

# GEOTECHNICAL INVESTIGATION FLORIDA AVENUE PARK

SAN BRUNO, CALIFORNIA



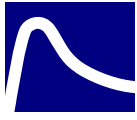
Prepared for:  
**MIG, INC**  
800 Hearst Avenue  
Berkeley, California 94710

MARCH 2017



**COTTON, SHIRES AND ASSOCIATES, INC.**  
CONSULTING ENGINEERS AND GEOLOGISTS

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March 29, 2017  
E5027

Mr. Mathew Gaber  
MIG, Inc.  
800 Hearst Avenue  
Berkeley, California 94710

**SUBJECT: Geotechnical Investigation**  
**RE: Florida Avenue Park**  
**San Bruno, California**

Dear Mr. Gaber:

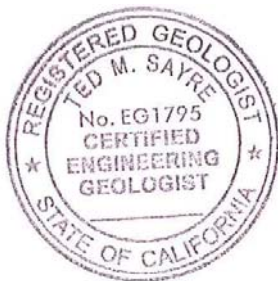
Cotton, Shires and Associates, Inc. (CSA) is pleased to provide MIG, Inc. with the following report in which we describe the findings, conclusions and recommendations of our geotechnical investigation for the proposed Florida Avenue Park in San Bruno, California. This investigation was performed in accordance with our proposal to you dated October 3, 2016.

In this report, we characterize the geotechnical conditions surrounding and underlying the park sites and provide conclusions and recommendations regarding geotechnical hazards, site grading, and pavement design.

We appreciate the opportunity to have been of service to you on this project. If you have any questions regarding this report, please feel free to call us.

Sincerely,  
**COTTON, SHIRES AND ASSOCIATES, INC.**

David T. Schrier  
Principal Geotechnical Engineer  
GE 2334



Ted Sayre  
Principal Engineering Geologist  
CEG 1799

DTS:TS:st

**GEOTECHNICAL INVESTIGATION  
FLORIDA AVENUE PARK  
San Bruno, California**

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## **EXECUTIVE SUMMARY**

In this Executive Summary, Cotton, Shires and Associates, Inc. (CSA) is providing pertinent conclusions and recommendations resulting from our Geotechnical Investigation performed for MIG, Inc. as part of the Florida Avenue Park project, located at 324 Florida Avenue at the intersection of Florida Avenue, Taylor Avenue, Martin Place, and San Anselmo Avenue North in San Bruno, California. We understand that the proposed project consists of constructing a park on the soon to be vacant lot, roughly ½ acre in size. A more detailed discussion of our findings, conclusions and recommendations is presented in the main body of this technical report.

### **Conclusions**

- Proposed park construction is feasible from a geotechnical standpoint, and the recommendations provided in this report should be incorporated into the design and construction of the project.
- The site should be subjected to strong seismic ground shaking within the life of the structure(s). The Florida Avenue Park is located approximately 1.6 miles northeast of the mapped main trace of the San Andreas Fault, 8.1 miles northeast of the San Gregorio fault, 16.8 miles southwest of the Hayward Fault and peak horizontal ground accelerations of up to 0.91g should be anticipated at the site.
- The Florida Avenue Park is situated just west of the historic bay margin, and is bordered by the Santa Cruz Mountains to the southwest and the San Francisco Bay to the northeast.
- The Florida Avenue Park is mapped as being underlain by coarse-grained alluvium.
- Groundwater was encountered at depths of 14 and 18 feet below ground surface during our subsurface exploration.
- We calculate that there is a moderate potential for liquefaction, and the park site could experience differential settlement due to liquefaction of medium dense saturated sandy soils at depths below the groundwater table.

- The proposed Florida Avenue Park site is underlain by moderate plasticity clay, and clayey sand. This soil is moderately expansive and appears to be potentially compressible.
- Assuming that the recommendations in this report are followed, we anticipate that the proposed lightly loaded improvements should settle less than 1/2 inch total, and 1/2 inch differential, under static loads of 1,800 psf or less.

### **Recommendations**

- To reduce the potential for adverse effects of differential subgrade movement, the hardscape areas (including scored paving) should be underlain by at least 18-inch thickness of imported engineered compacted fill reinforced with geogrid.
- Based on collected geotechnical data, site grading for the subgrade preparation, including excavating, should be within the capabilities of typical light to moderate excavation equipment (i.e., dozer, backhoes, excavators and drill rigs). During the dry season, temporary cut slopes of 2.5:1 (H:V) in alluvium should be satisfactory (depending on field observations and monitoring) for construction purposes. Permanent cuts in the alluvium should not exceed 2:1 (H:V).
- The final drawings and specifications should be reviewed and approved by a representative of this office to confirm that the recommendations of this report have been incorporated into the design of the project.
- Earthwork construction activities should be inspected and tested by a representative of our office to confirm that the recommendations of this report are incorporated into the construction of the project, and to address potential unanticipated soil conditions not encountered during site investigation.

**GEOTECHNICAL INVESTIGATION  
FLORIDA AVENUE PARK  
San Bruno, California**

**1.0 INTRODUCTION**

**1.1 Project Description**

In this report, Cotton, Shires and Associates, Inc. (CSA) is pleased to present the results of our geotechnical investigation for the new Florida Avenue Park, in San Bruno, California. The park will be located on approximately eight cleared lot, many of which were previously occupied by single family residences. The combined park site is bordered by San Anselmo Avenue N to the northeast, Florida Avenue to the southeast, Taylor Avenue to the southwest, and Martin Place to the west, as shown on the attached Site Location Map, Figure 1. We understand that the park will cover roughly half-of-an-acre. We also understand that the proposed park will consist of play structures, scored paving areas, a rubber surfaced adult exercise area, and landscaping.

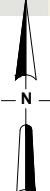
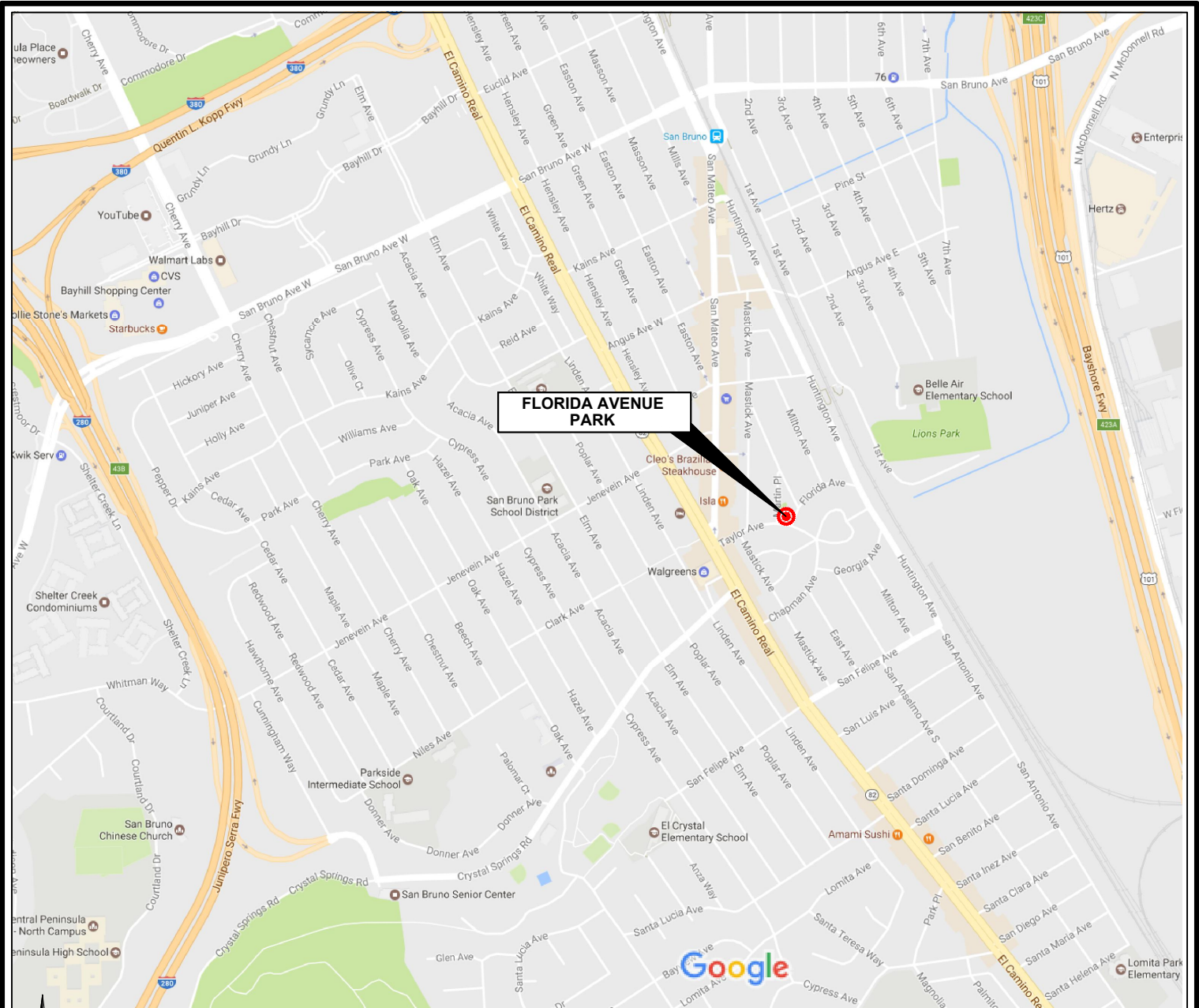
The Florida Avenue Park is situated on the alluvial fan of El Zanjon Creek, which historically flowed adjacent to the proposed park site. We performed this investigation between January and March of 2017, in accordance with our proposal dated October 3, 2016.

We anticipate that site grading will include excavating to remove loose surficial material, and replacing the loose fill material with compacted engineered fill in the improvement areas.

We anticipate that the dead-plus-live loads for the play structures and other improvements will be light.

**1.2 Purpose and Scope of Work**

The purpose of our investigation was to develop geotechnical data for project design. Our objectives were to: 1) evaluate surface and subsurface conditions; and 2) develop



Reference: Google Maps



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**Site Location Map**  
**Florida Avenue Park**  
SAN BRUNO, CALIFORNIA

|                    |                    |                      |
|--------------------|--------------------|----------------------|
| GEO/ENG BY<br>DTS  | SCALE<br>NTS       | PROJECT NO.<br>E5027 |
| APPROVED BY<br>DTS | DATE<br>March 2017 | FIGURE NO.<br>1      |

conclusions and recommendations regarding: geotechnical hazards, site grading including subgrade preparation.

The specific scope of work performed for our investigation included the following tasks:

- 1) Review of in-house geologic data;
- 2) Geotechnical reconnaissance and locating borings for underground utility markings/clearance;
- 3) Subsurface exploration (borings), logging and sampling;
- 4) Laboratory testing;
- 5) Engineering analyses;
- 6) Formulation of conclusions and recommendations; and
- 7) Preparation of this report.

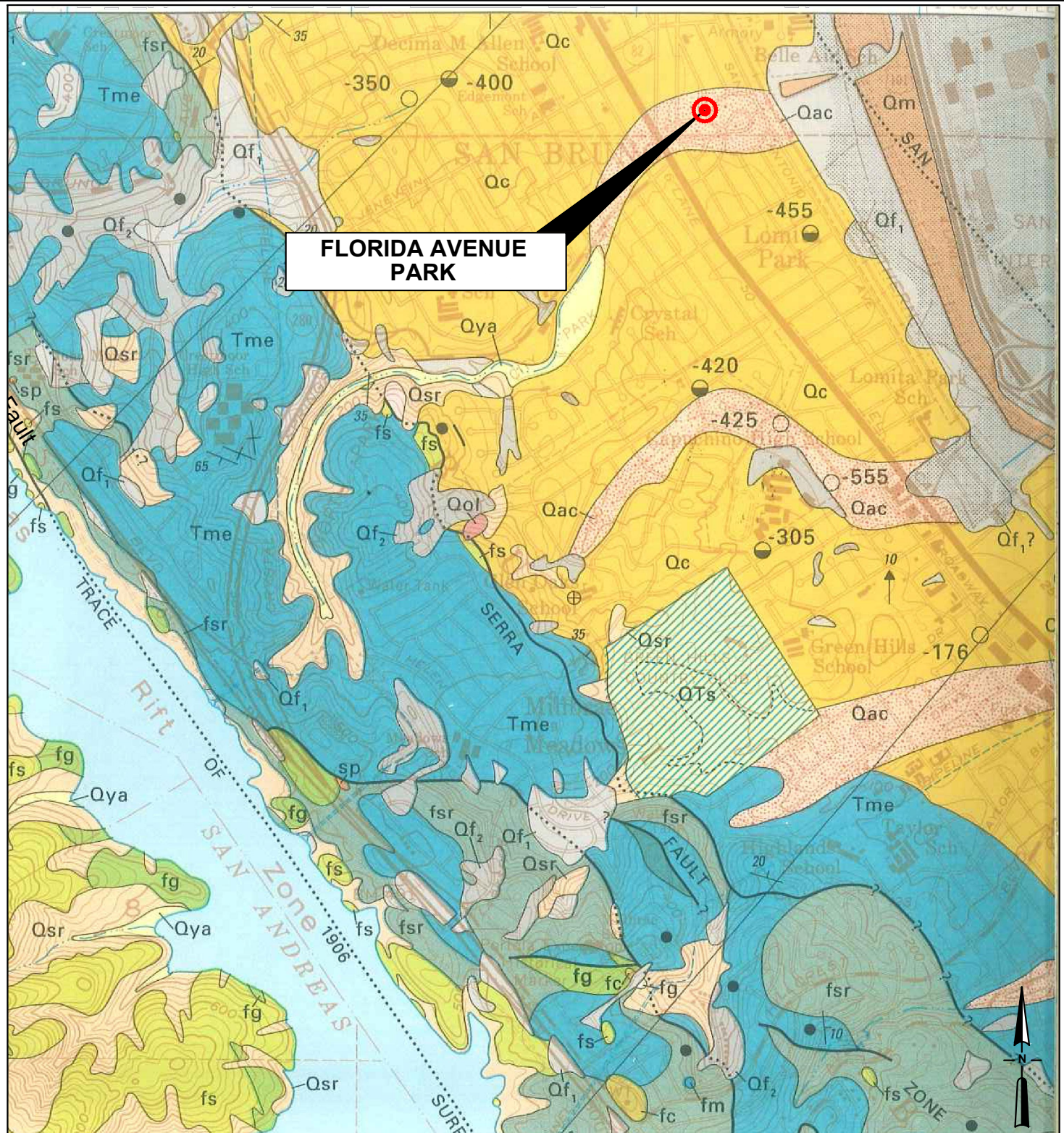
## **2.0 PHYSICAL AND GEOLOGIC SETTING**

### **2.1 Terrain**

The Florida Avenue Park is located at roughly elevation 14 feet adjacent to the bay margin. Generally, the terrain at, and surrounding, the proposed Florida Avenue Park area is level, with a very gently general slope towards the bay (east).

### **2.2 Geologic Setting**

The Florida Avenue Park site is located adjacent to margin of the San Francisco Bay. Historically, the tidal marshes appear to have been located roughly ¼ mile to the east. The historic the mouth of El Zanjon Creek appears have been located at or just south of the proposed Florida Avenue Park site (Tillery, Sowers and Pearce). The site is mapped as being underlain by coarse-grained alluvium (Geologic Map of the Montara Mountain and San Mateo 7-1/2' Quadrangles, San Mateo County, California; see attached Figure 2, Regional Geologic Map).



**FLORIDA AVENUE  
PARK**

**Geologic Unit**

|                 |                          |     |                  |
|-----------------|--------------------------|-----|------------------|
| Qya             | Younger alluvium         | Tme | Merced Formation |
| Qsr             | Slope wash               | fs  | Sandstone        |
| Qac             | Coarse-grained alluvium  | fg  | Greenstone       |
| Qyl             | Younger landslide        | fsr | Sheared rock     |
| Qol             | Older landslide deposit  | sp  | Serpentinite     |
| Qf <sub>1</sub> | Artificial Fill (Unit 1) |     |                  |
| Qf <sub>2</sub> | Artificial Fill (Unit 2) |     |                  |
| Qc              | Colma Formation          |     |                  |
| Qm              | Bay mud                  |     |                  |
| Qts             | Sedimentary deposits     |     |                  |

Source: Geologic Map of Montara Mountain and San Mateo 7-1/2' Quadrangles, San Mateo County, California. E.H. Pampeyan, I-2390

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**Geologic Map**  
**Florida Avenue Park**  
San Bruno, CALIFORNIA

|                           |                           |                             |
|---------------------------|---------------------------|-----------------------------|
| GEO/ENG BY<br><b>DTS</b>  | SCALE<br>NTS              | PROJECT NO.<br><b>E5027</b> |
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## 2.3 Seismic Setting

The Florida Avenue Park is situated in an area of high seismicity. The nearest and controlling active fault, with respect to site seismicity, is the San Andreas Fault. The mapped main trace of the San Andreas Fault is located approximately 1.6 miles southwest of the park site, San Gregorio Fault is mapped 8.1 miles to the southwest of the site, and the Hayward Fault is mapped 16.8 miles to the northeast (see attached San Francisco Bay Area Fault Map, Figure 3). Peak horizontal ground accelerations of up to 0.91g should be anticipated at the site.

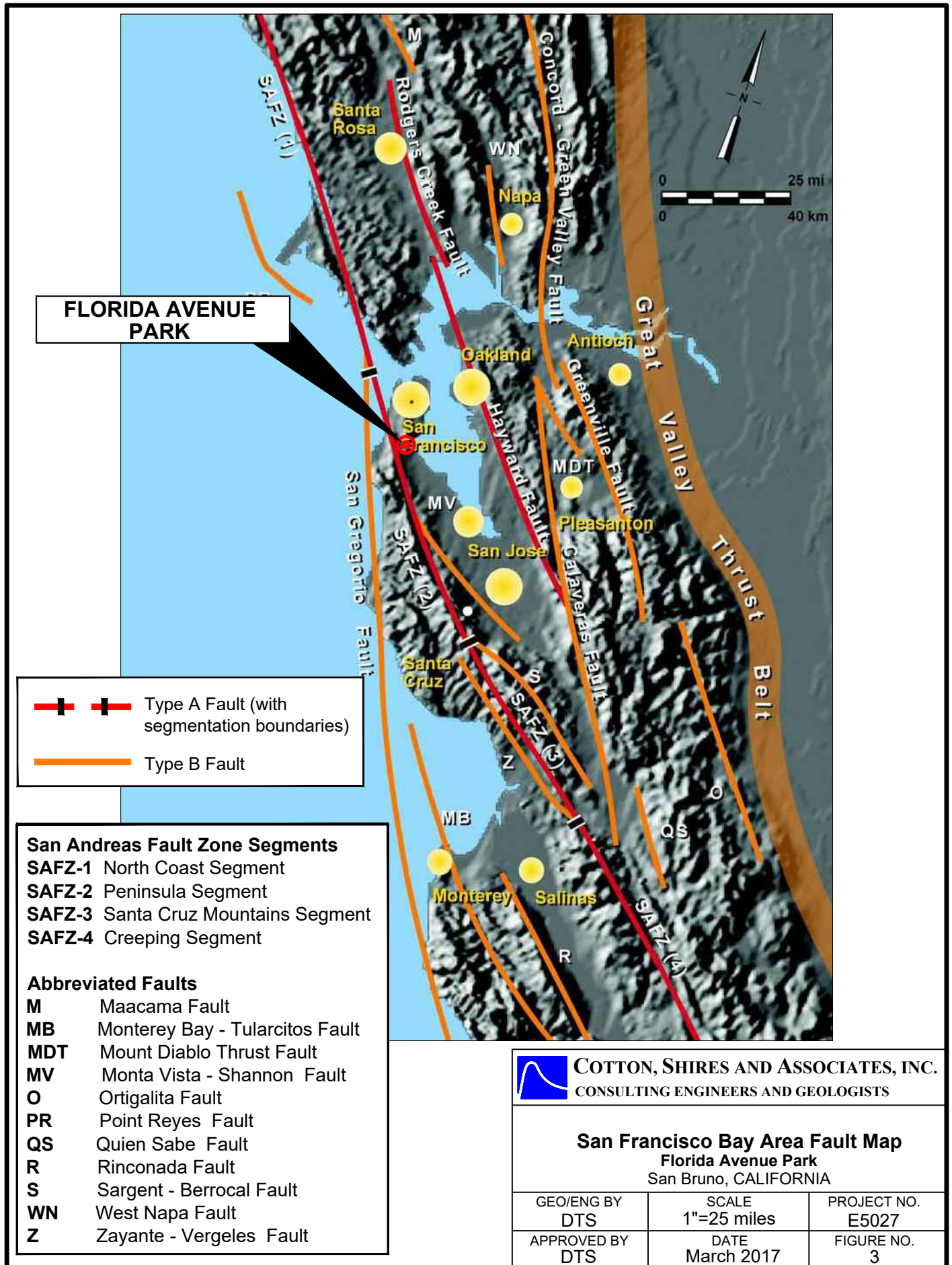
**2.3.1 Probabilistic Analysis** - We performed a peak ground acceleration analysis of the site employing the U.S.G.S. Seismic Design Tool, with the 2010 ASCE 7 (with March 2013 errata) Design Code. The results of our analysis indicate an appropriate Maximum Considered Earthquake Geometric Mean (MCE<sub>G</sub>) Peak Ground Acceleration (PGA<sub>M</sub>) of **0.91g**.

Taking into account the faults described above, the 2016 California Building Code (CBC), the ASCE 7-10 code coefficients presented in Section 5.4 of this report, and the results of the peak ground acceleration analysis, it is our opinion that the park sites could experience a peak horizontal ground acceleration (PGA<sub>M</sub>) as high as **0.91g**.

## 3.0 SITE CONDITIONS

### 3.1 Surface Conditions

The proposed park is located in a densely developed residential area of San Bruno, California. We understand that approximately eight lots were combined to form the proposed park site. At the time of our investigation, a residence was occupying the eastern side of the lot, along San Anselmo Avenue; however, we understand that the remaining structures were scheduled to be demolished. It is possible that buried utilities and abandon foundations still exist at the sites.



**FLORIDA AVENUE PARK**

- Type A Fault (with segmentation boundaries)
- Type B Fault

- San Andreas Fault Zone Segments**
- SAFZ-1** North Coast Segment
  - SAFZ-2** Peninsula Segment
  - SAFZ-3** Santa Cruz Mountains Segment
  - SAFZ-4** Creeping Segment

- Abbreviated Faults**
- M** Maacama Fault
  - MB** Monterey Bay - Tularcitos Fault
  - MDT** Mount Diablo Thrust Fault
  - MV** Monta Vista - Shannon Fault
  - O** Ortilgalita Fault
  - PR** Point Reyes Fault
  - QS** Quien Sabe Fault
  - R** Rinconada Fault
  - S** Sargent - Berrocal Fault
  - WN** West Napa Fault
  - Z** Zayante - Vergeles Fault

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|  |                      |                      |
|--|----------------------|----------------------|
| <b>San Francisco Bay Area Fault Map</b>      |                      |                      |
| Florida Avenue Park<br>San Bruno, CALIFORNIA |                      |                      |
| GEO/ENG BY<br>DTS                            | SCALE<br>1"=25 miles | PROJECT NO.<br>E5027 |
| APPROVED BY<br>DTS                           | DATE<br>March 2017   | FIGURE NO.<br>3      |

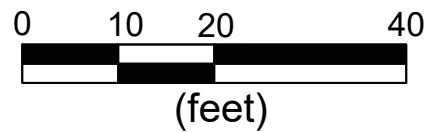
### **3.2 Subsurface Conditions**

We explored subsurface conditions at the Florida Avenue Park sites on January 11, 2017, by means of 2 exploratory borings both drilled to a depth of 31.5 feet at the locations shown on the attached Site Plan and Boring Location Map, Figure 4. In the borings, we encountered alluvial clays and clayey sands to the bottom of our borings (see attached Engineering Geologic Cross Section A-A', Figure 5). In Boring CSA/SD-1, we encountered 6.5 feet of stiff silty clay overlying medium dense to dense clayey sand down to 30 feet. Below 30 feet, we encountered stiff sandy clay which extended the bottom of our boring at 31.5 feet. In CSA/SD-2 we encountered 4.5 feet of stiff silty clay overlying medium dense to dense clayey sand which extended to the bottom of our boring at 31.5 feet. A detailed description of the exploration program and logs of the borings are presented in Appendix A of this report.

**3.2.1 Laboratory Testing** - We performed laboratory tests on several of the relatively undisturbed representative soil samples obtained from our borings. Those tests included Atterberg limits, in-situ unit weight, natural moisture content, and R-value testing. Based on the results of these tests, the near-surface alluvial soil has a moderate plasticity (Liquid Limit = 41, Plasticity Index = 19), high moisture contents (average of approximately 21.4 percent), moderate dry unit weights (average of approximately 109 pcf), and with moderate R-Value (approximately 34). The results of the laboratory tests performed on representative samples are presented on the boring logs in Appendix A (Field Investigation) and in Appendix B (Laboratory Testing).

### **3.3 Groundwater Conditions**

Groundwater was encountered in both exploratory borings at depths of 14 and 18 feet below ground surface as part of this investigation. Groundwater levels may be different at different times, climatic conditions and locations.





### EXPLANATION

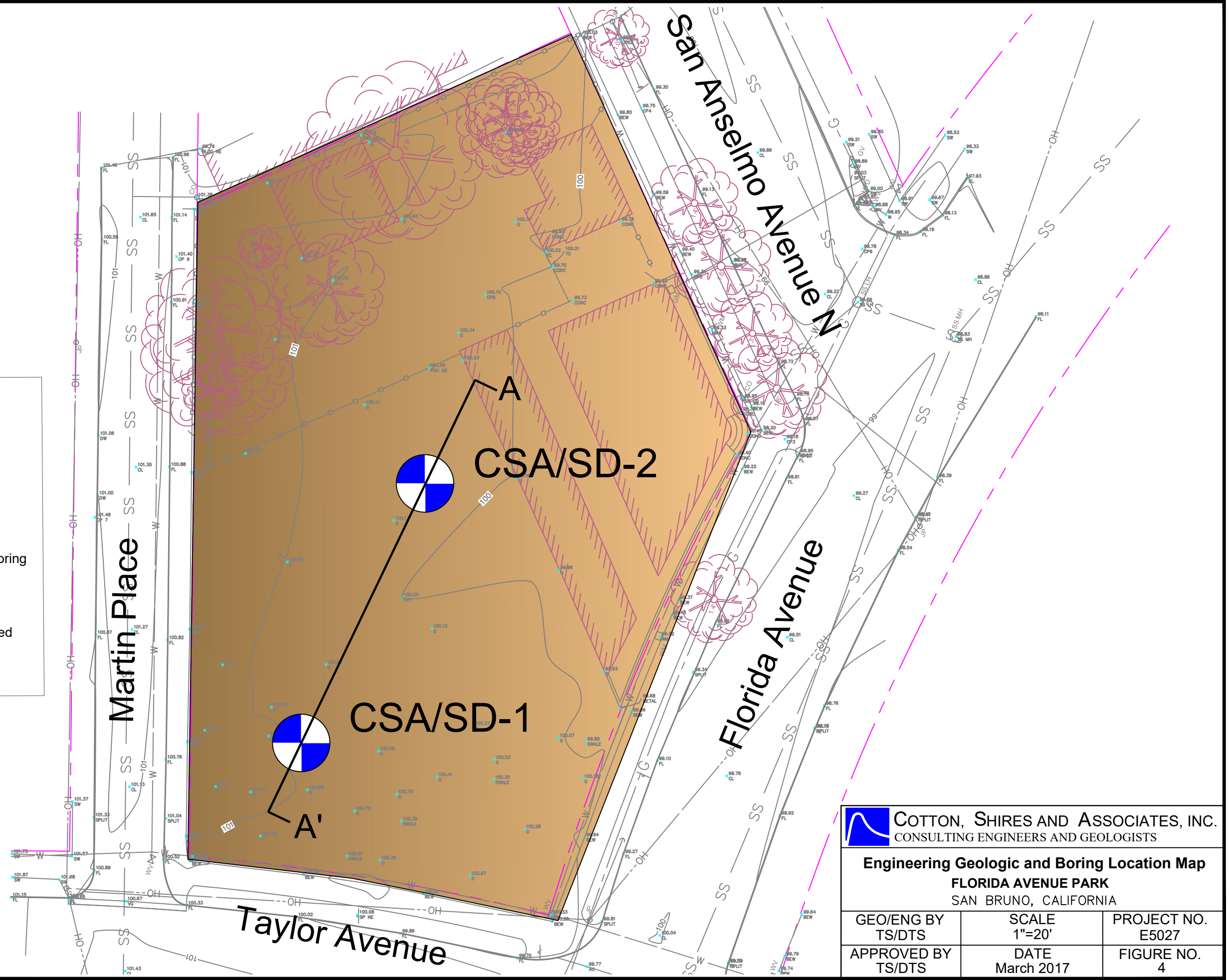
#### EARTH MATERIALS

**Qal** Alluvium; dark brown to black clay

#### SYMBOLS

 Small-Diameter Exploratory Boring Location and Designation  
CSA/SD-2

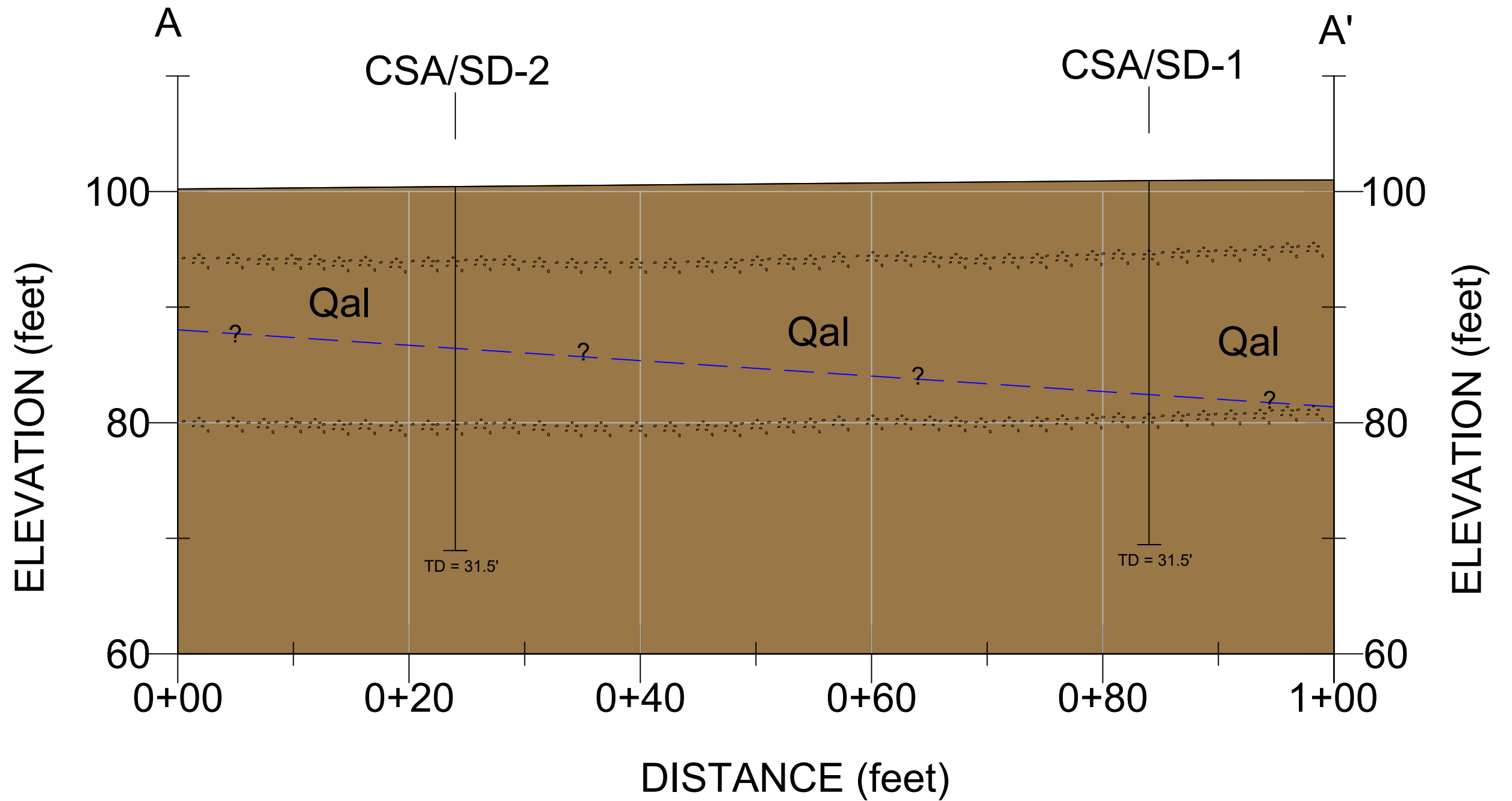
 Geologic Contact; dashed where approximate, queried where unknown



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CONSULTING ENGINEERS AND GEOLOGISTS

**Engineering Geologic and Boring Location Map**  
**FLORIDA AVENUE PARK**  
SAN BRUNO, CALIFORNIA

|                       |                    |                      |
|-----------------------|--------------------|----------------------|
| GEO/ENG BY<br>TS/DTS  | SCALE<br>1"=20'    | PROJECT NO.<br>E5027 |
| APPROVED BY<br>TS/DTS | DATE<br>March 2017 | FIGURE NO.<br>4      |



**EXPLANATION**

**EARTH MATERIALS**

**Qal** Alluvium; dark brown to black clay

**SYMBOLS**

**CSA/SD-2** Small-Diameter Exploratory Boring Location, Designation, and Total Depth

Geologic Contact; dashed where approximate, queried where unknown

Groundwater Encountered During Investigation

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**Engineering Geologic Cross Sections A-A'**  
**FLORIDA AVENUE PARK**  
SAN BRUNO, CALIFORNIA

|                       |                    |                      |
|-----------------------|--------------------|----------------------|
| GEO/ENG BY<br>TS/DTS  | SCALE<br>1"=20'    | PROJECT NO.<br>E5027 |
| APPROVED BY<br>TS/DTS | DATE<br>March 2017 | FIGURE NO.<br>5      |

#### 4.0 POTENTIAL GEOTECHNICAL HAZARDS

In the following section, we list potential geotechnical hazards at the Florida Avenue Park site along with the corresponding degrees of determined potential risk, and provide recommendations for possible mitigation measures.

#### 4.1 Seismic Hazards

Seismic ground shaking associated with a large earthquake on the San Andreas, San Gregorio or Hayward Faults is considered to be a **high** potential hazard at the park site. Peak ground accelerations of up to **0.91g** should be anticipated at the site (see report Section 2.3).

No faults are mapped through the proposed park lot, consequently the potential for surface faulting and ground rupture on the property is considered to be **low**. The main trace of the San Andreas Fault is the closest mapped active fault to the site, located approximately 1.6 miles to the southwest.

Seismically-induced ground failure mechanisms include: landsliding, liquefaction, lateral spreading, lurching, and differential compaction. Due to the level site, the potential for strong ground shaking to trigger a landslide is considered to be **low**.

The potential for liquefaction and dry densification of soils above the water table is considered **low to moderate** due to the medium dense sandy soils encountered in our subsurface exploration. We calculated that the park site will settle 1 to 1-1/2 inches total and 1/2 inch to 3/4 inch differential due to liquefaction and dry densification induced by seismic ground shaking.

Lurching and differential compaction are considered to have a **moderate** potential impact due to the stiff and medium dense near-surface, and could result in differential movement and possible distress of any improvements bearing on this material. In order to reduce this potential for differential ground movement under seismically-induced ground shaking (including the densification of dry sandy soils), we have provided recommendations to remove 18 inches fill material under all improvements and replace it

with geogrid-reinforced engineered compacted fill to mitigate some of the potential for differential-compaction-related distress to the trail pavement.

#### 4.2 Settlement Behavior

Based on our assumption of light improvement loads, we estimate that there is a **moderate** potential that shallow supported improvements bearing on the existing fill material, will compress differentially and result in a moderate amount of differential settlement. The recommended removal and replacement with 18 inches of engineered (geogrid reinforced) compacted fill should mitigate most of the potential adverse effects associated with differential settlement. For our analysis, we assumed that the static dead plus long term live load for the improvements would be less than 1,800 pounds per square foot (psf) bearing on at least 18 inches of engineered, compacted fill (with a layer of geogrid). Based on these assumption, we estimate that total static settlement for the improvements, should be roughly 1/2 inch, and differential settlements should be about 1/2 inch over 30 feet.

#### 4.3 Expansive Soils

Based on the results of our laboratory testing, the near-surface soils are classified as being moderately plastic and have potentially **moderate** expansive characteristics. Expansive soils could be subjected to volume changes due to seasonal fluctuations in moisture content of the surficial soils.

The recommended removal and replacement with 18 inches of engineered (geogrid reinforced) compacted fill should mitigate most of the potential adverse effects associated with differential expansive soil related movement.

## 5.0 RECOMMENDATIONS

### 5.1 Site Grading

Based on our field investigation, site grading for the Florida Avenue Park, including excavating, should be within the capabilities of typical light to moderate equipment (i.e., drill rigs, dozers, backhoes and excavators). Excavations above 10 feet should not require significant dewatering, provided that construction takes place during the dry season.

**5.1.1 Site Preparation** - All loose material, vegetation, any old concrete foundations, abandoned utilities, asphalt, debris, and other deleterious material should be stripped and removed from the areas to be occupied by the new improvements. This material should be disposed of in a suitable location off-site.

In areas to be occupied by improvements (including, but not limited to play structures, scored paving areas, and the rubber adult exercise surface) excavate at least 18 inches (or more, depending on the recommendations of the manufacturer) of existing soil and extending 2 foot horizontally beyond the improvement limits to create a uniform base, and **provide a minimum thickness of 18 inches of engineered fill (or more, if additional mitigation is desired) below the manufacturer's recommended subgrade** (frequently a manufacturer will recommends 6 inches of Class 2 Basercock for subgrade below pavers).

In areas to be filled (bottom of the excavations), the exposed surface should be scarified to at least an 8-inch depth, moisture conditioned to at least optimum moisture content and compacted to at least 90 percent relative compaction based on ASTM D-1557-12. Following scarification and compaction, the subgrade underlying all improvements should be covered with a layer of **Tensar TriAx TX170 geogrid** to help spread out new loads and reduce the potential for differential settlement.

**5.1.2 Compacted Fill** – The excavated on-site material should **not** be reused for compacted fill below structures (scored pavers, play structures, and the rubber adult exercise surface, etc.). Imported fill should be free of organic material, it should contain no material larger than 4 inches; it should have a plasticity index (PI) of less than 16; it should be free of hazardous contamination (per State of California requirements); and it should be free of Asphaltic Concrete grindings. The fill should be placed in horizontal

lifts not exceeding 8 inches in loose thickness, moisture conditioned to at least optimum moisture content, and compacted to at least 90 percent relative compaction based on ASTM D-1557-12.

**5.1.3 Utility Trench Backfill** - Planned pipelines (not irrigation lines) should be placed at least 3 feet below final ground surface. Utility trenches should be backfilled with approved on-site soil compacted per the recommendations for engineered fill above and below. Bedding materials for pipes should be graded and placed in accordance with the manufacturer's recommendations. The backfill should be compacted to at least 90 percent relative compaction based on based on ASTM D-1557-12. Equipment and methods should be used that are suitable for work in confined areas without damaging trench walls or conduits.

Where pipelines are located on slopes or roadways steeper than 12° (21 percent gradient), impervious clay (or low slump, 5-sack concrete) trench plugs (minimum 3 feet horizontal dimension) should be provided at minimum 50-foot intervals to avoid pop-outs due to high hydrostatic pressures developing in pervious trench bedding.

**5.1.4 Cut Slope Design** - Any new permanent cut slopes should not exceed an inclination of 2:1 (H:V). During the dry season, temporary cut slopes of 1.75:1 (H:V) in alluvium should generally be satisfactory for construction purposes, provided that they are inspected and approved by our field representative at the time of construction and monitored daily during construction. Excavation methods, shoring, bracing and safety of excavations are the responsibility of the contractor. All excavations should comply with applicable local, State and Federal safety regulations.

**5.1.5 Fill Slope Design** - All permanent fill slopes constructed with on-site material should have a maximum inclination of 2:1 (H:V).

**5.1.6 Keyway Design** - Fill materials placed on slopes steeper than 6:1 should have a keyway at the toe no less than 12 feet wide and be continuously benched at least 1 foot into the alluvium. The resulting subgrade should be inspected by our representative for firmness prior to placement of any new fill materials.

**5.1.7 Pavement Subgrade Preparation** - After general compaction and compaction of the utility trench backfills, any areas proposed for vehicle pavement subgrade (surface below the baserock) should be checked for yielding areas by proof-rolling with a loaded water truck or equivalent. Any yielding areas should be excavated and replaced with compacted fill. The upper 12 inches should be moisture conditioned to at least optimum moisture content, and compacted to at least 95 percent relative compaction (ATSM D1557-12).

**5.2 Pavement Design**

Any areas that will be accessed by vehicle traffic should be paved with asphaltic concrete over aggregate baserock. The laboratory testing of the existing fill material (assuming that this material would be re-used as engineered fill for the pavement subgrade) indicated that this material has an R-value of 34. In the following table we have provided pavement sections for various Traffic Indices:

| <b>Traffic Index (TI)</b> | <b>Caltrans Class 2 Baserock<br/>(inches)</b> | <b>Asphaltic Concrete (AC)<br/>(inches)</b> |
|---------------------------|---|---|
| 4                         | 4   | 2.5   |
| 4.5                       | 4.75  | 2.5   |
| 5                         | 4.75  | 3   |

For pedestrian use only pavement, the section should consist of 2.5 inches of AC over 4.5 inches of baserock compacted to 90% Relative Compaction.

Asphaltic concrete should be placed and compacted in accordance with the requirements of Section 39 of the Caltrans Standard Specifications; aggregate base rock should conform to the provisions of Section 26 (Caltrans) for 3/4-inch maximum Class 2 Aggregate Base, and should be compacted to at least 95 percent relative compaction (except 90% in areas that will be supporting pedestrian loads only) based on ASTM D-1557-12 rather than Caltrans Method 216.

### 5.3 Surface Drainage

We recommend that all surface drainage be permanently diverted away from the planned structures at a minimum 2% grade into an appropriate catch basin/storm drain system.

### 5.4 Seismic Design

A peak ground acceleration of 0.91g should be anticipated for design purposes at the park site. Based on our geotechnical investigation, the site location, our interpretation of the 2013 CBC documents related to Earthquake Loads and using the USGS Seismic Design Maps tool, we are providing the following parameter recommendations from the corresponding figures and tables:

| Parameter                         | Value         |
|-----------------------------------|---------------|
| Site Classification               | D             |
| Mapped Spectral Acc. 0.2 Sec. (g) | $S_s = 2.361$ |
| Mapped Spectral Acc. 1 Sec. (g)   | $S_1 = 1.134$ |
| Fa – Site Coefficient             | 1.0           |
| Fv – Site Coefficient             | 1.5           |
| $S_{MS} = F_a S_s$                | 2.361         |
| $S_{M1} = F_v S_1$                | 1.701         |
| $S_{DS} = 2/3 S_{MS}$             | 1.574         |
| $S_{D1} = 2/3 S_{M1}$             | 1.134         |

### 5.5 Technical Review

Supplemental geotechnical design recommendations should be provided by our firm based on specific design needs developed by the other project design professionals. This report, and any supplemental recommendations, should be reviewed by the contractor as part of the bid process. It is strongly recommended that no construction be started nor grading undertaken until the final drawings, specifications, and calculations have been reviewed and approved in writing by a representative of **Cotton, Shires and Associates, Inc.**

## **5.6 Earthwork Construction Inspection and Testing**

All excavations should be inspected by a representative of **Cotton, Shires and Associates, Inc.** prior to filling or pouring of concrete foundations. Any grading should also be inspected and tested as appropriate to assure adequate stripping and compaction. Our office should be contacted with a minimum of 48 hours advance notice of construction activities requiring inspection and/or testing services and a minimum of 72 hours advance notice and provision of representative laboratory compaction curve samples for testing of fill.

## **6.0 INVESTIGATION LIMITATIONS**

Our services consist of professional opinions and recommendations made in accordance with generally accepted engineering geology and geotechnical engineering principles and practices. No warranty, expressed or implied, or merchantability of fitness, is made or intended in connection with our work, by the proposal for consulting or other services, or by the furnishing of oral or written reports or findings.

Any recommendations and/or design criteria presented in this report are contingent upon our firm being retained to review the final drawings and specifications, to be consulted when any questions arise with regard to the recommendations contained herein, and to provide testing and inspection services for earthwork and construction operations. Unanticipated soil and geologic conditions are commonly encountered during construction that cannot be fully determined from existing exposures or by limited subsurface investigation. Such conditions may require additional expenditures during construction to obtain a properly constructed project. Some contingency fund is recommended to accommodate these possible extra costs.

This report is issued with the understanding that it is the responsibility of the owner, or of his representative, to ensure that the information and recommendations contained herein are called to the attention of the project architect and/or engineer and incorporated into the plans. Furthermore, it is also the responsibility of the owner, or of his representative, to ensure that the contractor and subcontractors carry out such recommendations in the field.

## 7.0 REFERENCES

Bowles, J.E., Foundation Analysis and Design, Third Edition, 1982, McGraw-Hill Book Company, Page 184, and Tables 2-6 and 2-7.

California Department of Conservation, Division of Mines and Geology, 1996, Probabilistic Seismic Hazard Assessment For the State of California, DMG Open File Report 96-08.

California Geological Survey, Guidelines for Evaluating and Mitigating Seismic Hazards in California: Special Publication 117A, 2008.

Duncan J.M., Horz R.C., and Yang T.L., August 1989, Shear Strength Correlations for Geotechnical Engineering, Virginia Tech, Department of Civil Engineering, Geotechnical Engineering.

Idriss I.M., Boulanger R.W., Soil Liquefaction During Earthquakes monograph, Earthquake Engineering Research Institute, 2008.

Pampeyan E.H., Geologic Map of the Montara Mountain and San Mateo 7-1/2' Quadrangles, San Mateo County, California.

Tillery, A. C., Sowers, J. M., Pearce, S., Creek & Watershed Map of San Mateo & Vicinity.

U. S. Department of the Navy, 1982, Design Manual Soil Mechanics, Foundations, and Earth Structures, NAVFAC DM-7.2.

U.S.G.S. Design Maps Web Application, ASCE 7-10, errata March 2013.

**APPENDIX A**

**Field Investigation  
Logs of Exploratory Borings**

## APPENDIX A FIELD INVESTIGATION

We explored subsurface conditions at the Florida Avenue Park sites in San Bruno, California on January 11, 2017, by means of two exploratory borings drilled to depths of 31.5 feet using track-mounted solid stem drilling equipment. The locations of the borings are shown on the attached Site Plan and Boring Location Map, Figure 4. The geologist who logged the borings visually classified the soils in accordance with ASTM D-2487. We obtained relatively undisturbed samples of representative materials encountered at selected depths. These samples were obtained in brass liners that were 2.5 inches in outside diameter and 6 inches long; the liners were placed inside a 3-inch diameter modified split-barrel California Sampler for sampling. The track-mounted drill rig sampler was driven with a 140-pound hammer that was raised by an automatic hammer and allowed to freely fall about 30 inches. We also performed Standard Penetration Tests at selected depths. The depths of the sampling are shown on the boring logs. The **bold** number at the conclusion of the sampling interval represents the corrected blow count from a modified California sampler to Standard Penetration Test value accomplished by multiplying the blow count by a factor of 0.68.

Descriptive logs of the borings are presented in this appendix. These logs depict our interpretation of the subsurface conditions at the dates and locations indicated, based on representative samples collected at roughly five-foot sampling intervals. It is not warranted that they are representative of subsurface conditions at other times and locations. The contacts on the logs represent the approximate boundaries between earth materials, and the transitions between these materials may be gradual.

# COTTON, SHIRES AND ASSOCIATES, INC.

## LOG OF EXPLORATORY DRILLING

Project Florida Ave Park Boring CSA/SD-1  
 Location 324 Florida Ave, San Bruno Project No. E5027  
 Drilling Contractor/Rig Britton/CME-55 Date of Drilling January 11, 2017  
 Ground Surface Elev. \_\_\_\_\_ Logged By KW Hole Diameter 8" Hollow Stem  
 Surface Bare Lot Weather Cloudy and sprinkling

| Depth (feet) | Graphic Log | USCS Class. | Geotechnical Description  | Sample Desig. | Dry Unit Weight (pcf) | Moisture Content (%) | SPT Blows/ft          | Sample Type | Recov. (%) | Remarks                      |
|--------------|-------------|-------------|---|---------------|-----------------------|----------------------|-----------------------|-------------|------------|------------------------------|
| 0 - 2        |             | CL          | <b>ALLUVIUM 0 - BOH</b><br>0 - 6.5 ft: Silty Clay, dark brown to black - stiff, moist to wet, high plasticity | T-1<br>T-2    | 92                    | 29.0                 | 4<br>5<br>5<br>(7)    | MC          | █          | R-Value - 34<br>LL=41, PI=19 |
| 2 - 4        |             | CL          |   | T-3<br>T-4    | 103                   | 22.4                 | 4<br>5<br>7<br>(8)    | MC          | █          |                              |
| 4 - 6        |             | CL          |   | T-5<br>T-6    | 111                   | 16.9                 | 5<br>10<br>11<br>(14) | MC          | █          |                              |
| 6 - 8        |             | SC          | 6.5 - 30 ft: Clayey Sand, light brown to white - medium dense, wet, angular                                   |               |                       |                      |                       |             |            |                              |
| 8 - 10       |             | SC          |   | T-7<br>T-8    |                       |                      | 7<br>11<br>15<br>(18) | MC          | █          |                              |
| 10 - 12      |             | SC          |   |               |                       |                      |                       |             |            |                              |
| 12 - 14      |             | SC          |   |               |                       |                      |                       |             |            |                              |
| 14 - 16      |             | SC          | - 15 ft: Chert clasts/angular   | B-1           |                       |                      | 5<br>5<br>8<br>(13)   | SPT         | █          |                              |
| 16 - 18      |             | SC          |   |               |                       |                      |                       |             |            |                              |
| 18 - 20      |             | SC          |   |               |                       |                      |                       |             |            |                              |
| 20 - 22      |             | SC          | - Saturated, w/ shells below 20 feet  | B-2           |                       |                      | 6<br>7<br>13<br>(20)  | SPT         | █          |                              |
| 22 - 24      |             | SC          |   |               |                       |                      |                       |             |            |                              |
| 24 - 26      |             | SC          |   | B-3           |                       |                      | 7<br>14<br>20<br>(34) | SPT         | █          |                              |
| 26 - 28      |             | SC          | - Dense and rounded below 25 feet   |               |                       |                      |                       |             |            |                              |
| 28 - 30      |             | SC          |   |               |                       |                      |                       |             |            |                              |

| Depth (feet) | Graphic Log | USCS Class. | Geotechnical Description  | Sample Desig. | Dry Unit Weight (pcf) | Moisture Content (%) | SPT Blows/ft | Sample Type | Recov. (%) | Remarks                 |
|--------------|-------------|-------------|---|---------------|-----------------------|----------------------|--------------|-------------|------------|-------------------------|
|              |             | CH          | 30 - BOH ft: Sandy Clay, dark brown to grey - stiff, wet, w/ white angular to subangular sand | B-4           |                       |                      | 4<br>3<br>4  | SPT         | █          | Likely disturbed sample |
| 32           |             |             | <b>TD = 31.5 feet</b><br>Groundwater encountered at 18 feet during drilling                   |               |                       |                      | ⑦            |             |            |                         |
| 34           |             |             |   |               |                       |                      |              |             |            |                         |
| 36           |             |             |   |               |                       |                      |              |             |            |                         |
| 38           |             |             |   |               |                       |                      |              |             |            |                         |
| 40           |             |             |   |               |                       |                      |              |             |            |                         |
| 42           |             |             |   |               |                       |                      |              |             |            |                         |
| 44           |             |             |   |               |                       |                      |              |             |            |                         |
| 46           |             |             |   |               |                       |                      |              |             |            |                         |
| 48           |             |             |   |               |                       |                      |              |             |            |                         |
| 50           |             |             |   |               |                       |                      |              |             |            |                         |
| 52           |             |             |   |               |                       |                      |              |             |            |                         |
| 54           |             |             |   |               |                       |                      |              |             |            |                         |
| 56           |             |             |   |               |                       |                      |              |             |            |                         |
| 58           |             |             |   |               |                       |                      |              |             |            |                         |
| 60           |             |             |   |               |                       |                      |              |             |            |                         |
| 62           |             |             |   |               |                       |                      |              |             |            |                         |

# COTTON, SHIRES AND ASSOCIATES, INC.

## LOG OF EXPLORATORY DRILLING

Project Florida Ave Park Boring CSA/SD-2  
 Location 324 Florida Ave, San Bruno Project No. E5027  
 Drilling Contractor/Rig Britton/CME-55 Date of Drilling January 11, 2017  
 Ground Surface Elev. \_\_\_\_\_ Logged By KW Hole Diameter 8" Hollow Stem  
 Surface Bare Lot Weather Cloudy and sprinkling

| Depth (feet) | Graphic Log | USCS Class. | Geotechnical Description  | Sample Desig. | Dry Unit Weight (pcf) | Moisture Content (%) | SPT Blows/ft           | Sample Type | Recov. (%) | Remarks |
|--------------|-------------|-------------|---|---------------|-----------------------|----------------------|------------------------|-------------|------------|---------|
| 0 - 4.5      |             | CL          | <b>ALLUVIUM 0 - BOH</b><br>0 - 4.5 ft: Silty Clay, dark brown to black - stiff, moist to wet, high plasticity | T-1<br>T-2    | 127                   | 20.1                 | 2<br>4<br>5<br>(6)     | MC          | █          |         |
| 4.5 - 10     |             | SC          | 4.5 - 10 ft: Clayey Sand, dark brown grey - medium dense, wet, subrounded                                     | T-3<br>T-4    | 106                   | 18.5                 | 3<br>7<br>9<br>(11)    | MC          | █          |         |
| 10 - 14      |             | SC          | 4.5 - 10 ft: Clayey Sand, light brown to white - medium dense, wet, subrounded                                | B-1<br>T-7    |                       |                      | 7<br>12<br>12<br>(16)  | MC          | █          |         |
| 14 - 20      |             |             | - Dense, saturated, and coarse grain below 20 feet  | B-2           |                       |                      | 6<br>6<br>12<br>(18)   | SPT         | █          |         |
| 20 - 25      |             |             | - Medium dense and fine grained below 25 feet   | B-3           |                       |                      | 11<br>20<br>18<br>(38) | SPT         | █          |         |
| 25 - 28      |             |             |   | B-4           |                       |                      | 11<br>11<br>13<br>(24) | SPT         | █          |         |

| Depth (feet) | Graphic Log | USCS Class. | Geotechnical Description  | Sample Desig. | Dry Unit Weight (pct) | Moisture Content (%) | SPT Blows/ft  | Sample Type | Recov. (%) | Remarks                 |
|--------------|-------------|-------------|---|---------------|-----------------------|----------------------|---------------|-------------|------------|-------------------------|
|              |             |             | - Dense, and medium to coarse grain below 30 feet                           | B-5           |                       |                      | 4<br>17<br>27 | SPT         | █          | Likely disturbed sample |
| 32           |             |             | <b>TD = 31.5 feet</b><br>Groundwater encountered at 14 feet during drilling |               |                       |                      | 34            |             |            |                         |
| 34           |             |             |   |               |                       |                      |               |             |            |                         |
| 36           |             |             |   |               |                       |                      |               |             |            |                         |
| 38           |             |             |   |               |                       |                      |               |             |            |                         |
| 40           |             |             |   |               |                       |                      |               |             |            |                         |
| 42           |             |             |   |               |                       |                      |               |             |            |                         |
| 44           |             |             |   |               |                       |                      |               |             |            |                         |
| 46           |             |             |   |               |                       |                      |               |             |            |                         |
| 48           |             |             |   |               |                       |                      |               |             |            |                         |
| 50           |             |             |   |               |                       |                      |               |             |            |                         |
| 52           |             |             |   |               |                       |                      |               |             |            |                         |
| 54           |             |             |   |               |                       |                      |               |             |            |                         |
| 56           |             |             |   |               |                       |                      |               |             |            |                         |
| 58           |             |             |   |               |                       |                      |               |             |            |                         |
| 60           |             |             |   |               |                       |                      |               |             |            |                         |
| 62           |             |             |   |               |                       |                      |               |             |            |                         |

**APPENDIX B**

**Laboratory Testing  
R-Value**

**APPENDIX B**  
**LABORATORY TESTING**

The laboratory analysis performed for the site consisted of limited testing of the principal soil types sampled during the field investigation to evaluate index properties and strength parameters of subsurface materials. The soil descriptions and the field and laboratory test results were used to assign parameters to the various materials at the site. The results of the laboratory testing program are presented in this appendix and on the boring logs.

The following laboratory tests were performed as part of this investigation:

1. Detailed soil description, ASTM D2487;
2. Natural moisture content of the soil, ASTM D2216;
3. In-situ unit weight of the soil (wet and dry);
4. Atterberg limits determination: ASTM D 4318; and
5. R-Value test, Caltrans 301.



# R-value Test Report (Caltrans 301)

|            |                             |         |          |                           |               |
|------------|-----------------------------|---------|----------|---------------------------|---------------|
| Job No.:   | 026-631                     | Date:   | 03/16/17 | Initial Moisture,         | 13.1          |
| Client:    | Cotton, Shires & Associates | Tested  | PJ       | <b>R-value</b>            | <b>34</b>     |
| Project:   | Florida Park - E5027        | Reduced | RU       | <b>Expansion Pressure</b> | <b>60 psf</b> |
| Sample     | Bucket @ 0-1'               | Checked | DC       |                           |               |
| Soil Type: | Dark Olive Brown Sandy CLAY |         |          |                           |               |

| Specimen Number              | A     | B     | C     | D | Remarks: |
|------------------------------|-------|-------|-------|---|----------|
| Exudation Pressure, psi      | 200   | 381   | 577   |   |          |
| Prepared Weight, grams       | 1200  | 1200  | 1200  |   |          |
| Final Water Added, grams/cc  | 52    | 29    | 17    |   |          |
| Weight of Soil & Mold, grams | 3125  | 3117  | 3080  |   |          |
| Weight of Mold, grams        | 2084  | 2105  | 2094  |   |          |
| Height After Compaction, in. | 2.56  | 2.44  | 2.36  |   |          |
| Moisture Content, %          | 18.0  | 15.8  | 14.7  |   |          |
| Dry Density, pcf             | 104.5 | 108.5 | 110.4 |   |          |
| Expansion Pressure, psf      | 47    | 90    | 211   |   |          |
| Stabilometer @ 1000          |       |       |       |   |          |
| Stabilometer @ 2000          | 118   | 80    | 54    |   |          |
| Turns Displacement           | 3.10  | 3.20  | 3.02  |   |          |
| R-value                      | 23    | 42    | 58    |   |          |

