obtained. If desired, further resistance to moisture vapor intrusion could be achieved with proper curing of the concrete, adding a sealant to the mix (e.g., Moxie), having a mix design with low slump (e.g., 2 to 4 inches), low water/cement ratio (we suggest not greater than 0.48), and high strength (we suggest at least 3000 psi).

The structural engineer/Architect and slab-on-grade floor installation contractor should refer to ACI 302 and ACI 360 for procedures and cautions regarding the use and placement of a vapor barrier. In areas of exposed concrete, control joints should be saw-cut into the slab after concrete placement in accordance with ACI Design Manual, Section 302.1R-37 8.3.12 (tooled control joints are not recommended). To control the width of cracking, continuous slab reinforcement should be considered in exposed concrete slabs.

Positive separations and/or isolation joints should be provided between slabs and all foundations, columns, or utility lines to allow independent movement. Interior trench backfill placed beneath slabs should be compacted in accordance with recommendations outlined in the Earthwork section of this report and Appendix D. Other design and construction considerations, as outlined in the ACI Design Manual, Section 302.1R are recommended.

EXTERIOR FLATWORK

We recommend exterior concrete flatwork subject to only pedestrian traffic be at least 4 inches thick and underlain by at least 4 inches of Class II aggregate base supported by approved subgrade engineered fill soils prepared per the “Earthwork” recommendations section of this report. Off-site flatworks should be designed and constructed per the recommendations of this report and per the building agency’s Standard Plans and Specifications.

To reduce the potential for distress to exterior flatwork that might be caused by differential movement of subgrade soils, we recommend that such flatwork be installed with crack-control joints at appropriate spacing as designed by the project architect. Flatwork, which should be installed with crack control joints, includes driveways, sidewalks, and architectural features. All subgrades should be prepared according to the earthwork recommendations previously given before placing concrete. Positive drainage should be established and maintained adjacent to all flatworks.

RETAINING WALL DESIGN CRITERIA

Retaining walls backfilled using free draining materials and engineered fill comprised of generally select onsite soils per this report may be designed using the equivalent fluid weights given in the table below. These values are also considered suitable for permanent shoring, if proposed.

TABLE 1
EQUIVALENT FLUID UNIT WEIGHTS FOR ENGINEERED BACKFILL[1]
(pounds per cubic foot)

WALL TYPE	LEVEL BACKFILL	SLOPE BACKFILL 2:1 (HORIZONTAL: VERTICAL)
CANTILEVER WALL (YIELDING)	50	70
RESTRAINED WALL	70	90

[1]For walls restraining native earth materials (no backfill), or for temporary shoring, please contact our office for additional analysis and recommendations.

Surcharges on retaining walls should generally be equal to 1/3 of the vertical load of the surcharge located within ten lateral feet of the wall.

Per 2022 California Building Code (CBC) Section 1803.5.12, for retaining walls supporting more than 6 feet backfill, lateral earth pressures due to earthquake loading should be considered for structures to be designed in Seismic Design Categories D, E or F. Lateral pressures due to earthquake motions on cantilever retaining walls (yielding walls), taller than 6 feet, may be calculated based on work by Seed and Whitman (1970). The total lateral thrust against a properly drained and backfilled cantilever retaining wall above the groundwater level can be expressed as:

$$P_{AE} = P_A + \Delta P_{AE}$$

For non-yielding (or "restrained") walls, the total lateral thrust may be similarly calculated based on work by Wood (1973):

$$P_{KE} = P_K + \Delta P_{KE}$$

Where P_A = Static Active Thrust (given previously Table 1)

P_K = Static Restrained Wall Thrust (given previously Table 1)

ΔP_{AE} = Dynamic Active Thrust Increment = (3/8) k_h γH^2

ΔP_{KE} = Dynamic Restrained Thrust Increment = k_h γH^2

k_h = ½ Peak Ground Acceleration = ½ (S_{DS}/2.5)

H = Total Height of the Wall

γ = Total Unit Weight of Backfill Soil ≈ 125 pounds per cubic foot

The increment of dynamic thrust in both cases should be based on a trapezoidal distribution (essentially an inverted triangle), with a line of action located at 0.6H above the bottom of the wall. The values above assume non-expansive backfill and free-draining conditions.

Measures should be designed to prevent moisture buildup behind all retaining walls. Drainage measures should include free draining backfill materials and sloped, perforated drains. These drains should discharge to an appropriate off-site location. The wall permeable back drain could consist of either CalTrans Class 2 permeable materials or with ¾-inch up to 2-inch size drainage rock wrapped in geotextile filter fabric. The back drain should be placed behind the entire wall height to within 18 inches of ground surface at the top of the wall. The width of free draining permeable materials behind the wall should be at least two feet. Alternatively, a prefabricated drainage system (e.g., Mira-drain) could be considered behind the wall to collect the water. Water passing through the back drain system should be directed into perforated/slotted pipes that direct the collected water to an appropriate outlet for disposal away from the wall. The pipes should be placed behind and at the bottom of the wall.

Waterproofing of the wall should be as specified by the project architect/engineer. Adequate drainage should be provided behind the below-grade retaining walls to collect water from irrigation, landscaping, surface runoff, or other sources, to achieve a free-draining backfill condition.

PAVEMENT SECTION ALTERNATIVES

The R-value test result by exudation at 300 psi is 10 for Sandy CLAY subgrade soil that was obtained from R-1 location shown in Figure 2 - Explorations Map. Based on the R-value indicated and the Traffic indices (T.I.'s) indicated below, pavement section alternatives for the on-site pavement were evaluated per the CalTrans "Highway Design Manual" (HDM). A factor of safety per CalTrans HDM was **not** applied for on-site pavements. The Traffic Index selected for the final pavement design should be based upon the CalTrans "Highway Design Manual" - latest revision and/or edition including consideration of the vehicular traffic anticipated, number of repetitions, etc., as determined by your general civil engineer or per regulatory agency requirements. Estimated pavement sections for light (T.I. = 5; e.g., daily cars and pickups, weekly light delivery trucks, occasional fire trucks up to 40 tons, etc.), and medium duty vehicles (T.I. = 6 to 7; e.g., weekly garbage trucks, construction equipment, etc.) are summarized on the following table:

Design Traffic Index	Table 4. RECOMMENDED PAVEMENT SECTION ALTERNATIVES Inches (Feet)							
	Non-treated Subgrade (12" Engineered Fill)		12" Lime Stabilized Soil (LSS) Subgrade[2]		Non-treated Subgrade (12" Engineered Fill)		12" Lime Stabilized Soil (LSS) Subgrade[2]	
	Asphalt Concrete (AC) (Type B)	Aggregate Base (AB) (Class 2[1])	Asphalt Concrete (AC) (Type B)	Aggregate Base (AB) (Class 2[1])	Portland Cement Concrete[3]	Aggregate Base (AB) (Class 2[1])	Portland Cement Concrete[3]	Aggregate Base (AB) (Class 2[1])
5.0	2" (0.15') 2.5" (0.2')	11" (0.9') 10" (0.85')	2" (0.15')	6" (0.5')	5" (0.4')	6" (0.5')	5" (0.4')	5" (0.5')
6.0	2.5" (0.2') 3" (0.25')	14" (1.15') 13" (1.1')	2.5" (0.2') 3" (0.25')	7" (0.6') 6" (0.5')	5" (0.4')	7" (0.6')	5" (0.4')	5" (0.5')
7.0	3" (0.25') 4" (0.35')	16" (1.35') 14" (1.15')	3" (0.25') 4" (0.35')	9" (0.75') 7" (0.6')	6" (0.5')	8" (0.65')	6" (0.5')	6" (0.5')

([1]Caltrans Class 2 aggregate base (AB). [2]LSS thickness to be verified and lime content to be determined based on laboratory tests to achieve at least 200 psi unconfined compressive strength (per CalTrans Test 373). [3]Portland Cement Concrete (PCC) should have a modulus of rupture of at least 600 psi and the concrete reinforced per the pavement designer).

The above sections should be used for preliminary design and planning purposes only. We recommend representative subgrade sample(s) be obtained and "R" Value test(s) be performed on actual earth materials exposed once pavement areas have been pioneered. These additional test results may then be used to evaluate pavement sections for construction. It is possible that significant variations in pavement sections (vs. those listed above) could result if the resulting test(s) is/are different than that used for this study.

The preliminary sections above should be reviewed and approved by the owner, the civil engineer, and the governing authorities prior to construction. In addition, other recommendations for the stated traffic indices are available, if needed. The total thickness of most sections would closely approximate those given. Thinner sections than those recommended could result in increased maintenance and/or shorter pavement life. If desired, please contact this office for further analysis.

Asphalt concrete paved areas should be designed, constructed, and maintained in accordance with, for example, the recommendations of the Asphalt Institute, CalTrans Highway Design Manual, or other widely recognized authority. Concrete paved areas should be designed and constructed in accordance with the recommendations of the American Concrete Institute, CalTrans Highway Design Manual, or other widely recognized authority, particularly regarding thickened edges, joints, and drainage.

Materials and compaction requirements within the structural sections should conform to the applicable provisions of the CalTrans Standard Specifications (latest edition) including at least 95 percent relative compaction of at least the uppermost twelve inches of subgrade earth materials. Asphalt concrete pavement should conform to the specifications of Type A or B per section 39, and aggregate base should conform to the specifications of Class II per Section 26 of the referenced specifications.

Concrete pavements could be reinforced with nominal rebar, such as at least #4 bars spaced no greater than 24 inches, on center, both ways, placed at above mid-slab height, but with proper concrete cover, as designed by the pavement engineer or structural engineer. If concrete pavements are to be unreinforced, then we suggest the designer use expansion/contraction and/or construction joints spaced no greater than 24 times the pavement thickness, both ways, in nearly square patterns, and detailed in general accordance with ACI Guidelines. Doweling of concrete pavements at critical pathways is also recommended.

We recommend that reinforced concrete pads be provided for truck pad areas in front of and beneath trash receptacles as determined by the structural designer. The trash collection trucks should be parked on the rigid concrete pavement when the trash receptacles are lifted. The concrete pads should be at least 5 inches thick and properly reinforced. Thickened edges should be used along outside edges of concrete pavements. Edge thickness should be at least 2 inches thicker than concrete pavement thickness and taper to the actual concrete pavement thickness 36 inches inward from the edge. Integral curbs may be used in lieu of thickened edges.

The above pavement section alternatives were estimated on the basis that a comparable soil type with R-value indicated above would constitute the final subgrade of the pavement. We emphasize that ACG should be retained to observe and test final subgrade soil(s) exposed to affirm that the soil is comparable to that indicated above. Where differing earth materials are encountered, they should be tested to affirm that they will also provide the same or better support for pavement sections like those recommended above for preliminary design.

Adequate drainage systems should be provided to prevent both surface and subsurface saturation of the subgrade soils. As a design option, a subdrain system beneath and along the edges of the pavements might be considered. The purpose of the system would be to mitigate saturation and loss of strength/stability of the subgrade soils. Subdrains should be especially considered beneath valley drains, if utilized for the project. As an alternate to edge drains (especially around landscape planters), barrier curbing that extends to at least four inches into the soil subgrade below the bottom of the aggregate base layer could be considered to limit infiltration of water beneath the adjacent pavement. Drainage inlets should be perforated (weep holes installed) at the level of the aggregate base layer. A layer of geotextile fabric should be placed on the outside of the drain inlet over the weep holes to reduce the potential for migration or piping of fines through the holes.

Base course or pavement materials should not be placed when the subgrade surface is wet. Surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade.

Pavement Construction Considerations

On most project sites, the site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrades may become disturbed due to utility excavations, construction traffic, rainfall, etc. As a result, the pavement subgrade may not be suitable for placement of aggregate base and pavement. We recommend the area underlying the pavement be rough graded and proof-rolled prior to placement of aggregate base material. Particular attention should be paid to high traffic areas and utility trenches that were backfilled.

Areas where disturbance has occurred and materials are unsuitable, they should be removed and replaced with compacted structural fill.

The aggregate base should be uniformly moisture-conditioned and compacted to at least 95 percent relative compaction (modified proctor) in accordance with this report. Base course or pavement materials should not be placed when the surface is wet. Surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade.

Minimizing subgrade saturation is an important factor in maintaining subgrade strength. Water allowed to pond on or adjacent to pavements could saturate the subgrade and cause premature pavement deterioration. The pavement should be sloped to provide rapid surface drainage, and positive surface drainage should be maintained away from the edge of the paved areas. Design alternatives which could reduce the risk of subgrade saturation and improve long-term pavement performance include crowning the pavement subgrades to drain toward the edges, rather than to the center of the pavement areas; and installing surface drains next to any areas where surface water could pond. Properly designed and constructed subsurface drainage will reduce the time subgrade soils are saturated and can also improve subgrade strength and performance. In areas where there will be irrigation adjacent to pavements, we recommend the owner consider installing perimeter drains for the pavements.

Preventative maintenance should be planned and provided for through an on-going pavement management program to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment.

SUBDRAINAGE

Subdrains might be needed to control subsurface water that might become perched in top and/or fill soils. Each case should be evaluated by the Geotechnical Engineer so that he/she could make appropriate mitigation recommendations.

LIMITATIONS

This report contains statements regarding opinions, conclusions, and recommendations, all of which involve certain risks and uncertainties. These statements are often, but are not always, made through the use of words or phrases such as “anticipates”, “intends”, “estimates”, “plans”, “expects”, “we believe”, “we consider”, “it is our opinion”, “mitigation or mitigate”, “suggest”, “may be”, “expected”, “predicated”, “advised”, and similar words or phrases, or future or conditional verbs such as “will”, “would”, “should”, “potential”, “can continue”, “could”, “may”, or similar expressions. Actual results may differ significantly from the expectations contained in the statements. Among the factors that may result in differences are the inherent uncertainties associated with earth material conditions, groundwater, project development activities, regulatory requirements, and changes in the planned development.

The analysis and recommendations submitted in this report are based in part upon the data from the exploratory borings at the indicated locations and in part on information provided by the client. The nature and extent of subsurface variations between the test borings across the site (or due to the modifying effects of weather and/or man) may not become evident until further exploration or during construction. If variations then appear evident, then the conclusions, opinions, and recommendations in this report shall be considered invalid, unless the variations are reviewed and the conclusions, opinions, and recommendations are modified or approved in writing.

This report was prepared to assist the client in the evaluation of the site and to assist the architect and/or engineer in the design of the improvements. This firm should be provided the opportunity for a general review of final plans and specifications to determine that the recommendations of this report have been properly interpreted and implemented in the plans and specifications.

If there are any significant changes in the project as described herein, then the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and conclusions and recommendations modified or verified in writing.

This report is issued for the client's use only. In addition, it is his responsibility to ensure that the information and recommendations contained herein are called to the attention of the designer for the project; and, that necessary steps are taken to implement the recommendations during construction.

The findings in this report were developed on the date(s) indicated. Changes in the conditions of the property can occur with the passage of time, whether they are due to natural processes or the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control. Therefore, this report and the findings on which it is based are subject to our review at the onset of and during construction, or within two years, whichever first occurs.

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

No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. If any changes in the nature, design, or location of the project as outlined in this report are planned, the conclusion and recommendations contained in this report shall not be considered valid unless ACG reviews the changes, and either verifies or modifies the conclusions of this report in writing.

This report is applicable only for the project and site studied and should not be used for design and/or construction on any other site.

We appreciate this opportunity to be of service on this project. If you have any questions regarding this report, then please do not hesitate to contact us.

REFERENCES

1. American Society for Civil Engineers, 2016 "Minimum Design Loads for Building and Other Structures," ASCE/SEI 7-16.
2. ASTM, "Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort," Volume 04.08
3. California Building Code, 2022, "California Code of Regulations, Title 24, Part 2, Volume 2 of 2," California Building Standards Commission, published by ICBO.
4. California Geological Survey (CGS), 2000 "Geologic map and map database of parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California"; Scale 1:75,000, by Blake, M.C., Graymer, R.W., Jones, D.L., and Soule, Adam.
5. CGS website (https://www.conservation.ca.gov/cgs/earthquakes) for Regulatory Maps, Reports and GIS data that includes Earthquake Fault Zones, Landslide and Liquefaction Zones.
6. Hart, Earl W., Revised 1994, "Fault-Rupture Hazard Zones in California, Alquist Priolo, Special Studies Zones Act of 1972," California Division of Mines and Geology, Special Publication 42.
7. Jennings, Charles W. and Bryant, William A., 2010, "Fault Activity Map of California" (scale 1: 750,000) published by CGS, Geologic Data Map No. 6.
8. SEAOC/OSHPD U.S. Seismic Hazard Maps (reference ASCE/SEI 7-16).
9. SDG Architects, Inc., May 22, 2023, Architectural Site Plan "TPC Rovina Lane - Site Plan Option D" (Sheet A01.D).
10. Atlas Civil Design, August 24, 2023, Preliminary Grading Plan, "2 Rovina Lane".
11. Google Earth Aerial Photography of the Subject Site.

APPENDIX A

VICINITY MAP

EXPLORATIONS MAP

NOTES:

Location of site (designated by yellow border) is approximate.

Source for base map: Imagery from Google Earth 2023©.

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ALLERION CONSULTING GROUP, INC.
1050 Melody Lane, Suite 160
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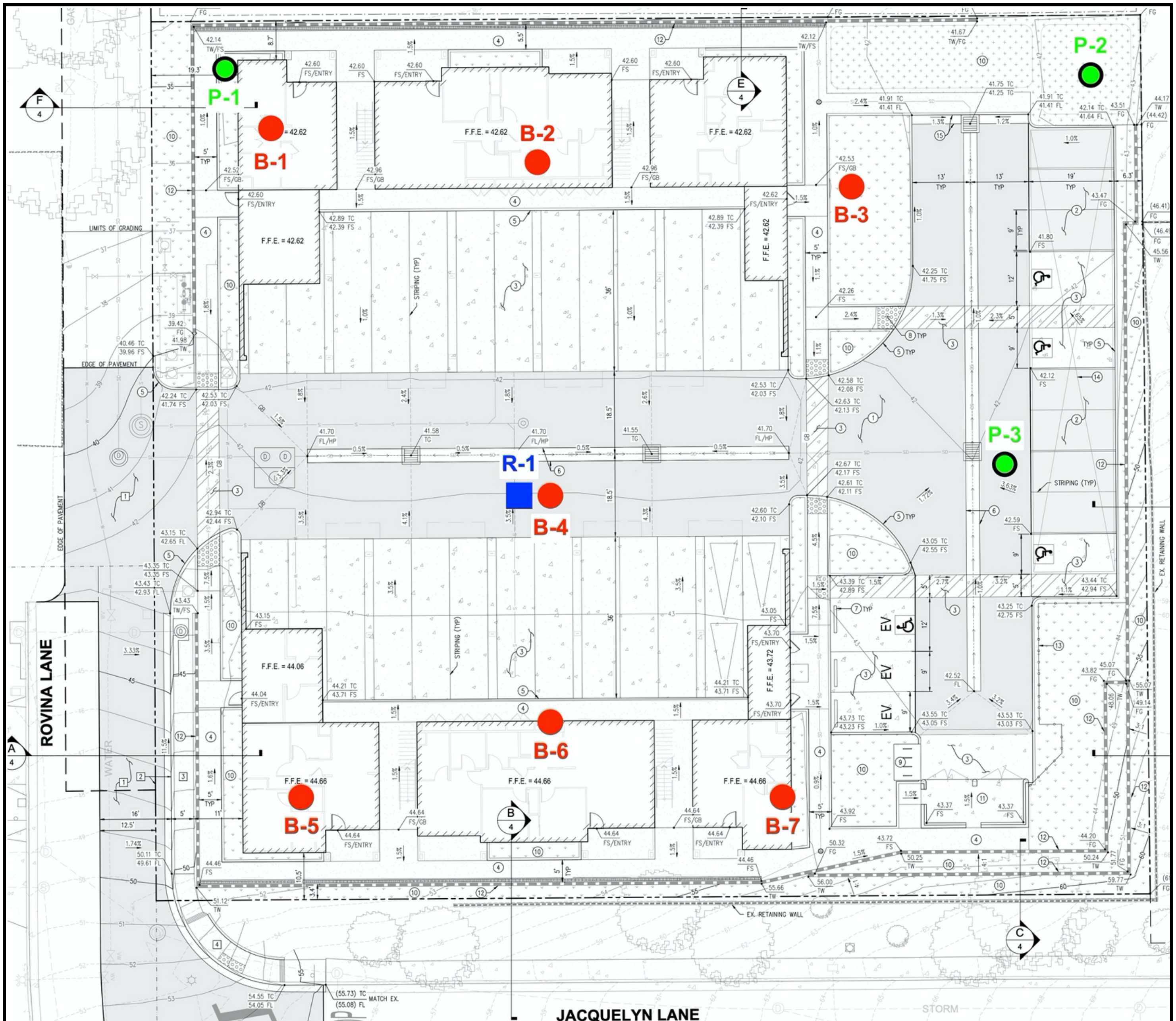
Phone: 916-742-5096

VICINITY MAP

Proposed Rovina Apartments
2 Rovina Lane
Petaluma, California

ACG JOB NO.	05-23040G
DATE	09/22/2023
FIGURE	1



LEGEND:

- B-x Approximate Location - Number of Boring
- R-x Approximate Location - R-value Sample
- P-x Approximate Location - Number of Percolation Test

NORTH +/-
N.T.S.

NOTE:

Source for base map: Atlas Civil Design, August 24, 2023, Preliminary Grading Plan, “2 Rovina Lane”.

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EXPLORATIONS MAP

Proposed Rovina Apartments
2 Rovina Lane
Petaluma, California

ACG JOB NO.	05-23040G
DATE	09/22/2023
FIGURE	2

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APPENDIX B

FIELD EXPLORATION METHODS

LOGS OF SUBSURFACE EXPLORATIONS

FIELD EXPLORATION METHODS

Field exploration included a general geotechnical engineering reconnaissance within the study area, as well as the excavation of subsurface explorations at approximate locations shown on the Explorations Map, Figure 2, Appendix A. Locations of explorations were determined in the field by estimating from the existing site features shown on an aerial photo. The exploration locations should only be considered accurate to the degree implied by the means and methods used to define them. The explorations were accomplished, and the soil logging and sampling performed by, a Staff Geologist and/or Engineer under the direct supervision of a California licensed Geotechnical Engineer. The explorations were conducted to determine the geometry and geotechnical characteristics of subsurface geologic deposits at the site.

The exploratory borings were advanced with 4-inch outer-diameter continuous flight helical solid stem augers (SSA) powered by a truck mounted drill rig. Relatively undisturbed soil samples were recovered from the borings at selected intervals by either a 1.4-inch SPT (standard penetration) or 2-inch inner-diameter samplers (Modified California) advanced with an automatic hammer driving a 140 lb. hammer freely falling 30 inches (standard 350-foot/lb. striking force). The number of blows of the hammer required to drive the samplers each 6-inch to 18-inch interval of each drive is denoted as the penetration resistance or "blow count" and provides a field estimate of soil consistency/relative density. Blow counts shown on the logs have not been corrected/converted. Selected undisturbed samples were retained in moisture-proof containers for laboratory testing and reference. Bulk soil samples were recovered directly from excavation cuttings and placed in sealed plastic sample bag(s).

Soils were logged in the field by the Staff Geologist or Engineer and were field classified based on inspection of samples and auger cuttings per the Unified Soil Classification System (ASTM D2487) by color, gradation, texture, type, etc. Groundwater observations were made in the explorations during and after drilling. Exploration log prepared for the exploration provides soil descriptions and field estimated depths. The exploration logs are included in this Appendix B. This log includes visual classifications of the materials encountered during drilling as well as the field engineer’s interpretation of the subsurface conditions. Final exploration logs included with this report represents the geotechnical engineer's interpretation of the field logs.

Samples of the subsurface soil earth materials were obtained from the exploratory borings for use in laboratory testing to further determine the soil’s engineering properties and geotechnical design parameters to be used for future site improvements. The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Bulk soil samples were recovered directly from excavation cuttings and placed in a plastic sample bag. Soil samples were then transported to ACG’s soil mechanics laboratory for further testing. Field descriptions within the exploration logs have been modified, where appropriate, to reflect laboratory test results. Upon completion of drilling the test borings were backfilled from final test boring depth up to original ground surface with soil cuttings or with cement grout and topped with soil cuttings.

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Geotechnical Log - Borehole

B-1

UTM	:	**Drill Rig**	: CME 55	**Job Number**	: 05-23040G
Latitude	: 38.225585	**Driller Supplier**	: Cal-Nev Geo Exploration	**Client**	: Pacific West Communities, Inc.
Longitude	: -122.620296	**Logged By**	: MK	**Project**	: Rovina Apartments
Ground Elevation	: 38 (ft)	**Reviewed By**	: EH	**Location**	: Petaluma, CA
Total Depth	: 3.5 ft BGL	**Date**	: 08/29/2023	**Loc Comment**	: Refer to Exploration Map

Elevation (ft)	Samples: Mod Cal Sample	Blows per 6 in: COMMENT	Blows per 6 in: TYPE	Blows per 6 in: BLOWS per 6 in (140 lb hammer 30 Inch drop)	Blows per 6 in: N	Blows per 6 in: REC(in)	Classification Code	Graphic Log	Depth (ft)	Material Description	Groundwater	Testing: Water Content, %	Testing: % Fines	Remarks
38–36							CL		0–2	Fill- moist, brown, fine grained sand coarse grained gravel hard, SANDY LEAN CLAY WITH GRAVEL (UNDOCUMENTED FILL).				
36–34.5	X		Mod Cal	11-19-21	40	18.0			2–3.5			8.4	60	
34									4	**B-1 refusal at 3.5 ft (Boring ended due to refusal in hard rock. Groundwater was not encountered. Boring was backfilled with soil cuttings.)**				

Elevation scale (ft): 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9

Depth scale (ft): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29

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Geotechnical Log - Borehole

B-2

UTM	:	Drill Rig	: CME 55	Job Number	: 05-23040G
Latitude	: 38.225585	Driller Supplier	: Cal-Nev Geo Exploration	Client	: Pacific West Communities, Inc.
Longitude	: -122.620073	Logged By	: MK	Project	: Rovina Apartments
Ground Elevation	: 41 (ft)	Reviewed By	: EH	Location	: Petaluma, CA
Total Depth	: 4 ft BGL	Date	: 08/29/2023	Loc Comment	: Refer to Exploration Map

Elevation (ft)	Samples: Mod Cal Sample	Blows per 6 in: COMMENT	TYPE	BLOWS per 6 in 140 lb hammer 30 Inch drop	N	REC(in)	Classification Code	Graphic Log	Depth (ft)	Material Description	Groundwater	Testing: Water Content, %	% Fines	Remarks
41–39							CL		0–2	Fill- moist, dark brown, fine grained sand stiff, SANDY LEAN CLAY (UNDOCUMENTED FILL).				
39–37.5	X		Mod Cal	2-5-11	16	18.0			2–3.5			8.7	59	
37.5–37							CL		3.5–4	Very stiff, moist, dark brown, fine grained sand fine grained gravel SANDY LEAN CLAY WITH GRAVEL.				

B-2 refusal at 4 ft (Boring ended due to refusal in hard rock. Groundwater was not encountered. Boring was backfilled with soil cuttings.)

Elevation scale: 41 to 12 ft; Depth scale: 1 to 29 ft.

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Geotechnical Log - Borehole

B-3

UTM	:	Drill Rig	: CME 55	Job Number	: 05-23040G
Latitude	: 38.225525	Driller Supplier	: Cal-Nev Geo Exploration	Client	: Pacific West Communities, Inc.
Longitude	: -122.619813	Logged By	: MK	Project	: Rovina Apartments
Ground Elevation	: 42 (ft)	Reviewed By	: EH	Location	: Petaluma, CA
Total Depth	: 11.5 ft BGL	Date	: 08/29/2023	Loc Comment	: See Explorations Map

Elevation (ft)	Samples: SPT	Samples: MOD CAL Sample	COMMENT	TYPE	BLOWS per 6 in (140 lb hammer 30 Inch drop)	N	REC(in)	Classification Code	Graphic Log	Depth (ft)	Material Description	Groundwater	Water Content, %	% Fines	LL	PI	Remarks
42								CL		0	Stiff, moist, dark brown, fine grained sand SANDY LEAN CLAY.						
39		X		Mod Cal	2-6-12	18	18			2–3.5			12.7	67	41	30	
38								CL		4	Stiff, moist, brown, fine grained sand fine grained gravel SANDY LEAN CLAY WITH GRAVEL.						
36	X			SPT	3-5-7	12	18			5–6.5							
31	X			SPT	2-19-50	> 50	18			10–11.5							
30										11.5	**B-3 refusal at 11.5 ft (Boring ended due to refusal in hard rock. Groundwater was not encountered. Boring was backfilled with soil cuttings.)**						

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Geotechnical Log - Borehole

B-4

UTM	:	Drill Rig	: CME 55	Job Number	: 05-23040G
Latitude	: 38.225338	Driller Supplier	: Cal-Nev Geo Exploration	Client	: Pacific West Communities, Inc.
Longitude	: -122.620057	Logged By	: MK	Project	: Rovina Apartments
Ground Elevation	: 44 (ft)	Reviewed By	: EH	Location	: Petaluma, CA
Total Depth	: 3.5 ft BGL	Date	: 08/29/2023	Loc Comment	: Refer to Exploration Map

Elevation (ft)	Samples: Bulk	Samples: SPT	Blows per 6 in: COMMENT	Blows per 6 in: TYPE	Blows per 6 in: BLOWS per 6 in 140 lb hammer 30 Inch drop	Blows per 6 in: N	Blows per 6 in: REC(in)	Classification Code	Graphic Log	Depth (ft)	Material Description	Groundwater	Testing: Water Content, %	Testing: Dry Unit Weight, pcf	Testing: % Fines	Testing: Expansion Index (EI)	Remarks
44–42	Bulk							CL		0–2	Very stiff, moist, brown, fine grained sand coarse grained gravel SANDY LEAN CLAY WITH GRAVEL.					44	
42–40.5		SPT		SPT	2-6-13	19	18			2–3.5			12.1	90	62		
40.5–15										3.5–29	**B-4 refusal at 3.5 ft (Boring ended due to refusal in hard rock. Groundwater was not encountered. Boring was backfilled with soil cuttings.)**						

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Geotechnical Log - Borehole

B-5

UTM	:	Drill Rig	: CME 55	Job Number	: 05-23040G
Latitude	: 38.225128	Driller Supplier	: Cal-Nev Geo Exploration	Client	: Pacific West Communities, Inc.
Longitude	: -122.620256	Logged By	: MK	Project	: Rovina Apartments
Ground Elevation	: 50 (ft)	Reviewed By	: EH	Location	: Petaluma, CA
Total Depth	: 21.5 ft BGL	Date	: 08/29/2023	Loc Comment	: Refer to Exploration Map

Elevation (ft)	Samples: Mod Cal Sample	Samples: SPT	COMMENT	TYPE	BLOWS per 6 in (140 lb hammer 30 Inch drop)	N	REC(in)	Classification Code	Depth (ft)	Material Description	Groundwater	Water Content, %	Dry Unit Weight, pcf	% Fines	LL	PI	Remarks
50								CH	0	Fill- moist, dark brown, fine grained sand fine grained gravel stiff, SANDY FAT CLAY WITH GRAVEL (UNDOCUMENTED FILL).							
47	X			Mod Cal	3-4-7	11	9		2–3.5			7.4		51	52	30	
46								ML	4	Hard, moist, light brown with orange, fine grained sand SANDY SILT.							
44		X		SPT	17-35-47	82	18		5–6.5			11.0	117				
40	X			Mod Cal	8-50/2"	> 50	8		10–10.5								
39								SM	10.5	Very dense, moist, light brown with orange mottled, fine to medium grained SILTY SAND.							
38								ML	12	Medium Stiff, moist, brown, fine grained SANDY SILT.							
34		X		SPT	1-3-17	20	18		15–16.5			9.9	109	53			
34									16	- Very stiff, moist, light brown with orange mottled.							
32									18	- brown.							
29		X		SPT	8-16-19	35	18		20–21.5								
29								SM	21	(dense), moist, grey, fine to coarse grained coarse grained gravel SILTY SAND WITH GRAVEL, (with rock fragments).							

B-5 Terminated at 21.5 ft (Groundwater was not encountered. Boring was backfilled with cement grout and topped with soil cuttings.)

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Geotechnical Log - Borehole

B-6

UTM	:	Drill Rig	: CME 55	Job Number	: 05-23040G
Latitude	: 38.225201	Driller Supplier	: Cal-Nev Geo Exploration	Client	: Pacific West Communities, Inc.
Longitude	: -122.620072	Logged By	: MK	Project	: Rovina Apartments
Ground Elevation	: 48 (ft)	Reviewed By	: EH	Location	: Petaluma, CA
Total Depth	: 1.5 ft BGL	Date	: 08/29/2023	Loc Comment	: Refer to Exploration Map

Elevation (ft)	Samples	Blows per 6 in: COMMENT	TYPE	BLOWS per 6 in, 140 lb hammer 30 Inch drop	N	REC(in)	Classification Code	Graphic Log	Depth (ft)	Material Description	Groundwater	Testing	Remarks
48							CL			Stiff, moist, dark brown, fine grained sand SANDY LEAN CLAY.			
47									1				
46									2	**B-6 refusal at 1.5 ft (Boring ended due to refusal in hard rock. Groundwater was not encountered. Boring was backfilled with soil cuttings.)**			
45									3				
44									4				
43									5				
42									6				
41									7				
40									8				
39									9				
38									10				
37									11				
36									12				
35									13				
34									14				
33									15				
32									16				
31									17				
30									18				
29									19				
28									20				
27									21				
26									22				
25									23				
24									24				
23									25				
22									26				
21									27				
20									28				
19									29				

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Geotechnical Log - Borehole

B-7

UTM	:	Drill Rig	: CME 55	Job Number	: 05-23040G
Latitude	: 38.225134	Driller Supplier	: Cal-Nev Geo Exploration	Client	: Pacific West Communities, Inc.
Longitude	: -122.619868	Logged By	: MK	Project	: Rovina Apartments
Ground Elevation	: 55 (ft)	Reviewed By	: EH	Location	: Petaluma, CA
Total Depth	: 1.5 ft BGL	Date	: 08/29/2023	Loc Comment	: Refer to Exploration Map

Elevation (ft)	Samples	COMMENT	TYPE	BLOWS per 6 in (140 lb hammer 30 Inch drop)	N	REC(in)	Classification Code	Graphic Log	Depth (ft)	Material Description	Groundwater	Testing	Remarks
55–54							CL		0–1	Stiff, moist, dark brown, fine grained sand SANDY LEAN CLAY.			
53									2	**B-7 refusal at 1.5 ft (Boring ended due to refusal in hard rock. Groundwater was not encountered. Boring was backfilled with soil cuttings.)**			

Blows per 6 in spans COMMENT, TYPE, BLOWS per 6 in, N and REC(in). Elevation scale: 55 to 26 ft; depth scale: 1 to 29 ft.

APPENDIX C

LABORATORY TESTING

LABORATORY TESTING

Samples retrieved during the field exploration were taken to the soil mechanics laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) described in Appendix B. An applicable laboratory testing program was formulated for classification testing and to determine engineering properties of the subsurface earth materials. The field descriptions were confirmed or modified based on the test results.

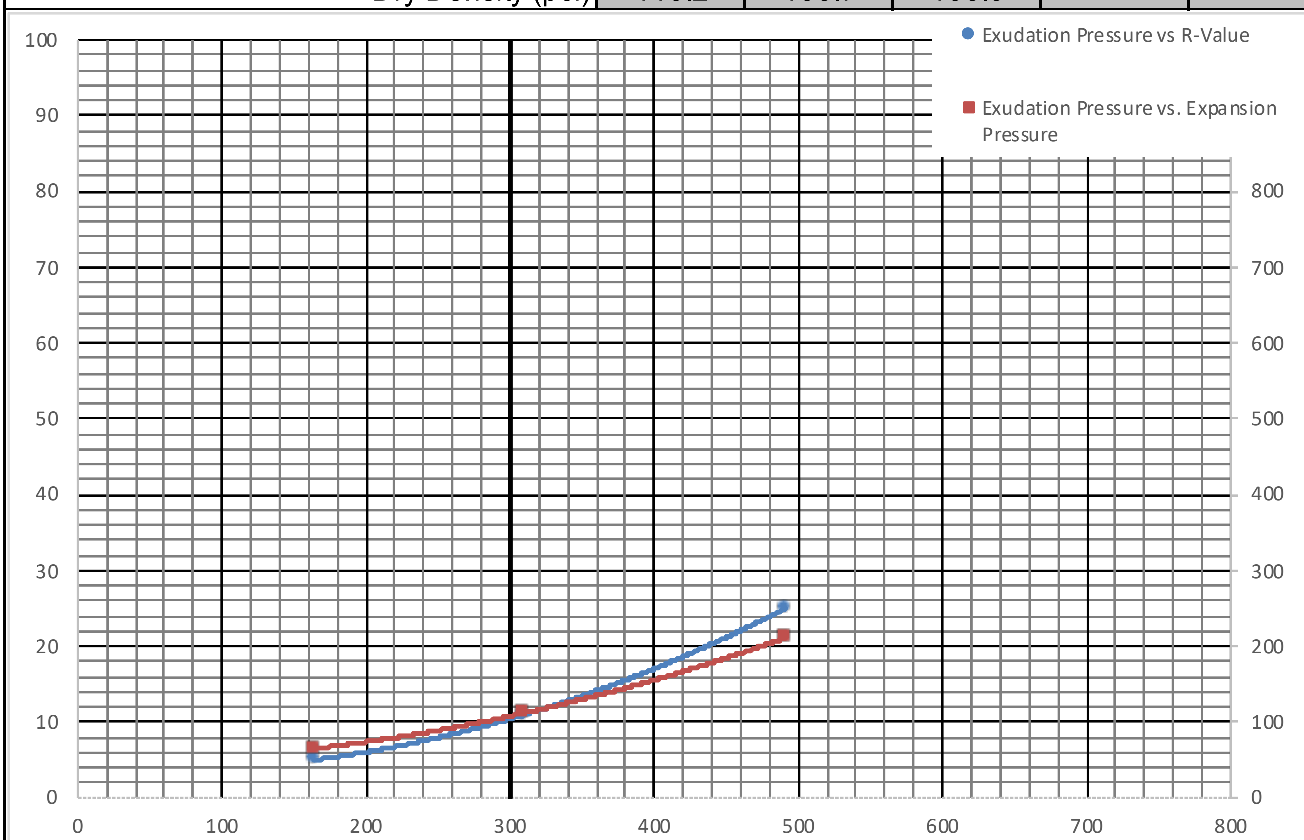
Soil mechanics laboratory tests were performed on soil samples recovered from the explorations to further determine the physical and engineering properties of the soils. These tests included R-value test (CTM 301), gradation (ASTM D422), dry density (ASTM D 2937), Atterberg limits (ASTM D 4318), natural moisture content (ASTM D 2216), and evaluation for soil corrosion, including pH and minimum resistivity (CA DOT Test #643), sulfate content (CA DOT Test #417), and chloride content (CA DOT Test #422m). The results of these tests are shown on the Exploration Log at the depth that each sample was recovered. The R-value test results and soil corrosion test results are attached. The laboratory test results were used for the geotechnical engineering analyses, and the development of engineering, earthwork, and construction recommendations.

COOPER TESTING LABORATORY

R-Value
CTM 301

CTL Job No.:	1191-008	Boring:		Reduced By:	RU
Client:	Allerion Consulting Group	Sample:	R-1	Checked By:	PJ
Project Number:	05-23040G	Depth:	0.5-2'	Date:	9/19/23
Project Name:	Rovina Apartments			**R-Value**	**10**
Soil Description:	Dark Brown Sandy CLAY				
Remarks:				**Expansion Pressure**	**105**

Specimen Designation	A	B	C	D	E
Compactor Foot Pressure (psi)	130	60	20		
Exudation Pressure (psi)	491	310	164		
Exudation Load (lbf)	6170	3896	2061		
Height After Compaction (in)	2.44	2.53	2.61		
Expansion Pressure (psf)	211	112	65		
Stabilometer @ 2000	106	130	144		
Turns Displacement	3.64	4.58	5.15		
R-value	26	11	5		
Corrected R-Value	25	11	5		
Moisture Content (%)	17.7	20.1	22.5		
Wet Density (pcf)	129.7	128.1	129.9		
Dry Density (pcf)	110.2	106.7	106.0		



Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 09/15/2023
Date Submitted 09/12/2023

To: Mohammed Khalid
Allerion Consulting Group, Inc.
1050 Melody Lane Suite 160
Roseville, CA 95678

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 05-23040G Site ID : B-4 @0-2'.
Thank you for your business.

* For future reference to this analysis please use SUN # 90560-187894.

EVALUATION FOR SOIL CORROSION

Soil pH	5.93		
Minimum Resistivity	1.93 ohm-cm (x1000)		
Chloride	4.0 ppm	0.00040	%
Sulfate	13.6ppm	0.00136	%

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422m

APPENDIX D

GUIDE SPECIFICATIONS FOR EARTHWORK

GUIDE SPECIFICATIONS FOR EARTHWORK

A. General Description

1. This item shall consist of all clearing and grubbing, removal of existing obstructions, preparation of the land to be filled, filling the land, spreading, compaction and control of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades and slopes as shown on the accepted plans.

2. The Geotechnical Engineer is not responsible for determining line, grade elevations or slope gradients. The property owner or his representative shall designate the party that will be responsible for those items of work.

B. Geotechnical Report

1. The Geotechnical Report has been prepared for this project by Allerion Consulting Group (ACG), Roseville, California, (916-742-5096). This report was for design purposes only and may not be sufficient to prepare an accurate bid. A copy of the report is available for review at **ACG's** office.

2. Contents of these guide specifications shall be integrated with the Geotechnical Report of which they are a part and shall not be used as a self-contained document. Where a conflict occurs between these guide specifications and the conclusions and recommendations contained in the report, then the conclusions and recommendations shall take precedence and these guide specifications adjusted accordingly.

C. Site Preparation

1. Clearing Area(s) to be Filled: All trees, brush, logs, rubbish, and other debris shall be removed and disposed of to leave the areas that have been disturbed with a neat appearance. Underground structures shall be removed or may be crushed in place upon approval by the Geotechnical Engineer. Excavations and depressions resulting from the removal of the above items shall be cleaned out to firm undisturbed soil and backfilled with suitable materials in accordance with the specifications contained herein. Stockpiles of clean soil may be reused as filled material provided the soil is free of significant vegetation, debris, rubble, and rubbish and is approved by the Geotechnical Engineer.

2. Surfaces upon which fill is to be placed, as well as subgrades of structure pad(s) left at existing grade, shall have all organic material removed; or, with permission of the Geotechnical Engineer, closes cut and remove vegetation and thoroughly disc and blend the remaining nominal organics into the upper soil. Discing must be thorough enough so that no concentrations of organics remain, which may require re-discing or cross-discing several times.

3. Organic laden material removed per paragraph C.2. above, may be used as fill in landscaped areas provided that the material shall not extend closer than ten (10) feet to any structure, shall not exceed two (2) feet in thickness or be used where the material could, in the opinion of the Geotechnical Engineer, create a slope stability problem, and shall be compacted to at least eighty-two (82) percent relative compaction per ASTM Test Designation D 1557. Alternatively, the organic laden material may be hauled off-site and suitably disposed of.

4. Upon completion of the organic removal, exposed surface shall be plowed or scarified to a depth of at least six (6) inches, and until the surface is free from ruts, hummocks, or other uneven features which would tend to prevent uniform compaction by the equipment to be used. Where vegetation has been close cut and removed and remaining organics blended with the upper soil, further scarifying may not be necessary. Where fills are to be placed on hill slopes, scarifying shall be to depths adequate to provide bond between fill and fill foundation. Where considered necessary by the Geotechnical Engineer, (typically where the slope ratio of the original ground is steeper than five (5) horizontal to one (1) vertical), the ground surface shall be stepped or benched to achieve this bond. Vertical dimension of the required benches shall be as determined by the Geotechnical Engineer, based upon location, degree, and condition of the hill slope.

5. After the foundation for the fill has been cleared and scarified, it shall be disced or bladed until it is uniform and free from large clods, uniformly moisture conditioned to the range specified by the Geotechnical Engineer, and compacted to not less than [refer to report -- if not recommended, use 90] percent of maximum dry density as determined by ASTM D 1557, or to such other density as may be determined appropriate for the materials and conditions and acceptable to the Geotechnical Engineer and the owner or his representative.

D. Fill Materials

1. Materials for fill shall consist of material approved by the Geotechnical Engineer.

2. The materials used for fill shall be free from organic matter and other deleterious substances and shall not contain rocks, clods, lumps, or cobbles exceeding four (4) inches in greatest dimension with not more than fifteen (15) percent larger than two and one-half (2-1/2) inches.

3. Imported materials to be used for fill shall be non-expansive [typically, have a plasticity index not exceeding twelve (12)], shall be of maximum one (1) inch size, and shall be tested and approved by the Geotechnical Engineer prior to commencement of grading and before being imported to the site.

4. The Contractor shall notify the Geotechnical Engineer at least four (4) working days in advance of the Contractor's intention to import soil; shall designate the borrow area; and, shall permit the Geotechnical Engineer to sample the borrow area for the purposes of examining the material and performing the appropriate tests to evaluate the quality and compaction characteristics of the soil. Compaction requirements for the material shall be based upon the characteristics of the material as determined by the Geotechnical Engineer.

E. Placement of Fill

1. The selected fill material shall be placed in level, uniform layers (lifts) which, when compacted, shall not exceed six (6) inches in thickness. Water shall be added to the fill, or the fill allowed to dry as necessary to obtain fill moisture content at which compaction as specified can be achieved. Each layer shall be thoroughly mixed during the spreading to obtain uniformity of moisture in each layer.

2. The fill material shall be compacted within the appropriate moisture content range (typically optimum to slightly above the optimum) as determined by the Geotechnical Engineer for the soil(s) being used.

3. Each layer of fill shall be compacted to not less than [refer to report; if not recommended, use 90] percent of maximum dry density as determined by ASTM Test Designation D 1557. Compaction equipment shall be of such design that it will be able to compact the fill to the specified density. Compaction shall be accomplished while the fill material is within the specified moisture content range. Compaction of each layer shall be continuous over its entire area and the compaction equipment shall make sufficient trips to ensure that the required density has been obtained. No ponding or jetting is permitted.

4. If work has been interrupted for any reason, the Geotechnical Engineer shall be notified by the contractor at least two (2) working days prior to the intended resumption of grading.

F. Geotechnical Engineer

1. Owner is retaining Geotechnical Engineer to make observations and tests to determine general compliance with Plans and Specifications, to verify expected or unexpected variations in subsurface conditions, and to give assistance in appropriate decisions. Cost of Geotechnical Engineer will be borne by the Owner, except costs incurred for re-tests and/or re-observations caused by failure of the Contractor to meet specified requirements will be paid by the Owner and back charged to Contractor.

G. Observation and Testing

1. Field density tests shall be made by the Geotechnical Engineer or his representative of the compaction of each layer of fill. Density tests shall be taken in the compacted material below any surfaces disturbed by the construction equipment. When these tests indicate that the density of any layer of fill or portion thereof is below the required density or moisture content, the particular layer or portion shall be reworked until the required density or moisture content has been obtained.

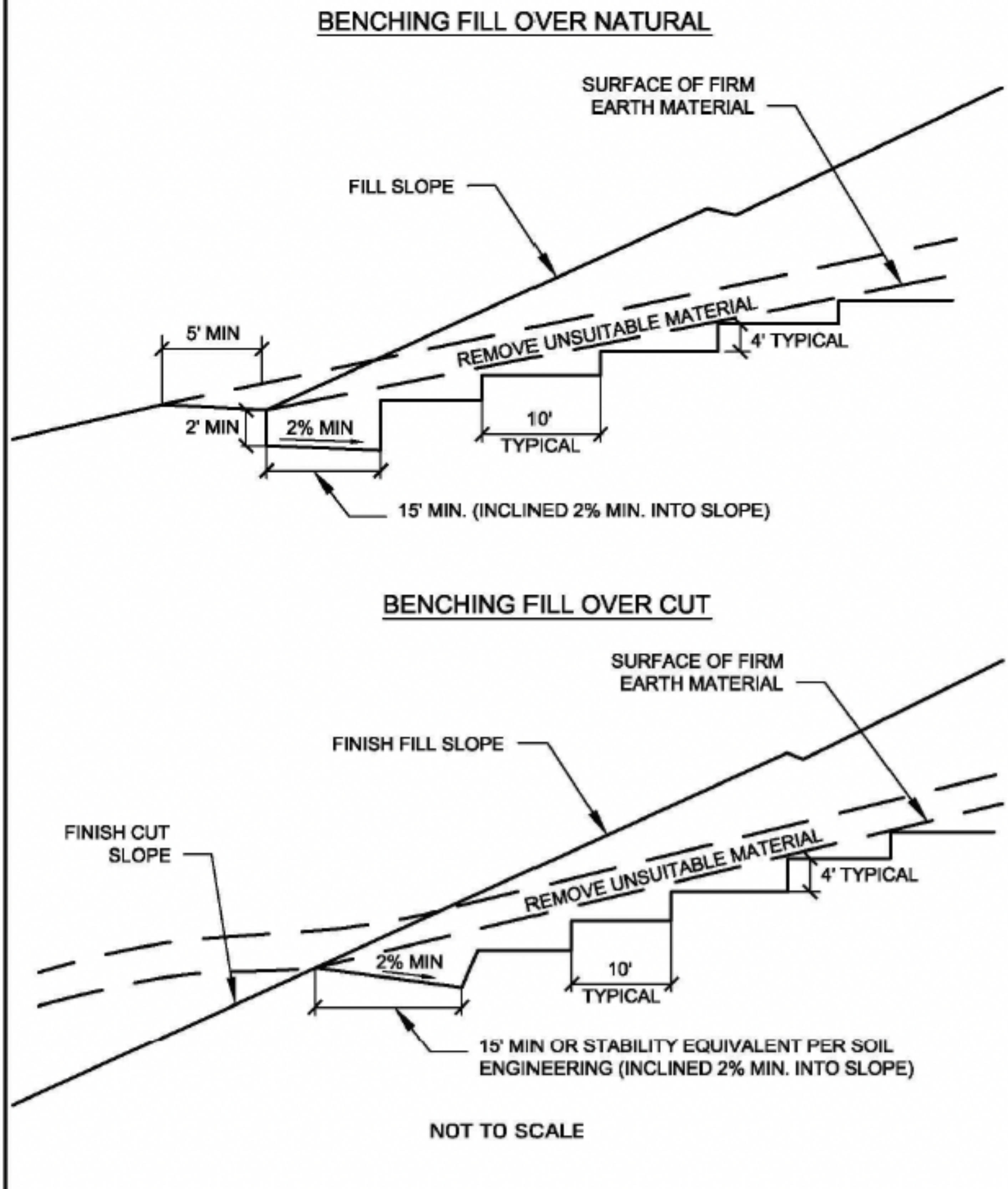
2. All aspects of the site earthwork shall be observed and tested as deemed necessary by the Geotechnical Engineer or his representative so that he can render a professional opinion of the completed fill for substantial compliance with plans and specifications and design concepts. The grading contractor shall give the Geotechnical Engineer at least two (2) working days' notice prior to beginning any site earthwork to allow proper scheduling of the work.

H. Seasonal Limits

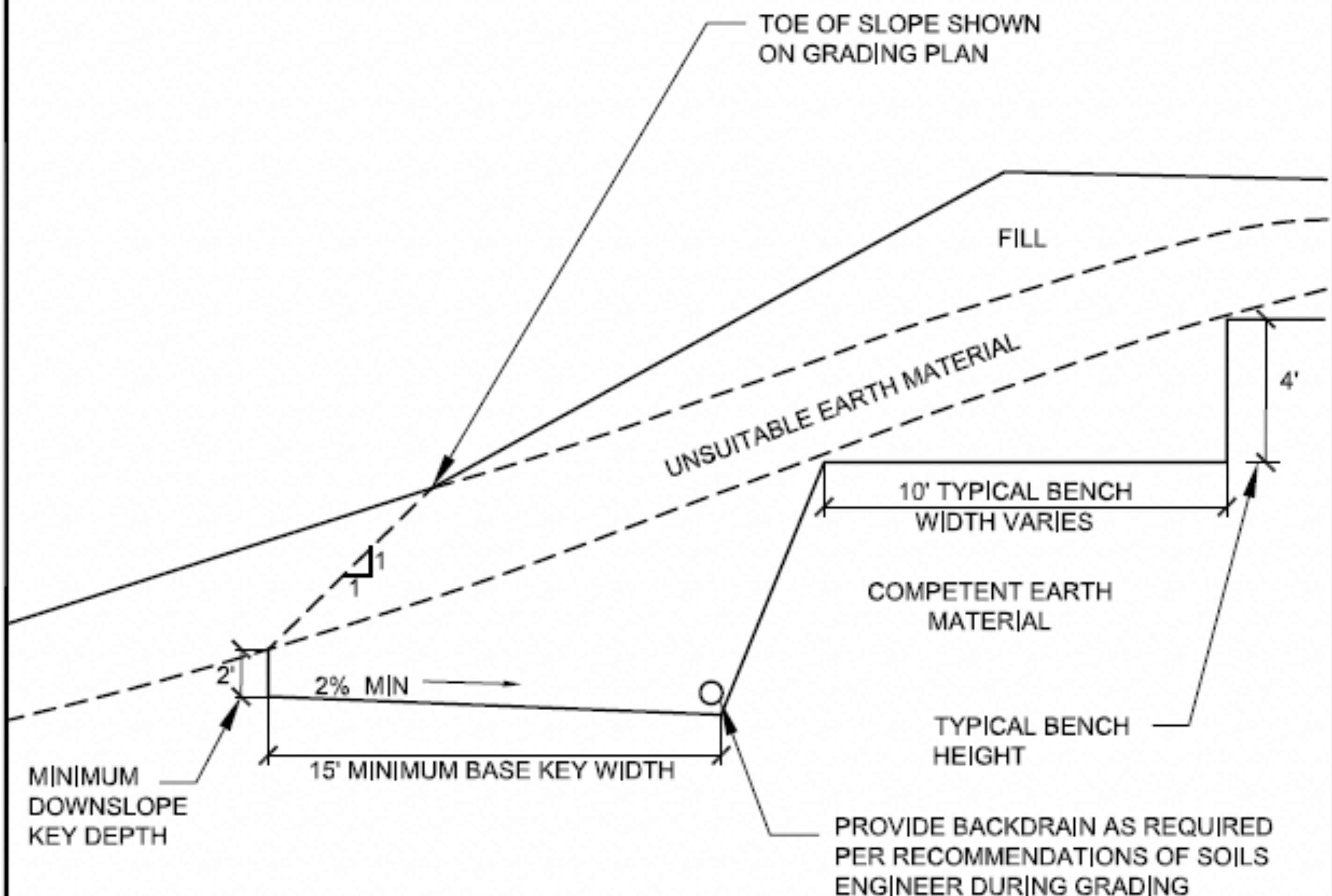
1. No fill material shall be placed, spread, or compacted during unfavorable weather conditions. When work is interrupted by heavy rain, fill operations shall not be resumed until the Geotechnical Engineer or his representative indicates that the moisture content and density of the previously placed fill are as specified.

GRADING DETAILS

(On following pages)



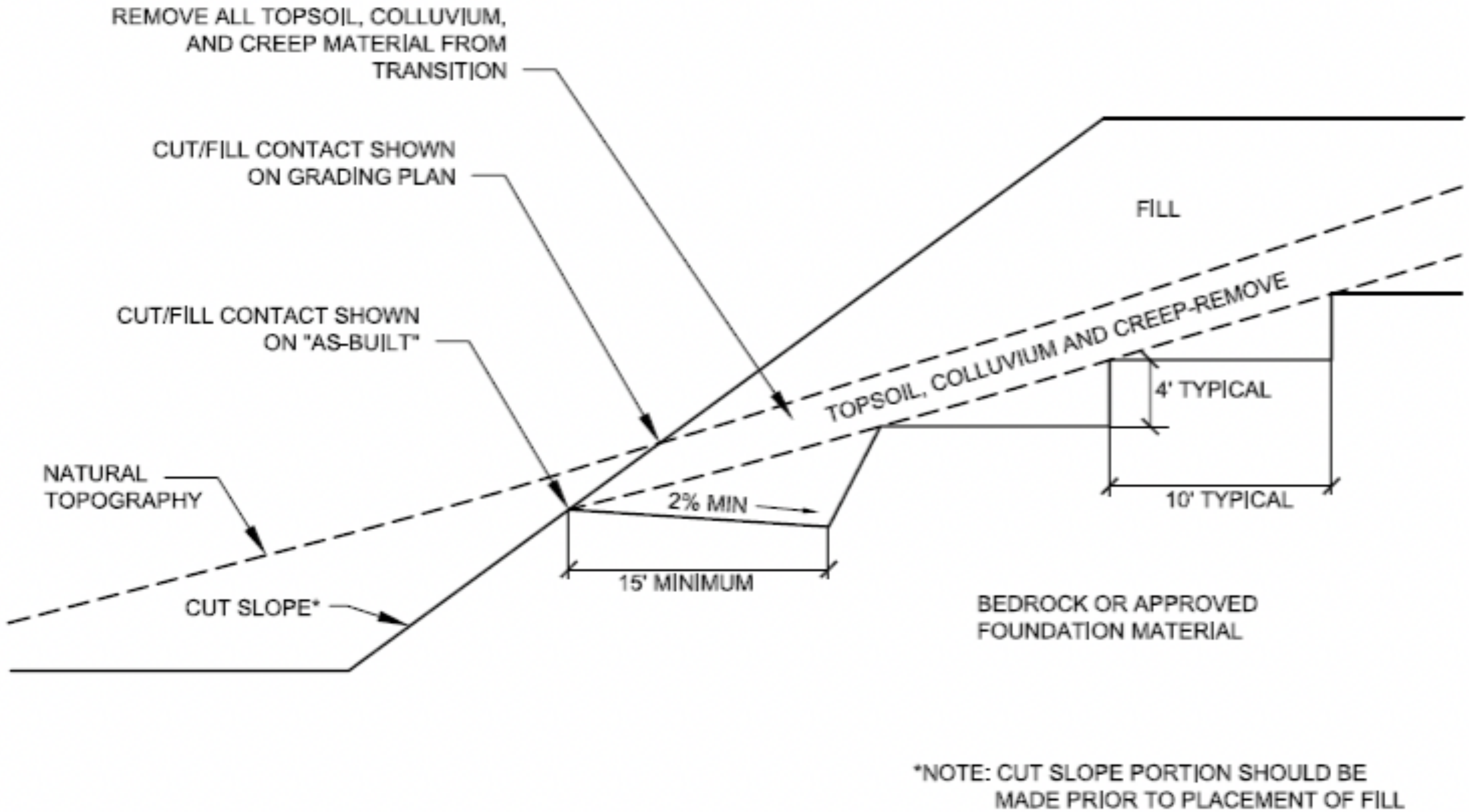
BENCHING FOR COMPACTED FILL DETAIL



WHERE NATURAL SLOPE GRADIENT IS 5:1 OR LESS,
BENCHING IS NOT NECESSARY. FILL IS NOT TO BE
PLACED ON COMPRESSIBLE OR UNSUITABLE MATERIAL.

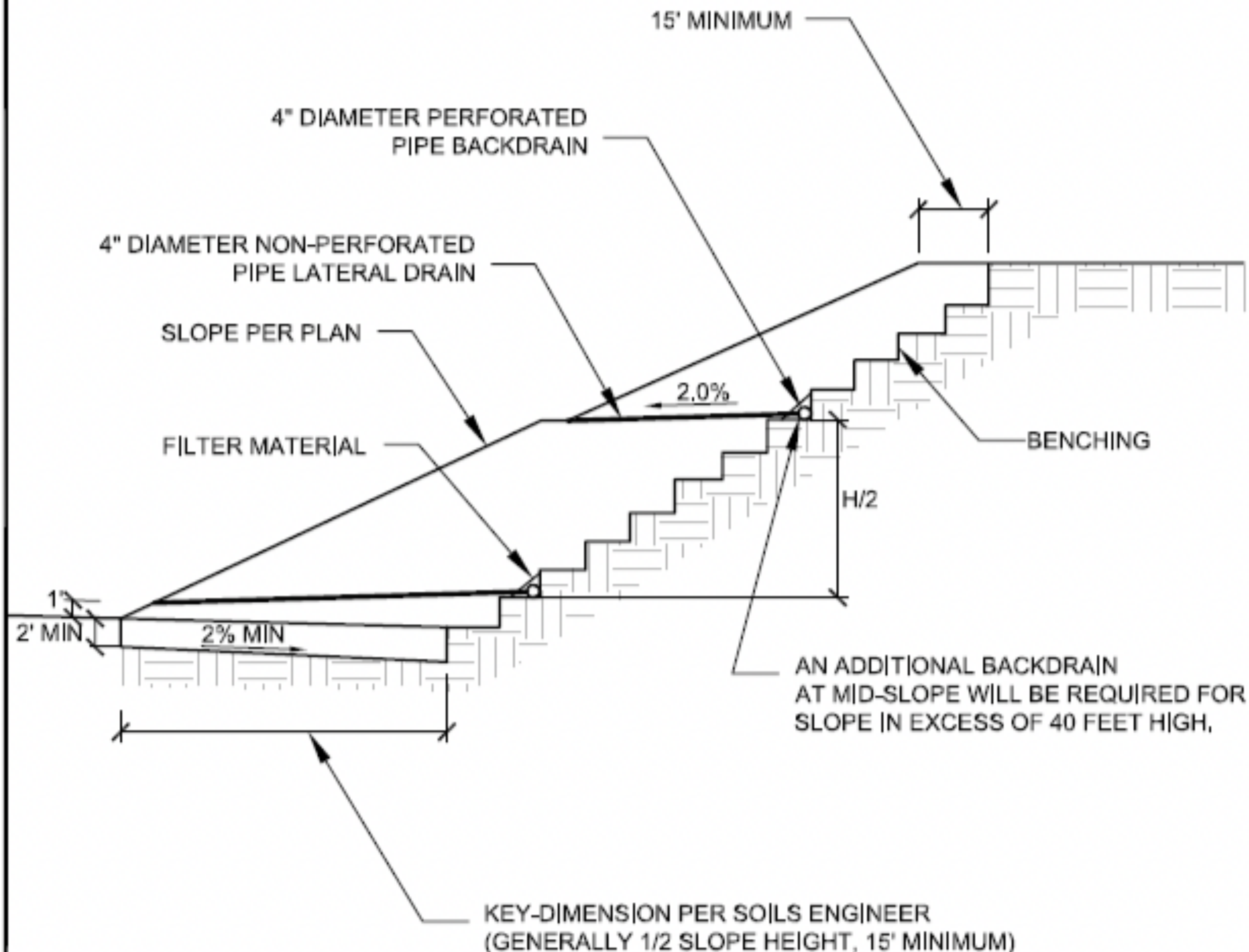
NOT TO SCALE

FILL SLOPE ABOVE NATURAL GROUND DETAIL



NOT TO SCALE

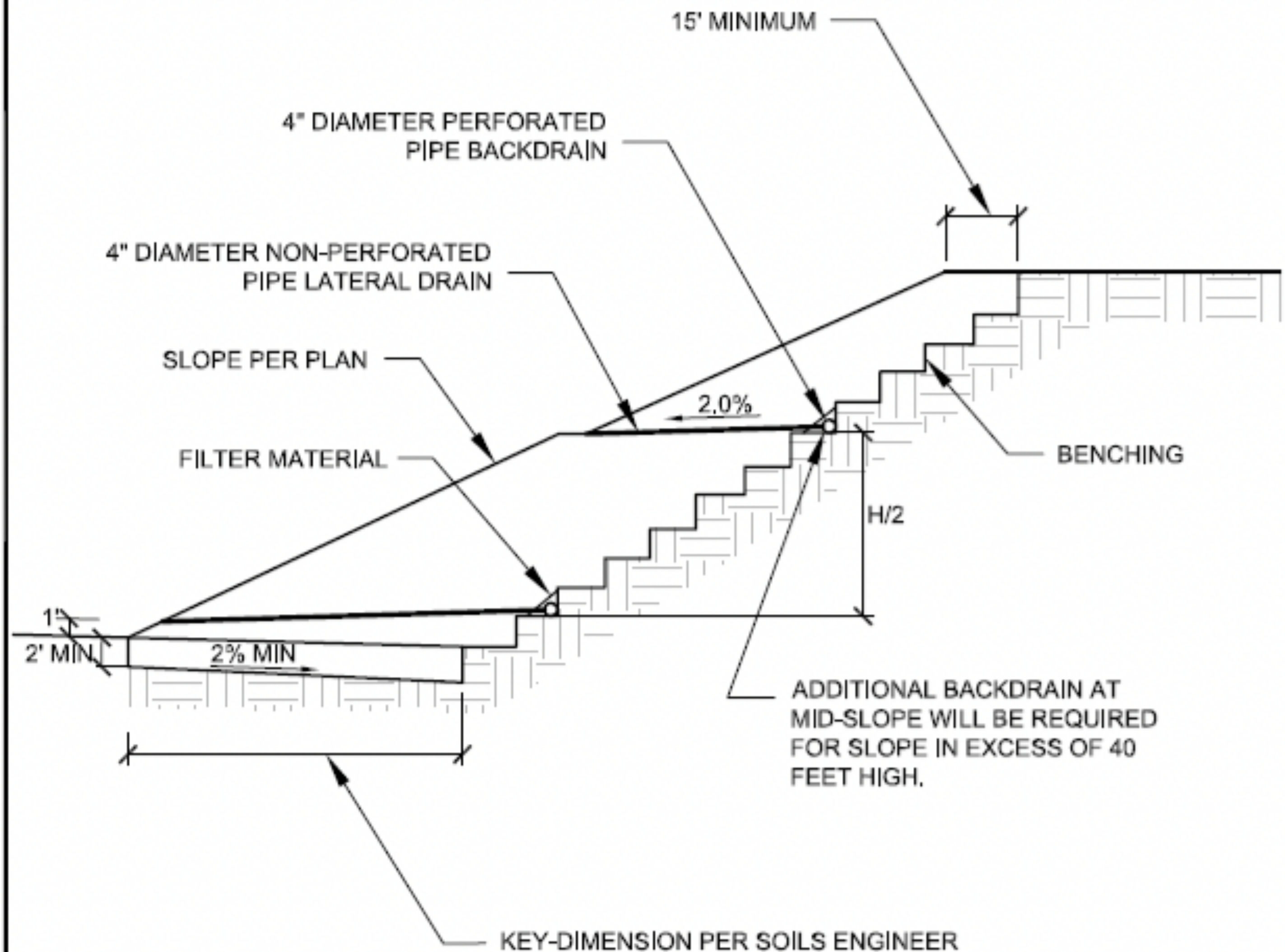
FILL SLOPE ABOVE CUT SLOPE DETAIL



DIMENSIONS ARE MINIMUM RECOMMENDED

NOT TO SCALE

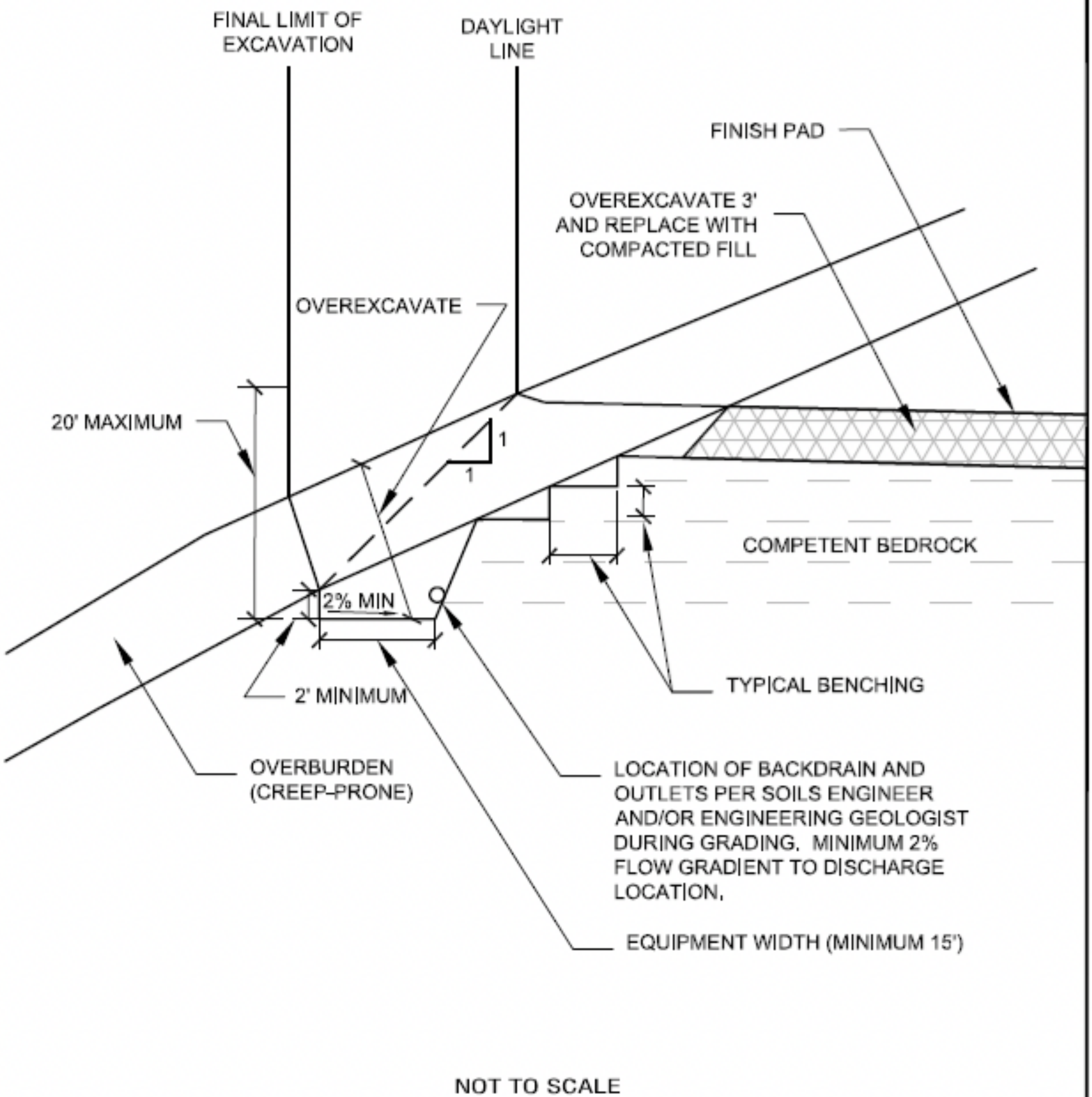
TYPICAL SLOPE STABILIZATION FILL DETAIL



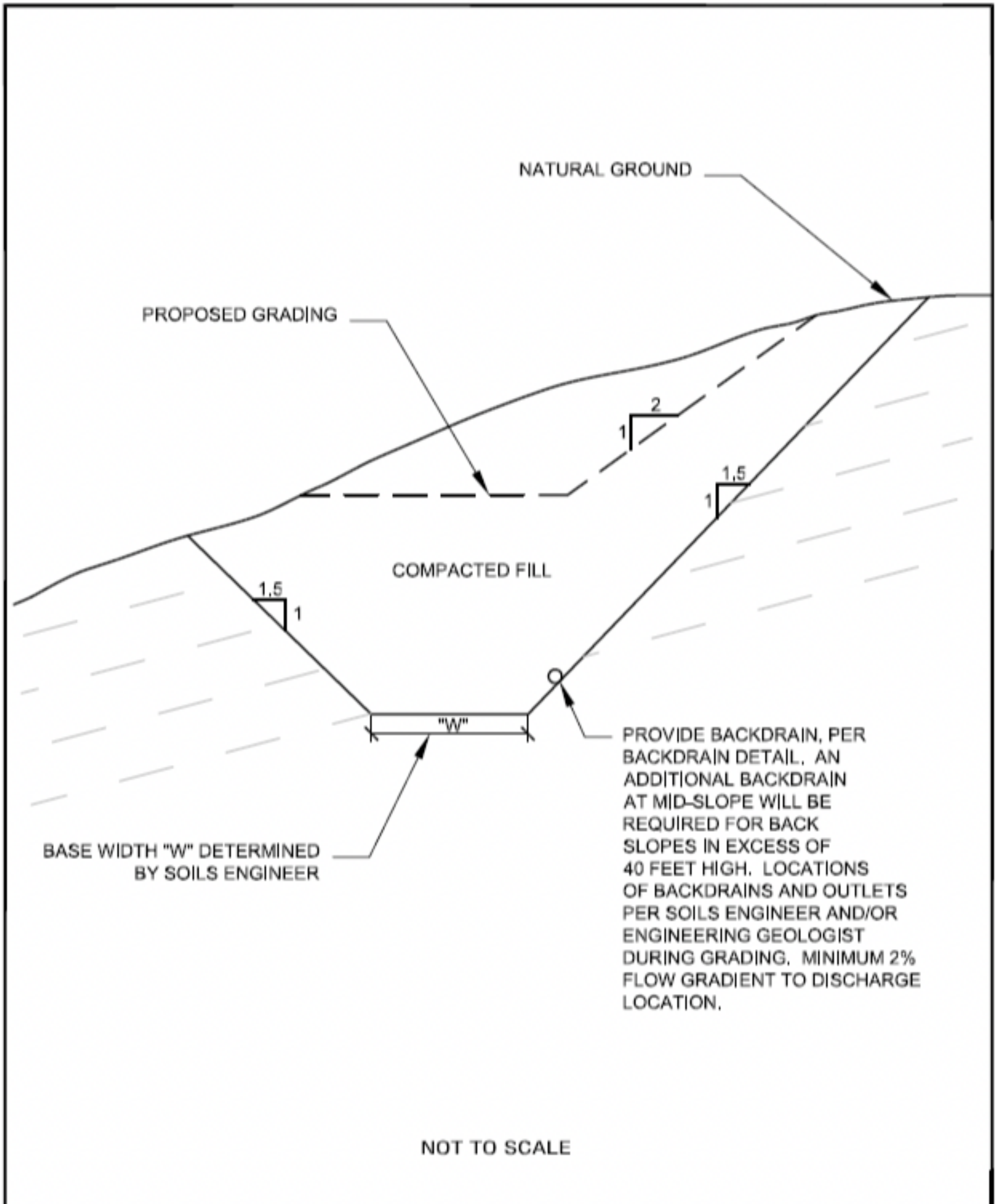
DIMENSIONS ARE MINIMUM RECOMMENDED

NOT TO SCALE

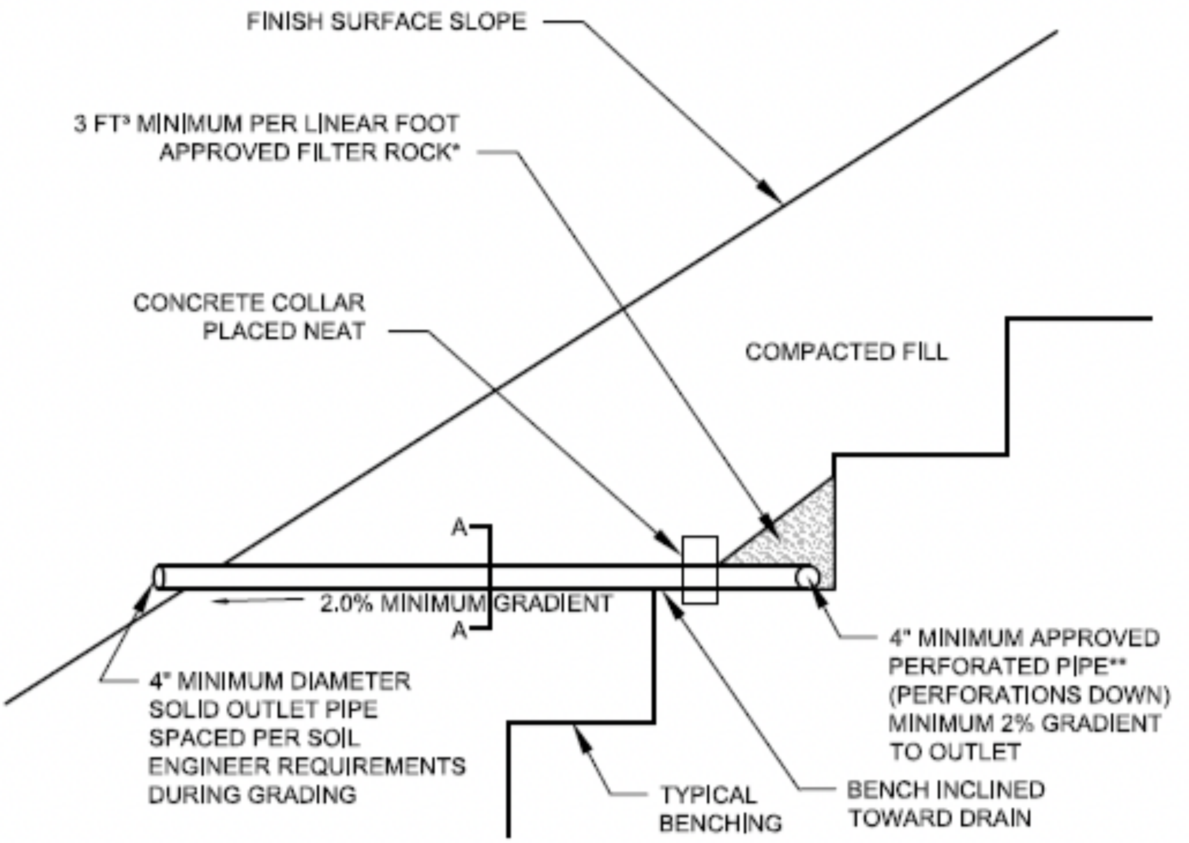
TYPICAL BUTTRESS FILL DETAIL



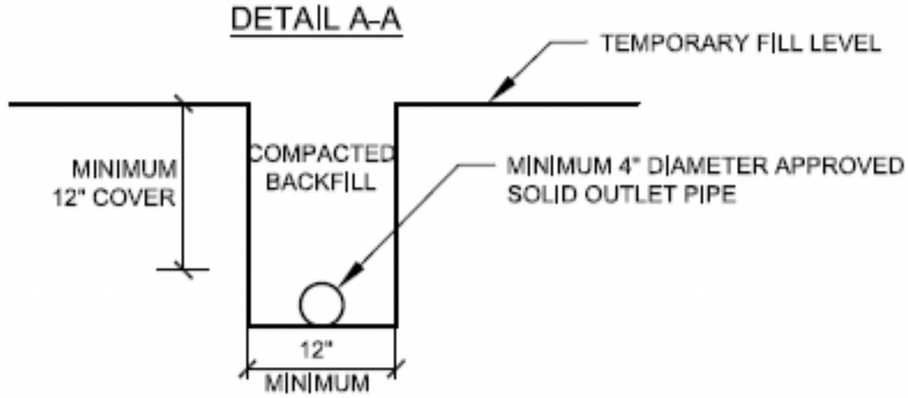
DAYLIGHT SHEAR KEY DETAIL



TYPICAL SHEAR KEY DETAIL



DETAIL A-A



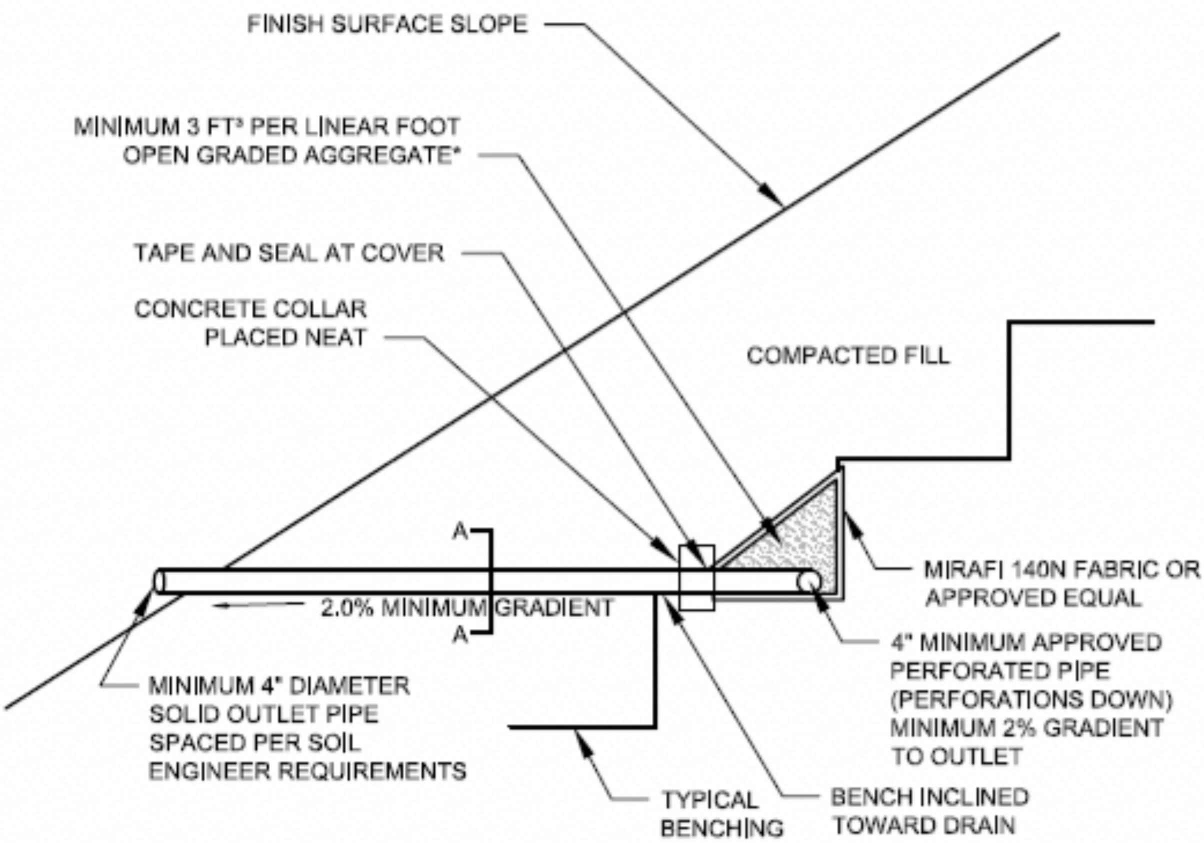
**APPROVED PIPE TYPE:
SCHEDULE 40 POLYVINYL CHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 PSI

*FILTER ROCK TO MEET FOLLOWING SPECIFICATIONS OR APPROVED EQUAL:

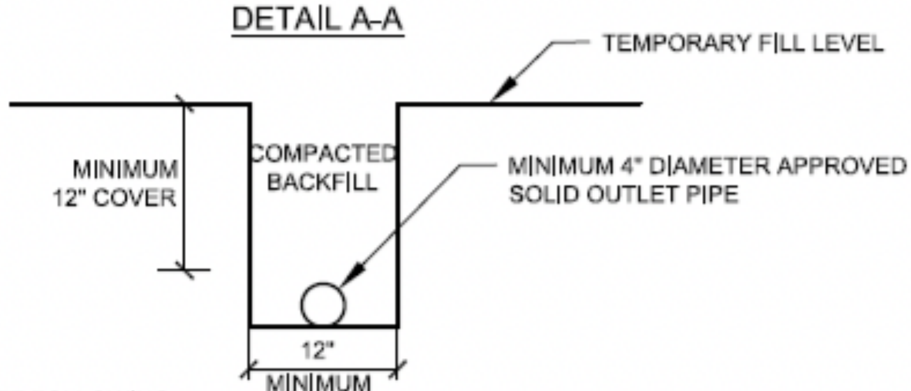
SIEVE SIZE	PERCENTAGE PASSING
1"	100
¾"	90-100
⅜"	40-100
NO. 4	25-40
NO. 30	5-15
NO. 50	0-7
NO. 200	0-3

NOT TO SCALE

TYPICAL BACKDRAIN DETAIL



DETAIL A-A

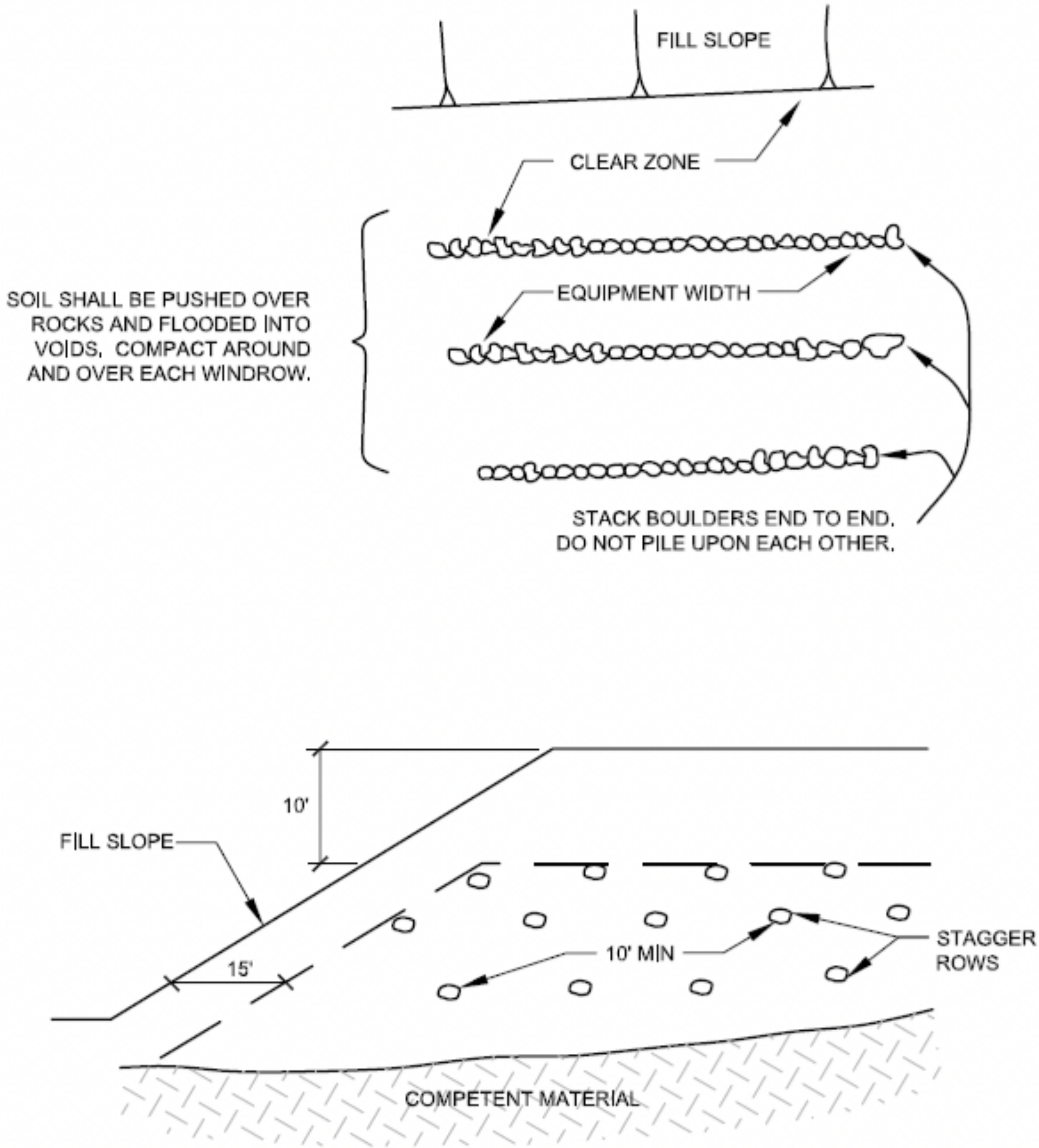


*NOTE; AGGREGATE TO MEET FOLLOWING SPECIFICATIONS OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE PASSING
1 ½"	100
1"	5-40
¾"	0-17
⅜"	0-7
NO. 200	0-3

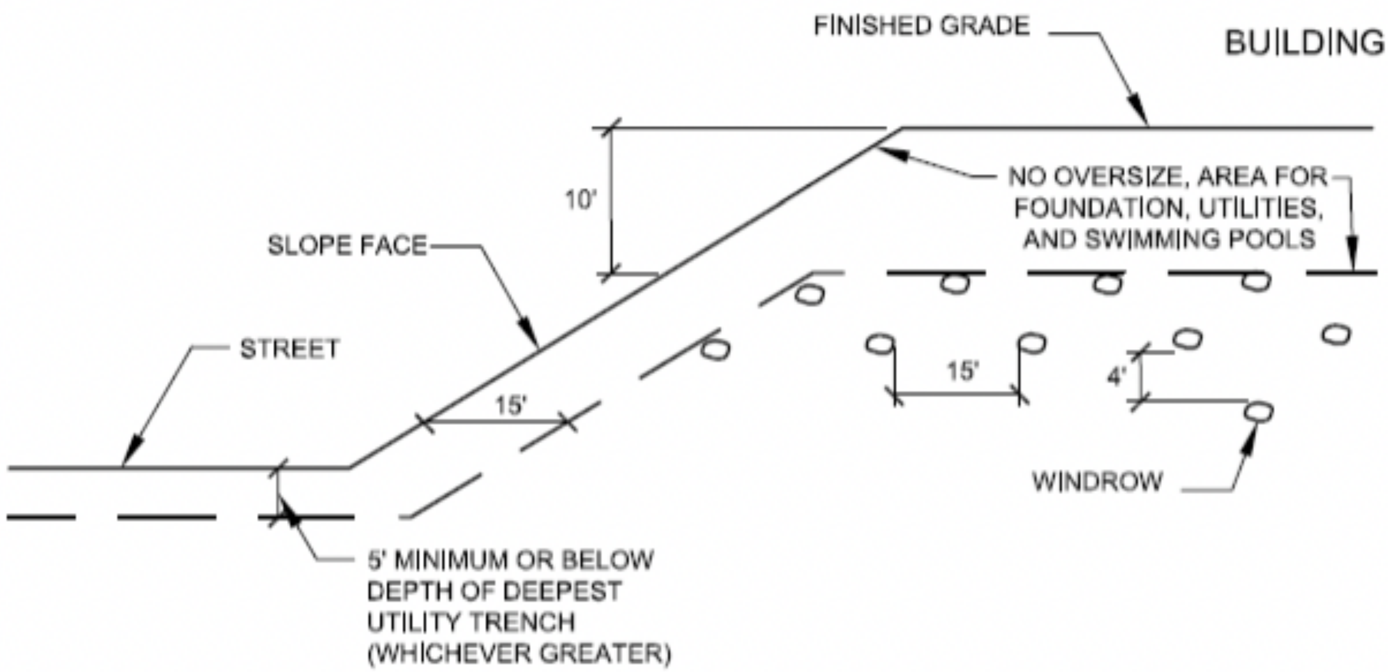
NOT TO SCALE

BACKDRAIN DETAIL (GEOFRABIC)

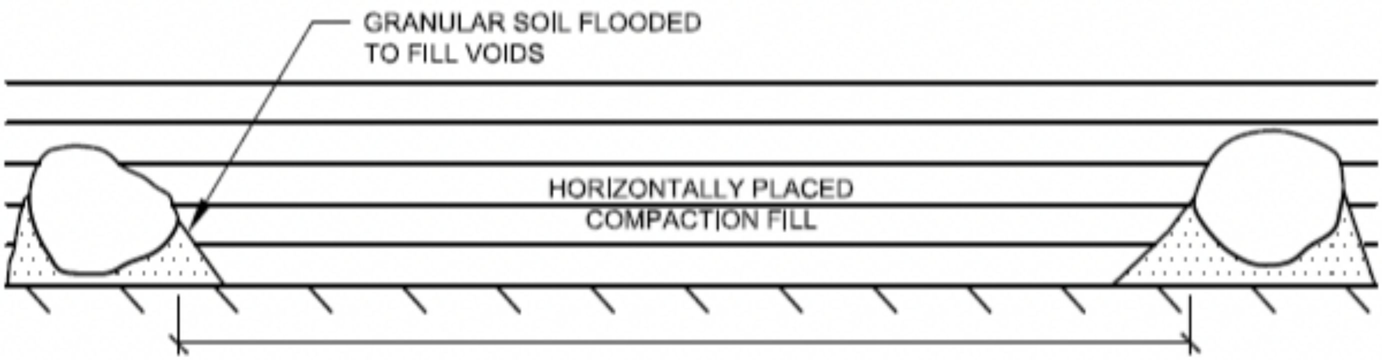


NOT TO SCALE

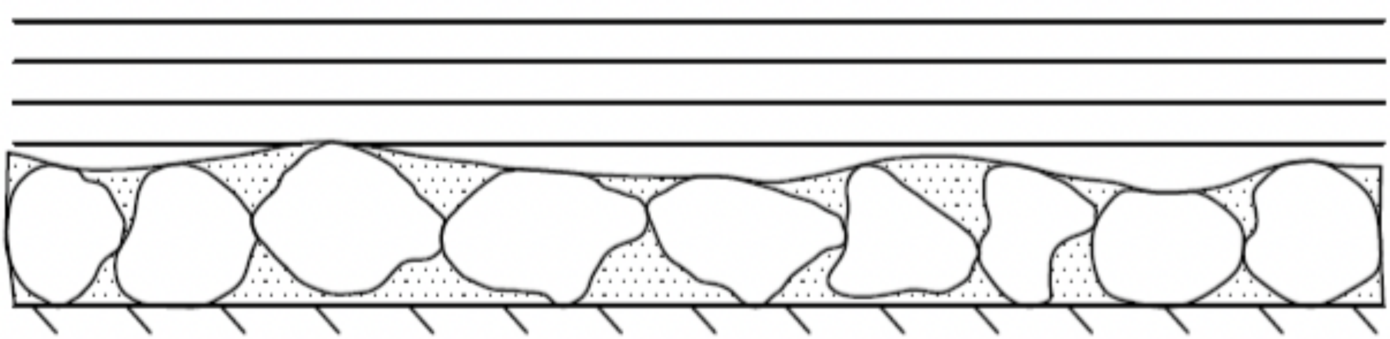
ROCK DISPOSAL DETAIL



TYPICAL WINDROW DETAIL (EDGE VIEW)



PROFILE VIEW

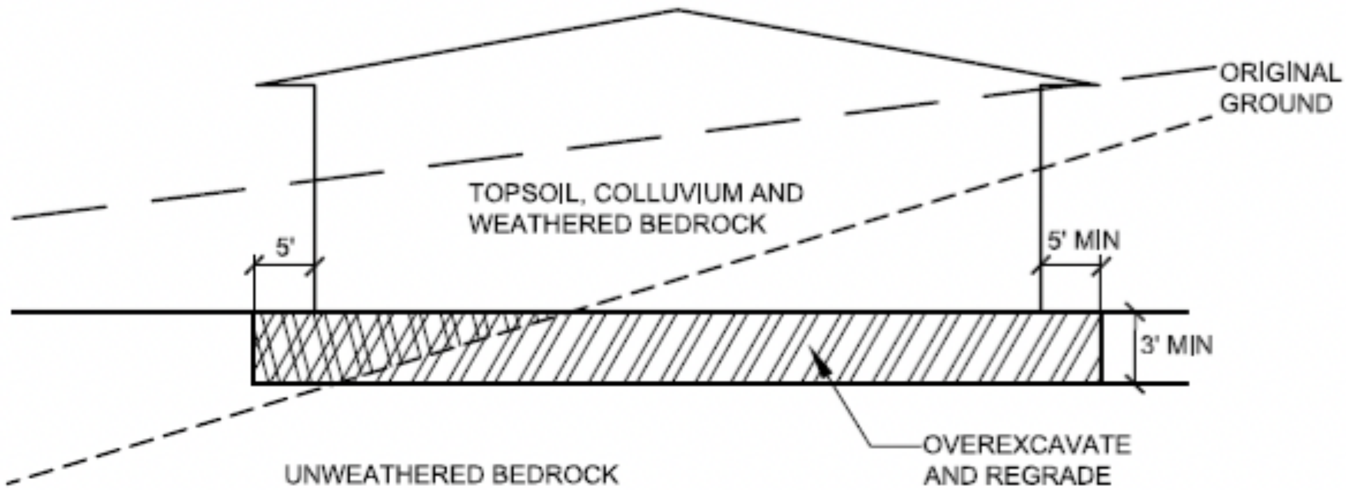


NOT TO SCALE

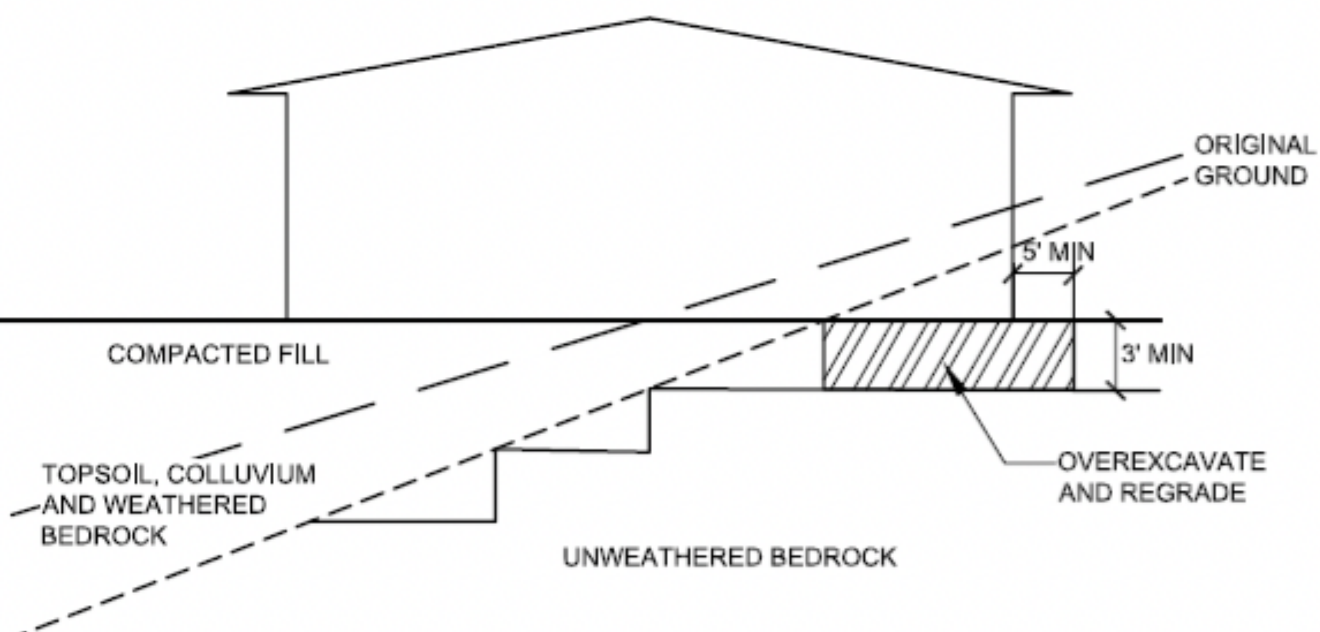
ROCK DISPOSAL DETAIL

GENERAL GRADING RECOMMENDATIONS

CUT LOT

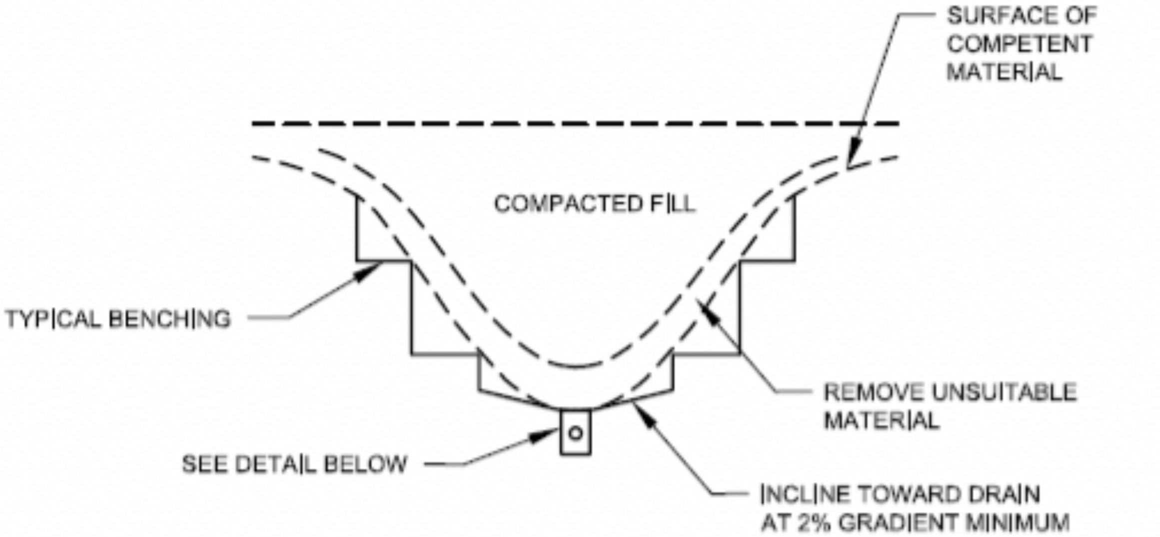


CUT/FILL LOT (TRANSITION)

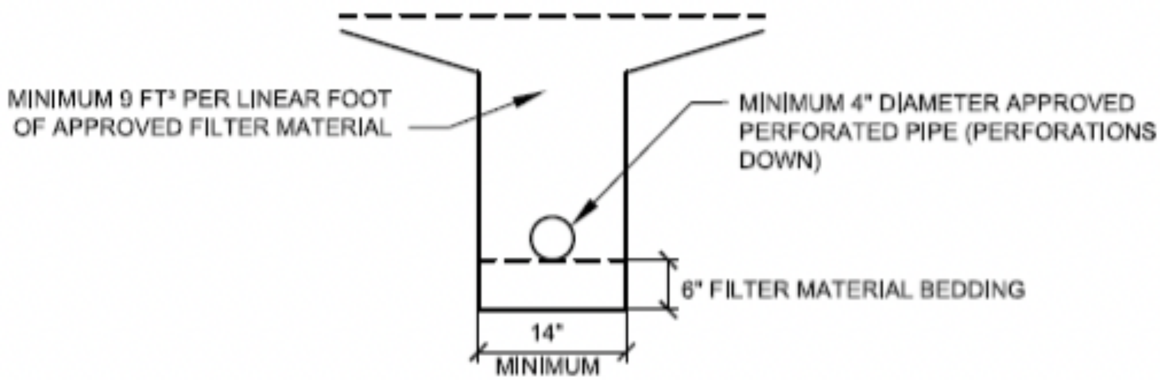


NOT TO SCALE

TRANSITION LOT DETAIL



DETAIL



FILTER MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE PASSING
1"	100
¾"	90-100
⅜"	40-100
NO. 4	25-40
NO. 30	18-33
NO. 8	5-15
NO. 50	0-7
NO. 200	0-3

APPROVED PIPE TO BE SCHEDULE 40 POLY-VINYL-CHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 psi

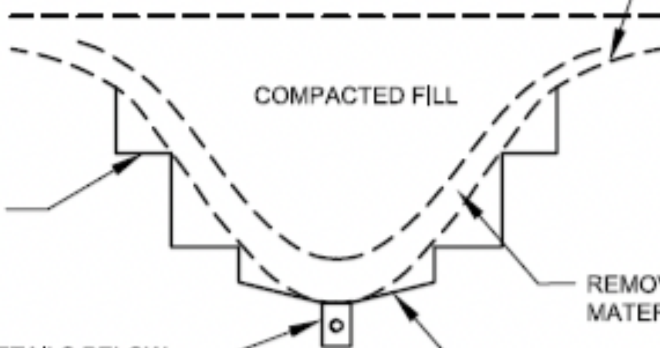
PIPE DIAMETER TO MEET THE FOLLOWING CRITERIA, SUBJECT TO FIELD REVIEW BASED ON ACTUAL GEOTECHNICAL CONDITIONS ENCOUNTERED DURING GRADING

LENGTH OF RUN	PIPE DIAMETER
INITIAL 500'	4"
500' TO 1500'	6"
> 1500'	8"

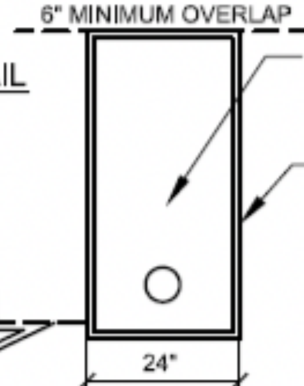
NOT TO SCALE

TYPICAL CANYON SUBDRAIN DETAIL

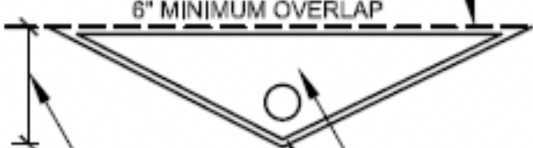
CANYON SUBDRAIN DETAILS



TRENCH DETAILS



OPTIONAL V-DITCH DETAIL



APPROVED PIPE TO BE SCHEDULE 40 POLY-VINYLCHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 PSI.

DRAIN MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE PASSING
1 ½"	88-100
1"	5-40
¾"	0-17
⅜"	0-7
NO. 200	0-3

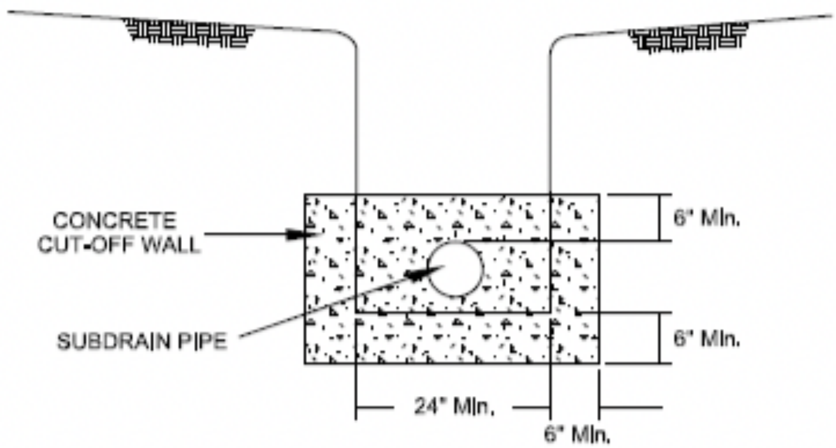
PIPE DIAMETER TO MEET THE FOLLOWING CRITERIA, SUBJECT TO FIELD REVIEW BASED ON ACTUAL GEOTECHNICAL CONDITIONS ENCOUNTERED DURING GRADING

LENGTH OF RUN	PIPE DIAMETER
INITIAL 500'	4"
500' TO 1500'	6"
> 1500'	8"

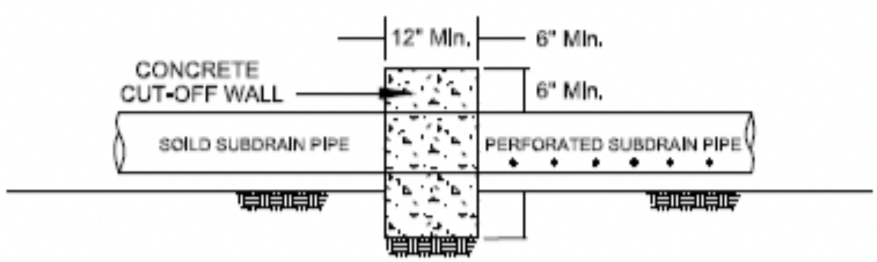
NOT TO SCALE

GEOFABRIC SUBDRAIN

FRONT VIEW



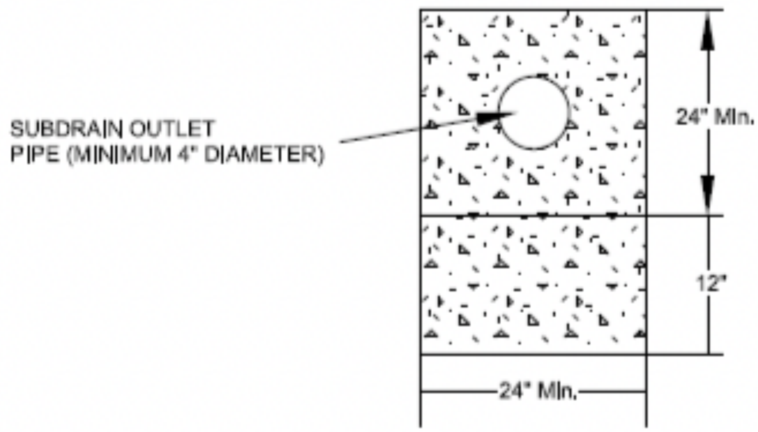
SIDE VIEW



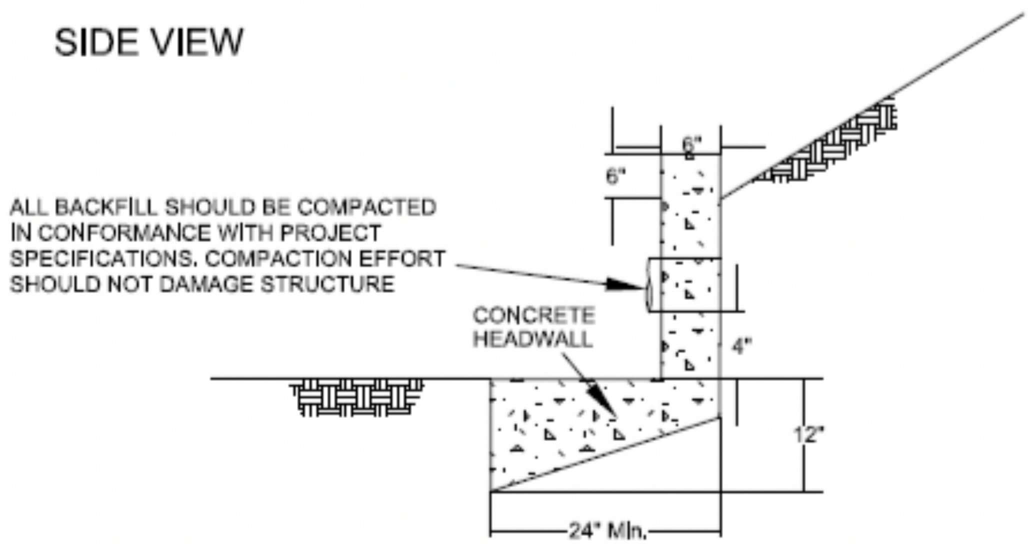
NOT TO SCALE

RECOMMENDED SUBDRAIN CUT-OFF WALL

FRONT VIEW



SIDE VIEW



NOTE: HEADWALL SHOULD OUTLET AT TOE OF SLOPE OR INTO CONTROLLED SURFACE DRAINAGE DEVICE

ALL DISCHARGE SHOULD BE CONTROLLED

THIS DETAIL IS A MINIMUM DESIGN AND MAY BE MODIFIED DEPENDING UPON ENCOUNTERED CONDITIONS AND LOCAL REQUIREMENTS

NOT TO SCALE

TYPICAL SUBDRAIN OUTLET HEADWALL DETAIL

APPENDIX E

SEAOC/OSHPD U.S. Seismic Hazard Maps

USGS web services were down for some period of time and as a result this tool wasn't operational, resulting in *timeout* error.
USGS web services are now operational so this tool should work as expected.

OSHPD

2 Rovina Ln, Petaluma, CA 94952, USA

Latitude, Longitude: 38.22554, -122.62004

Date	9/22/2023, 11:39:57 AM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	C - Very Dense Soil and Soft Rock

Type	Value	Description
S_S	1.5	MCE_R ground motion. (for 0.2 second period)
S_1	0.6	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.8	Site-modified spectral acceleration value
S_{M1}	0.84	Site-modified spectral acceleration value
S_{DS}	1.2	Numeric seismic design value at 0.2 second SA
S_{D1}	0.56	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	1.2	Site amplification factor at 0.2 second
F_v	1.4	Site amplification factor at 1.0 second
PGA	0.623	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	0.747	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	1.814	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.989	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.7	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.774	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.623	Factored deterministic acceleration value. (Peak Ground Acceleration)
PGA_{UH}	0.775	Uniform-hazard (2% probability of exceedance in 50 years) Peak Ground Acceleration
C_{RS}	0.912	Mapped value of the risk coefficient at short periods
C_{R1}	0.904	Mapped value of the risk coefficient at a period of 1 s
C_V	1.2	Vertical coefficient

DISCLAIMER

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