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812 W. Wabash Avenue, Eureka, CA 95501-2138

Reference: 018181

June 11, 2019



Journey Aquarian
610 Dry Creek Road
Healdsburg, CA 95542

**Subject:** **Engineering Geologic Evaluation and Soils Reporting for Existing and Proposed Improvements, APN's 216-081-013, 216-135-015, 216-136-004, and 216-135-008; Harris, Humboldt County, California**

Journey Aquarian:

This report presents the results of SHN's investigation of engineering geologic and soils conditions for a series of existing and proposed improvements in the Harris area of southern Humboldt County. The improvements at the subject sites consist of widely distributed facilities associated with cannabis cultivation and domestic purposes across four adjacent parcels. These improvements consist of structures, ponds, and cultivation areas (typically light-frame greenhouses occupying graded earthen pads). We understand these sites are engaged in the county permitting process relative to commercial cannabis production. This report is intended to address all items requested in the "Soils Report Checklist" provided on the Humboldt County Planning and Building Department's website (Humboldt County, 2016), as well as the specific requirements outlined in a letter from the county's Cannabis Services Division, dated August 6, 2018 (this letter references Permit Application No. 12125 and Case No. CUP 16-539). We understand that the client will be requesting retroactive permitting from the Humboldt County Planning and Building Department for the existing improvements, as well as all relevant future permits for the proposed improvements.

The purpose of our investigation was to evaluate the engineering geologic conditions relative to existing structures, ponds, and graded cultivation areas, and to evaluate areas where future improvements are planned. This report only intends to address these specific areas and should not be extrapolated to other areas of the property. Relative to our evaluation of existing structures, it is our intent to assess the subgrade and bearing materials beneath these structures, but we do not address the adequacy of the foundation itself; the assessment of structural elements is being addressed by others in the permitting process. Relative to proposed improvements, our assessment focuses on the geologic suitability of the site (exposure to geohazards and potential to influence site geologic conditions) and general geotechnical conditions (identification of problematic soil conditions, for example), but we recognize that improvement plans are conceptual at this time. Therefore, we provide generic recommendations for site preparation and grading, as well as pond construction. If additional details arise in the future, we expect that additional geotechnical reporting may be required.

Although our reporting may inform the design or maintenance of ranch roads on the subject properties, we understand that that the transportation planning for this permit application is being addressed by others. Site-specific recommendations relative to individual road points are beyond the scope of this evaluation.

The recommendations in this report satisfy the requirements for obtaining a Humboldt County Building Permit while maintaining the professional standard of care for this type of work. We recognize the limitations of retroactive analysis of previously completed grading and construction, and below we discuss the limitations of this approach and suitable uses for these improvements.

## 1.0 Project Location and Site Description

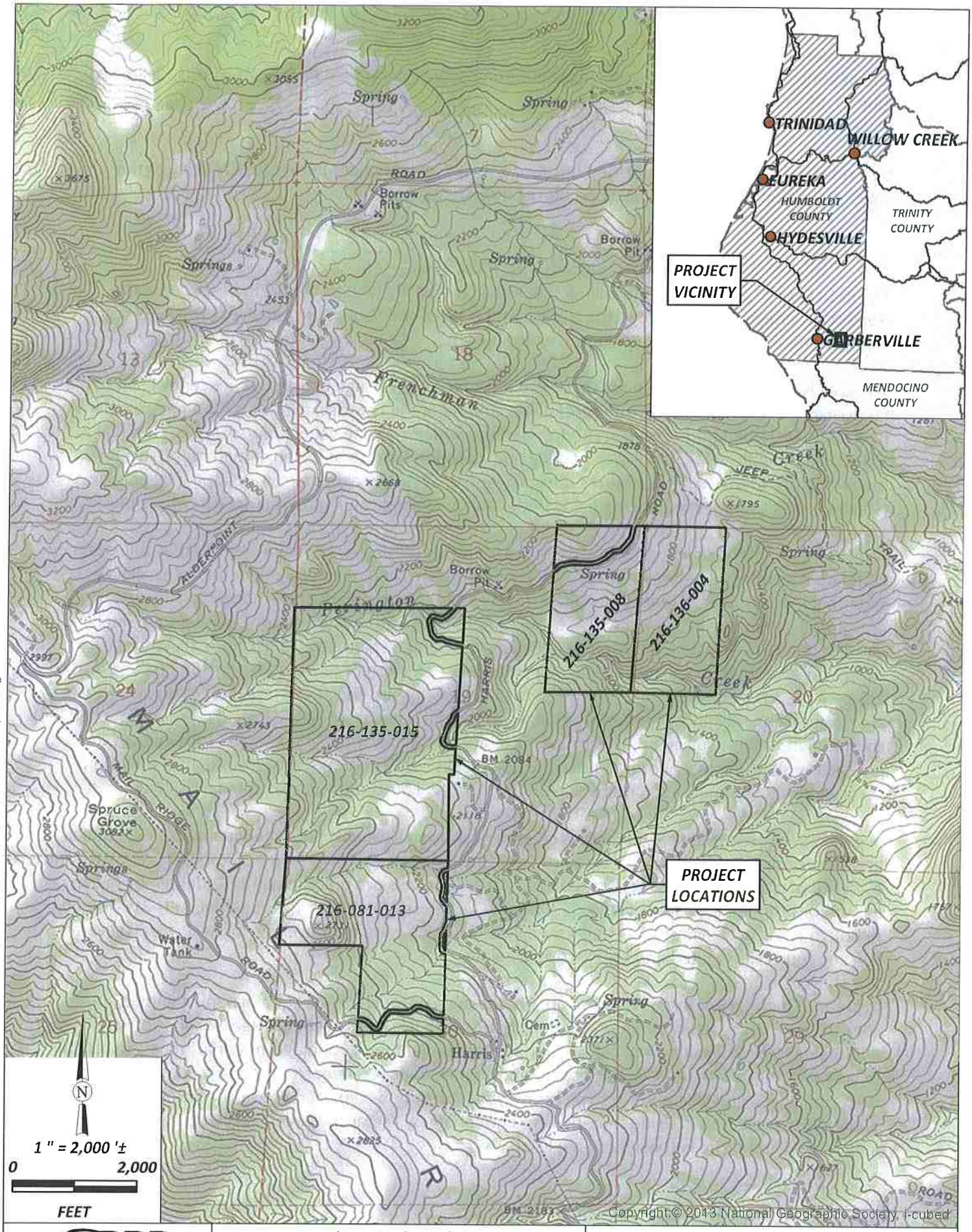
The subject site is located along the Harris Road, in the Perington Creek watershed, east of Garberville in southern Humboldt County (Figure 1). The project area is spread across four parcels and consists of three separate permit applications. The individual applicants and the subject parcels are as follows, including a latitude and longitude for a prominent feature within each parcel:

- **Journey Aquarian ("Ranch" parcel)**
  APN 216-081-013
  Latitude: 40.090968
  Longitude: -123.665870
- **Myers and Aquarian, LLC**
  CUP Application #12124
  APN 216-135-015
  Latitude: 40.097794
  Longitude: -123.668572
- **Humboldt Kingz, LLC (including "Pond" parcel)**
  CUP Application #12125
  APN's: 216-136-004 and 216-135-008
  Latitude: 40.102728
  Longitude: -123.653698
  Note: The letter from the County Cannabis Services Division (dated August 6, 2018) is specifically focused on the CUP application for these parcels (216-136-004 and 216-135-008).

Site plans for the individual development sites are attached at the back of this report.

## 2.0 Field Investigations

A certified engineering geologist from SHN visited the site on September 6, 2018, to observe site conditions. At the time of this visit, we conducted a visual inspection of the existing structures, a pond, and a series of graded fill pads; and we evaluated the site setting, construction materials, and configuration of the subject improvements. The graded pads were visually inspected for geometry (cut and fill slope steepness), drainage, and integrity. Subsurface exploration, sampling, and testing is

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|---|---|---|
| SHN Consulting Engineers & Geologists, Inc. | Journey Aquarian Soils Report Harris, California | Project Locations Map |
| | | SHN 018181 |
| December 2018 | Figure1_ProjectLocationMap | Figure 1 |

beyond the scope of this investigation because it would be marginally informative relative to the conclusions regarding the as-built condition of these features.

## 3.0 Site Conditions and Geologic Hazards

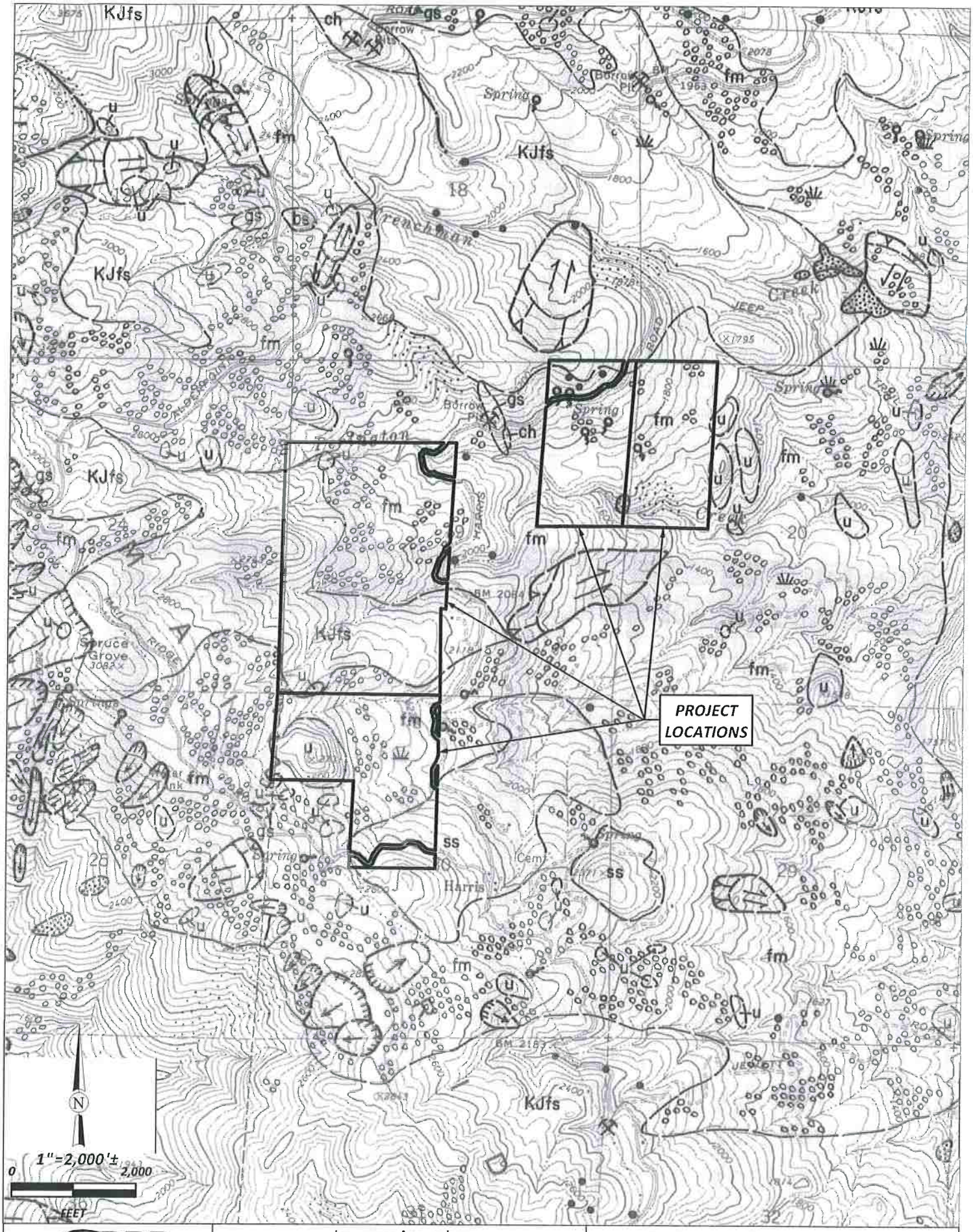
The project site occurs on uplands along the broad crest of Mail Ridge, the northwest-southeast trending drainage divide between the main stem Eel River and South Fork Eel River. The sites occur along Perington Creek and its tributaries, which flow to the east toward the main stem Eel River.

The area is mapped as being underlain by Cretaceous to Jurassic age bedrock of the central belt of the Franciscan Complex (Figure 2). The central belt subunit of the Franciscan Complex is a heterogeneous bedrock unit formed during crustal subduction that contains a wide variety of rock types. The unit is structurally complex with pervasive shearing and a preponderance of mélange materials (block-in-matrix texture where hard rock blocks are entrained in a low-strength matrix). Mapping by Spittler (1984) shows the subject parcels as being underlain by mélange and various large sandstone blocks.

Landsliding in this terrain is strongly correlative to the underlying earth materials. In areas underlain by competent sandstone bedrock, topography is notably sharp and mass wasting occurs as shallow debris slides and rock topples. Areas underlain by mélange are associated with earthflow type mass wasting. Geomorphic mapping by Spittler (1984) shows limited amounts of mass wasting in the four parcels discussed herein, reflecting the geology and general absence of steep terrain (Figure 2). With the exception of a single, small debris slide mapped along Perington Creek on APN 216-135-008 and an adjacent "debris slide slope", areas of inferred mass wasting are shown as "disrupted ground." These areas represent indistinct geomorphic mapping units that are described as "irregular ground" caused by complex landsliding, soil creep, or erosion. They are commonly mapped in prairie areas (where the ground is visible in aerial photographs), where soft soils result in hummocky ground; they are often associated with geomorphic conditions resulting from soil processes unrelated to landsliding.

In general, we observed field conditions consistent with the available published mapping. Substantial areas of resistant bedrock are present on the western parcels (APN's 216-081-013 and 216-135-015) and evidence of mass wasting is very limited. The eastern parcels are predominantly underlain by mélange, except for prominent bedrock outcrops along the eastern edge of the eastern parcel, APN 216-136-004. Although areas of significant recent earthflow deformation were not observed in these areas, several soft soil zones were noted and are discussed below.

In areas of high seismicity, such as the project site, the potential for soil liquefaction should be considered. Susceptibility to liquefaction decreases with increasing geologic age, because of weathering and the degree of densification, compaction, and/or cementation. Geologic materials most susceptible to liquefaction are late Holocene age sand- and silt-rich deposits, deposited within the last several thousand years, and located next to streams, rivers, bays, or ocean shorelines. These conditions do not apply at the project site. Given that the site is underlain by Cretaceous age bedrock, the potential for liquefaction at the site is considered negligible.

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| Consulting Engineers & Geologists, Inc. | Journey Aquarian<br>Soils Report<br>Harris, California | Geology and Geomorphic Features Related To Landsliding (Spittler, 1984)<br>SHN 018181 |
| | December 2018 \| Figure2_GeologyMap | Figure 2 |

# GEOLOGY AND GEOMORPHIC FEATURES RELATED TO LANDSLIDING
# HARRIS 7.5' QUADRANGLE, HUMBOLDT COUNTY, CALIFORNIA

Compiled by
Thomas E. Spittler, Geologist
California Department of Conservation
Division of Mines and Geology
1984

## EXPLANATION

TRANSLATIONAL/ROTATIONAL SLIDE: relatively cohesive slide mass with a failure plane that is deep-seated in comparison to that of a debris slide of similar areal extent; sense of motion along slide plane is linear in a translational slide and arcuate or "rotational" in a rotational slide; complex versions with rotational heads and translation or earthflows downslope are common; translational movement along a planar joint or bedding discontinuity may be referred to as a block glide; indicates scarp, indicates direction of movement; solid where active, dashed where dormant, queried where uncertain.

EARTHFLOW: mass movement resulting from slow to rapid flowage of saturated soil and debris in a semiviscous, highly plastic state; after initial failure, the flow may move, or creep, seasonally in response to destabilizing forces; indicates scarp, indicates direction of movement; solid where active, dashed where dormant.

DEBRIS SLIDE: unconsolidated rock, colluvium, and soil that has moved slowly to rapidly downslope along a relatively steep (generally greater than 65 percent), shallow translational failure plane; forms steep, unvegetated scars in the head region and irregular hummocky deposits (when present) in the toe region; scars likely to ravel and remain unvegetated for many years; revegetated scars recognized by steep, even-faceted slope and light-bulb shape; includes scarp and slide deposits; solid where active, dashed where dormant.

DEBRIS FLOW/TORRENT TRACK: long stretches of bare, generally unstable stream channel banks scoured and eroded by the extremely rapid movement of water-laden debris; commonly triggered by debris sliding in the upper part of the drainage during high intensity storms; scoured debris may be deposited downslope as a tangled mass of organic material in a matrix of rock and soil; debris may be reactivated or washed away during subsequent events; solid where active.

DEBRIS SLIDE SLOPE: geomorphic feature characterized by steep (generally greater than 65 percent), slopes that have been sculpted by numerous debris slide events; vegetated soils and colluvium above shallow soil/bedrock interface may be disrupted by active debris slides or bedrock exposed by former debris sliding; slopes near angle of repose may be relatively stable except where weak bedding planes and extensive bedrock joints and fractures parallel slope.

ACTIVE SLIDE: too small to delineate at this scale.

DISRUPTED GROUND: irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at this scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion; boundaries usually are indistinct.

Qsc STREAM/RIVER CHANNEL DEPOSITS (Holocene): sand and gravel in active stream channel along major streams and rivers; characteristically unvegetated.

Q ALLUVIUM (Holocene): sand and gravel deposited by streams above active channel; characteristically vegetated.

Qrt RIVER TERRACE DEPOSITS (Holocene-Pleistocene): dominantly sand and gravel with minor amounts of silt and clay deposited during higher stands of major streams and rivers.

Qf ALLUVIAL FAN DEPOSITS (Holocene): alluvial sand and gravel deposited in characteristic fan-cone shape at the mouths of eroding stream canyons.

QTwu UNDIFFERENTIATED WILDCAT GROUP (Pleistocene-Miocene): mudstone, shale, sandstone, siltstone and minor amounts of conglomerate; degree of consolidation highly variable.

Ty YAGER FORMATION (Tertiary): siltstone, sandstone, silty shale, mudstone, and conglomerate; moderately well consolidated; highly sheared in places; silty shale and mudstone often disaggregates by slaking when wetted; sandstone units are generally massive; finer-grained strata are often well bedded.

KJfs FRANCISCAN CENTRAL BELT SANDSTONE (Cretaceous-Jurassic): graywacke (sandstone) with minor lenses and beds of siltstone and shale; sandstone generally well consolidated and massive; in many places the sandstone is highly fragmented or broken with individual fragments surrounded by crushed material.

fm FRANCISCAN CENTRAL BELT MELANGE (Cretaceous-Jurassic): highly sheared argillaceous matrix surrounding pebble-size to individually mappable blocks of various rock types; the highly erodible, sheared matrix generally is unstable and prone to landsliding on relatively gentle slopes; blocks mapped include:

- ss graywacke, sandstone
- gs greenstone, greenschist
- ch chert
- bs blueschist
- sp serpentine
- u lithology undetermined

LITHOLOGIC CONTACT: dashed where approximately located.

FAULT: dashed where approximately located.

LINEAMENT: linear feature of unknown origin observed on aerial photographs.

35 STRIKE AND DIP OF BEDDING

QUARRY OR BORROW PIT

SPRING

MARSH

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| Consulting Engineers & Geologists, Inc. | City of Eureka<br>Martin Slough Interceptor<br>Eureka, California | Geology and Geomorphic Features Related to Landsliding Explanation (Spittler, 1984)<br>SHN 018181 |
| December 2018 | Figure2a_GeologyExplanation | Figure 2a |

The entire Northern California region, including the project site, is an area subject to high levels of seismicity due to proximity to the Mendocino Triple Junction. The risk of strong seismic shaking at the site, as throughout the region, is considered moderate to high. No active fault is mapped in the site vicinity; therefore, the risk of surface fault rupture is very low.

# 4.0 Seismic Design Parameters

Based on the results of our field investigation and knowledge of the regional geology, we classify the geologic subgrade at the project site as Site Class C (very dense soil and soft rock), in accordance with Table 20.3-1 in American Society of Civil Engineers ASCE 7-10 (ASCE, 2010).

Based on the Site Class, Risk Category (I), and the project latitude and longitude, we obtained the "code based" design spectral response acceleration parameters using the United States Geological Survey (USGS) "U.S. Seismic Design Maps tool," v. 3.1.0, updated January 30, 2017 (USGS, 2017). Calculated values are presented in Table 1.

Table 1. □ Seismic Design Criteria
Harris, CA □

| Criteria | Calculated Value |
|---|---|
| $S_S$ | 1.500 |
| $S_1$ | 0.630 |
| $F_a$ | 1.0 |
| $F_v$ | 1.5 |
| $S_{MS}$ | 1.500 |
| $S_{M1}$ | 0.818 |
| $S_{DS}$ | 1.0 |
| $S_{D1}$ | 0.546 |
| Seismic Design Category | D |

# 5.0 Geotechnical Assessment of Individual Sites

## 5.1 APN 216-081-013

In general, this parcel is associated with rocky conditions and a general absence of significant mass wasting; for the intended purposes, it is a favorable development site with minimal exposure to geologic hazards. Most of the improvements at this site occur on a series of large graded benches below an existing sandstone outcrop (and quarry) that forms a high promontory in the western part of the parcel. Rock at the site is hard, blue-gray sandstone.

Existing structures on this parcel include a modular residence, a barn, and two small stock ponds. Agricultural greenhouses (light frame "hoop" houses) are present on one of the upper graded benches. We understand much of the site grading was completed about seven years ago and was completed by you (a licensed excavation contractor). During our site review, we noted that the existing grading

appeared to have been completed following industry standards relative to cut and fill slope geometries and so on. No evidence of significant erosion or settlement was noted relative to these graded pads.

Existing stock ponds on this parcel are favorably located and appear to have been constructed using standard dimensions and methods. These retention structures appear to be associated with low potential for negative environmental impacts relative to their geotechnical condition. Additional spillway improvements may be appropriate.

Proposed improvements on this parcel include relocation of a 10,000-square foot cultivation area and an 800,000-gallon off-stream rain catchment pond ("Pond 5"). The proposed cultivation area will occupy the large graded bench below the quarry site, which is a favorable location for development and will require no additional grading. This cultivation area may straddle the cut-fill line that crosses the graded pad, which may pose a modest differential settlement potential. Pond 5 is planned in a favorable, low-gradient area that will offer relatively simple construction. We understand the pond would be excavated mostly below grade, utilizing a relatively low, broad embankment.

**Conclusions and Recommendations.** From a geotechnical standpoint, APN 216-081-013 is a low-risk site that is not subject to substantial geologic hazards. Further, the existing or proposed improvements are unlikely to have a deleterious impact on the surrounding geologic environment. Therefore, we conclude that the existing and proposed improvements are acceptable from a geotechnical standpoint. This endorsement of the geotechnical site condition is rendered with the assumption that the intended uses relate to the development of agricultural structures and assumes that structures for human occupancy will not be developed at the site without further investigation.

Specific recommendations for parcel 216-081-013 include the following:

- The surface of the large graded pads at the site may be subject to modest differential settlement under significant structural loads. These types of loads are unlikely relative to the type of lightweight "hoop house" style greenhouse we envision at the site, and we do not anticipate significant settlement. However, you, as the Owner, should be aware of the potential for differential settlement. Should structures be proposed at the site that are sensitive to differential settlement (heavier greenhouses or those associated with a concrete slab-on-grade), they should be located on the cut portion of the graded pad or special foundation recommendations would apply.
- Generic earthwork recommendations for development of the water retention pond are presented below. -

## 5.2 APN 216-135-015

Parcel 216-135-015 occurs as an upland area directly west of Harris Road. Perington Creek flows along the northern parcel boundary. Existing improvements on this parcel related to geotechnical site conditions include a metal storage shed and a single cultivation area. We understand this cultivation area is to be relocated elsewhere on the parcel. An 800,000-gallon rain catchment pond ("Pond 7") is to be developed at this site.

The existing metal shed is in a favorable location; additional investigation to evaluate the bearing conditions at this site is unwarranted, as we expect the bearing capacity of site soils to greatly exceed that necessary to support the structure.

At the time of our site visit, we reviewed the proposed locations for a water storage pond and the relocation of the existing cultivation area. The pond ("Pond 7") is proposed in an upland area near the existing metal shed. This site is associated with a modest slope gradient; we expect the pond to be partially below grade with an embankment on the downslope margin. The area is prairie ground, and we expect site soils to be relatively soft with dispersed rocks. The site is favorable from a geotechnical standpoint and is not exposed to significant geologic hazards.

The cultivation area is to be relocated to the southeastern corner of the parcel on a topographic saddle that provides a favorable development site. We expect minor grading would be required to develop a suitable area to conduct cultivation at this site. The area is not subject to geologic hazards and will not substantially impact existing geologic conditions.

Soft soil areas were noted on this parcel, which may impact road development and/or maintenance. We noted recent road repair that indicates an awareness of the challenges of maintaining ranch roads in areas subject to soft, wet soils. In general, these areas should be treated with closely spaced drainage relief structures and abundant quantities of aggregate. Geotextile fabric may be useful in particularly difficult areas.

**Conclusions and Recommendations.** From a geotechnical standpoint, APN 216-135-015 is a low-risk site that is not subject to substantial geologic hazards. Further, the existing or proposed improvements are unlikely to have a deleterious impact on the surrounding geologic environment. Therefore, we conclude that the existing and proposed improvements are acceptable from a geotechnical standpoint. Specific recommendations for parcel 216-135-015 include the following:

- Generic recommendations for site preparation, earthwork, and pond construction are presented below.

## 5.3 APN 216-136-004 and 216-135-008

These contiguous parcels are located between Harris Road and Perington Creek and a series of closely spaced tributaries. The primary existing improvements on these parcels are a large in-stream pond and a series of seven cultivation areas. Proposed improvements include a 1-million-gallon water storage pond and an additional cultivation area.

In general, topography in this area slopes to the south or southeast, toward the Perington Creek canyon, which flows along the southern boundary of the two subject parcels. A broad topographic bench several hundred feet north of Perington Creek is present on the western parcel (216-136-004) and is occupied by the large in-stream pond. Rocky knolls form topographic flat areas along the eastern margin of the eastern parcel (216-135-008).

Mass wasting on the subject parcels is limited to debris sliding along the steep Perington Creek inner gorge, which is well outside the area being considered for the proposed site activities. Much of the area appears rocky with prominent outcrops present in the northwest corner of the western parcel and along the eastern margin of the eastern parcel. Localized pockets of soft ground are apparent.

Existing cultivation areas are present on the eastern parcel, dispersed among small gardens that have been developed with little, if any, grading. Where adequately located relative to watercourses, these cultivation areas will remain. These areas are acceptable from a geotechnical standpoint and are not associated with geologic impacts. Where the existing cultivation areas encroach on watercourses, they will be relocated to the new, proposed cultivation "Area H." Area H is located in a broad topographic swale and offers a favorable topographic setting to develop a cultivation area, as minimal grading would be required. The area is acceptable from a geologic standpoint, although it is subject to soft soils and appropriate design improvements should be made.

Soft soil areas were noted on these parcels, which may impact road development and/or maintenance. In general, these areas should be treated with closely spaced drainage relief structures and abundant quantities of aggregate. Geotextile fabric may be useful in particularly difficult areas.

**Existing and Proposed Ponds.** The western parcel is occupied by a large 6-million-gallon, in-stream pond. We understand the pond was constructed in about 2004 for logging purposes, and that you assisted in the construction (you therefore offer important information about the means and methods of the construction). We understand the pond was 24 feet deep with a flat bottom at the time of construction (it is likely shallower now). The pond was developed at the eastern edge of the topographic flat described above; therefore, the pond was largely excavated below grade with a large embankment extending across the eastern edge. The embankment for the pond has a crest width on the order of 10 to 15 feet with slope gradients on the outboard face of about 1½:1 (horizontal:vertical [H:V]). Maximum embankment height is estimated at 30 feet; therefore, the toe of the embankment extends outward on the order of 45 to 50 feet to the east. Soil at the site appears to be rocky material with abundant fines; it appears to function adequately as it has formed a firm embankment with low permeability (there is no evidence for significant throughflow). The pond has between 2 and 3 feet of freeboard. It is drained by a well-built 8-foot-wide, concrete-lined spillway that reportedly rarely sees flow (described as "infrequent sheet flow on rare occasions").

A 1-million-gallon water storage pond is proposed just to the southwest of the existing pond. We understand this off-stream rain catchment pond will be located a minimum of 100 feet from existing wetlands. The site is a low-gradient area favorable for development of a water retention structure. We expect soils to be of low permeability and easily excavated. Seasonally shallow groundwater may be a consideration, especially if a pond liner is used. From a geotechnical standpoint, the site is associated with low exposure to hazards and is unlikely to impact the surrounding geologic conditions.

**Conclusions and Recommendations.** From a geotechnical standpoint, APNs 216-136-004 and 216-135-008 are low-risk sites that are not subject to substantial geologic hazards. Further, the existing or

proposed improvements are unlikely to have a deleterious impact on the surrounding geologic environment. Therefore, we conclude that the existing and proposed improvements are acceptable from a geotechnical standpoint.

Specific recommendations for parcels 216-136-004 and 216-135-008 include the following:

- The area around proposed cultivation "Area H" is associated with soft soils that will be difficult to develop or manage when excessive moisture is present. Specific design considerations should be incorporated to prevent erosion or settlement due to soft soils. Generous application of aggregate will greatly enhance the feasibility of successful development of cultivation areas at this site. Geotextiles may also be advantageous if especially problematic areas are encountered.
- From a geotechnical standpoint, the existing 6-million-gallon pond is favorably located. The pond appears to have been well-built and is associated with a low potential for environmental impacts (From a geological perspective, impacts would occur due to failure of the embankment or the spillway). We understand the biological and ecological suitability of the pond is being addressed by others, and is not a consideration here. The site and existing structure appear stable and have persisted for over 20 years without issues; the structure is not impacting the geologic conditions at the site.
- As such, we find no compelling geotechnical justification for removal of this pond. Biology aside, removal of the pond would be a massive undertaking with an uncertain outcome. The decommissioning of a pond of this size would result in a large area of disturbance, would require a massive earthwork effort, and would create a substantial long-term sedimentation source (even considering best practices for erosion control).
- Generic recommendations for site preparation, earthwork, and pond construction are presented below.

# 6.0 Geotechnical Recommendations

## 6.1 Site Preparation and Grading -

We recommend the following basic site preparation and grading: -

- As appropriate, notify Underground Service Alert prior to commencing site work.
- Strip and remove all existing vegetation and root systems from areas of proposed development (that is, the solar array, battery shed, generator building, diesel tanks, greenhouses, water tanks, clone/ tool shed, garbage and compost areas, and two water storage ponds). Strip and remove the footprint areas of these developments, plus an additional 5 feet outward.

Additional grading will vary depending on the structure/improvement in question, on the existing topography at the proposed location, and on the selected type of foundation.

In general, we recommend the following for cut slopes and fill slopes:

- Cut slopes should be no steeper than 2H:1V. Cut slopes greater than 5 feet in height should be reviewed by the geotechnical engineer for stability.
- Fill slopes should be no steeper than 2H:1V. Fill slopes greater than 5 feet in height should be reviewed by the geotechnical engineer for stability. All material used to construct fill slopes should be free of excessive organics or particles larger than 4 inches. (Note: Specific discussion about material used to construct fill slopes for the ponds is in Section 6.2.) Where fill is placed on existing slopes steeper than 5H:1V, the fill material should be keyed and benched into competent native soil.
- Preferably, all level pads should be constructed so that foundation excavations (for example, footing trenches and slab-on-grade excavations) are cut into native, undisturbed soil (not into fill material). Alternately, foundation excavations may be cut into properly compacted engineered fill, if an at least 1-foot-thick layer of properly compacted engineered fill remains below the base of the excavation.

The following installation measures should be followed:

- Moisture-condition the material to near optimum moisture content. -
- Place fill in horizontal lifts no greater than 8 inches in uncompacted thickness. -
- Compact each lift to at least 90 percent relative compaction[1] before placing the next lift. -

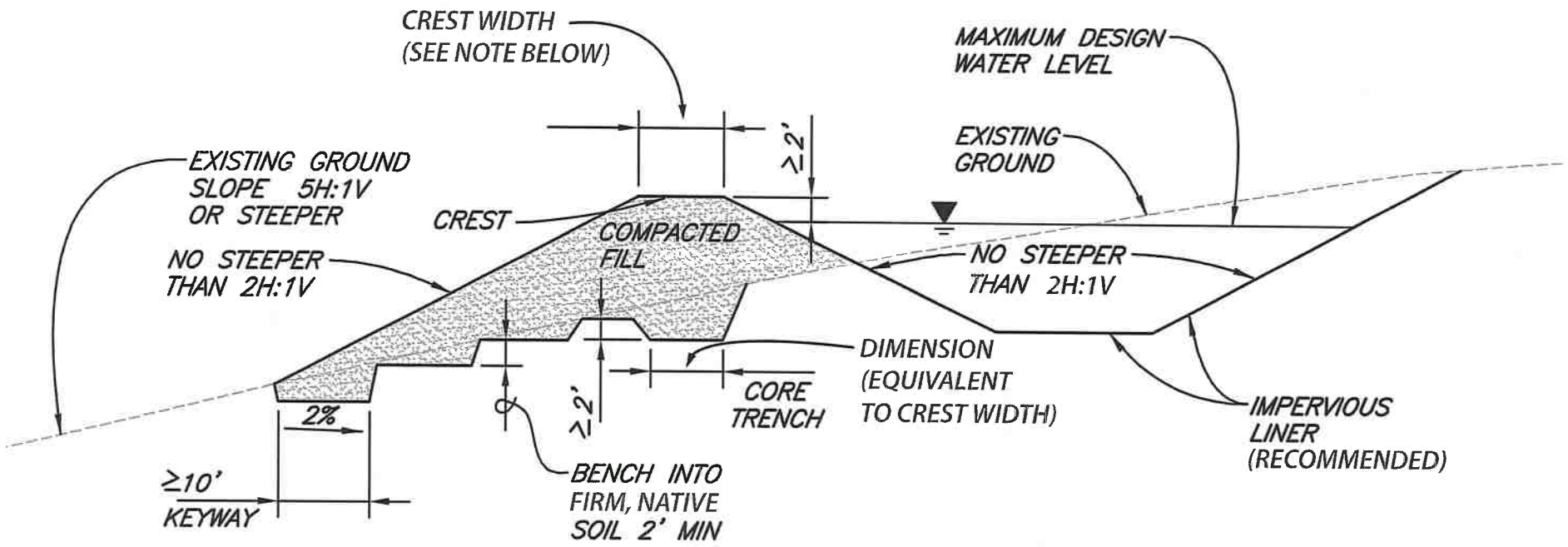
Sufficient construction inspection and materials testing should be performed, as determined by the geotechnical engineer or qualified representative, to confirm that the grading is completed in accordance with the design recommendations.

Also, in general, final grades around the project site should be constructed so that surface water drains away from all structures. The grade should fall at least 6 inches within the first 10 feet (a 5 percent grade), moving outward from the structures. Surface runoff should be directed to the nearest project drainage control system and not allowed to pond.

## 6.2 Pond Design and Construction

- Design the pond such that the volume of material from cuts is, at a minimum, equal to the volume of material needed for fills. If possible, design the pond such that the volume of material from cuts is approximately 10 percent greater than the volume of material needed for fills.
- The exterior and interior slopes of the pond embankments should be inclined no steeper than 2H:1V (see conceptual embankment section in Figure 3).

[1] Relative compaction refers to the in-place dry density of a soil expressed as a percentage of the maximum dry density of the same soil, as determined by the ASTM D1557 Test Method. Optimum moisture content is the water content (percentage by dry weight) corresponding to the maximum dry density.




*NOTE: THIS SCHEMATIC APPLIES TO EMBANKMENTS ON SLOPES OF 5H:1V OR STEEPER*

*CREST WIDTH: FOR EMBANKMENTS <10 FEET HIGH, CREST WIDTH SHOULD BE A MINIMUM OF 6 FEET; FOR TALLER EMBANKMENTS, CREST WIDTH SHOULD BE 10 FEET*

NOT TO SCALE

| | | | |
|---|---|---|---|
| | SHN Consulting Engineers & Geologists, Inc. | Journey Aquarian<br>Soils Report<br>Harris, California | Pond Embankment Illustrative Cross Section<br>SHN 018181 |
| | | December 2018 / Figure3_PondSchematic | Figure 3 |

- The crest of pond embankments should be at least 2 feet (freeboard) above the maximum pond water level to minimize the potential for breaching during a seismic event.
- The crest of pond embankments should be at least 6 feet wide for embankments less than 10 feet high; taller embankments should have crest widths of at least 10 feet.
- A core trench at least 10 feet wide should be excavated beneath the axis of dam embankments. The trench should extend at least 2 feet vertically into firm, native soils.
- If embankment fills are placed on existing slopes steeper than 5H:1V, then the fill should be benched into firm, native soil a minimum of 2 feet, and the toe should be supported by a keyway. The keyway should be at least 10 feet wide and sloped 2 percent into the slope.
- All finished grades should be designed such that surface water runoff is directed away from the top and toe of cut and fill slopes. Water should not be allowed to pond along the tops or toes of slopes. To the extent possible, finished grades should promote sheet runoff, rather than concentrated runoff.
- Where concentrated runoff does occur (such as, at pond outlets), flow energy should be dissipated by installing rock slope protection (RSP). A permeable, nonwoven geotextile fabric should be placed over the prepared ground surface before installation of any RSP.

For pond construction, we recommend the following:

- All earthworks should be performed by an experienced, licensed contractor.
- Strip and remove all existing vegetation and root systems from the footprint areas of the ponds, plus an additional 5 feet outward. Note that the footprint areas are delineated by the total extent of earthwork to be performed (that is, the perimeter of all cut and fill surfaces).
- During excavation of the design cuts, stockpile the excavated material for future use as embankment fill. All embankment fill should be free from woody debris, roots, organics, and rocks retained on the 4-inch sieve. A rock sorter and/or crusher may be required to remove/modify the oversized particles (rocks retained on a 4-inch sieve). Embankment fill should be comprised of greater than 50 percent fine-grained material (silts and clays) to prevent water seepage through the embankment. To the extent possible, blend the stockpiled material into a uniform mixture. The geotechnical engineer or qualified representative should be present during excavating and stockpiling to ensure the adequacy of the excavated material. If the excavated material is deemed inadequate, then an alternate source must be determined (from either a borrow area elsewhere onsite or soil imported from offsite).
- After completion of the design cuts, scarify the upper 12 inches of exposed subgrade soils, moisture-condition to a uniform moisture content of at least 2 percent above optimum, and compact to at least 90 percent relative compaction.
- Place embankment fill materials in horizontal layers no greater than 8 inches in loose thickness, moisture-condition to a uniform moisture content at least 2 percent above optimum, and compact to at least 90 percent relative compaction.
- Installation of an impervious liner on the interior of the pond is recommended. Follow all liner manufacturer's installation procedures. Many options are available. Geosynthetic clay liners

(GCLs) may be considered for pond applications, because they have a low leakage rate, high puncture resistance, long life expectancy, and relatively simple installation procedures.

- Immediately following completion of pond earthwork, exterior slopes should be seeded/planted with suitable erosion-control vegetation (native grass, for example). Trees and large shrubs should not be planted on the embankment.
- Sufficient construction inspection and materials testing should be performed, as determined by the geotechnical engineer or qualified representative, to confirm that the pond is constructed in accordance with the design recommendations. At a minimum, the following should be tested for adequate compaction:
  - Scarified and compacted subgrade soils
  - Initial lifts of embankment fill material to verify the contractor's means and methods
  - Middle lifts of embankment fill material (that is, the lift that is halfway up the total design height of the embankment)
  - Final lifts of embankment fill material

## 7.0 Limitations and Closure

This engineering geologic and soils reporting evaluation is an investigation of limited scope. Our intent is to evaluate general site conditions to inform the regulatory process relative to compliance permitting. Additional site-specific work may be necessary to refine the generic recommendations included herein, as the project evolves through the approval process.

The conclusions and recommendations presented in this report are professional opinions derived in accordance with current standards of professional practice. Our recommendations are based on the assumption that design of the improvements will conform to their intent. No warranty is expressed or implied.

We hope that this report provides the information that you need at this time. If you have any questions, or require additional information, please do not hesitate to contact our office at (707) 441-8855.

Respectfully,

SHN

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