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GEOTECHNICAL CONSULTANTS

REPORT
GEOTECHNICAL INVESTIGATION
Mixed Use Development
131 Liberty Street
Petaluma, California

Prepared for:

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TABLE OF CONTENTS

INTRODUCTION 1

WORK PERFORMED 3

SITE CONDITIONS 5
  A. Surface Conditions 5
  B. Subsurface Conditions 5
  C. Groundwater 7
  D. Faulting and Seismicity 7

DISCUSSION AND CONCLUSIONS 8

RECOMMENDATIONS 11

  A. Site Preparation and Grading 11
  B. Foundations 15
  C. Seismic Design Criteria 17
  D. Concrete Slabs-on-Grade 18
  E. Retaining Walls 19
  F. Asphalt Pavement Structural Sections 21
  G. Geotechnical Engineering Drainage 23
  H. Supplemental Services 25

MAINTENANCE 26

LIMITATIONS 26

ILLUSTRATIONS 27

LIST OF REFERENCES 28

DISTRIBUTION 29

LIST OF ILLUSTRATIONS

Plate 1	Site Plan
Plates 2 - 5	Logs of Test Borings 1 through 4
Plate 6	Soil Classification Chart & Key to Test Data
Plate 7	Rock Classification Criteria
Plate 8	Typical Underslab Drain Detail
Plate 9	Wall Drainage Detail

INTRODUCTION

This report presents the results of our geotechnical investigation for the subject project. The project site is shown on the *Grading & Drainage Plan*, titled "Mixed Use Project, 131 Liberty Street, Petaluma," dated November 10, 2017 and prepared by Steven J. Lafranchi & Associates, Inc. The plan is partially reproduced and shown on Plate 1.

We understand that an existing one-story office/retail building will be removed for new development. A plan prepared by MAD Architecture indicates the proposed development will consist of a two-story retail/office building, four apartment structures with two stories over ground level garages, and one two-story apartment structure with an attached garage and handicap adaptable on the bottom floor. The floor elevations of the structures will step up the slope from east to west. We understand that the structures will have plaster and metal cladding. Ground levels will have concrete slab-on-grade floors. Foundation loads are expected to be typical for the type of construction indicated. We understand reinforced concrete mat foundations are planned. We further understand that unretained cuts and fills will be relatively minor and less than about 4 feet high. Retaining walls will be less than about 5 feet. The structures will be accessed by a one-way driveway that enters on Liberty Street on the east and exits on Court Street on the west. Additional parallel parking will be provided along the north parcel boundary.

The scope of our investigation, as outlined in our agreement dated March 17, 2017, included reviewing selected published geologic information from our files, exploring subsurface conditions, and performing laboratory testing on selected samples to determine characteristics pertinent to design and construction. Based on our work, we have developed the geotechnical conclusions and recommendations concerning:

1. Proximity of the site to published active faults.
2. Soil/sediment and ground water conditions observed.
3. Site preparation and grading.
4. Foundation type(s) and design criteria.
5. Concrete slabs-on-grade.
6. Retaining walls.
7. Pavement thickness designs based on an assumed Resistance (R)-Value.
8. Geotechnical engineering drainage.
9. Supplemental services.

Our scope of work did not include an evaluation of any potential hazardous waste contamination or corrosion potential of the soil or groundwater at the site. Further, our scope of services did not include evaluation of areas beyond the proposed improvements (i.e., existing utilities, existing development, off-site improvements including the retaining along the southern parcel boundary).

WORK PERFORMED

We reviewed our previous work in the near vicinity, and selected published geologic and geotechnical information summarized in the List of References.

On March 21, 2017, our geotechnical engineer met with Mr. William Wilson at the site to observe existing surface conditions and mark our planned test boring locations. On April 12, 2017, our geologist explored the subsurface conditions to the extent of four test borings. The test borings were drilled with a truck mounted, B-53 drill rig equipped with 6-inch diameter solid flight augers. The completed test borings were drilled to depths of between about 10 and 19-1/2 feet.

The test borings were located by our geotechnical engineer by pacing or estimating distances from the features shown on the available plan. The approximate test boring locations are shown on Plate 1. The test boring locations should be considered accurate only to the degree implied by the method used.

Our geologist logged the conditions exposed and obtained bulk and relatively undisturbed samples at selected intervals for visual classification and laboratory testing. The samples were obtained with a 2.4-inch, inside-diameter (i.d.), split-spoon sampler, or 1.5-inch i.d. Standard Penetration Test (SPT) sampler driven with a 140-pound automatic trip hammer. The stroke during driving was about 30 inches. The blows required to drive the 2.4-inch sampler were recorded and converted to Standard Penetration Resistance Values for correlation with other data. The blows required to drive the SPT sampler do not require conversion. The logs of the test borings showing the materials encountered, sample depths, and converted and unconverted blow counts are presented on Plates 2 and 5. The materials encountered are classified in accordance with the Unified Soil Classification System and Rock Classification Criteria, presented on Plates 6 and 7, respectively.

The logs show our interpretation of the subsurface conditions on the date and locations indicated, and it is not warranted that they are representative of the subsurface conditions at other locations and times. Also, the stratification lines on the logs represent the approximate boundaries between material types; the transition may be gradual. The test borings were backfilled with cement grout or drilling spoils, as appropriate.

Representative samples of the soils encountered were laboratory tested to determine their moisture content, density, strength, and classification (Atterberg limits, minus No. 200 sieve). The test results are generally presented on the logs in the manner described in the Key to Test Data, Plate 6.

SITE CONDITIONS

A. Surface Conditions

The 0.34-acre, rectangular-shaped parcel is zoned in a mixed use (commercial and residential) area in downtown Petaluma. The parcel is approximately 60 feet wide in the north-south direction, and 240 feet long in the east-west direction. The site is bounded by Liberty Street on the east and Court Street on the west. The terrain is sloping from west to east with an elevation differential of about 12 feet. An approximately 4,100 square-foot, existing one-story structure occupies the southeastern portion of the parcel. An approximately 30-inch high timber wall is situated on the west side of the structure. The timber wall is in poor condition and failing. An asphalt driveway extends along the northern boundary between Liberty and Court Streets. Overflow parking is on the eastern portion of the parcel. According to the plan shown on Plate 1, a 5- to 7-foot high wall extends along a portion of the common southern parcel. A concrete staircase steps up to a platform at the west end of the wall.

B. Subsurface Conditions

The geologic map by Bezore, et al. (2002) indicates the site is underlain by marine sandstone of the Wilson Grove formation. The sandstone is generally light gray to light yellow brown, fine-grained, well sorted, and massive to poorly bedded. Localized lenses of pebble conglomerate are commonly found within the formation.

Our test borings were limited to asphalt paved portions of the parcel due to the existing building. Based on our test borings, the pavement section (asphalt overlays, fabric, and aggregate baserock) is about 1 foot thick across the site. The pavement section is underlain by about 2 to 4-1/2 feet of variable density old fills. The old fills variably consist of weak clayey sands and sandy clays of high expansion potential, and decrease in thickness from east to west. The cumulative depths of old pavement, loose clayey sands and expansive clays are noted as "weak" on the right side of the test boring logs.

Where encountered, highly expansive soils will be subject to seasonal moisture variations that could heave and crack lightly loaded, shallow foundations and slabs-on-grade. The results of our laboratory tests are presented on the test boring logs

Below the weak fills, we encountered fine-grained sandstone, siltstone and conglomerate sediments of the Wilson Grove formation. These sediments typically resemble soils that are relatively strong and incompressible under the anticipated range of loading. The sediments we encountered in our test borings ranging from about 3 to 5-1/2 feet below the pavement surface, and extend to the maximum depths explored (10 to 19-1/2 feet).

C. Groundwater

Groundwater seepage was observed in Test Boring 1 only. Groundwater was first observed in Test Boring 1 at a depth of 13 feet (interface between the clayey sandstone and underlying conglomerate sediments). The water level was measured to be 11 feet after drilling. Free groundwater did not develop in Test Borings 2 through 4 during drilling. Groundwater conditions are expected to vary seasonally and at different locations. Shallow perched groundwater conditions can occur near the surface and perch on stiff soil or sediment layers. Our work did not include an evaluation of flooding.

D. Faulting and Seismicity

Published geologic maps of the area do not show active faults crossing the site. The nearest fault currently considered seismically active (experiencing surface rupture within about the last 11,000 years) is the Rodgers Creek fault, located approximately 6 miles to the northeast. The main San Andreas fault zone is located approximately 13-1/2 miles to the southwest. Other faults not currently considered 'Holocene-active' are located in closer proximity to the site. Our authorized scope of work did not include subsurface investigation to evaluate the presence of active faults crossing the site.

As throughout the entire Northern California area, ground shaking from earthquakes represents a significant geologic hazard to developments. The intensity of ground shaking will be dependent on several factors such as distance from the site to the earthquake focus, depth of the earthquake, magnitude of the earthquake, duration of ground shaking, and response of the underlying soil and rock.

DISCUSSION AND CONCLUSIONS

Based on the results of our investigation, we conclude that the planned development is feasible from a geotechnical engineering viewpoint. The primary geotechnical concerns are: 1) the presence of up to 4-1/2 feet of weak and locally highly expansive soils variable density old fills; and 2) the existing retaining wall to remain.

Upon saturation, weak/porous soils and variable density old fills will lose strength and consolidate rapidly under loads of new fill and structural elements. Saturation will occur when the natural evaporation of soil moisture is inhibited by new fill and structural elements. Expansive soils undergo significant volumetric changes with seasonal variations in moisture content. Such movements can result in unacceptable heaving and cracking of lightly-loaded structural elements, such as foundations, concrete slabs, and pavements. We judge that the potential adverse affects resulting from the variable density fill soils can be mitigated by removing and replacing them with select fill materials, as needed, to subgrade elevations. Either mat foundations or spread footings would be satisfactory for support. Where excavations encounter firm sediments, excavation of firm, non-expansive materials and replacement with select fill will not be required. A representative from Bauer Associates, Inc., should review all excavations prior to placement of new fills. Expansive soils are not suitable for use as fill within the upper 1 foot of subgrade where mat foundations are used, and within the upper 30 inches where spread footings are used. Where critical use slabs are underlain by cut and fill, or differential fill thicknesses greater than 3 feet, increased compaction (i.e., 93 percent) will be necessary.

We did not evaluate the existing retaining wall, stairs or platform along the southern portion of the parcel. A geotechnical concern includes potential influences on the wall from construction equipment, new building loads, wall backdrain conditions, etc. Wall backfill conditions were covered by the existing improvements and not available for our observation. The contractors will need to develop plans in order to protect the wall during construction, and implement supplemental recommendations to be provided when conditions are exposed during construction. We do not know what, if any, effect the proposed project will have on the existing retaining wall.

Less critical slabs, such as strip walkways, may be constructed on properly prepared subgrade provided that: 1) the slabs are separated from foundations and provided with control joints; 2) slabs are designed to minimize cracking (i.e., reinforced); and 3) some soil related cracking related to heave and differential settlement is considered acceptable.

Improved performance of less critical slabs could be attained by removal of all, or at least a portion of, the weak and expansive soils and replacement with select engineered fill.

Within planned asphalt paved areas, the old pavement sections should be removed. Following their removal, the variable density, old fills must be excavated and recompacted to at least 18 inches below the stripped existing grade or planned subgrade, whichever is deeper. If desired, the upper 18 inches of soil could be non-expansive select fill to reduce new pavement section thicknesses.

Control of surface run-off will significantly enhance the stability of the site. The site should be graded to slope away from foundations, slabs and roadway edges. The discharge of roof gutter downspouts must be collected into non-perforated pipes that discharge into the site storm drainage. In critical interior slab areas, underslab drains should be provided beneath the slab rock to reduce the risk of water build-up in the slab rock. Water trapped in the slab rock could permeate through the concrete slab, which could result in wet slabs and/or damaged floor coverings. For less critical use slabs, outlets should be provided in the slab rock to reduce the risk of water build up in the slab rock. All collected water must be discharged into the site storm drainage system.

Groundwater seepage was observed in Test Boring 1 during drilling, but did not develop in Test Borings 2 through 4. However, perched groundwater conditions will vary seasonally and by location across the site, particularly after periods of prolonged rainfall or during the winter and spring months. Excavations performed in the summer or autumn months will typically result in a lower risk of encountering groundwater. Our work did not include an evaluation of flooding potential.

The published geologic maps do not indicate active faults passing through the site. Since future fault rupture is generally considered more likely to follow the trace of the most recent fault rupture, we estimate the risk of future surface rupture during earthquakes to be low.

As throughout the entire Northern California area, ground shaking from earthquakes represents a significant geologic hazard to the site development. The intensity of ground shaking will be dependent on several factors such as the distance from the site to the earthquake focus, magnitude and depth of the earthquake, and response of the underlying soil and rock. Severe ground shaking could induce ground movements in weak soils on steep slopes. It will be necessary to design and construct the project in strict accordance with current standards for earthquake-resistant construction.

RECOMMENDATIONS

A. Site Preparation and Grading

The following is presented for general grading. We must review and approve any grading planned, since site grading may have a negative impact on site stability.

Areas to be graded should be cleared of existing improvements and their foundations, pavements, designated trees, rubble, debris and old fills. Material generated by the clearing operations should be removed from the site. Wells, cesspools, and other voids encountered or generated during clearing should be either backfilled with granular material or compacted soil, or capped with concrete as determined by us and in accordance with Sonoma County requirements.

Areas to be graded should be stripped of the upper soils containing root growth and organic matter. The strippings should be removed from the site, stockpiled for reuse as topsoil, or mixed with at least two parts soil and used as fill in areas at least 10 feet beyond structures, walks and paved areas.

For the purpose of definition, "select fill areas" referred to in this report are the planned residential units and commercial building. Select fill areas also include the zones extending for a distance of at least 5 feet beyond outside edges of critical slabs and perimeter footings or other footings extending from buildings. Within the select fill areas, existing weak surface soils and old fills should be removed for their full depth. As encountered in our test borings, weak soils and old fills varied up to about 5-1/2 feet. Additional excavation may be necessary to provide a minimum section of select fill (12 inches in mat foundation areas, and 30 inches in spread footing foundation areas). Some of the non-expansive excavated materials may be suitable for reuse as select fill, and if desired for reuse, should be stockpiled separately from the expansive soil spoils. The depth and extent of overexcavation should be approved in the field by us.

If isolated deeper zones of soft, saturated, dry (shrinkage cracks), highly porous or organic soils are encountered during excavation and recompaction, these soils should be removed to expose firm soils. The depth and extent of overexcavation should be observed by us in the field.

Within the stripping and excavation areas, the exposed bottoms should be moisture conditioned to at least 2 percent above optimum moisture content (4 percent for expansive soils), scarified, and compacted to at least 90 percent relative compaction. Relative compaction refers to the in-place dry density of the soil expressed as a percentage of the maximum dry density of the same soil, as determined by ASTM D 1557-12. Optimum moisture content is the water content (percentage by dry weight) corresponding to the maximum dry density.

If grading is performed during the winter or spring seasons, we anticipate that higher groundwater conditions may be encountered. Severe groundwater conditions may result in the need for dewatering, placement of stabilization fabrics, and/or placement of ballast rock to achieve stable excavation bottoms.

Expansive soils are not suitable for use as select fill. Expansive soils are suitable only for use as general fill provided that: 1) all rock sizes greater than 6 inches in largest dimension and perishable materials are removed; and 2) the fill materials are approved by us prior to use. Select fill should be used within 12 or 30 inches of subgrade in 'select fill' areas, as previously described. Portions of the on-site excavated soils may be suitable for use as select fill provided they are separated from the expansive soils. We can identify suitable materials during grading. Imported fill should be free of organic matter, non-expansive and should generally conform to the following requirements:

Sieve Size	Percent Passing
6-inch	100
4-inch	90-100
No. 200	15-60

Liquid Limit - 40 Maximum
Plasticity Index - 15 Maximum
(ASTM D 4318-10 Wet Test Method)

Fill should be placed in thin lifts (normally 6 to 8 inches depending on compaction equipment), uniformly moisture conditioned to at least 2 percent above optimum moisture content (4 percent for expansive soils), and compacted to at least 90 percent relative compaction. Where the engineered fill thickness differential is greater than 2 feet, fill should be compacted to at least 93 percent relative compaction. In vehicle traffic areas, the upper 6 inches of subgrade should be compacted to at least 95 percent relative compaction. All surfaces should be finished to present a smooth, unyielding subgrade.

In general, fill and cut slopes should be constructed no steeper than 2:1. Slopes steeper than 2:1 should be retained. Graded slopes should be planted with quick growing, dense vegetation or protected from erosion by other measures upon completion of grading. Ground cover should be maintained on the slopes.

At all times, temporary construction excavations should conform to the regulations of the State of California, Department of Industrial Relations, Division of Industrial Safety or other stricter governing regulations. The performance of temporary cut slopes is the responsibility of the contractor/owner.

B. Foundations

Foundations may consist of either a reinforced concrete mat, or spread footings bearing into select engineered fill graded in accordance with our previous recommendations.

Mat Foundation

Foundation support can be obtained from the planned mat foundation. The mat should be underlain by at least 1 foot of engineered fill placed and compacted in accordance with the recommendations presented in this report. Further, the mat should be at least 10 inches thick and reinforced in both directions to span at least 6 feet and cantilever at least 4 feet at the edges of non-support. The mat should be designed using allowable bearing pressures of 1500 pounds per square foot (psf) for dead plus long-term live loads, and 2250 psf for total design loads.

Where portions of the foundation extend 12 inches below lowest adjacent grade, those areas may impose a passive equivalent fluid pressure of 200 pcf and a friction factor of 0.3 times the net vertical dead load. Passive pressures should be neglected within the upper foot, unless footings are confined by other construction. A coefficient of subgrade reaction of 150 pounds per cubic inch may be used for mat design.

Utility line connections at the edge of the mat should be flexible to resist breakage in the event that tilting of the mat or differential settlement occurs.

Spread Footing Foundations

Spread footings should be at least 12 inches wide and 12 inches deep, or as appropriately sized by the structural engineer. All spread footings should bear at least 12 inches into select engineered fill, as recommended by us. Perimeter wall footings should be continuous. Where foundations are constructed in select fill areas, grading should be performed to provide at least 12 inches of select fill beneath footings.

Spread footings can be designed using an allowable bearing pressure of 2,000 and 3,000 psf for dead plus long-term live loads and total design loads, respectively. We should observe the footing excavations prior to the placement of reinforcing steel and concrete.

The portion of the foundations extending into engineered fill may impose a passive equivalent fluid pressure of 350 pcf, triangular distribution, and a friction factor of 0.35 times the net vertical dead load. Passive pressures should be neglected within the upper 1 foot, unless footings are confined by other construction.

C. Seismic Design Criteria

The following criteria is based on Google Earth site latitude and longitude coordinates of 38.23408° N and -122.64406° W, respectively, 2016 California Building Code (CBC) guidelines, and USGS Earthquake Ground Motion Parameters:

Spectral Response Acceleration, S_S (0.2 sec.) – 1.509g
Spectral Response Acceleration, S_1 (1.0 sec.) – 0.600g
Seismic Design Category – D

Title 24, Part 2, Section 1613.3.2, of the 2016 CBC indicates that site categorization for seismic design should be based on the average soil values within the upper 100 feet of the site. Although the scope of our investigation was limited to relatively shallow test borings (ranging to about 19-1/2 feet deep), we estimate that a Site Classification "C" will be appropriate for design. Upon request, we could perform supplemental exploration to determine the actual subsurface conditions ranging to 100 feet.

D. Concrete Slab-On-Grade

Provided surface materials are prepared as recommended in the *Site Preparation and Grading* section of this report, critical slabs-on-grade may be used. Non-critical exterior area slabs, such as strip walkways, may be constructed on properly prepared subgrade provided that: 1) the slabs are separated from foundations with felt paper, mastic, or other positive and low friction separation; 2) slabs are designed to minimize cracking (i.e., reinforced and provided with control joints); and 3) soil related cracking related to heave and differential settlement is considered acceptable. We should be contacted if improved performance of non-critical exterior slabs is desired.

During foundation installation and utility trench excavation and backfilling, previously compacted subgrade soils may become disturbed. Where this is the case, these soils should be uniformly moisture conditioned to above optimum moisture content and rerolled to provide a smooth, unyielding surface compacted to at least 90 percent relative compaction.

Subgrade should be maintained at a uniform moisture, at least 2 percent above optimum moisture content, until the concrete slabs are placed. Slabs should be underlain with a capillary moisture break and cushion layer consisting of at least four inches of clean, free-draining crushed rock. The crushed rock should be at least 1/4-inch, and no larger than 3/4-inch, in size.

Moisture will condense on the underside of slabs. Where moisture migration through slabs is detrimental, waterproofing methods and specifications should be determined by others for incorporation into the project plans. The use of slab underdrains is shown on Plate 8, and discussed below in *Geotechnical Engineering Drainage*. Slabs should be at least 4 inches thick and reinforced to reduce cracking. Exterior and utility area slabs should be carefully separated from foundations with felt paper, mastic, or other positive and low friction separation

Some cracking of slabs must be anticipated considering concrete shrinkage. Reinforcing must be carefully installed in accordance with the structural engineer's recommendations to minimize the potential of cracking. We typically recommend the use of rebar reinforcing, placed on blocks as directed by the structural engineer. We have previously observed that welded wire mesh is often not properly located in the slabs.

E. Retaining Walls

Foundation support for retaining walls can be obtained from spread footings designed in accordance with the recommendations presented above.

Retaining walls free to rotate (yield more than 0.1 percent of the wall height at the top of the backfill) and with level backfill should be designed to resist an active lateral earth pressure (triangular distribution) of 40 pcf. Rigid walls which cannot yield should be designed for an "at-rest" lateral earth pressure of 60 pcf. A minimum factor of safety of 1.5 against overturning and sliding should be used in the design of retaining walls.

Seismic wall stability may be evaluated based on a uniform lateral earth pressure of 9xH psf (where H is the height of the wall in feet). This pressure is in addition to the active equivalent fluid pressures presented in this report. For restrained walls, seismic pressures may be assumed to act in combination with active rather than at-rest earth pressures. The factor of safety against instability under seismic loading should be at least 1.1.

These pressures do not consider additional loads resulting from adjacent foundations, traffic, or other downward loads. A surcharge equivalent to 2 feet of additional backfill should be applied to walls subject to vehicle surcharge. If additional surcharge loadings are anticipated, we can assist in evaluating their effects.

Retaining walls should be provided with backdrains to prevent the build-up of hydrostatic pressure. The drains and backfill should be constructed as shown on Plate 9. The top of the perforated drainage pipe should be located at least 8 inches below adjacent interior slabs to reduce the risk of seepage through walls into interior building areas.

Where migration of moisture through retaining walls would be detrimental, retaining walls should be waterproofed as specified by the Project Architect or Structural Engineer. Backfill materials should be compacted in a manner to prevent over-stressing the wall. Further, wall bracing should be considered. Retaining walls will yield slightly during backfilling. Therefore, retaining walls should be backfilled prior to building on or adjacent the walls. On-site non-expansive soils may be used as backfill outside of the zone defined by a 1:1 projection from the top of the footing. The use of imported granular material will generally require less backfilling effort. We should be contacted to observe the backfill of retaining walls.

We typically recommend that foundations not be located within retaining wall backfills to avoid the potential for differential settlement. Mitigation may include designing foundations to span from retaining walls to beyond the backfill area. We should be contacted to provide supplemental consultation if foundations will extend across retaining wall backfills.

F. Asphalt Pavement Structural Sections

A minimum R-Value of 5 is typically used for pavement areas underlain by expansive soils. The final pavement section will depend on the actual subgrade materials encountered during construction. Subgrade materials should be evaluated when the subgrade is exposed.

Using an assumed R-Value of 5 and the assumed Traffic Indices (T.I.'s) below, we recommend the following pavement sections. Traffic Indices are typically provided by the Project Civil Engineer.

T.I.	Asphalt Concrete (inches)	Aggregate Base (inches)
4.0	3.0	8.0
4.5	3.0	9.0
5.0	3.0	10.0
5.5	3.0	12.0
6.0	3.0	14.0

*R-Value = 78 minimum

If the upper 12 inches of subgrade soils consist of non-expansive soils, then a reduced Class 2 Aggregate Base sections for each T.I. may be used. Please contact us to provide supplemental recommendations if expansive soils will not be used beneath new pavement sections.

The flexible pavement materials and construction methods should conform to the quality requirements of the State of California, Caltrans Standard Specifications, current edition, and that of Sonoma County. We have not developed pavement thicknesses for paved areas adjacent to dumpsters. We understand that recommendations for dumpster areas are available from the waste disposal service companies.

Where the expansive soils at the pavement edges are subject to wetting and drying, edge cracking should be anticipated. Periodic patching should be performed to prevent water from entering the cracks. Edge cracking can be reduced by installation of a perimeter moisture vapor cutoff. The cutoff, if constructed, could consist of a compacted select fill dike 36 inches deep and 8 feet wide, or a concrete curb 4 inches wide and at least 30 inches below subgrade. Conventional curbs and sidewalks typically provide only limited protection.

Prior to preparation of the subgrade, all underground utilities in the paved areas should be installed and properly backfilled, and the concrete curbs and gutters or header-boards should be in place. Subgrade soil should be uniformly moisture conditioned to 2 percent above optimum moisture content (4 percent for expansive soils) and compacted to at least 95 percent relative compaction (93 percent for expansive soils), providing a firm and unyielding surface. This may require scarifying and recompacting to achieve uniformity. The aggregate base materials should be placed in thin lifts in a manner to prevent segregation, uniformly moisture conditioned, and compacted to at least 95 percent relative compaction to provide a smooth, unyielding surface.

G. Geotechnical Engineering Drainage

Ponding water will be detrimental to foundations and structural elements. Therefore, the site should be graded to provide positive drainage away from building foundations and slab edges.

Roofs should be provided with gutters, and the downspouts connected to non-perforated pipes discharging into the storm drain system or onto erosion resistant areas well away from the structures and slopes. Roof downspouts and surface drains must be maintained entirely separate from subsurface drainage.

In critical use slab-on-grade areas, underslab drains should be provided beneath the slab rock to reduce the risk of water build-up in the slab rock and to increase mitigation of moisture migration through slabs. The subdrain trenches should be 12 inches wide, 12 inches deep and cross the slab area, as directed by us. The slab rock should be connected to the subdrain rock. The materials (i.e., pipe, rock and fabric) should conform to those shown graphically on Plate 8. In less critical use slab areas, outlets should be provided in the slab rock to reduce the risk of water build up in the slab rock.

Retaining wall backdrains should be constructed to reduce hydrostatic pressures against retaining walls. The backdrains should be at least 12 inches wide and extend up to the height of the drained portion of the walls. Plate 9 presents criteria for retaining wall backdrains. Subdrains should consist of 4-inch diameter, perforated pipe, installed perforations down, placed at the bottom of the drain and sloped to drain to outlets by gravity. The subdrain pipe should consist of PVC Schedule 40 or ABS with a SDR of 35 or better. The trench should be backfilled with clean, free-draining, 3/4 or 1-1/2-inch crushed drain rock separated from adjacent soil/rock by a non-woven filter fabric. As alternatives to standard drain rock and fabric, Class II permeable material complying with Section 68, "Caltrans" may be used without fabric or a prefabricated synthetic drainage structure such as Miradrain 6000 (or equivalent) may be used. The upper 12 inches of the drain should be backfilled with compacted, non-expansive clayey soil to exclude surface water. If groundwater seepage is encountered during grading, additional subdrains should be installed as recommended by us.

H. Supplemental Services

We should be contacted during design to discuss our recommendations and the design approach. We should review the final plans for conformance with the intent of our recommendations.

During grading and foundation construction, we should provide intermittent geotechnical engineering observations, along with necessary field and laboratory testing, during: 1) removal of weak soils; 2) fill placement and compaction; 3) preparation and compaction of subgrade; 4) excavation of foundations; and 5) special inspection of reinforced concrete. These observations and tests would allow us to check that the contractor's work conforms with the intent of our recommendations and the project plans and specifications. These observations also permit us to check that conditions encountered are as anticipated, and modify our recommendations, as necessary. Upon completion of the project, we should perform a final observation prior to occupancy. We should summarize the results of this work in a final report.

These supplemental services are performed on an as-requested basis, and we can accept absolutely no responsibility for items that we are not notified to observe. These supplemental services are in addition to this investigation, and are charged for on an hourly basis in accordance with our Schedule of Charges. We must be provided with at least 48 hours notice for scheduling our initial site visit, and 24 hours thereafter.

MAINTENANCE

Periodic land maintenance will be required. Drains should be checked frequently, and cleaned and maintained as necessary.

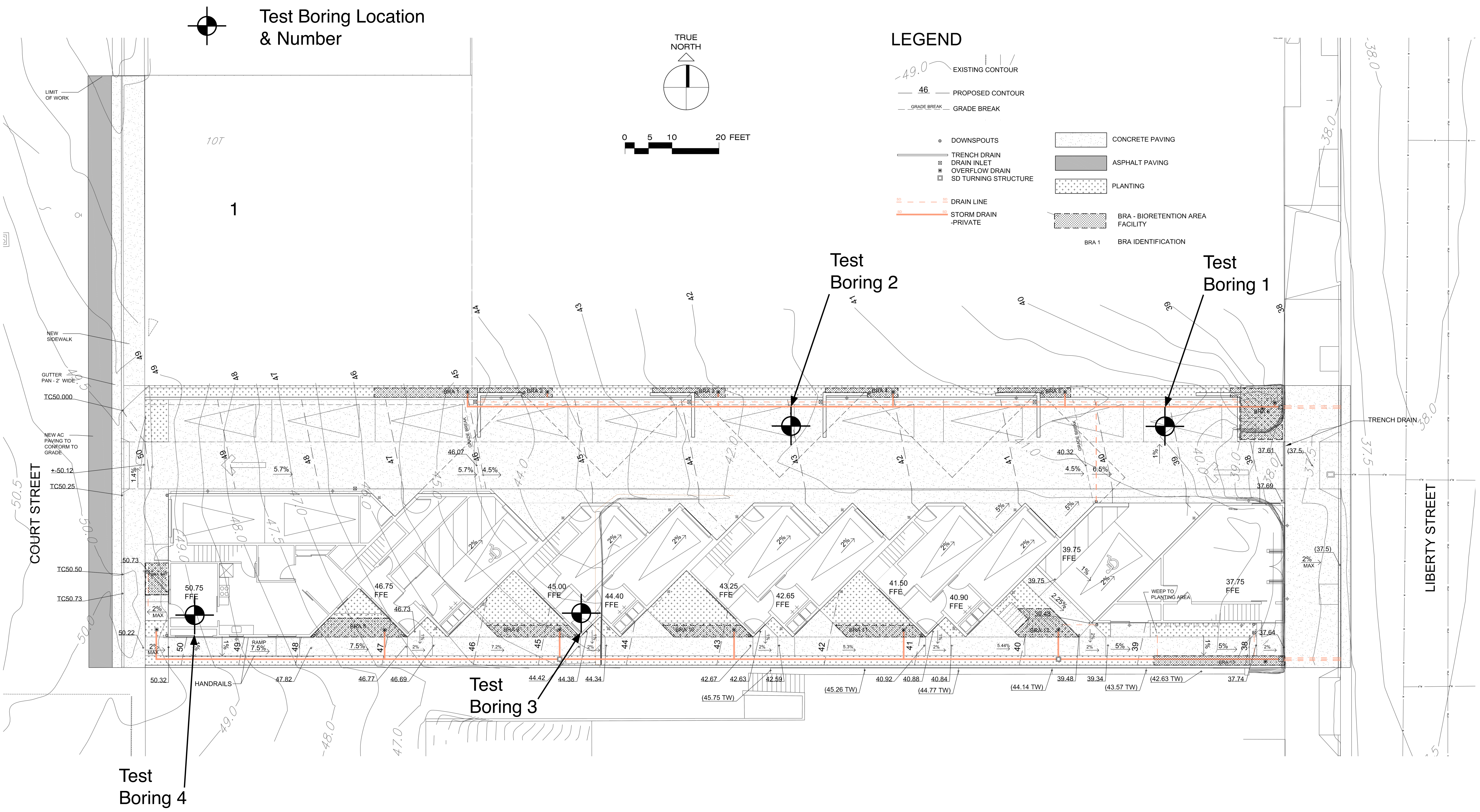
LIMITATIONS

We performed the investigation and prepared this report in accordance with generally accepted standards of the geotechnical engineering profession. No other warranty, either express or implied, is given.

If the project is revised, or if conditions different from those described in this report are encountered during construction, we should be notified immediately so that we can take timely action to modify our recommendations, if warranted. Site conditions and standards of practice change. Therefore, we should be notified to update this report if construction is not performed within 18 months of the submittal date.

ILLUSTRATIONS

Plate 1 Site Plan
Plates 2 - 5 Logs of Test Borings 1 through 4
Plate 6 Soil Classification Chart & Key to Test Data
Plate 7 Rock Classification Criteria
Plate 8 Typical Underslab Drain Detail
Plate 9 Wall Drainage Detail



Reference: "Grading & Drainage Plan," dated November 10, 2017, prepared by Steven J. Lafranchi & Associates, Inc.
Note: The locations of all features are approximate and may vary.

BAUER ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

Job No:	3384.1
Date:	12/17
By:	GDS

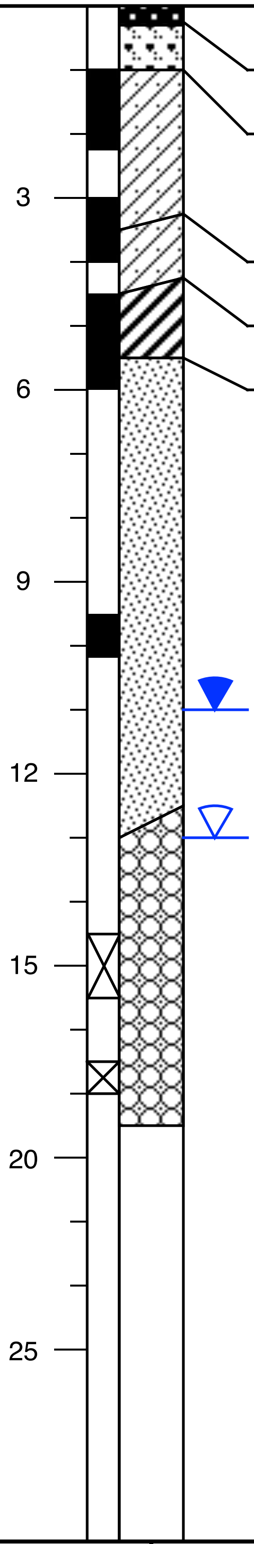
SITE PLAN

131 LIBERTY STREET
Petaluma, California

PLATE
1

Equipment: B53 w/ 6" flight augers
Date: April 12, 2017
Elevation: ***40-1/2'

Laboratory Tests	Blows/Foot*	Moisture Content (%)	Dry Density (pcf)
	5	12.1	118
	3	16.3	112
Classification LL = 70 PL = 19 PI = 51 Percent Minus No. 200 = 75	11 12" 26 6"	26.6	97
	42 8"		
	59** 9"		
	53** 9"		



1" ASPHALT CONCRETE o/ FABRIC o/ 2" ASPHALT CONCRETE

BROWN SANDY GRAVEL (GW), medium dense, moist (Baserock Fill)

DARK GRAY GRAVELLY CLAYEY SAND (SC)
loose, moist (Fill)
grading clayey and wet at 2'
fine roots at 3 to 3-1/2'

DARK GRAY CLAYEY SAND (SC)
loose, wet (Fill)

BROWN SANDY CLAY (CH)
stiff, moist (Probable Fill)

Weak Soils

MOTTLED ORANGE-BROWN CLAYEY SANDSTONE
poorly consolidated, low hardness, friable, moderately weathered, moist, sand is very fine, poorly graded

water level at 11' after drilling

water first observed at 13'

MOTTLED YELLOW- & ORANGE-BROWN CONGLOMERATE
poorly consolidated, low hardness, friable, moderately weathered, wet, poorly graded sand and fine gravel

Bottom of boring at about 19-1/2 feet
Groundwater observed at locations indicated

* Blows converted to Standard Penetration Resistance values
** Sampled with 1.5" inside diameter Standard Penetration Test sampler; blows do not require conversion
*** Elevation interpolated from *Grading & Drainage Plan*, dated 11-10-17, by Steven J. Lafranchi & Associates

BAUER ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

Job No: 3384.1
Date: 4/17
By: GDS

LOG OF TEST BORING 1

131 LIBERTY STREET
Petaluma, California

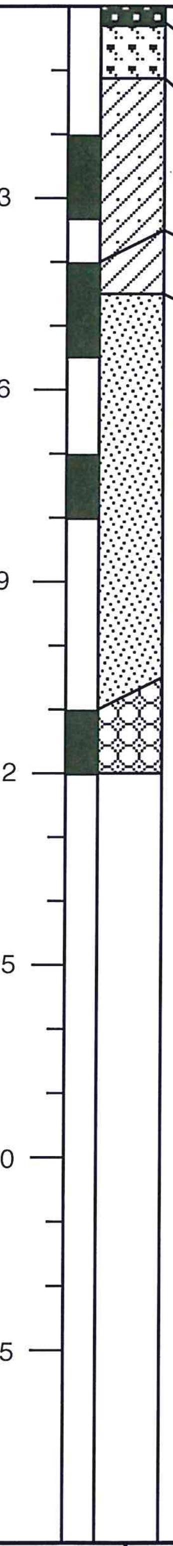
PLATE
2

Equipment: B53 w/ 6" flight augers

Date: April 12, 2017

Elevation: ^41-1/2'

Laboratory Tests	Blows/Foot*	Moisture Content (%)	Dry Density (pcf)
	2		
		15.2	115
	26		
TX = 3800 (720)		15.7	112
	38		
	32		



2" ASPHALT CONCRETE o/ FABRIC o/ 1-1/2" ASPHALT CONCRETE

BROWN SANDY GRAVEL (GW), medium dense, moist (Baserock Fill)

BROWN GRAVELLY CLAY (CL) stiff, wet (Fill)

DARK GRAY CLAYEY SAND (SC) loose, wet (Fill)

MOTTLED BROWN SANDY CLAY (CL) medium stiff, wet (Possible Fill)

MOTTLED ORANGE-BROWN SANDSTONE poorly consolidated, low hardness, friable, moderately weathered, moist, sand is very fine- and medium-grained, poorly graded

trace of gravels at 9', increased gravels with increasing depth

MOTTLED YELLOW-BROWN CONGLOMERATE poorly consolidated, low hardness, friable, moderately weathered, moist, poorly graded sand and fine gravel

Bottom of boring at about 12 feet
No groundwater seepage observed during drilling

Weak Soils

BAUER ASSOCIATES, INC.

GEOTECHNICAL CONSULTANTS

Job No: 3384.1
Date: 4/17
By: GDS

LOG OF TEST BORING 2

131 LIBERTY STREET
Petaluma, California

PLATE

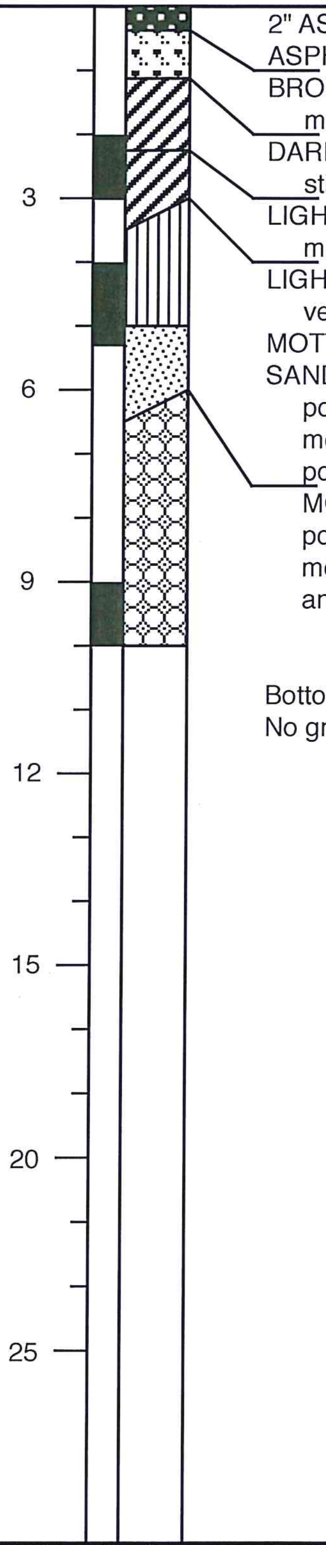
3

Equipment: B53 w/ 6" flight augers

Date: April 12, 2017

Elevation: ^44-1/2'

Laboratory Tests	Blows/Foot*	Moisture Content (%)	Dry Density (pcf)
Classification LL = 55 PL = 17 PI = 38 Percent Minus No. 200 = 54	13	18.6	109
	26		
	38		



2" ASPHALT CONCRETE o/ FABRIC o/ 3" ASPHALT CONCRETE

BROWN SANDY GRAVEL (GW), medium dense, moist (Baserock Fill)

DARK BLUE GRAY SANDY CLAY (CH) stiff, moist (Fill)

LIGHT BROWN SANDY CLAY (CH) medium stiff, moist, occasional gravel (Fill)

LIGHT BROWN CLAYEY SILT (ML) very stiff, moist

MOTTLED YELLOW- & ORANGE-BROWN SANDSTONE poorly consolidated, low hardness, friable, moderately weathered, moist, sand is very fine, poorly graded

MOTTLED YELLOW-BROWN CONGLOMERATE poorly consolidated, low hardness, friable, moderately weathered, moist, poorly graded sand and fine gravel

Bottom of boring at about 10 feet
No groundwater seepage observed during drilling

BAUER ASSOCIATES, INC.

GEOTECHNICAL CONSULTANTS

Job No: 3384.1
Date: 4/17
By: GDS

LOG OF TEST BORING 3

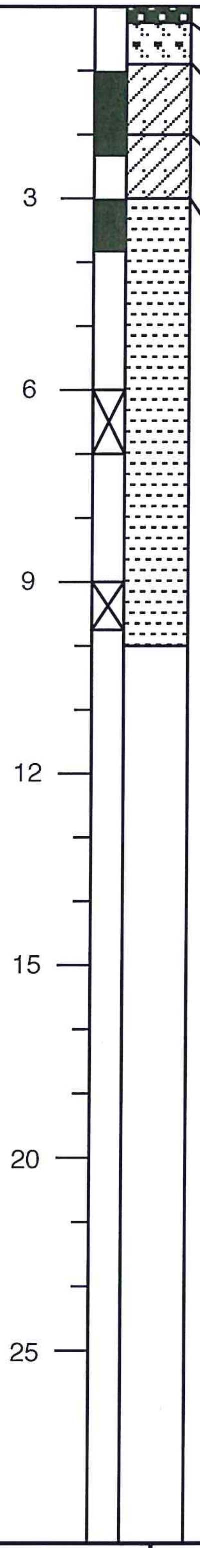
131 LIBERTY STREET
Petaluma, California

PLATE

4

Equipment: B53 w/ 6" flight augers
Date: April 12, 2017
Elevation: ^49'

Laboratory Tests	Blows/Foot*	Moisture Content (%)	Dry Density (pcf)
	6		
		19.6	105
	33		
	55**		
	54**		



1-1/2" ASPHALT CONCRETE o/ FABRIC o/
1-1/2" ASPHALT CONCRETE

BROWN SANDY GRAVEL (GW), medium
dense, moist (Baserock Fill)

GRAY CLAYEY SAND (SC), loose,
moist, with occasional gravel (Fill)

MOTTLED BROWN & YELLOW-BROWN
CLAYEY SAND (SC)
medium dense, moist (Fill)

MOTTLED LIGHT BROWN & ORANGE-BROWN
SILTSTONE
poorly consolidated, low hardness, friable,
moderately weathered, damp

Weak Soils

Bottom of boring at about 10 feet
No groundwater seepage observed during drilling

BAUER ASSOCIATES, INC.

GEOTECHNICAL
CONSULTANTS

Job No: 3384.1
Date: 4/17
By: GDS

LOG OF TEST BORING 4

131 LIBERTY STREET
Petaluma, California

PLATE
5

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than #200 sieve	GRAVELS more than half coarse fraction is larger than no. 4 sieve size	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	⁙	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	⁙	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	⁝	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND MIXTURES
			GC	▨	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND MIXTURES
	SANDS more than half coarse fraction is smaller than no. 4 sieve size	CLEAN SANDS WITH LITTLE OR NO FINES	SW	∴	WELL GRADED SANDS, GRAVELLY SANDS
			SP	∴	POORLY GRADED SANDS, GRAVEL-SAND MIXTURES
		SANDS WITH OVER 12% FINES	SM	⁝	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			SC	▨	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than half is smaller than #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	▥	INORGANIC SILTS, SILTY OR CLAYEY FINE SANDS, VERY FINE SANDS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	▨	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS OR LEAN CLAYS
			OL	▪	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	▥	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	▨	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	▨	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	▩	PEAT AND OTHER HIGHLY ORGANIC SOILS

KEY TO TEST DATA

LL — Liquid Limit (in %)
PL — Plastic Limit (in %)
G — Specific Gravity
SA — Sieve Analysis
Consol — Consolidation
■ "Undisturbed" Sample
☒ Bulk or Disturbed Sample
☐ No Sample Recovery

	Shear Strength, psf	Confining Pressure, psf	
*Tx	320	(2600)	Unconsolidated Undrained Triaxial
Tx CU	320	(2600)	Consolidated Undrained Triaxial
DS	2750	(2000)	Consolidated Drained Direct Shear
FVS	470		Field Vane Shear
*UC	2000		Unconfined Compression
LVS	700		Laboratory Vane Shear

Notes: (1) All strength tests on 2.8" or 2.4" diameter sample unless otherwise indicated
(2) * Indicates 1.4" diameter sample

BAUER ASSOCIATES, INC. GEOTECHNICAL CONSULTANTS	Job No: 3384.1 Date: 4/17 By: GDS	**SOIL CLASSIFICATION CHART & KEY TO TEST DATA** 131 LIBERTY STREET Petaluma, California	PLATE 6

I. CONSOLIDATION OF SEDIMENTARY ROCKS; usually determined from unweathered samples. Largely dependent on cementation.

U = Unconsolidated
P = Poorly consolidated
M = Moderately consolidated
W = Well consolidated

II. BEDDING OF SEDIMENTARY ROCKS

Splitting Property	**Thickness in Feet**	**Stratification**
Massive	greater than 4.0	very thick bedded
Blocky	2.0 to 4.0	thick bedded
Slabby	0.2 to 2.0	thin bedded
Flaggy	0.05 to 0.2	very thin bedded
Shaly or Platy	0.01 to 0.05	laminated
Papery	less than 0.01	thinly laminated

III. FRACTURING

Intensity	**Size of Pieces in Feet**
Crushed	less than 0.05
Intensely fractured	0.05 to 0.1
Closely fractured	0.1 to 0.5
Moderately fractured	0.5 to 1.0
Occasionally fractured	1.0 to 4.0
Very little fractured	greater than 4.0

IV. HARDNESS

Soft – Reserved for plastic material alone
Low Hardness – Can be gouged deeply or carved easily with a knife blade.
Moderately Hard – Can be readily scratched with a knife blade; scratch leaves a heavy trace of dust and is readily visible after the powder has been blown away.
Hard – Can be scratched with difficulty; scratch produces little powder and is often faintly visible.
Very Hard – Cannot be scratched with a knife blade; knife leaves a metallic streak.

V. STRENGTH OF UNFRACTURED SPECIMEN

Plastic – Capable of being molded by hand.
Friable – Crumbles by rubbing specimen with fingers.
Weak – Crumbles under light hammer blows.
Moderately Strong – Withstands a few heavy hammer blows before fracturing.
Strong – Withstands a few heavy ringing hammer blows and usually yields large fragments.
Very Strong – Resists heavy ringing hammer blows and yields with difficulty only dust and small flying fragments.

VI. WEATHERING; The physical and chemical disintegration and decomposition of rocks and minerals by natural processes such as oxidation, reduction, hydration, solution, carbonation, and freezing and thawing.

Deep – Moderate to complete decomposition of minerals, extensive disintegration, deep and thorough discoloration, fractures all extensively coated with oxides, carbonates and/or silt and clay.
Moderate – Slight change or partial decomposition of minerals, little disintegration, little to no effect on cementation, moderate to occasionally intense discoloration, fractures moderately coated with oxides, carbonates and/or silt and clay.
Little – No megascopic decomposition of minerals, little to no effect on cementation, slight and intermittent or localized discoloration, fractures coated with few oxides
Fresh – Unaffected by weathering agents, no disintegration or discoloration.

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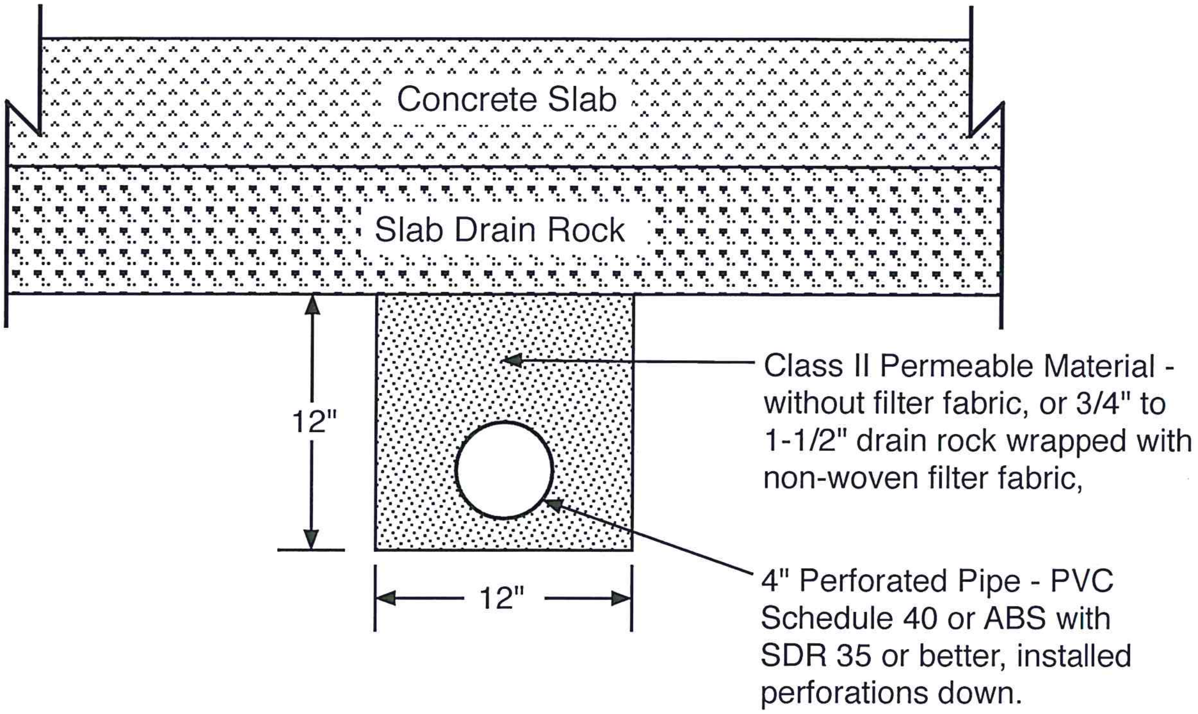
Job No: 3384.1
Date: 4/17
By: GDS

ROCK CLASSIFICATION CRITERIA

131 LIBERTY STREET
Petaluma, California

PLATE
7



TYPICAL SLAB UNDERDRAIN DETAIL

(Not to scale)

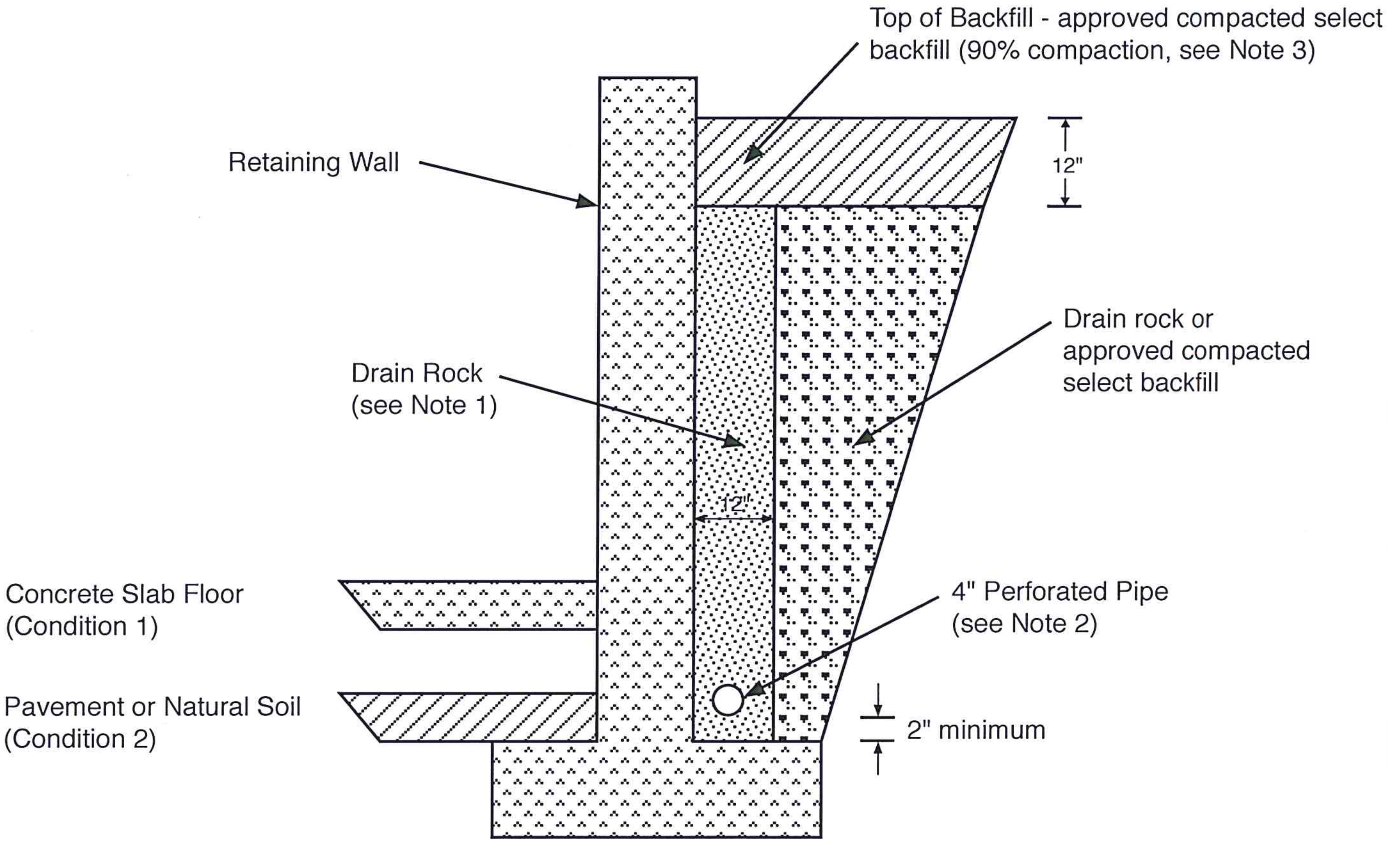
NOTES:

1) Drain pipe, drain rock, and filter fabric materials should conform to those specified in the geotechnical investigation report.

2) Pipes should be placed at approximately 15 to 20 feet on center, and within isolated areas.

3) Outlets should be provided through foundations and sloped to drain at a minimum gradient of 1% to outfalls.

BAUER ASSOCIATES, INC. GEOTECHNICAL CONSULTANTS	Job No: 3384.1 Date: 4/17 By: GDS	**TYPICAL UNDERSLAB DRAIN DETAIL** 131 LIBERTY STREET Petaluma, California	PLATE **8**



WALL DRAINAGE DETAIL

(Not to scale)

NOTES:

(1) Drain rock should be either: 1) clean, free-draining, and meet the requirements for Class II Permeable material, Section 68, State of California "Caltrans" Standard Specifications, latest edition; or 2) 3/4 or 1-1/2 inch crushed drain rock separated from the adjacent soil/rock by non-woven filter fabric.

Prefabricated synthetic drainage structure, such as Miradrain 6000 or equivalent, may be used in lieu of drainrock along the back of the retaining wall.

(2) Pipe should consist of PVC Schedule 40 or ABS with an SDR of 35 or better, installed perforations down. Pipes for subsurface walls should be sloped at a minimum gradient of 1% to drain to outlets by gravity or sump with automatic pump. The pipe invert should be a minimum of 8 inches below adjacent interior slabs-on-grade. Surface drainage should not be connected to subsurface drain pipes.

(3) The upper 12 inches of the drain should be backfilled with compacted clayey soils to exclude surface water. Retaining walls should be backfilled with materials approved by us and per the recommendations in the report. Backfilling methods should be appropriate to avoid over-stressing the wall structures. Wall bracing should be considered prior to backfilling.

BAUER ASSOCIATES, INC.

GEOTECHNICAL
CONSULTANTS

Job No: 3384.1
Date: 4/17
By: GDS

WALL DRAINAGE DETAIL

131 LIBERTY STREET
Petaluma, California

PLATE
9

LIST OF REFERENCES

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DISTRIBUTION

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