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## Geotechnical Study

Cardey Residence Driveway Repair Use Permit Exception to
the Conservation Regulations, #P18-00116-UP &
Request for Exception to Road and Street Standards
Planning Commission Hearing June 20, 2018

*Experience is the difference*

# GEOTECHNICAL STUDY REPORT

## CARDEY RESIDENCE DRIVEWAY
## 1100 MCCORMICK LANE
## NAPA, CALIFORNIA

**Project Number:**

3508.01.09.1

**Prepared For:**

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August 25, 2017

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## INTRODUCTION

This report presents the results of our geotechnical study for the proposed repair of the driveway which provides access to the property at 1100 McCormick Lane in Napa, California. The driveway was damaged and made impassible from landslide activity adjacent to a creek. The site location is shown on Plate 1, Appendix A.

We understand that it is desired to locally repair the landslide with the goal of regaining driveway access to the property. The Landslide extends beyond the easement limits for the driveway. We anticipate that grading and retaining wall options are being considered to achieve the desired result.

## SCOPE

The purpose of our study, as outlined in our Professional Service Agreement dated April 26, 2017, was to generate geotechnical information for the design and construction of the project. Our scope of services included reviewing selected published geologic data pertinent to the site; evaluating the subsurface conditions with borings, a slope inclinometer and laboratory tests; analyzing the field and laboratory data; and presenting this report with the following geotechnical information:

1. A brief description of the soil, bedrock, landslide debris and groundwater conditions observed during our study;

2. A map showing the limits of the landslide;

3. Cross sections indicating the subsurface geometry of the landslide; and

4. Specific conclusions and recommendations regarding:

    a. Primary geotechnical engineering concerns regarding the future activity of the landslide;

    b. Potential mitigation measures associated with reconstructing the driveway including the construction or retaining walls and or grading options;

    c. Drainage improvements that may improve the stability of the driveway area; and

    d. Supplemental geotechnical engineering services.

## STUDY

### Site Exploration

We reviewed our previous geotechnical studies in the vicinity and selected geologic references pertinent to the site. The geologic literature reviewed is listed in Appendix B. On, May 22, 2017 we performed a geotechnical reconnaissance of the site and explored the subsurface conditions by drilling three borings to depths ranging from about 13½ to 30½ feet. The borings were drilled with a portable auger driven by a hydraulic power-pack equipped with 8-inch diameter, hollow stem augers at the approximate locations shown on the Exploration Plan, Plate 2. A slope inclinometer casing was installed in one of the borings within the landslide area which was grouted in place. Subsequently, baseline and secondary readings were taken using a slope inclinometer to assist in determining the depth of movement within the landslide. The boring and inclinometer locations were determined approximately by pacing their distance from features shown on the Exploration Plan and should be considered accurate only to the degree implied by the method used. Our project geologist located and logged the borings and obtained samples of the materials encountered for visual examination, classification, and laboratory testing.

While on site we collected surface profile data to generate a cross section view of the site conditions. This is presented on Plate 3. Information collected from subsurface program is also presented on Plate 3

Relatively undisturbed samples were obtained from the borings at selected intervals by driving a 2.43-inch inside diameter, split spoon sampler, containing 6-inch long brass liners, using a 140-pound hammer dropping approximately 30 inches. The sampler was driven 12 to 18 inches. The blows required to drive each 6-inch increment were recorded and the blows required to drive the last 12 inches, or portion thereof, were converted to equivalent Standard Penetration Test (SPT) blow counts for correlation with empirical data. Disturbed samples were also obtained at selected depths by driving a 1.375-inch inside diameter (2-inch outside diameter) SPT sampler, without liners or rings, using a 140-pound hammer dropping approximately 30 inches. The sampler was driven 12 to 18 inches, the blows to drive each 6-inch increment were recorded, and the blows required to drive the final 12 inches, or portion thereof, are provided on the boring logs.

The logs of the borings showing the materials encountered, groundwater conditions, converted blow counts and sample depths are presented on Plates 4 through 6. The soils are described in accordance with the Unified Soil Classification System, outlined on Plate 7. Bedrock is described in accordance with Engineering Geology Rock Terms, shown on Plate 8.

The boring logs show our interpretation of the subsurface soil, groundwater, and bedrock conditions on the date and at the locations indicated. Subsurface conditions may vary at other locations and times. Our interpretation is based on visual inspection of soil and bedrock samples, laboratory test results, and interpretation of drilling and sampling resistance. The location of the soil and bedrock boundaries should be considered approximate. The transition between soil and bedrock types may be gradual.

## Laboratory Testing

The samples obtained from the borings were transported to our office and to verify soil classifications, evaluate characteristics, and assign tests pertinent to our analysis. Selected samples were laboratory tested to determine their classification (Atterberg Limits, percent of silt and clay). The test results are presented on the boring logs and on Plate 9.

# SITE CONDITIONS

## General

Napa County is located within the California Coast Range geomorphic province. This province is a geologically complex and seismically active region characterized by sub-parallel northwest-trending faults, mountain ranges and valleys. The oldest bedrock units are the Jurassic-Cretaceous Franciscan Complex and Great Valley sequence sediments originally deposited in a marine environment. Subsequently, younger rocks such as the Tertiary-age Sonoma Volcanics group, the Plio-Pleistocene-age Clear Lake Volcanics and sedimentary rocks such as the Guinda, Domengine, Petaluma, Wilson Grove, Cache, Huichica and Glen Ellen formations were deposited throughout the province. Extensive folding and thrust faulting during late Cretaceous through early Tertiary geologic time created complex geologic conditions that underlie the highly varied topography of today. In valleys, the bedrock is covered by thick alluvial soils.

## Geology

Published geologic maps (Clahan et al., 2004) indicate the property is underlain by Cretaceous to Late Jurassic bedrock of the Great Valley Sequence. The bedrock is described as consisting of sandstone, pebble conglomerate, shale, and siltstone.

## Landslides

Published landslide maps (Dwyer, 1976) indicate slope instability at the site. The slide is categorized as a small landslide and described as “definite” and “active”. The extents and the instability are not clearly mapped, however it appears to be in the general location of the landslide addressed in this report. The observed landslide is mapped on Plate 2 and based on our field observation appears to consist of primarily translational with some rotational components movement.

## Surface

The landslide area extends primarily over steeply north sloping terrain. This site is currently occupied by the existing asphalt paved driveway and several surface drainage improvements including earthen and stone lined ditches and culverts. The landslide area has been highly disturbed and includes vertical displacements of up to 8 feet. The downslope extent of the landslide extends onto steep creek bank slopes with gradients in excess of 1:1, (horizontal to vertical).

## Subsurface

Our borings and laboratory tests indicate that the landslide area we studied is blanketed by 3½ to 15½ feet of disturbed landslide deposits. The landslide deposits consisted of clays, clays with sand and sandy clays with gravel. These soils exhibit moderate to high plasticity (LL = 46-

69; PI = 24-48). These landslide deposits are underlain by bedrock of the Great Valley Sequence.

The bedrock extends from beneath the surface materials to the maximum depths explored (30½ feet). The bedrock consisted of shale deposits which appeared firm, friable to plastic, and highly weathered. The rock was pervasively shattered with very close fractures. Field observations of the bedrock indicate near vertical fracture and bedding planes. A detailed description of the subsurface conditions found in our borings is given on Plates 4 through 6, Appendix A. Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-10, titled "Minimum Design Loads for Buildings and Other Structures" (2010), we have determined a Site Class of C should be used for the site.

## Corrosion Potential

Mapping by the Natural Resources Conservation Service (2017) indicates that the corrosion potential of the near surface soil is high for uncoated steel and low for concrete. Performing corrosivity tests to verify these values was not part of our requested and/or proposed scope of work. Should the need arise, we would be pleased to provide a proposal to evaluate these characteristics.

## Groundwater

Groundwater seeped into the borings at about 20½ feet below the ground surface at the time of excavation. On hillsides, rainwater typically percolates through the porous surface materials and migrates downslope in the form of seepage at the interface of the surface materials and bedrock, and through fractures in the bedrock. Fluctuations in the seepage rates typically occur due to variations in rainfall intensity, duration and other factors such as periodic irrigation.

# DISCUSSION AND CONCLUSIONS

## Seismic Hazards

### General

We did not observe subsurface conditions within the portion of the property we studied that would suggest the presence of materials that may be susceptible to seismically induced densification or liquefaction. Therefore, we judge the potential for the occurrence of these phenomena at the site to be low.

### Seismicity

Data presented by the Working Group on California Earthquake Probabilities (2007) estimates the chance of one or more large earthquakes (Magnitude 6.7 or greater) in the San Francisco Bay region within the next 30 years to be approximately 63 percent. Therefore, future seismic shaking should be anticipated at the site. It will be necessary to design and construct the proposed repairs in strict adherence with current standards for earthquake-resistant construction.

Faulting

We did not observe landforms within the area that would indicate the presence of active faults and the site is not within a current Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). However, the site is located near the Browns Valley Section of the West Napa Fault Zone which experienced a magnitude 6.0 earthquake on August 24, 2014. This section was not currently defined as active. Preliminary mapping following the August 24th earthquake located surface ruptures approximately ¼ of a mile east of the project site and landforms suggestive of surface rupture 1/10 of a mile southwest of the site. In addition, several northwest-trending Earthquake Fault Zones exist in close proximity to and within several miles of the site (Bortugno, 1982). The shortest distances from the site to the mapped surface expression of these faults are presented in the table below.

| ACTIVE FAULT PROXIMITY | | |
|---|---|---|
| **Fault** | **Direction** | **Distance-Miles** |
| San Andreas | SW | 31 |
| Healdsburg-Rodgers Creek | SW | 11 |
| Concord-Green Valley | E | 10 |
| Cordelia | E | 8 |
| West Napa | E | <1 |

Lurching

Seismic slope failure or lurching is a phenomenon that occurs during earthquakes when slopes or man-made embankments yield and displace in the unsupported direction. Provided the repairs and retaining walls are installed as recommended herein, and/or the proposed fills are adequately keyed into underlying bedrock material, as subsequently discussed, we judge the potential for impact to the proposed repair from the occurrence of this phenomenon at the site is low. However, some of these secondary earthquake effects are unpredictable as to location and extent, as evidenced by the 1989 Loma Prieta Earthquake.

## Geotechnical Issues

Landslide Repair Options

Because the landslide extends beyond the limits of the driveway easement, we anticipate that the planned repair will be focused on regaining a passable driveway and not repairing the entire landslide. Based on our study, it appears that there are at least two feasible repair solutions depending on the final alignment of the driveway and the assumption that we are not repairing the entire landslide. One solution is to retain the new driveway with a wall, remove any landslide debris behind the wall, and backfill the wall with engineered fill. Another option is to remove the landslide deposits and replace them as an engineered fill. The first option may be costlier but requires less space and area to repair. The grading only option may require steeper slopes to fit within existing constraints which would require geogrid reinforcement within the fill.

Expansive Soil

The soil we encountered in our borings is moderately to highly expansive. With current projects, we do not recommend using expansive soil within the backfill zone of retaining walls or within the upper 12 inches of pavement areas. Since this project is an effort to regain a driveway to your existing property we are not including recommendations to reduce the effects of expansive soil. It should be expected that retaining walls may yield slightly during the winter months and pavement edges may crack. The conditions after repair should be consistent with the existing conditions of your existing retaining walls and pavements. If it is desired to have improved performance of this area, we can provide recommendations to reduce the impacts from expansive soil.

## RECOMMENDATIONS

### Seismic Design

Seismic design parameters presented below are based on Section 1613 titled "Earthquake Loads" of the 2016 California Building Code (CBC). Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-10, titled "Minimum Design Loads for Buildings and Other Structures" (2010), we have determined a Site Class of C should be used for the site. Using a site latitude and longitude of 38.3016°N and 122.3300°W, respectively, and the U.S. Seismic Design Maps from the United States Geological Survey (USGS) website (http://earthquake.usgs.gov/designmaps/us/application.php), we recommend that the following seismic design criteria be used for structures at the site.

| 2016 CBC Seismic Criteria | |
|---|---|
| **Spectral Response Parameter** | **Acceleration (g)** |
| $S_S$ (0.2 second period) | 1.907 |
| $S_1$ (1 second period) | 0.690 |
| $S_{MS}$ (0.2 second period) | 1.907 |
| $S_{M1}$ (1 second period) | 0.897 |
| $S_{DS}$ (0.2 second period) | 1.271 |
| $S_{D1}$ (1 second period) | 0.598 |

### Grading

Site Preparation

Areas to be developed should be cleared of vegetation and debris including that left by the removal of the existing driveway. Trees and shrubs that will not be part of the proposed development should be removed and their primary root systems grubbed. Cleared and grubbed material should be removed from the site and disposed of in accordance with County Health Department guidelines. We did not observe septic tanks, leach lines or underground fuel tanks during our study. Any such appurtenances found during grading should be capped and sealed and/or excavated and removed from the site, respectively, in accordance with established guidelines and requirements of the County Health Department. Voids created during clearing should be backfilled with engineered fill as recommended herein.

Stripping

Areas to be graded should be stripped of the upper few inches of soil containing organic matter. Soil containing more than two percent by weight of organic matter should be considered organic. Actual stripping depth should be determined by a representative of the geotechnical engineer in the field at the time of stripping. The strippings should be removed from the site, or if suitable, stockpiled for re-use as topsoil in landscaping.

Excavations

For the grading only solution, a keyway will be required. The keyway should be at least 8 feet wide, extend at least 2 feet into bedrock on the downhill side and should be sloped to drain to the rear. Keyway excavations should extend laterally to at least a 1:1 imaginary line extending down from the toe of the fill. Keyway subdrains are discussed hereinafter in "Subsurface Drainage." The excavated materials should be stockpiled for later use as compacted fill.

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 stability of temporary cut slopes, such as those constructed during the installation of underground utilities, should be the responsibility of the contractor. Depending on the time of year when grading is performed, and the surface conditions exposed, temporary cut slopes may need to be excavated to 1½:1, or flatter. The tops of the temporary cut slopes should be rounded back to 2:1 in weak soil zones.

Subsurface Drainage

A subdrain should be installed at the rear of the keyways and where evidence of seepage is observed. The subdrain should consist of a 4-inch diameter (minimum) perforated plastic pipe with SDR 35 or better embedded in Class 2 permeable material. The permeable material should be at least 12 inches thick and extend at least 48 inches above the bottom of the keyway (see Plate 10) and/or 12 inches above and below the seepage zone.

The depth and extent of subdrains should be determined and approved by the geotechnical engineer in the field during construction. In addition, subdrains should be installed at a minimum slope of 1 percent and should have cleanouts located at their ends and at turning points. "Sweep" type elbows and wyes should be used at all turning points and cleanouts, respectively. Subdrain outlets and riser cleanouts should be fabricated of the same material as the subdrain pipe as specified herein. Outlet and riser pipe fittings should not be perforated. A licensed land surveyor or civil engineer should provide "record drawings" depicting the locations of subdrains and cleanouts.

Fill Quality

All fill materials should be free of perishable matter and rocks or lumps over 6 inches in diameter and must be approved by the geotechnical engineer prior to use. We anticipate that the landslide repair will consist of the removal of the landslide deposits and the subsequent replacement of the excavated material as engineered fill. In general, we judge that the onsite soil and bedrock are suitable for placement as engineered fill within the landslide repair area.

Fill Placement

The surface exposed by stripping and removal of the landslide deposits and the weak and creep-prone surface soils should be scarified to a depth of at least 6 inches, uniformly moisture-conditioned at least 4 percent above optimum and compacted to at least 90 percent of the maximum dry density of the materials as determined by ASTM Test Method D-1557. In expansive soil areas, moisture conditioning should be sufficient to completely close all shrinkage cracks for their full depth. If grading is performed during the dry season, the shrinkage cracks may extend to a few feet below the surface. Therefore, it may be necessary to excavate a portion of the dry, cracked soils to obtain the proper moisture condition and degree of compaction. Approved fill material should then be spread in thin lifts, uniformly moisture-conditioned to near optimum and properly compacted. All fills, including those placed to establish site surface drainage, should be compacted to at least 90 percent relative compaction. Fills should be continually keyed and benched into firm, undisturbed bedrock. An illustration of this grading technique is shown on Plate 10.

Permanent Cut and Fill Slopes

In general, cut and fill slopes should be designed and constructed at slope gradients of 2:1 (horizontal to vertical) or flatter, unless otherwise approved by the geotechnical engineer in specified areas. Where steeper slopes are required, retaining walls should be used. Fill slopes steeper than 2:1 will require the use of geogrid to increase stability. Fill slopes should be constructed by overfilling and cutting the slope to final grade. “Track walking” of a slope to achieve slope compaction is not an acceptable procedure for slope construction. Permanent cut slopes should be observed in the field by the geotechnical engineer to verify that the exposed soil and bedrock conditions are as anticipated. The geotechnical engineer is not responsible for measuring the angles of these slopes. Denuded slopes should be planted with fast-growing, deep-rooted groundcover to reduce sloughing or erosion.

Reinforced Fill Slopes

We understand that it may be necessary to construct slopes as steep as 1.5:1 in the process of repairing the driveway area. One of the design considerations for reinforced fill-slopes is the height of the slope. Once the alignment has been determined, we will be able to determine the slope heights and provide geogrid type, length and frequency.

The geogrid should be installed following the manufacturer's recommendations for placement, overlapping and connections. Geogrid placements should be performed under the observation of RGH personnel. Fill should be constructed by overfilling and cutting the slope to final grade. "Track walking" of a slope to achieve slope compaction is not an acceptable procedure for slope construction.

During construction, we should observe the actual conditions exposed. These observations will allow us to check that the soil/rock conditions are as anticipated, and to modify our recommendations, if necessary.

Wet Weather Grading

Generally, grading is performed more economically during the summer months when on-site soils are usually dry of optimum moisture content. Delays should be anticipated in site grading performed during the rainy season or early spring due to excessive moisture in on-site soils. Special and relatively expensive construction procedures, including dewatering of excavations and importing granular soils, should be anticipated if grading must be completed during the winter and early spring or if localized areas of soft saturated soils are found during grading in the summer and fall.

Open excavations also tend to be more unstable during wet weather as groundwater seeps towards the exposed cut slope. Severe sloughing and occasional slope failures should be anticipated. The occurrence of these events will require extensive clean up and the installation of slope protection measures, thus delaying projects. The general contractor is responsible for the performance, maintenance and repair of temporary cut slopes.

## Retaining Walls

Retaining walls constructed at the site must be designed to resist lateral earth pressures plus additional lateral pressures that may be caused by surcharge loads applied at the ground surface behind the walls. Retaining walls free to rotate (yielding greater than 0.1 percent of the wall height at the top of the backfill) should be designed for active lateral earth pressures. If walls are restrained by rigid elements to prevent rotation, they should be designed for "at rest" lateral earth pressures.

Retaining walls should be designed to resist the following earth equivalent fluid pressures (triangular distribution):

| EARTH EQUIVALENT FLUID PRESSURES | | |
|---|---|---|
| **Loading Condition** | **Pressure (pcf)** | **Additional Seismic Pressure (pcf)*** |
| Active - Level Backfill | 42 | 14 |
| Active - Sloping Backfill 3:1 or Flatter | 53 | 34 |
| At Rest - Level Backfill | 63 | 35 |

*If required

These pressures do not consider additional loads resulting from adjacent foundations or other loads. If these additional surcharge loadings are anticipated, we can assist in evaluating their effects. Where retaining wall backfill is subject to vehicular traffic, the walls should be designed to resist an additional surcharge pressure equivalent to two feet of additional backfill.

Retaining walls will yield slightly during backfilling. Therefore, walls should be backfilled prior to building on, or adjacent to, the walls. Backfill against retaining walls should be compacted to at least 90 and not more than 95 percent relative compaction. Over-compaction or the use of large compaction equipment should be avoided because increased compactive effort can result in lateral pressures higher than those recommended above.

Foundation Support

If a retaining wall is used to support the proposed improvements it should be supported on a system of grade beams interconnecting drilled, cast-in-place piers.

Drilled Piers

Drilled, cast-in-place, reinforced concrete piers should be used for foundation support where grading is not used to mitigate the landslide. Drilled piers should gain support below the landslide debris in undisturbed bedrock. Piers should be spaced no closer than 3 pier diameters, center to center.

Skin Friction - The portion of the piers extending below the bedrock surface may be designed using an allowable skin friction of 750 pounds per square foot (psf) for dead load plus long term live loads. This value can be increased by ⅓ for total loads, including downward vertical wind or seismic forces. A skin friction value of 150 psf should be used to resist uplift forces. End bearing should be neglected because of the difficulty of cleaning out small diameter pier holes, and the uncertainty of mobilizing end bearing and skin friction simultaneously.

Lateral Forces - Lateral loads on piers will be resisted by passive pressure on the bedrock. An equivalent fluid pressure of 350 pounds per cubic foot (pcf) acting on 2 pier diameters should be used. Confinement for passive pressure may be assumed at a depth where 7 horizontal feet is reached, measured from the slope face to the face of the pier.

Pier Drilling - We encountered groundwater and caving-prone soil within the planned pier depth during our study. If groundwater is encountered during drilling, it may be necessary to de-water the holes and/or place the concrete by the tremie method. If caving soil is encountered, it may be necessary to case the holes. Difficult drilling may be required to achieve the required penetration. The drilling subcontractor should review this report, become familiar with site conditions as they pertain to his operation and draw his own conclusions regarding drilling difficulty, suitable drill rigs and the need for casing and dewatering prior to bidding.

Concrete - Concrete mix design and placement should be done in accordance with the current ADSC and/or ACI specifications. Concrete should not be allowed to mushroom at the top of the piers or below the bottom of grade beams.

Wall Drainage and Backfill

Retaining walls should be backdrained as shown on Plate 11, Appendix A. The backdrains should consist of 4-inch diameter, rigid perforated pipe embedded in Class 2 permeable material. The pipe should be PVC Schedule 40 or ABS with SDR 35 or better, and the pipe should be sloped to drain to outlets by gravity. The top of the pipe should be at least 8 inches below lowest adjacent grade. The Class 2 permeable material should extend to within 1½ feet of the surface. The upper 1½ feet should be backfilled with compacted soil to exclude surface water. The ground surface behind retaining walls should be sloped to drain. Where migration of moisture through retaining walls would be detrimental, retaining walls should be waterproofed.

## Geotechnical Drainage

This section presents recommendations for surface drainage. For the discussion of subsurface drainage related to grading, especially on hillsides, refer to the "Subsurface Drainage" section.

### Surface

Surface water should be diverted away from the landslide repair area and onto erosion resistant natural drainages or into the site's surface drainage system. Surface drains must be maintained entirely separate from subsurface drainage. Surface drainage gradients should slope away from the existing residence foundations in accordance with the requirements of the CBC or local governing agency.

## Maintenance

Periodic land maintenance, especially on hillsides, will be required. Surface and subsurface drainage facilities should be checked frequently, and cleaned and maintained as necessary or at least annually. A dense growth of deep-rooted ground cover must be maintained on all slopes to reduce sloughing and erosion. Sloughing and erosion that occurs must be repaired promptly before it can enlarge.

## Supplemental Services

### Pre-Bid Meeting

It has been our experience that contractors bidding on the project often contact us to discuss the geotechnical aspects. Informal contacts between RGH and an individual contractor could result in incomplete or misinterpreted information being provided to the contractor. Therefore, we recommend a pre-bid meeting be held to answer any questions about the report prior to submittal of bids. If this is not possible, questions or clarifications regarding this report should be directed to the project owner or their designated representative. After consultation with RGH, the project owner or their representative should provide clarifications or additional information to all contractors bidding the job.

### Plan and Specifications Review

Coordination between the design team and the geotechnical engineer is recommended to assure that the design is compatible with the soil, geologic and groundwater conditions encountered during our study. RGH Consultants (RGH) recommends that we be retained to review the project plans and specifications to determine if they are consistent with our recommendations. In the event we are not retained to perform this recommended review, we will assume no responsibility for misinterpretation of our recommendations.

Construction Observation and Testing

Prior to construction, a meeting should be held at the site that includes, but is not limited to, the owner or owner's representative, the general contractor, the grading contractor, the foundation contractor, the underground contractor, any specialty contractors, the project civil engineer, other members of the project design team and RGH. This meeting should serve as a time to discuss and answer questions regarding the recommendations presented herein and to establish the coordination procedure between the contractors and RGH.

In addition, we should be retained to monitor all soils related work during construction, including:

- Site stripping, over-excavation, grading, and compaction of near surface soils;
- Placement of all engineered fill and trench backfill with verification field and laboratory testing;
- Observation of all foundation excavations; and
- Observation of retaining wall back drains installations.
- Site stripping, over-excavation and grading of disturbed landslide deposits;
- Placement of all engineered fill with verification field and laboratory testing;
- Observation of all keyway and bench excavations; and
- Observation of subdrain installations.

If, during construction, we observe subsurface conditions different from those encountered during the explorations, we should be allowed to amend our recommendations accordingly. If different conditions are observed by others, or appear to be present beneath excavations, RGH should be advised at once so that these conditions may be evaluated and our recommendations reviewed and updated, if warranted. The validity of recommendations made in this report is contingent upon our being notified and retained to review the changed conditions.

If more than 18 months have elapsed between the submission of this report and the start of work at the site, or if conditions have changed because of natural causes or construction operations at, or adjacent to, the site, the recommendations made in this report may no longer be valid or appropriate. In such case, we recommend that we be retained to review this report and verify the applicability of the conclusions and recommendations or modify the same considering the time lapsed or changed conditions. The validity of recommendations made in this report is contingent upon such review.

These supplemental services are performed on an as-requested basis and are in addition to this geotechnical study. We cannot accept responsibility for items that we are not notified to observe or for changed conditions we are not allowed to review.

## LIMITATIONS

This report has been prepared by RGH for the exclusive use of Steven Cardey and his consultants as an aid in the design and construction of the proposed improvements described in this report.

The validity of the recommendations contained in this report depends upon an adequate testing and monitoring program during the construction phase. Unless the construction monitoring and testing program is provided by our firm, we will not be held responsible for compliance with design recommendations presented in this report and other addendum submitted as part of this report.

Our services consist of professional opinions and conclusions developed in accordance with generally accepted geotechnical engineering principles and practices. We provide no warranty, either expressed or implied. Our conclusions and recommendations are based on the information provided to us regarding the proposed construction, the results of our field exploration, laboratory testing program, and professional judgment. Verification of our conclusions and recommendations is subject to our review of the project plans and specifications, and our observation of construction.

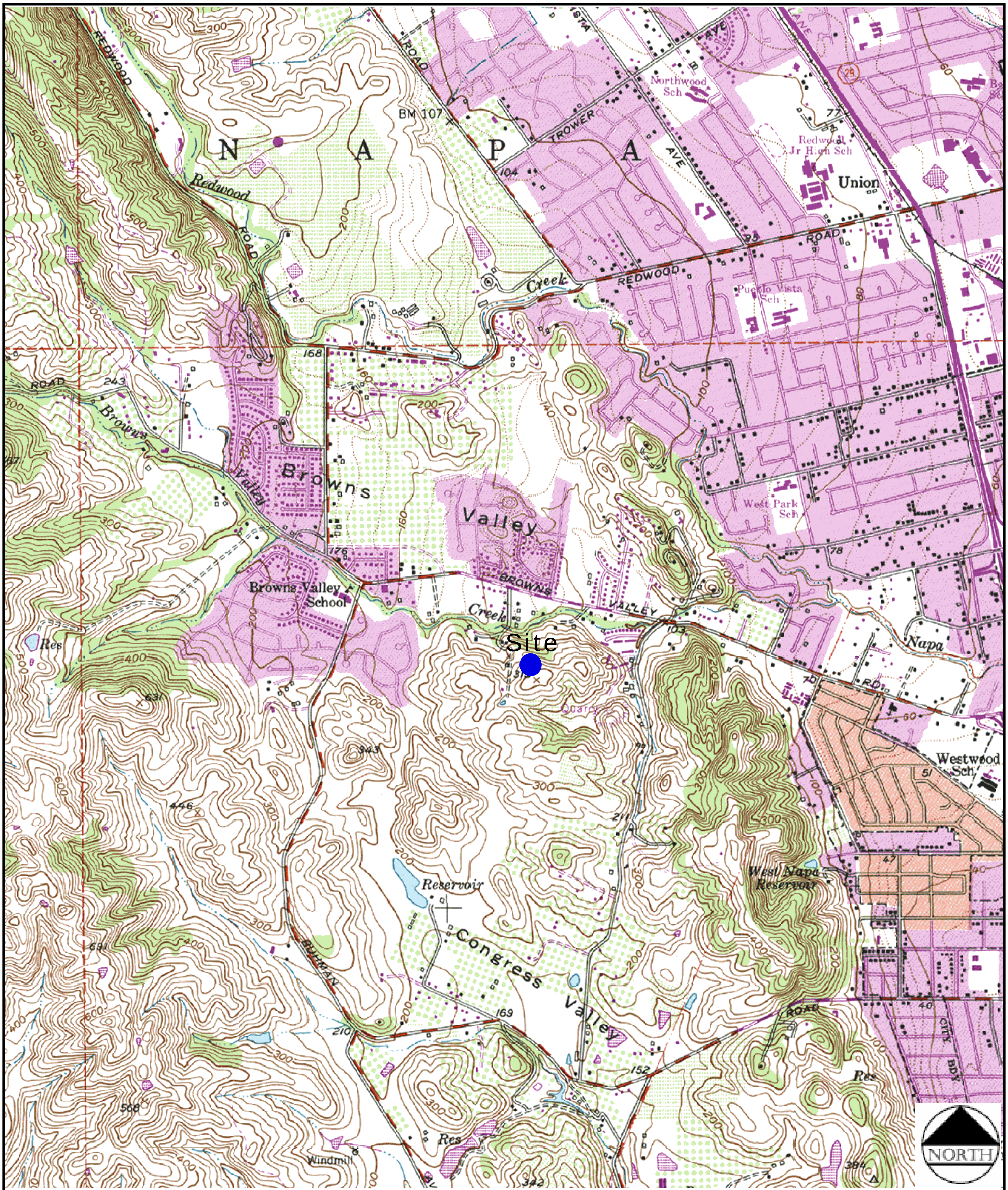
The borings represent subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions elsewhere or at other times. Site conditions and cultural features described in the text of this report are those existing at the time of our field exploration on May 22, 2017, and may not necessarily be the same or comparable at other times.

It should be understood that slope failures including landslides, debris flows and erosion are on-going natural processes which gradually wear away the landscape. Residual soils and weathered bedrock can be susceptible to downslope movement, even on apparently stable sites. Such inherent hillside and slope risks are generally more prevalent during periods of intense and prolonged rainfall, which occasionally occur, in northern California and/or during earthquakes. Therefore, it must be accepted that occasional, unpredictable slope failure and erosion and deposition of the residual soils and weathered bedrock materials are irreducible risks and hazards of building upon or near the base of any hillside or any steeper slope area throughout northern California. By accepting this report, the client and other recipients acknowledge their understanding and acceptance of these risks and hazards, and the terms and conditions herein.

The scope of our services did not include an environmental assessment or a study of the presence or absence of toxic mold and/or hazardous, toxic or corrosive materials in the soil, surface water, groundwater or air (on, below or around this site), nor did it include an evaluation or study for the presence or absence of wetlands. These studies should be conducted under separate cover, scope and fee and should be provided by a qualified expert in those fields.

# APPENDIX A - PLATES

## LIST OF PLATES




Reference: Maptech Topoquad, Napa, California Quadrangle

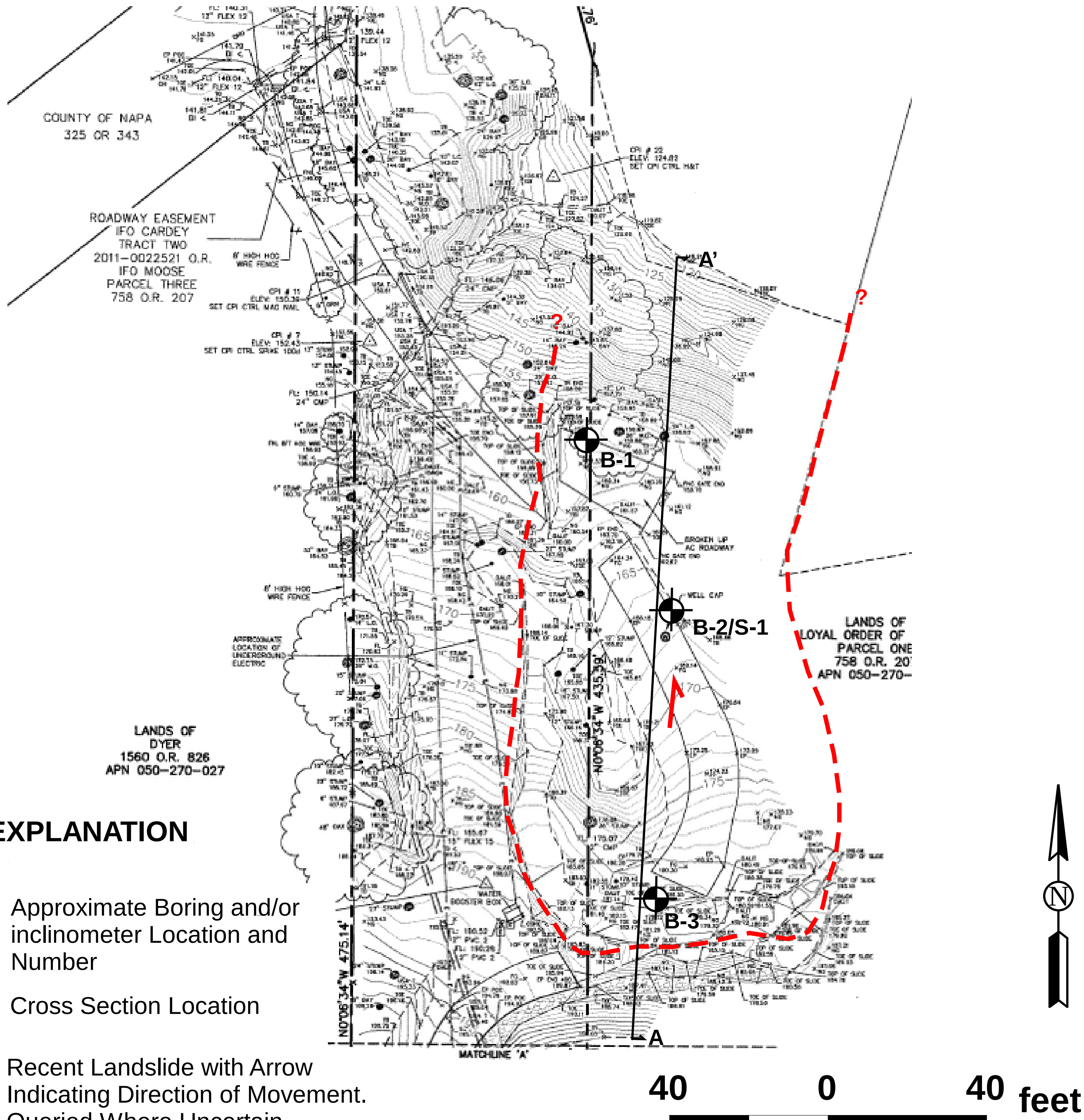
Scale: 1" = 2000'

# RGH
CONSULTANTS

Job No: 3508.01.09.1 | Date: AUG 2017

**SITE LOCATION MAP**
Cardey Residence Driveway
1100 McCormick Lane
Napa, California

PLATE
1




**EXPLANATION**

B-3/S-1

Approximate Boring and/or inclinometer Location and Number

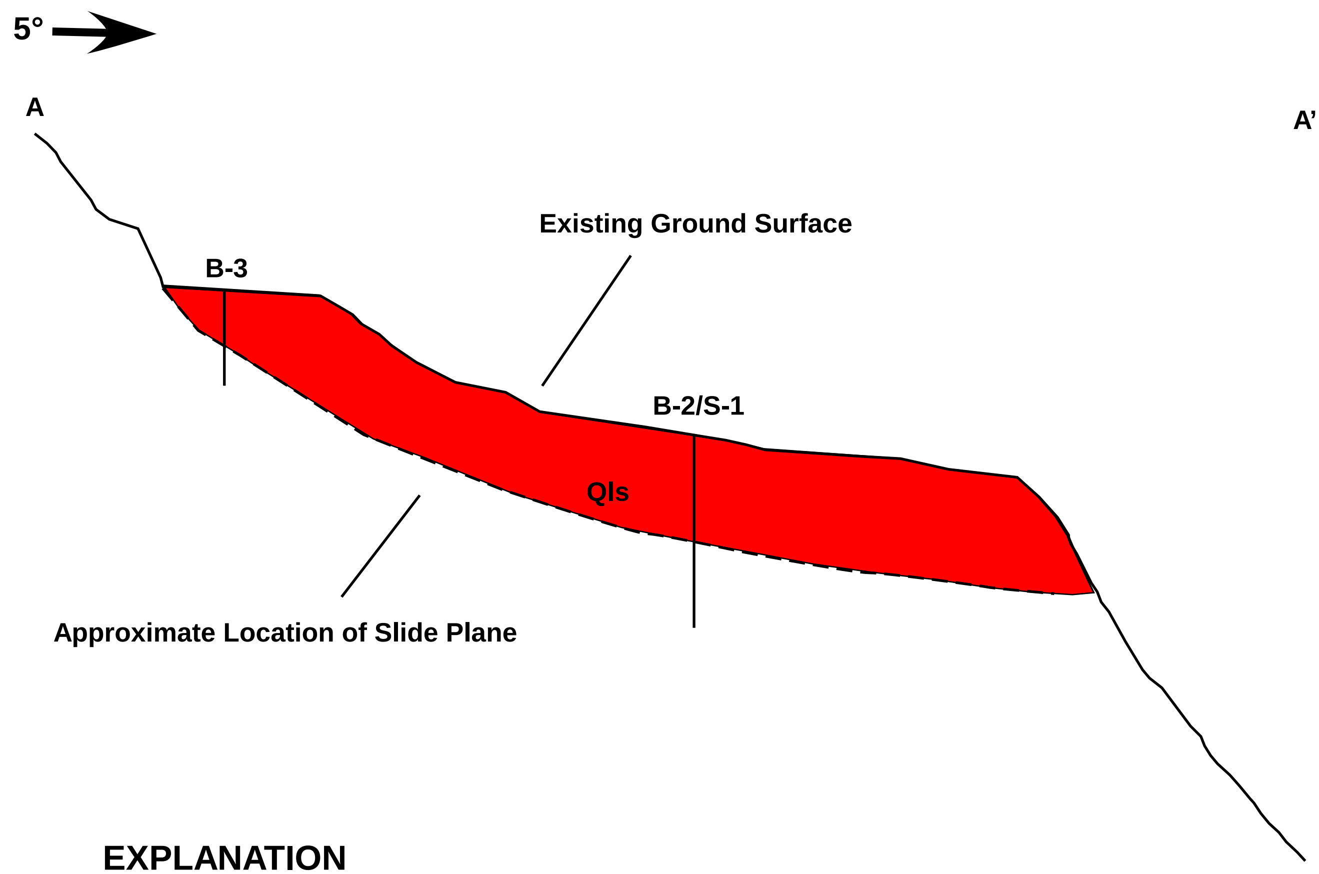
Cross Section Location

Qls

Recent Landslide with Arrow Indicating Direction of Movement. Queried Where Uncertain.

Reference: "Topographic Map", By Cinquini & Passarino, Inc. Land Surveying, Dated January 29, 2017 Scale: 1" = 40'

| | | |
|---|---|---|
| RGH CONSULTANTS | **EXPLORATION PLAN**<br>Cardey Residence Driveway<br>1100 McCormick Lane<br>Napa, California | PLATE<br>**2** |
| Job No: 3508.01.09.1 Date: AUG 2017 | | |




## EXPLANATION

**B-2/S-1** Approximate Boring and/or Slope Inclinometer Location and Number

30 0 30 feet

| | | |
|---|---|---|
| RGH CONSULTANTS<br>Job No: 3508.01.09.1 Date: AUG 2017 | **CROSS SECTION A - A'**<br>Cardey Residence Driveway<br>1100 McCormick Lane<br>Napa, California | PLATE<br>**3** |

| | | |
|---|---|---|
| Date(s) Drilled **05/22/17** | Logged By **JNK** | Checked By **JNK** |
| Drilling Method **Flight Auger** | Drill Bit Size/Type **8 inch** | Total Depth of Borehole **13.5 feet bgs** |
| Drill Rig Type **Portable** | Drilling Contractor **De Novo** | Approximate Surface Elevation **Existing Ground Surface** |
| Groundwater Level and Date Measured **Not Encountered** | Sampling Method(s) **Modified California, SPT** | Hammer Data **140 pound, 30 inches, cathead** |

| Elevation (feet) | Depth (feet) | Sample Type | Sampling Resistance, blows/ft | Graphic Log | MATERIAL DESCRIPTION | Dry Density (pcf) | Water Content (%) | % <#200 Sieve | PI, % | LL, % | Expansion Index (EI) | UC, ksf | REMARKS AND OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | Asphalt Pavement Section | | | | | | | | |
| | | | | | MEDIUM BROWN SANDY CLAY WITH GRAVEL (CL), soft, moist with gravel (Landslide Debris). | | | | | | | | |
| | | | 4 | | GRAY BROWN CLAY with SAND (CH), soft, moist, (Landslide Debris) | | | | 48 | 69 | | | |
| | 5 | | 13 | | GRAY BROWN SHEARED SHALE, firm, friable, highly weathered, extremely close fractures, vertical orientation of fractures/bedding. | | | | | | | | |
| | 10 | | 26 | | | | | | | | | | |
| | | | 73 | | | | | | | | | | |
| | | | | | BOTTOM OF BORING B-1 AT 13 1/2 FEET | | | | | | | | |
| | 15 | | | | | | | | | | | | |
| | 20 | | | | | | | | | | | | |
| | 25 | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | |

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Job No: 3508.01.09.1 | Date: AUG 2017

**LOG OF BORING B-1**
Cardey Residence Driveway
1100 McCormick Lane
Napa, California

PLATE
**4**

| | | |
|---|---|---|
| Date(s) Drilled **05/22/17** | Logged By **JNK** | Checked By **JNK** |
| Drilling Method **Flight Auger** | Drill Bit Size/Type **8 inch** | Total Depth of Borehole **30.5 feet bgs** |
| Drill Rig Type **Portable** | Drilling Contractor **De Novo** | Approximate Surface Elevation **Exisiting Ground Surface** |
| Groundwater Level and Date Measured **21.5** | Sampling Method(s) **Modified California, SPT** | Hammer Data **140 pound, 30 inches, cathead** |

| Elevation (feet) | Depth (feet) | Sample Type | Sampling Resistance, blows/ft | Graphic Log | MATERIAL DESCRIPTION | Dry Density (pcf) | Water Content (%) | % <#200 Sieve | PI, % | LL, % | Expansion Index (EI) | UC, ksf | REMARKS AND OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | Asphalt Pavement Section | | | | | | | | |
| | | | | | BROWN SANDY CLAY (CL), soft, medium stiff to stiff, moist, few gravels and roots (Landslide Debris). | | | | | | | | |
| | | | 5 | | | | | 85.6 | 24 | 46 | | | |
| | 5 | | | | | | | | | | | | |
| | | | 8 | | | | | | | | | | |
| | | | 15 | | | | | | | | | | |
| | 10 | | | | MEDIUM BROWN SANDY CLAY (CL), with gravel, stiff to very stiff, moist, with angular shale gravel (Landslide Debris). | | | | | | | | |
| | | | 20 | | | | | | | | | | |
| | | | 15 | | | | | | | | | | |
| | 15 | | 21 | | | | | | | | | | |
| | | | | | GRAY GRAY-BROWN SHEARED SHALE, firm, friable, highly weathered, near vertical bedding/fractures. | | | | | | | | |
| | | | 20 | | | | | | | | | | |
| | 20 | | | | | | | | | | | | |
| | | | 14 | | | | | | | | | | |
| | | | 17 | | | | | | | | | | |
| | 25 | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | |
| | | | | | BOTTOM OF BORING B-2/S1 AT 30 1/2 FEET | | | | | | | | |

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Job No: 3508.01.09.1 Date: AUG 2017

**LOG OF BORING B-2/S1**
Cardey Residence Driveway
1100 McCormick Lane
Napa, California

PLATE
**5**

| | | | | | |
|---|---|---|---|---|---|
| Date(s) Drilled | 05/22/17 | Logged By | JNK | Checked By | JNK |
| Drilling Method | Flight Auger | Drill Bit Size/Type | 8 inch | Total Depth of Borehole | 15 feet bgs |
| Drill Rig Type | Portable | Drilling Contractor | De Novo | Approximate Surface Elevation | Existing Ground Elevation |
| Groundwater Level and Date Measured | Not Encountered | Sampling Method(s) | Modified California, SPT | Hammer Data | 140 pound, 30 inches, cathead |

| Elevation (feet) | Depth (feet) | Sample Type | Sampling Resistance, blows/ft | Graphic Log | MATERIAL DESCRIPTION | Dry Density (pcf) | Water Content (%) | % <#200 Sieve | PI, % | LL, % | Expansion Index (EI) | UC, ksf | REMARKS AND OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | Asphalt Pavement Section | | | | | | | | |
| | | | | | GRAY BROWN SANDY CLAY (CH), soft, moist, few roots and gravel (Landslide Debris). | | | | | | | | |
| | | | 3 | | | | | 84.4 | 36 | 57 | | | |
| | 5 | | 3 | | | | | | | | | | |
| | | | 4 | | | | | | | | | | |
| | | | | | GRAVELS AT 7 1/2 FEET | | | | | | | | |
| | | | | | WET AT 7 1/2 FEET | | | | | | | | |
| | | | 88 | | GRAY-BROWN SHEARED SHALE, firm, friable, near vertical bedding/fractures. | | | | | | | | |
| | 10 | | | | | | | | | | | | |
| | | | 73\8 | | | | | | | | | | |
| | 15 | | | | REFUSAL AT 15 FEET | | | | | | | | |
| | 20 | | | | | | | | | | | | |
| | 25 | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | |

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Job No: 3508.01.09.1 | Date: AUG 2017

**LOG OF BORING B-3**
Cardey Residence Driveway
1100 McCormick Lane
Napa, California

PLATE
6

| Elevation (feet) | Depth (feet) | Sample Type | Sampling Resistance, blows/ft | Graphic Log | MATERIAL DESCRIPTION | Dry Density (pcf) | Water Content (%) | % <#200 Sieve | PI, % | LL, % | Expansion Index (EI) | UC, ksf | REMARKS AND • OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |

## COLUMN DESCRIPTIONS

1. Elevation (feet): Elevation (MSL, feet).
2. Depth (feet): Depth in feet below the ground surface.
3. Sample Type: Type of soil sample collected at the depth interval shown.
4. Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating •interval using the hammer identified on the boring log.
5. Graphic Log: Graphic depiction of the subsurface material encountered.
6. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and •other descriptive text.
7. Dry Density (pcf): Dry density, in pcf.
8. Water Content (%): Water content, percent.
9. % <#200 Sieve: % <#200 Sieve
10. PI, %: Plasticity Index, expressed as a water content.
11. LL, %: Liquid Limit, expressed as a water content.
12. Expansion Index (EI): Expansion Index (EI)
13. UC, ksf: Unconfined compressive strength, in kips per square foot.
14. REMARKS AND •OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field •personnel.

## FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

## MATERIAL GRAPHIC SYMBOLS

- Asphaltic Concrete (AC)
- Fat CLAY, CLAY w/SAND, SANDY CLAY (CH)
- Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
- Shale

## TYPICAL SAMPLER GRAPHIC SYMBOLS

- Auger sampler
- Bulk Sample
- 2.5-inch-OD California w/ brass rings
- CME Sampler
- Grab Sample
- 3.0-inch-OD Modified California w/ brass liners
- Pitcher Sample
- 2-inch-OD unlined split spoon (SPT)
- Shelby Tube (Thin-walled, fixed head)

## OTHER GRAPHIC SYMBOLS

- Water level (at time of drilling, ATD)
- Water level (after waiting)
- Minor change in material properties within a stratum
- Inferred/gradational contact between strata
- ? Queried contact between strata

## GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Job No: 3508.01.09.1 | Date: AUG 2017

**SOIL CLASSIFICATION AND KEY TO TEST DATA**
Cardey Residence Driveway
1100 McCormick Lane
Napa, California

PLATE 7

## LAYERING

| | |
|---|---|
| MASSIVE | Greater than 6 feet |
| THICKLY BEDDED | 2 to 6 feet |
| MEDIUM BEDDED | 8 to 24 inches |
| THINLY BEDDED | 2½ to 8 inches |
| VERY THINLY BEDDED | ¾ to 2½ inches |
| CLOSELY LAMINATED | ¼ to ¾ inches |
| VERY CLOSELY LAMINATED | Less than ¼ inch |

## JOINT, FRACTURE, OR SHEAR SPACING

| | |
|---|---|
| VERY WIDELY SPACED | Greater than 6 feet |
| WIDELY SPACED | 2 to 6 feet |
| MODERATELY SPACED | 8 to 24 inches |
| CLOSELY SPACED | 2½ to 8 inches |
| VERY CLOSELY SPACED | ¾ to 2½ inches |
| EXTREMELY CLOSELY SPACED | Less than ¼ inch |

## HARDNESS

Soft - pliable; can be dug by hand
Firm - can be gouged deeply or carved with a pocket knife
Moderately Hard - can be readily scratched by a knife blade; scratch leaves 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 pocket knife, leaves a metallic streak

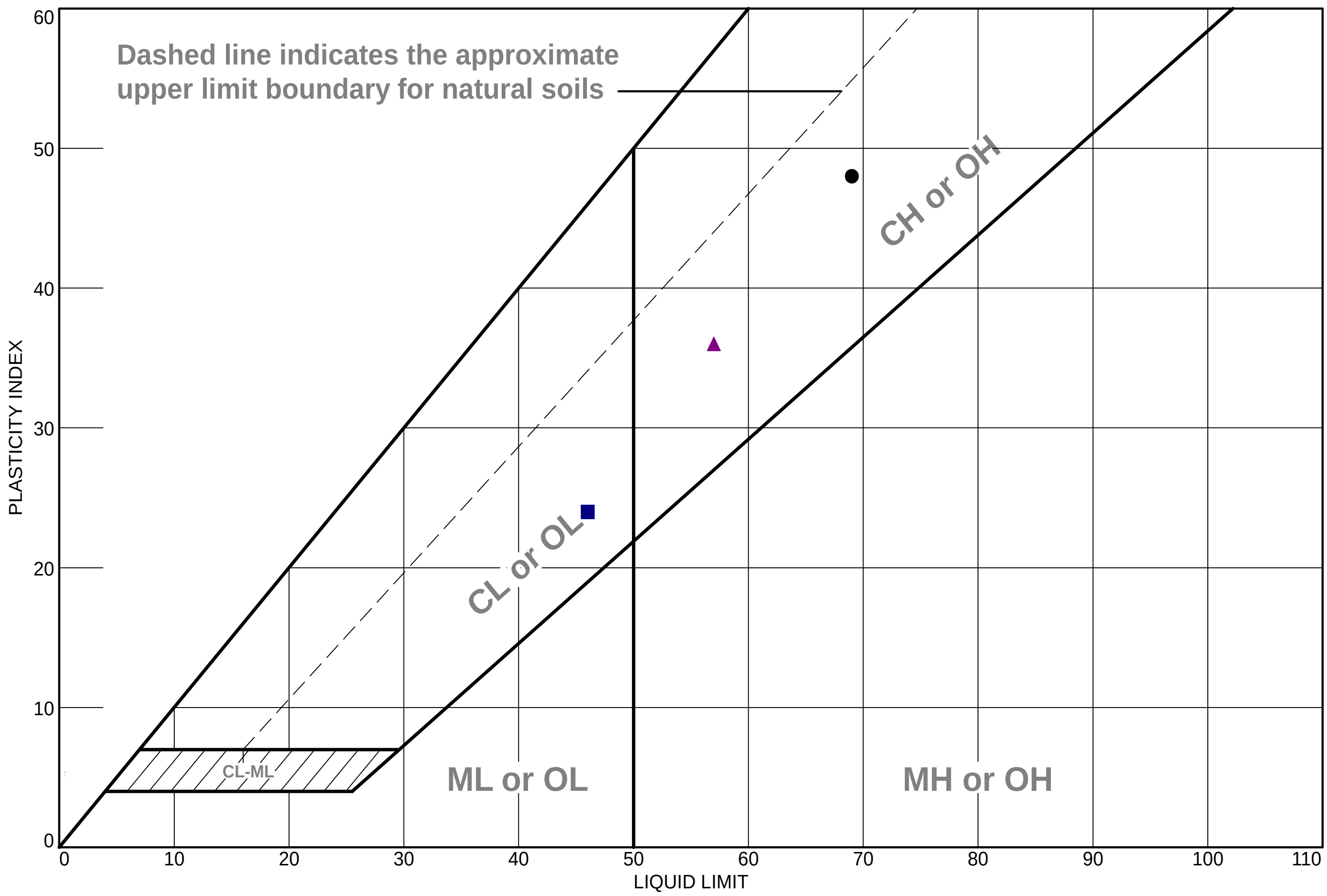
## STRENGTH

Plastic - capable of being molded by hand
Friable - crumbles by rubbing with fingers
Weak - an unfractured specimen of such material will crumble under light hammer blows
Moderately Strong - specimen will withstand a few heavy hammer blows before breaking
Strong - specimen will withstand a few heavy ringing hammer blows and usually yields large fragments
Very Strong - rock will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments

## DEGREE OF WEATHERING

Highly Weathered - abundant fractures coated with oxides, carbonates, sulphates, mud, etc., thorough discoloration, rock disintegration, mineral decomposition
Moderately Weathered - some fracture coating, moderate or localized discoloration, little to no effect on cementation, slight mineral decomposition
Slightly Weathered - a few stained fractures, slight discoloration, little or no effect on cementation, no mineral composition
Fresh - unaffected by weathering agents; no appreciable change with depth

# LIQUID AND PLASTIC LIMITS TEST REPORT




| | MATERIAL DESCRIPTION | LL | PL | PI | %<#40 | %<#200 | USCS |
|---|---|---|---|---|---|---|---|
| ● | Brown Clay W/ Sand (CH) | 69 | 21 | 48 | | | CH |
| ■ | Brown Clay (CL) | 46 | 22 | 24 | | 85.6 | CL |
| ▲ | Brown Clay W/ Sand (CH) | 57 | 21 | 36 | | 84.4 | CH |
| | | | | | | | |
| | | | | | | | |

**Project No.** 3508.01.09.1 **Client:** RGH Consultants

**Project:** Cardey Residence Driveway

● **Source of Sample:** B-1 **Depth:** 3.0'

■ **Source of Sample:** B-2 **Depth:** 3.5' & 4.0'

▲ **Source of Sample:** B-3 **Depth:** 3.0'

**Remarks:**

▲ Sampled 5/23/17
Received 5/30/17
Reported 6/13/17

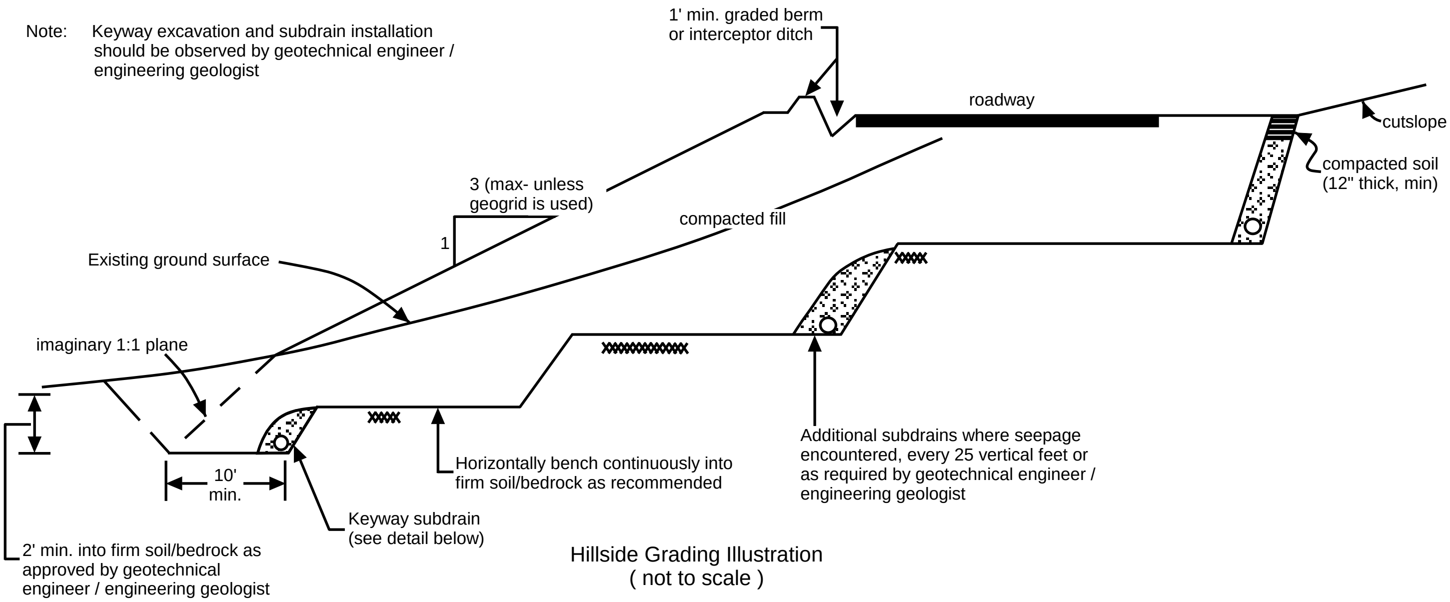
RGH CONSULTANTS

Job No: 3508.01.09.1 | Date: AUG 2017

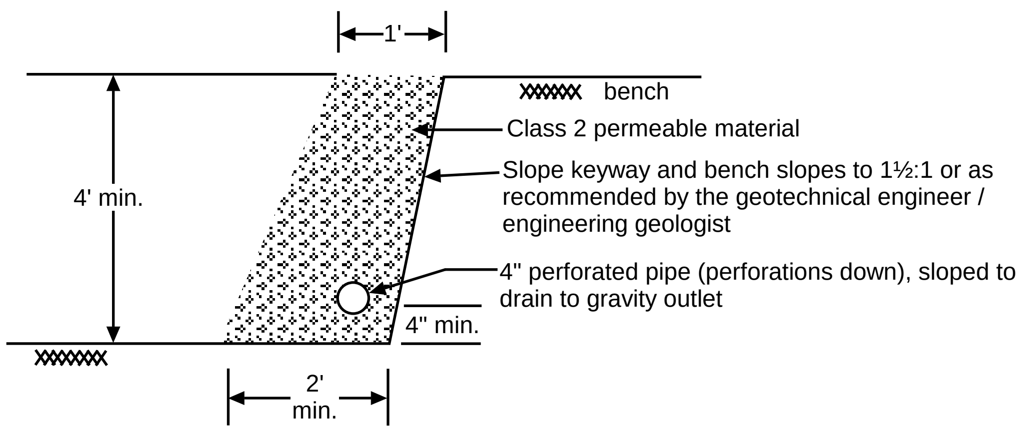
**CLASSIFICATION TEST DATA**
Cardey Residence Driveway
1100 McCormick Lane
Napa, California

PLATE

**9**

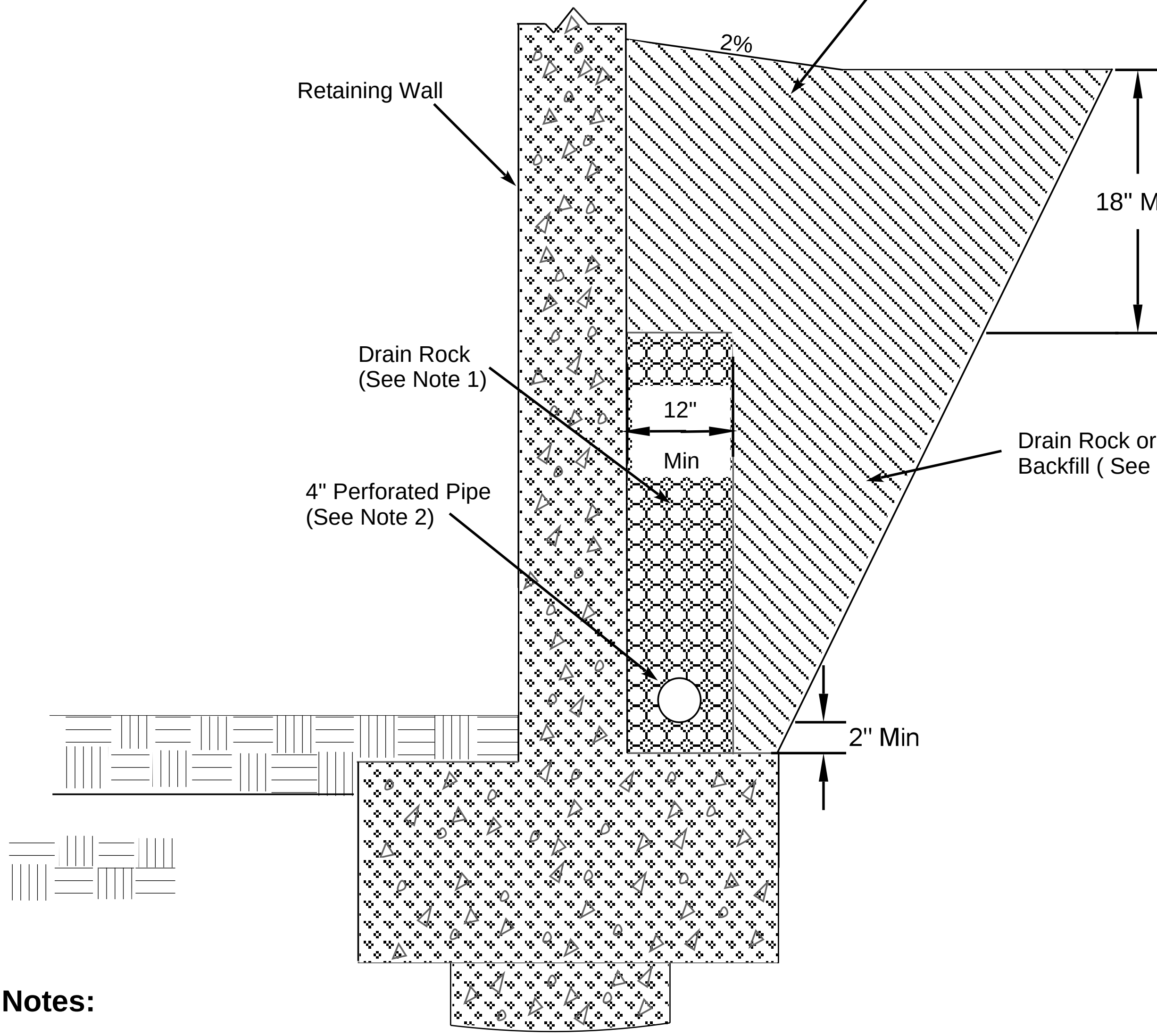



Hillside Grading Illustration
( not to scale )




Keyway Subdrain
( not to scale )

| | | |
|---|---|---|
| RGH CONSULTANTS | **HILLSIDE GRADING ILLUSTRATION**<br>Cardey Residence Driveway<br>1100 McCormick Lane<br>Napa, California | PLATE<br>**10** |
| Job No: 3508.01.09.1 — Date: AUG 2017 | | |




**Notes:**

1. Drain rock should meet the requirements for Class 2 Permeable Material, Section 68, State of California “Caltrans” Standard Specification, latest edition. Drain rock should be placed to approximately three-quarters the height of the retaining wall.

2. Pipe should conform to the requirements of Section 68 of State of California “Caltrans” Standards, perforations placed down, sloped at 1% for gravity flow to outlet or sump with automatic pump. The pipe invert should be located at least 8 inches below the lowest adjacent finished surface.

3. During construction the contractor should use appropriate methods such as temporary bracing and/or light compaction equipment to avoid overstressing the walls.

Not to Scale

| RGH CONSULTANTS | RETAINING WALL BACKDRAIN ILLUSTRATION<br>Cardey Residence Driveway<br>1100 McCormick Lane<br>Napa, California | PLATE<br>11 |
|---|---|---|
| Job No: 3508.01.09.1 — Date: AUG 2017 | | |

## APPENDIX B - REFERENCES

American Society of Civil Engineers, 2010, Minimum Design Loads for Buildings and Other Structures, ASCE Standard ASCE/SEI 7-10.

Bortugno, E.J., 1982, Map Showing Recency of Faulting, Santa Rosa Quadrangle in Wagner and Bortugno, Geologic Map of the Santa Rosa Quadrangle: California Division of Mines and Geology, Regional Geologic Map Series, Map No. 2A, Santa Rosa Quadrangle, Scale 1:250,000.

Bryant, W.A., and Hart, E.W., Interim Revision 2007, Fault-Rupture Zones in California; California Geological Survey, Special Publication 42, p. 21 with Appendices A through F.

California Building Code, 2016, California Building Standard Commission.

Clahan, K.B., Wagner, D.L., Saucedo, G.J., Randolph-Loar, C.E., Sowers, J.M., 2004, Geologic Map of the Napa 7.5' Quadrangle, Napa County, California: A Digital Database.

Dwyer, M.J., Noguchi, N., and O'Rourke, J., 1976, Reconnaissance Photo-Interpretation Map of Landslides in 24 Selected 7.5-Minute Quadrangles in Lake, Napa, Solano, and Sonoma Counties, California: U.S. Geological Survey OFR 76-74, 25 Plates, Scale 1:24,000.

Huffman, M.E., and Armstrong, C.F, 1980, Geology for Planning in Sonoma County, California: California Division of Mines and Geology Special Report 120, 31 p., 5 plates.

Natural Resources Conservation Service, United States Department of Agriculture, accessed April 14, 2015. Web Soil Survey, available online at http://websoilsurvey.nrcs.usda.gov/.

Working Group on California Earthquake Probabilities, 2007, Uniform California Earthquake Rupture Forecast (UCERF): Notes on Southern California Earthquake Center (SCEC) Web Site (http://www.scec.org/ucerf/).

## APPENDIX C - DISTRIBUTION

Steven Cardey (3,1e)
1100 McCormick Lane
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scardey@sbcglobal.net

Bartelt Engineering (1e)
Attention: Paul Bartelt
paul@barteltengineering.com

JJP:TAW:JNK:jk:ejw



s:\project files\3501-3750\3508\3508.01.09.1 cardy residence driveway\gs report.doc

RGH CONSULTANTS
Experience is the difference

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November 20, 2017

Steven Cardey
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Geotechnical Review
Grading Plans
Cardey Residence Driveway
1100 McCormick Lane
Napa, California

Project Number: 3508.01.09.1

This letter documents our geotechnical review of the grading plans for the new driveway to be constructed at 1100 McCormick Lane in Napa, California. The new driveway is being constructed to bypass a slope failure that compromised the original driveway. The results of our geotechnical study for the project were presented in a report dated August 25, 2017. The grading plans we reviewed are Sheets C1 through C11 of a plan set titled "Cardey Residence," prepared by Bartelt Engineering dated November 2017.

Based on our review, we conclude that the geotechnical aspects of the driveway plans are in general conformance with the intent of the recommendations presented in the geotechnical study report. Review of hydrological calculations addressing surface drainage systems and verifying survey lines and grades is not within our area of expertise and was not included in our scope of services for this plan review.

During construction, we should observe site excavations, compaction of fills and backfills, subdrain installations, and perform field and laboratory testing. These observations and testing will allow us to check the contractor's methods and materials, verify that the soil/groundwater/rock conditions are as anticipated, and modify our recommendations, if necessary. Our geotechnical consultation and grading observation and testing services provided during the construction phase of the project will be documented in a written report.

We trust this provides the information you require at this time. Please call if you have questions.

Very truly yours,
RGH Consultants

Jared J. Pratt
Project Manager

Travis A. Whitted
Senior Geotechnical Engineer

JJP:TAW:jp:ejw
Electronically submitted



cc: Bartelt Engineering
Attention: Paul Bartelt
paulb@barteltengineering.com

s:\project files\3501-3750\3508\3508.01.09.1 cardy residence driveway\plan review.doc