Larkspur Excavation and Remediation Project

Date: April 22, 2019
To: All Plan Holders and Builder’s Exchanges for the subject Project
CC: Steve Moore, P.E., General Manager, Ross Valley Sanitary District
From: Joshua Andresen, P.E.
Subject: Addendum No. 1 – Larkspur Excavation and Remediation Project

TO ALL PROSPECTIVE BIDDERS:


It shall be the responsibility of the general (prime) contractor to inform any affected sub-contractors of the content of this Addendum.

CHANGES TO ATTACHMENTS:

GEOTECHNICAL REPORT

The attached geotechnical report, prepared by Cal Engineering & Geology (CE&G), provides additional information about the subsurface conditions at specific locations beneath the site. The opinions and recommendations provided therein are those of CE&G and are not associated with any direction or recommendations of Kennedy/Jenks Consultants, Inc. This document is provided for informational purposes only. Those opinions and recommendations, either written or expressed therein, are related to the professional opinion of the geotechnical engineer and should not be taken as direction on approaches to performing remediation work at this site. The information and opinions are provided as means to allow each bidder the opportunity to draw their own conclusions to the information in the development of their respective bid.

Joshua Andresen, P.E. C70354

22 April 2019
Date
April 18, 2019

Joshua Andresen, P.E.
Kennedy/Jenks Consultant
303 Second Street, Suite 300 South
San Francisco, California  94107

Subject: Geotechnical Data Report
Larkspur Excavation and Remediation
Larkspur, California
Project 190380

Dear Mr. Andresen:

Cal Engineering & Geology, Inc. (CE&G) is pleased to submit this geotechnical data report to support Kennedy/Jenks for the Larkspur Excavation and Remediation Project in Larkspur, California. Our investigation included performing a field exploration program, geotechnical laboratory testing, and preparing this report.

CE&G appreciates the opportunity to submit this geotechnical data report. If there are questions concerning the information provided herein, please do not hesitate to contact us.

Sincerely,

CAL ENGINEERING & GEOLOGY

Dan Peluso, P.E., G.E.
Associate Engineer
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1. Introduction

1.1 General

Cal Engineering & Geology, Inc. (CE&G) have provided geotechnical subsurface exploration services for Kennedy/Jenks for the Ross Valley Sanitary District to collect geotechnical data for use in the engineering analyses and geotechnical design of shoring to allow for excavation for the planned PCB remediation work at the Ross Valley Sanitation District’s former wastewater treatment plant site in Larkspur, California.

1.2 Project Team

The design of the excavations necessary for the proposed remediation of this site is being directed by Kennedy/Jenks. Cal Engineering and Geology’s work is to provide pertinent geotechnical and geologic information regarding the development of shoring design for selected portions of the planned excavation at the site where Kennedy/Jenks has requested.

1.3 Project Description

The Project includes excavations up to 15 feet below the existing ground surface to allow for remediation of PCB contamination at the site. Portions of excavations will be in close proximity to existing retaining walls located in the northern portion of the property and to areas that are deemed sensitive in the northeastern and southeastern portions of the property. In a majority of the areas scheduled for excavation, temporary slopes will be created to allow for the excavations. It is anticipated that excavations in the north portion of the remediation area may need to extend in close proximity to the existing retaining walls and hence require shoring. This is the primary focus of our project. Areas in the northeast and southeast portions of the property which may also require shoring do not extend in close proximity to structures, but may extend close to areas where disturbance is desired to be minimized, and where shallow groundwater is likely to be encountered in granular fill soils.

The location of the Project is shown in Figure 1, Site Location Map.

1.4 Purpose and Scope of Services

The geotechnical investigation of conditions at the site was completed to assess existing subsurface conditions and to provide a basis of geotechnical design recommendations for temporary slopes and/or shoring walls to be constructed at the site.
The scope of work completed for the geotechnical data and report included:

1. Review of the 60-percent progress plans prepared by Kennedy/Jenks for remediation of the site, dated February 2019;

2. Completion of an office study to identify relevant geologic and geotechnical information available for the site, including published geologic maps, and previously prepared reports regarding the site and vicinity. This included a review of reports by Treadwell and Rollo prepared in March 2000, and December 2005, which contained information regarding geotechnical borings and test pits excavated at the site, along with laboratory data;

3. A review of plans for an existing soil nail wall and existing segmental retaining wall located in the northern portion of the property;

4. A subsurface exploration and laboratory testing program to develop additional information needed for others to complete geotechnical analyses and preparation of the project design;

5. Provide limited feasibility evaluation of the potential shoring options for selected portions of the planned excavation;

6. The preparation of this geotechnical data report.

### 1.5 Previous Site Investigations

The following documents were provided by Kennedy/Jenks Consultants.

- Preliminary geotechnical investigation for a proposed hotel and office buildings prepared by Treadwell and Rollo, Project 2561.02, dated March 30, 2000.


- Site grading and improvement plans for 2000 Larkspur Landing Circle by Nute Engineering, dated January 2007, including details for a segmental retaining wall.

- As-built plans for permanent soil nail retaining wall, and soldier pile wall prepared by Drill Tech, Job No. 712, dated May 15, 2007.
Sixty (60) percent progress plan for remediation of poly chlorinated biphenyls, former wastewater treatment plant by Kennedy/Jenks Consultants, Job No. 1565036.04, dated February 2019.

We utilized the existing site plan and survey control (Sheet 3/15) of the Kennedy/Jenks plan as a base map for our geotechnical data compilation.
2. Site Conditions

2.1 Site Description

The subject property consists of a graded, developed parcel located at the northeast corner of the intersection of Sir Francis Drake Boulevard, and Larkspur Landing Circle, Larkspur, California. The northwest portion of the property is bordered by Drake’s Way. The site prior to development was roughly occupied by a southwest-trending valley that extended to the bay. The northwest side of the valley was bordered by a bedrock ridge and a small knob of bedrock near the southwest corner of the property. The southeast portion of the property is bordered by a second bedrock ridge that extended to the southwest toward the bay. It appears as though the extreme southwest portion of the property consists of inter-mingled alluvial and bay sediments, extending up the axis of the drainage course. The more inland portion of the drainage course axis contains more alluvium and colluvium. The overall elevation change at the property is on the order of 50 feet.

Past grading on the property has consisted of cutting and filling to create pads for development. The site was originally utilized for some type of storage or building structures as observed in an 1897 USGS topographic map (Figure 3). The stored materials or structures were present in the extreme southern portion of the property. The December 2005 Treadwell and Rollo report indicates that the site and nearby areas were quarried. A wastewater treatment plant was built in 1948 and according to a Treadwell and Rollo report was in service through 1985. The construction of the wastewater treatment plant may have taken advantage of quarry excavations made earlier on the site. The wastewater treatment plant had below-grade clarifiers and biofilters, a below grade sludge digestor, a sludge holding pit, a chlorine contact chamber and accessory buildings. These structures were removed, and the excavations backfilled with engineered fill. The December 30, 2005 Treadwell and Rollo report indicates that the engineered fill was placed under the observation of John Hom and Associates and references a Hom report dated November 29, 2000 that referenced field density testing at the site. Treadwell and Rollo report that the fill was placed to a minimum relative compaction of 90 percent of maximum density. The below-grade portions of the clarifiers and digestors were reported to be up to 25 feet below the existing grade.

Since the time of the December 30, 2005 Treadwell and Rollo report, an office building has been constructed just offsite to the southwest of the property. A soil nail wall and a segmental retaining wall have been constructed in the extreme northern portion of the property. Above these walls is a large level area which apparently is intended for future parking. The western segment of the wall, which is the soil nail wall, largely retains a cut pad consisting of Franciscan bedrock. The eastern wall, which is the segmental retaining wall, retains a level fill which was
placed within the axis of the natural drainage course/swale that had descended to the southwest. It is believed that both of these retaining walls were constructed around 2007 based on the plans reviewed.

The property is adjoined by a residential development to the north. To the northeast is a small reservoir (Tubbs Lake) that may be partially filled with sediment and is surrounded by dense native vegetation. Treadwell and Rollo in their 2005 report indicated that the lake had a depth of about 10 feet. We did not observe this lake directly, but its presence is implied from the current topographic map of the area (Figure 1). To the southeast of the property is a large hill which is in a relatively natural condition and supports a transmission tower. To the south of the property is an older commercial building that was originally a brick kiln that has been rehabilitated for a restaurant and office space. An office building is located to the southwest of the property at the intersection of Sir Francis Drake Boulevard with Larkspur Landing Circle.

2.1.1 Graded Area Above Retaining Walls

Site drainage from the parking area above the retaining walls is directed by sheet flow to earthen “V” drains located within the graded pad parallel to the walls. The extreme western portion of the pad is cut, while the eastern portion of the pad is fill. Cut slopes can be observed to the north of the pad. Drainage from the pad once directed to the “V” drains is collected by a downdrain located behind the segmental retaining wall. This downdrain discharges into a storm drain which directs the drainage to the south. It is unclear where the storm drain discharges at this point and it may simply be allowed to drain onto the property. Other surface drainage is directed from the northeastern portion of the property to the east into a graded earthen swale. This graded swale extends to the south and then to the southwest to a drain inlet located along the south edge of the property adjacent to Sir Francis Drake Boulevard. It appears as though this drain catches most of the site drainage. A second storm drain system is shown on the existing site plan provided by Kennedy/Jenks in the extreme south portion of the property which is now occupied by an unpaved parking area.

During our site observation, we observed water flowing into the drainage swale along the east side of the property at at-least two locations from the area near Tubbs Lake located to the northeast of the property. Ponding water was observed in the northeastern portion of the property along the earthen swale.

2.2 Site History

Historic topographic maps from 1890/1897 (Figure 3) show some structures or stored materials in the extreme southern portion of the property and continuing onto the property to the southeast. The property otherwise appears to be in a relatively natural state with a broad, gently south-
dipping ground surface in the southern two-thirds of the property, flanked by ridges to the northwest and southeast, and with the axis of a drainage course ascending from the southwest corner of the property offsite to the northeast. Treadwell and Rollo report both the site and adjoining areas were quarried. The area was extensively graded in the 1940s for the construction of a wastewater treatment plant (Figure 2). The creation of the wastewater treatment plant involved significant grading in the southern two-thirds of the property to allow for the construction of the plant. Based on our review of the Treadwell Rollo report, the wastewater treatment plant was built in 1948 and was in service through 1985. The Treadwell Rollo report of December 30, 2005 indicates that the structures for the wastewater treatment plant and accessory buildings had been removed and excavations backfilled with engineered fill placed under the supervision of John Hom & Associates as indicated in a report prepared by Hom dated November 29, 2000, The Treadwell Rollo report (2005) indicates that below grade portions of the clarifiers and digestors were up to 25 feet deep below existing grade suggesting up to 25 feet of compacted fill exists at some portions of the property. The southern portion of the site was later redeveloped with a Sanitary District office and a Maintenance Facility yard. The Maintenance Facility Yard and parking areas are gravel-covered.

A soil nail wall was constructed in 2007, in the northwest portion of the property. The soil nail wall largely retains a bedrock cut pad, but the extreme eastern portion of the soil nail wall also appears to retain some fill. The segmental retaining wall, located to the east of the soil nail wall, was also constructed around 2007 based on plans reviewed.

This wall largely supports fill. We did not observe information regarding who placed or tested this fill. We believe that the narrow pad and the short fill slope below the segmental retaining wall was also constructed at the same time that the segmental retaining wall was constructed. Other improvements consist of the installation of some storm drains.
3. Geology

3.1 Geologic Setting

The hills surrounding the property consist of sandstones and shales of the Franciscan formation. The sandstones are generally brown and gray, moderately hard to hard and locally well-bedded. The west portion of the property is a large cut pad that exposes bedrock. The bedrock exposed on natural slopes has a veneer of soil and weathered bedrock of variable thickness. The central portion of the property is blanketed by fill up to 25 feet thick. The fill overlies bay mud in the extreme south portion of the property with some alluvial and colluvial deposits possible in the north and east portions of the property. Much of the fill is believed to overlie bedrock exposed by excavations made to remove wastewater treatment structures.

3.2 Faulting

According to Bryant and Hart (2007), the site is not located within an Alquist-Priolo Earthquake Fault Zone, as mapped by the State of California.

As far as tectonic and fault implications for the project goals, the area has been scrutinized by numerous researchers for evidence suggestive of Holocene ground rupture, and/or ground deformation. No evidence for fault ground rupture has been reported, and the broad scale of regional deformation is not judged to pose a concern for the project.

3.3 Geohazard Mapping

Geohazard mapping was performed by Gilpin Geoscience in a companion report included in reports prepared by Treadwell and Rollo (2000 and 2005). Some of the geohazards have been eliminated by grading performed since the Gilpin Geoscience report. Most of the remaining geohazards noted by Gilpin are offsite and are not considered consequential to the planned shoring and excavation conditions being assessed in this current report.

Knudsen and others (2000) show the site as lying within a relatively broad area of high to very high liquefaction susceptibility in the areas on the southern portion of the site, which generally does not include the areas requiring shoring that are part of this study.

The site is not shown on the State of California Seismic Hazard Map showing areas of required investigation prepared by the California Geologic Survey.
3.4 Regional Groundwater

Water was observed ponding on the surface of the property in the northeast portion of the property. This is believed to be derived in part from recent surficial rainwater flowing down from the offsite slopes to the northeast and onto the level area near the northeast corner of the property. However ponding water was also noted in this area in a report by Gilpin Geosciences prepared in 1999 and contained in the 2005 Treadwell and Rollo report. The groundwater level in this area likely varies seasonally due to rainfall and surface runoff toward this area. The groundwater levels are also likely influenced by excavations made to remove the waste water treatment structures. Only the extreme southern portion of the property is considered to be potentially tidally influenced through the presence of Bay muds. It is estimated that the groundwater table in the extreme south portion of the property may vary from sea level to as much as 5 feet above sea level.
4. Site Investigation

4.1 Site Reconnaissance

CE&G performed a field reconnaissance of the site on March 13, 2019, prior to the excavation of the borings, and on March 21, 2019, following the excavation of the borings. The reconnaissance of the site prior to the excavation of the borings was to mark the boring locations for Underground Service Alert (USA). The locations of the borings were adjusted based on observations and discussions in the field.

A cursory observation of the sculpted gunite-faced soil nail wall and the segmental retaining wall revealed no significant distress suggesting movement of the walls.

Ponding water was observed in the northeast portion of the property. Ponding water appears to be derived partially from the direction of surface flow from graded areas on the subject property toward the pond and partially from the southwesterly surface flow of water derived from the adjoining property to the northeast.

4.2 Subsurface Exploration

4.2.1 Scope of Explorations

Five geotechnical borings were completed for the geotechnical subsurface exploration of the Larkspur Project. The borings were drilled using a truck-mounted drilling rig. Prior to drilling, CE&G coordinated with Kennedy/Jenks regarding selection of the final location of the borings. The locations of the completed borings were marked in the field and recorded by measuring with a tape from established points of reference and by using a hand-held GPS device. The approximate locations of the borings are shown on the Figure 4.

The five borings were drilled by Woodward Drilling on March 19, 2016. Surface conditions at the locations of boring B-1 and B-2 consisted of a thin fill pad that appears to have been constructed in association with the segmental retaining wall. Borings B-3a, B-3b and B-3c were excavated in a graded area of the pad in the northeast portion of the property. The reason for the close spacing of these three borings is due to the difficult drilling conditions encountered in this area; see the borings logs for details. Fill is present in this area, but the depth was not ascertained fully as the fill could not be fully penetrated by the drill rig. The drill rig utilized a 6-inch hollow-stem auger. The borings were drilled to between approximately 6 and 30-½ feet below the existing ground surface.
Upon completion, the borings were backfilled with cement grout in accordance with the County of Marin permit. Drilling spoils were collected in 55-gallon drums that were labeled and deposited at an on-site location in the central portion of the site near some existing 55-gallon drums.

4.2.2 Logging and Sampling

The materials encountered in the borings were logged in the field by a CE&G geologist. The soils were visually classified in the field, office, and laboratory according to the Unified Soil Classification System (USCS) in general accordance with ASTM D2488.

During the drilling operations, soil samples were obtained using one of the following sampling methods:

- California Modified (CM) Sampler; 3.0-inch outer diameter (O.D.), 2.5-inch inner diameter (I.D.) (ASTM D1586)
- Standard Penetration Test (SPT) Split Spoon Sampler; 2.0-inch O.D., 1.375-inch I.D. (ASTM D1586)

The samplers were driven 18 inches (unless otherwise noted on the boring logs) with a 140-pound automatic trip-hammer dropping 30 inches in general conformance with ASTM D6066 procedures. The number of blows required to drive the SPT or CM sampler each 6-inch increment was recorded for each sample. The results are included on the boring logs in Appendix A. The blow counts included on the boring logs are uncorrected and represent the field values.

Soil samples obtained from the borings were packaged and sealed in the field to reduce the potential for moisture loss and disturbance. The samples were taken to CE&G’s Hayward office and Cooper Testing Labs for laboratory testing and storage.

4.2.3 Soil Conditions Encountered

Following is a summary of the soil conditions encountered in the borings.

Boring 1 encountered fill consisting of a silty sand that is medium dense to a depth of about 3½ feet to 10½ feet, completely weathered bedrock was encountered. The bedrock consists of clayey sand derived from complete weathering of sandstone and shale. This material is firm to stiff and contains some sandstone rock fragments. At 10 ½ feet, sandstone bedrock was encountered. The sandstone is light brown to gray, moderately hard, weak to medium strong and slightly to moderately weathered. The material we classified as bedrock had SPT blow-counts in
excess of 50 blows for a driven depth of 4 to 6 inches. Obvious groundwater was not encountered in Boring B-1.

Boring B-2 is located near the center of a south-trending drainage course/swale that had been filled to create the parking area behind the segmental retaining wall. Fill was encountered to a depth of about 12 feet. The fill consists of lean to fat clay with sand that is red-brown, gray and blue; moist, firm and contain some sandstone rock fragments. At 12 feet, colluvium was encountered. The colluvium consists of clayey sand that is very dark gray, wet, loose with some fine to coarse sand and sandstone rock fragments. Sandstone bedrock was encountered at 15 feet below the ground surface. The sandstone bedrock is brown, moderately hard, and weak to medium strong. Again, the bedrock had SPT values in excess of 50 blows for 6 inches.

Borings, 3a, 3b and 3c were drilled in the northeast portion of the site in below an area where some shoring is anticipated. The boring 3a was completed to a depth of 6 feet where drilling refusal was encountered. The material encountered in Boring 3a consists of silt with sandstone rock debris that is brown and wet. It appears as though the sandstone rock debris may be subangular sandstone gravel and cobbles that have been placed to bridge soft zones in the fill, or possibly used as backfill to fill excavations made to remove wastewater treatment facility structures. Similar material was encountered in Boring B-3b which was excavated to a total depth of 11 feet and in Boring B-3c which was excavated to a total depth of 7 feet. The boring location was removed from the original location in an attempt to find a location that did not have the sandstone gravel or cobbles which prevented the advancement of the auger. The drill rig bit experienced damage during drilling and the auger drive stem broke during excavation of Boring B-3c.

For a more detailed description of the soils encountered in the borings, the logs of the borings and laboratory test results are included in Appendices A and B.

4.2.4 Groundwater Conditions Encountered

Groundwater was not encountered in Boring B-1. Groundwater was encountered in Boring B-2 at a depth of 12 feet. This appears to be at the contact between the fill and the colluvium. This groundwater is likely surface water that has infiltrated into the fill behind the segmental retaining wall and then infiltrated into the colluvium. The groundwater encountered in boring B-2 is considered to be perched on the underlying bedrock.

In the vicinity of Borings B-3a through B-3c, ponding water was observed on the ground surface in close proximity to the boring locations. This water appears to be surface water directed to a low area on the site. Portions of the surface water come from the site, while other portions of the surface water are derived from offsite properties to the northeast. Borings
drilled by Treadwell and Rollo encountered water at approximately 5 feet below the ground surface in this area during February 2000.

It should be noted that groundwater depth is subject to seasonal fluctuations depending on rainfall, water recharging programs, well pumping, or other factors that may not be evident at the time of our investigation. Additionally, the use of hollow-stem drilling which supports the sides of the holes with segments of auger can seal out water from the sides of the boring. For this reason, groundwater measurements from hollow-stem auger drilled borings are generally not considered to be accurate. We consider it likely that a groundwater level fluctuation of up to about elevation +5.0 mean sea level may occur in fill, alluvium, colluvium and bay sediments in the central and southern portions of the site.

4.3 Geotechnical Laboratory Testing

Laboratory testing was performed to obtain information regarding the physical and index properties of selected samples recovered from the exploratory borings. Tests performed included natural moisture content, dry unit weight, Atterberg Limits, grain size distribution, and triaxial unconsolidated undrained testing. Tests were completed in general conformance with applicable ASTM standards. The results of the laboratory tests will be made available when they have been completed, and will be summarized on the boring logs in Appendix A and in Appendix B.
5. General Findings

Shoring excavations are proposed in three general locations on the property:

1. In the northern portion of the property adjacent to an existing segmental retaining wall,

2. In the northeast portion of the property adjacent to a ponding surface water/wetlands area, and

3. In the southeast portion of the property adjacent to a hill and an offsite commercial development.

Shoring should be designed and constructed in accordance with the Caltrans Trenching and Shoring Manual.

5.1 Excavation and Shoring Area in the Northern Portion of the Property

Excavations for site remediation in the northern portion of the property adjacent to the segmental retaining wall are anticipated to be up to 15 feet in height. Sections have been provided which show the anticipated earth materials that will be encountered during the excavation. The earth materials consist of fill, colluvium, weathered bedrock and bedrock. The deepest existing fill is located near the central portion of the segmental retaining wall. Bedrock outcrops were observed to the west and east of the segmental retaining wall. Groundwater was only encountered in Boring B-2 located near the center of the swale in the colluvium deposits and is considered to be water perched on the underlying bedrock. Figure 6, Profiles, provides our interpretation of the subsurface conditions in this area, especially in relation to the existing segmental block retaining wall and the depth and lateral extent of fill soil overlying bedrock.

It is our opinion that shoring in this area can consist of soil nails and/or soldier piles with lagging to the depths required. Soldier piles can also utilize tie-backs. For general shoring design considerations, at-rest earth pressures should be considered when the plane of the soil nail wall shoring or the soldier pile and lagging shoring intersects a 1/2:1 (horizontal to vertical) plane projected downward from the toe of the existing segmental block retaining wall. Lower, active pressure shoring design values can be used for shoring sections farther away from the retaining wall. Any of the earth materials located below the base of the excavation can be used for lateral resistance. However, the lateral resistance for the existing fill and colluvium will be less than that of the weathered bedrock and bedrock.
In summary, geotechnical issues for construction of temporary shoring in this area include:

- The excavation of deeper shoring piles into bedrock and groundwater. It is anticipated that conventional construction drilling equipment can excavate soldier piles, tie-backs or soil nails to the required embedments. Difficult drilling conditions requiring coring may locally be necessary for the shoring piles that extend deeper into bedrock.

- Groundwater is considered to be limited to the fill and colluvial deposits near the center of the axis of the colluvial swale. It may be possible to drain the central portion of the swale area by the installation of a dewatering well if desired.

5.2 Excavation and Shoring in the Northeast Portion of the Property

Excavations made for the current report only extended 6 to 11 feet below the ground surface and encountered silt with sandstone debris. The sandstone debris consisted of hard, sub-angular gravel and cobbles that were likely placed either for backfill of excavations made to remove waste water treatment structures or possible to bridge soft fill zones in areas that required equipment access and/or possibly for drainage. We did not complete a boring to the natural earth materials. Based on nearby borings by Treadwell and Rollo (Borings B-4 and B-23), it is estimated that 15 to 18 feet of fill may exist in this area with bedrock at an elevation of about +4.0 to +7.0 mean sea level below the ground surface. Water was observed ponding at the ground surface in this area at the time of our exploration. Water was also reported to be ponding in this area in the Gilpin Geosciences report. The sources of the ponding water as observed during our current exploration appear to be from surface drainage from the northern portion of the subject property and surface flow from the adjoining property to the northeast. Treadwell and Rollo reported water at 5 feet below the ground surface in boring B-4 which was listed as having a surface elevation of +19 mean sea level. This would suggest that the groundwater elevation is at +14 mean sea level. We believe that this groundwater elevation is high, but because of the excavations made in the past and the influence of surface water, we cannot rule out variability of ground water elevations.

In addition to the possibility of encountering groundwater in this area, silty soils with abundant granular sandstone fragments should be anticipated to be encountered in excavations.

It is anticipated that any shoring in this area will need to consider hydrostatic pressures in the design. It is possible that some seasonal variations may exist in this area which could reduce groundwater levels to a lower level. If time is not of the essence, it is recommended that this area be excavated during a drier period of the year. It may be desirable to excavate this area first to try to do as much remediation as possible with conventional excavating equipment, opening
large areas and with temporary slopes. In areas where workers will enter excavations and worker safety is to be considered, temporary slopes can be created at a 1 ½:1 (horizontal to vertical) gradient for slopes taller than 5 feet and at 1:1 (horizontal to vertical) gradient for slopes less than 5 feet, provided the soils are not wet.

If full remediation cannot be performed without placing shoring, the temporary excavations suggested will provide a better observation of the earth materials that underlie this area and will provide a better assessment of what shoring methods may be utilized. For worker safety, a 1:1 (horizontal to vertical) temporary slope up to 5 feet high can be made above the shoring wall to reduce the shoring wall height. A level excavation beyond the shoring wall that is equal to the shoring wall height will allow for a level surcharge to be considered. It may also provide for easier installation of dewatering wells behind the shoring, if required. This will reduce the lengths of shoring pile reinforcement.

Shoring methods that may be utilized can consist of soil nails and/or soldier piles with lagging to the depths required. Soldier piles can also utilize a tie-back. For general shoring design considerations, active earth pressures can be utilized because there are no structures that may be threatened/damaged by the excavation. The existing fill, natural soil and bedrock can be used for resistance to lateral loads. However, given the variability of the depth to bedrock as noted by Treadwell and Rollo in their nearby borings, it is recommended that the shoring design utilize only values suitable for the existing fill and natural soil.

In summary, geotechnical issues for construction of temporary shoring in this area are surface water and groundwater, variability of the fill (fine-grained versus granular) and variability of the depth to bedrock due to excavations made to remove the waste water facilities. It is anticipated that conventional construction drilling equipment can be utilized excavate soldier piles, tie-backs or soil nails to the required embedments. Casing may be required due to groundwater conditions and in areas of clean gravel in the fill where caving may be experienced.

### 5.3 Excavation and Shoring in the Southeast Portion of the Property

The shoring in the southeast portion of the site will extend through the surface drainage swale that is located along the eastern/southeastern portion of the site. It is likely that high groundwater conditions will exist in this area in the winter time period, but it may be less in the summer time period. We did not complete any borings in this area. Borings previously excavated in this area by Treadwell and Rollo (Borings B-3 and B-16) encountered bedrock at elevations of -9.0 and -3.0 mean sea level, respectively. The bedrock is overlain by stiff and dense fill and possibly some stiff and dense natural deposits. Groundwater was encountered at elevation +6.0 mean sea level in Treadwell and Rollo Boring B-3.
For worker safety, it is our opinion that excavations can be created to a depth of 15 feet, utilizing 1:1 (horizontal to vertical) cut slopes for those excavations 5 feet or less in height and 1 ½:1 (horizontal to vertical) temporary slopes for those slopes higher than 5 feet. Groundwater will likely be encountered. It is anticipated that any progressive movement of the southeast side of the excavation area that extends toward the commercial property and to the offsite hillside will eventually encounter bedrock which would minimize the potential for offsite failure of the excavated areas.
6. Limitations

The findings of this report are based upon information provided to us regarding the existing improvements, our geologic reconnaissance, subsurface conditions described on the boring logs, the results of the laboratory testing program, interpretation and analysis of the collected data, and professional judgment.

Site conditions described in the text of this report are those existing at the time of our last field reconnaissance and are not necessarily representative of the site conditions at other times or locations.

The findings of this report should be considered valid for a period of five years unless the conditions of the site change. After a period of three years, CE&G should be contacted to review the site conditions and prepare a letter regarding the applicability of this report.

The evaluation or identification of the potential presence of hazardous materials at the site was not requested and was beyond the scope of this investigation and report.
7. References


Caltrans, 2011, Revision No. 01, Trenching and Shoring Manual, California Department of Transportation Offices of Structure Construction, Sacramento.

FIGURES
1. Parcel boundaries from Marin County Online Database; accessed November 2017.

Wood Island	

FIGURE 1

BASEMAP REFERENCE

GEOTECHNICAL INVESTIGATION
2000 LARKSPUR LANDING CIR.
LARKSPUR, CALIFORNIA

SITE TOPOGRAPHY - 2018

00
EG
EH

300
0
150
200
240
280
320
120
160
200
80
40

745 Ygnacio Valley Rd.
Walnut Creek, CA 94596
Phone: (925) 935-9771

190380
APRIL 2019
FIGURE 1
FIGURE 2
BASEMAP REFERENCE
1. PARCEL BOUNDARIES FROM MARIN COUNTY ONLINE DATABASE; ACCESSED NOVEMBER 2017.

GEOTECHNICAL INVESTIGATION
2000 LARKSPUR LANDING CIR.
LARKSPUR, CALIFORNIA

SITE TOPOGRAPHY - 1954

0 150 300 600 FEET
1. PARCEL BOUNDARIES FROM MARIN COUNTY ONLINE DATABASE; ACCESSED NOVEMBER 2017.
APPENDIX A

Boring Logs
### UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

#### Field Identification

<table>
<thead>
<tr>
<th>Group Symbols</th>
<th>Typical Names</th>
<th>Laboratory Classification Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clean Gravels</strong></td>
<td>Well-graded gravels, gravel-sand mixtures, little or no fines</td>
<td>$C_G = \frac{D_{60}}{D_{10}} \geq 4$ and $C_C = \left(\frac{D_{60}}{D_{10}}\right)^2 \left(\frac{D_{60} \times D_{10}}{D_{60}}\right) \geq 1$ and $\leq 3$</td>
</tr>
<tr>
<td><strong>Poorly graded gravels, gravel-sand mixtures, little or no fines</strong></td>
<td>$C_G = \frac{D_{60}}{D_{10}} \geq 6$ and $C_C = \left(\frac{D_{60}}{D_{10}}\right)^2 \left(\frac{D_{60} \times D_{10}}{D_{60}}\right) \geq 1$ and $\leq 3$</td>
<td></td>
</tr>
<tr>
<td><strong>Clayey gravels, poorly graded gravel-sand-clay mixtures</strong></td>
<td>If fines classify as ML or CH, use dual symbol GC/GM</td>
<td></td>
</tr>
<tr>
<td><strong>Silt-Clayey Gravel, Gravel-Silt, Clayey Sand, Sand/Clayey Sand</strong></td>
<td>If fines classify as CL or CH, use dual symbol GC/GM</td>
<td></td>
</tr>
</tbody>
</table>

#### Identification Procedures on Percentage Passing the No. 40 Sieve

**PLASTICITY CHART**

For Classification of Fine-Grained Soils and Fine-Grained Fraction of Coarse-Grained Soils

Equation of "A"-Line: $\text{PI} = 4 \times \left(\frac{\text{LL}}{20}\right)^2$ when $\text{LL} = 4$ to 25.5, then $\text{PI} = 0.73 \times (\text{LL} - 20)$

Equation of "U"-Line: $\text{LL} = 16 \times \text{PI}$ when $\text{PI} = 0$ to 7, then $\text{PI} = 0.9 \times (\text{LL} - 8)$

#### Key to Sampler Types and Other Log Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>California Standard Sampler</td>
</tr>
<tr>
<td>CM</td>
<td>California Modified Sampler</td>
</tr>
<tr>
<td>SPT</td>
<td>Standard Penetration Test Sampler</td>
</tr>
<tr>
<td>SHL</td>
<td>Shelby Tube Sampler</td>
</tr>
<tr>
<td>BU</td>
<td>Bulk Sample</td>
</tr>
<tr>
<td>LL</td>
<td>Liquid Limit of Sample (ASTM D-4318)</td>
</tr>
<tr>
<td>PI</td>
<td>Plasticity Index of Sample (ASTM D-4318)</td>
</tr>
<tr>
<td>Q_u</td>
<td>Unconfined Compression Test (ASTM D-2166)</td>
</tr>
<tr>
<td>PSA</td>
<td>Particle-Size Analysis (ASTM D-422 &amp; D-1140)</td>
</tr>
<tr>
<td>C</td>
<td>Consolidation Test (ASTM D-2435)</td>
</tr>
<tr>
<td>TXUU</td>
<td>Unconsolidated Undrained Compression Test (ASTM D-2850)</td>
</tr>
</tbody>
</table>

#### Key to Sample Intervals

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>Length of Sampler Interval with a CS Sampler</td>
</tr>
<tr>
<td>CM</td>
<td>Length of Sampler Interval with a CM Sampler</td>
</tr>
<tr>
<td>SPT</td>
<td>Length of Sampler Interval with a SPT Sampler</td>
</tr>
<tr>
<td>SHL</td>
<td>Length of Sampler Interval with a SHL Sampler</td>
</tr>
<tr>
<td>BU</td>
<td>Bulk Sample Recovered for Interval Shown (i.e., cuttings)</td>
</tr>
<tr>
<td>L</td>
<td>Length of Coring Run with Core Barrel Type Sampler</td>
</tr>
<tr>
<td>NR</td>
<td>No Sample Recovered for Interval Shown</td>
</tr>
</tbody>
</table>

---

UNIFIED SOIL CLASSIFICATION SYSTEM

AND KEY TO BORING LOG
### Rock Hardness Descriptions

<table>
<thead>
<tr>
<th>Hardness</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Hard</strong></td>
<td>Cannot be scratched with knife or sharp pick. Breaking of hand specimen requires several hard blows of geologist’s pick.</td>
</tr>
<tr>
<td><strong>Hard</strong></td>
<td>Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.</td>
</tr>
<tr>
<td><strong>Moderately Hard</strong></td>
<td>Can be scratched with knife or pick. Gouges or grooves to 1/4-inch deep can be excavated by hard blow of geologist’s pick. Hand specimens can be detached by moderate blow.</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>Can be grooved or gouged 1/16-inch deep by firm pressure of knife or pick point. Can be excavated in small chips to pieces about 1-inch maximum size by hard blows of the point of a geologist’s pick.</td>
</tr>
<tr>
<td><strong>Soft</strong></td>
<td>Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small tin pieces can be broken by finger pressure.</td>
</tr>
<tr>
<td><strong>Very Soft</strong></td>
<td>Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.</td>
</tr>
</tbody>
</table>

### Rock Weathering Descriptions

<table>
<thead>
<tr>
<th>Weathering</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fresh</strong></td>
<td>Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.</td>
</tr>
<tr>
<td><strong>Very Slight</strong></td>
<td>Rock generally fresh, joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.</td>
</tr>
<tr>
<td><strong>Slight</strong></td>
<td>Rock generally fresh, joints stained, and discoloration extends into rock up to 1 inch. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dulled and discolored. Crystalline rocks ring under hammer.</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.</td>
</tr>
<tr>
<td><strong>Moderately Severe</strong></td>
<td>All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist’s pick. Rock goes “clunk” when struck.</td>
</tr>
<tr>
<td><strong>Severe</strong></td>
<td>All rock except quartz discolored or stained. Rock “fabric” clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.</td>
</tr>
<tr>
<td><strong>Very Severe</strong></td>
<td>All rock except quartz discolored or stained. Rock “fabric” discernible. But mass effectively reduced to “soil” with only fragments of strong rock remaining.</td>
</tr>
<tr>
<td><strong>Complete</strong></td>
<td>Rock reduced to “soil.” Rock “fabric” not discernible or discernible only in small scattered locations. Quartz may be present as dikes or stringers.</td>
</tr>
</tbody>
</table>

### Bedding Thickness & Joint/Fracture Spacing Descriptions

<table>
<thead>
<tr>
<th>Centimeters</th>
<th>Inches</th>
<th>Bedding</th>
<th>Joints/Fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2</td>
<td>&lt; ¾</td>
<td>Laminated</td>
<td>Extremely Close</td>
</tr>
<tr>
<td>2-5</td>
<td>¾-2</td>
<td>Very Thin</td>
<td>Very Close</td>
</tr>
<tr>
<td>5-30</td>
<td>2-12</td>
<td>Thin</td>
<td>Close</td>
</tr>
<tr>
<td>30-90</td>
<td>12-36</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>90-300</td>
<td>36-120</td>
<td>Thick</td>
<td>Wide</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>&gt; 120</td>
<td>Very Thick</td>
<td>Very Wide</td>
</tr>
</tbody>
</table>

CLIENT: Ross Valley Sanitation District
PROJECT NUMBER: 190380
LOCATION: Belmont, CA

**LITHOLOGIC SYMBOLS**
*Unified Soil Classification System*
- **CH**: USCS High Plasticity Clay
- **CL**: USCS Low Plasticity Clay
- **GM**: USCS Silty Gravel
- **GP-GC**: USCS Poorly-graded Gravel with Clay
- **ML**: USCS Silt
- **SC**: USCS Clayey Sand
- **SM**: USCS Silty Sand
- **SP**: USCS Poorly-graded Sand

**SAMPLER SYMBOLS**
- California Modified Sampler
- Grab Sample
- Shelby Tube
- Standard Penetration Test

**WELL CONSTRUCTION SYMBOLS**

**ABBREVIATIONS**
- **LL**: LIQUID LIMIT (%)
- **PI**: PLASTIC INDEX (%)
- **W**: MOISTURE CONTENT (%)
- **DD**: DRY DENSITY (PCF)
- **NP**: NON PLASTIC
- **-200**: PERCENT PASSING NO. 200 SIEVE
- **PP**: POCKET PENETROMETER (TSF)
- **TV**: TORVANE
- **PID**: PHOTIONIZATION DETECTOR
- **UC**: UNCONFINED COMPRESSION
- **ppm**: PARTS PER MILLION
- **\(\rightarrow\)**: Water Level at Time Drilling, or as Shown
- **\(\downarrow\)**: Water Level at End of Drilling, or as Shown
- **\(\downarrow\)**: Water Level After 24 Hours, or as Shown
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Graphic Log</th>
<th>Material Description</th>
<th>Sample Type</th>
<th>Blow Counts (Field Value)</th>
<th>Pocket Pen (tsf)</th>
<th>Dry Unit Wt. (pcf)</th>
<th>Moisture Content (%)</th>
<th>Plasticity Index (%)</th>
<th>Plastic Limit (%)</th>
<th>Liquid Limit (%)</th>
<th>Atterberg Limits</th>
<th>Fines Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>Silty SAND (SM), yellowish orange and gray, moist, medium dense, very fine sand, iron stains (ARTIFICIAL FILL)</td>
<td>CM</td>
<td>15-21-28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Lean to Fat CLAY with Sand (CL-CH), very dark gray and yellowish orange, moist, firm, very fine sand (HIGHLY WEATHERED BEDROCK) Sandstone rock fragments</td>
<td>CM</td>
<td>11-39-50/5*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Lean to Fat CLAY (CL-CH), yellowish orange, moist, firm, caliche, manganese and iron stains, very fine sand, sandstone rock fragments</td>
<td>CM</td>
<td>18-50/4*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>SANDSTONE, gray, dry, moderately hard, weak to medium strong, slightly to moderately weathered, well cemented, very fine grained (BEDROCK)</td>
<td>SPT</td>
<td>12-19-39</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>3 minutes to drill form 15 ft to 20 ft No recovery 4 minutes to drill form 20 ft to 25 ft</td>
<td>SPT</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>No recovery 3 minutes to drill form 25 ft to 30 ft Cuttings are gray, dry, consistent</td>
<td>SPT</td>
<td>50/5*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>SANDSTONE, gray, dry, moderately hard, weak to medium strong, slightly to moderately weathered, very fine grained Bottom of borehole at 30.6 ft. Borehole backfilled with cement grout.</td>
<td>SPT</td>
<td>35-50/1*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lean to Fat CLAY with Sand (CL-CH), red brown and gray, moist, firm, very fine sand (ARTIFICIAL FILL)

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
<th>MATERIAL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>Lean to Fat CLAY with Sand (CL-CH), red brown and gray, moist, firm, very fine sand (ARTIFICIAL FILL)</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>color change to very dark gray, sandstone rock fragments</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Sandy Lean CLAY (CL), very dark gray, red brown, and blue, moist, firm, fine to very fine sand, sandstone rock fragments</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Clayey SAND (SC), blue and very dark gray, wet, loose, fine to coarse sand, sandstone rock fragments, iron stains (COLLUVIUM)</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>SANDSTONE, completely discolored, dry, moderately hard, weak to medium strong, moderately weathered, well cemented, very fine grained (BEDROCK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 minutes to drill form 15 ft to 20 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drilling refusal at 23.6 ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bottom of borehole at 23.6 ft. Borehole backfilled with cement grout.</td>
</tr>
<tr>
<td>DEPTH (ft)</td>
<td>GRAPHIC LOG</td>
<td>MATERIAL DESCRIPTION</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>SILT (ML) with Sandstone Rock Debris, brown, wet (ARTIFICIAL FILL)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rig chatter throughout</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Drilling refusal</td>
</tr>
</tbody>
</table>

Bottom of borehole at 6.0 ft. Borehole backfilled with cement grout.
SILT (ML) with Sandstone Rock Debris, brown, wet (ARTIFICIAL FILL)

Rig chatter from 8 ft. to 11 ft.

Drilling refusal

Bottom of borehole at 11.0 ft. Borehole backfilled with cement grout.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Graphic Log</th>
<th>Material Description</th>
<th>Sample Type</th>
<th>Blow Counts (Field Value)</th>
<th>Pocket Pen (fpf)</th>
<th>Dry Unit Wt. (pcf)</th>
<th>Moisture Content (%)</th>
<th>Plasticity Index (%)</th>
<th>Plastic Limit (%)</th>
<th>Liquid Limit (%)</th>
<th>Atterberg Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>SILT (ML) with Sandstone Rock Debris, brown, wet (ARTIFICIAL FILL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rig chatter throughout</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Drilling refusal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bottom of borehole at 7.0 ft. Borehole backfilled with cement grout.
APPENDIX B

Laboratory Test Results