Earth Focus Geological Services, Inc.

www.earthfocusgeology.com
115 Orchard Drive, Fremont, CA 94536
Tel/Fax (510) 794-7495

January 15, 2018
Project No: F17-01515

Mr. Ben Halali
4901 Rue Calais
San Jose, CA 94138

Subject: Fault Rupture Hazard Evaluation
Hayward Segment of the Hayward Fault Zone
Proposed New Multi-Unit Residential Development
25036 to 25096 Carlos Bee Boulevard, APN: 445-170-39-13
Hayward, California

Coordinates: Latitude: 37.6616 N Longitude: 122.0710 W

Dear Mr. Halali:

As requested, we have performed a fault rupture hazard evaluation for the vacant lots identified as 25036 to 25096 Carlos Bee Boulevard in Hayward, California (see Figure 1). The west portion of the property is within the Earthquake Fault Zone for the seismically active Hayward fault as established by the State of California (Hart and Bryant, 1997; and State Geologist, 2012; see Figure 2). The purpose of this study was to assess the potential for ground surface rupture hazard from active faulting for the west portion of the project site within the Earthquake Fault Zone.

This evaluation is based on geologic logging of a single exploratory trench (see Figure 3); a review of published and unpublished geologic reports and maps of the site area; review of aerial photographs of the site vicinity; discussions with Mr. Lou Richardson, Certified Engineering Geologist, the City of Hayward peer reviewing geologist; and professional judgments and opinions made from such information. As determined from this investigation, no active traces of the Hayward fault zone were identified within the exploration limits of the trench (see Figure 3).

SCOPE OF WORK

The scope of work for this project was as follows.

- Perform a reconnaissance to observe the current site conditions
- Review available published and unpublished geologic data, maps, and reports
- Review aerial photographs of the site vicinity
- Geologically log an exploratory trench within the Earthquake Fault Zone
- Discuss trench exposures with Mr. Lou Richardson
- Analyze the data gathered and evaluate the potential for surface ground rupture hazard
- Prepare this report presenting our research and findings

SITE DESCRIPTION

The project site is located on a generally west-facing slope in hilly terrain along the west flank of the East Bay Hills. The property is east and uphill of Mission Boulevard (State Highway 238) along the north side of Carlos Bee Boulevard (see Figure 1). Overlook Avenue, the nearest cross street, intersects Carlos Bee Boulevard at the east end of the site where the property reaches its highest elevation. The west end of the site is bounded by the YMCA property (formerly the Hillcrest School site) at the lowest elevation. There are single-family residences overlooking the site along the top of a slope to the north that front onto Palisade Street.

The majority of the property consists of six adjacent lots that front onto Carlos Bee Boulevard. All of the lots are currently vacant; however, the two end lots had been previously developed with homes, based on our review of historic aerial photographs. The parcel at the intersection of Overlook Avenue and Carlos Bee Boulevard contains some foundation remnants and retaining walls from the prior development. In the late 1950s, the property was graded to create a series of terraced lots that step down the hill facing Carlos Bee Boulevard. The property also includes a continuous slope behind the terraced lots that leads up to the neighboring residential lots above. The lots are now overgrown with grasses and there are several mature trees located near the center of the site. The far west end of the property was observed to be muddy.

PROPOSED DEVELOPMENT

We understand that a series of residential units grouped into four separate pods are planned for the project site. The locations of the proposed structures are to take advantage of the existing terraced building pads. Site access is proposed along a single long driveway connected to Overlook Avenue. The proposed development scheme is shown on the Site Plan prepared by Kodama Diseno, Architects & Planners, dated November 16, 2017 (see Figure 3).

GEOLOGY

Geologic Setting

The project site is located within the San Francisco Bay portion of the Coast Ranges geomorphic province of California, a region characterized by northwest-trending ridges and intervening valleys influenced by the strike of the San Andreas and related faults. The lots are on the west flank of the East Bay Hills which are underlain by a variety of sedimentary, igneous, and metamorphic bedrock types that range from Jurassic to Miocene in age. The geologic structure of the area has been severely complicated by faulting related to the active Hayward fault zone. Fault traces within the Hayward fault zone have been variously mapped to the west within close proximity to the subject property (Dibblee, 1980 and 2005; Graymer and others, 1996; Herd, 1978; Jennings and Bryant, 2010; Lienkaemper, 1992; Radbruch, 1967; Radbruch-Hall, 1974; and Robinson, 1956).

Bedrock

Igneous rocks, mainly rhyolite and gabbro, are the most prominent rock types in the site area. Rhyolite is typically associated with gabbro, serpentinite, and ultramafic rocks. Gabbro and the other rock types form a sequence of related rocks collectively known as the Coast Range ophiolite (or ancient sea floor) of Jurassic age that is widespread in the East Bay Hills. However, the published geologic maps indicate that the project site is underlain by sedimentary rocks assigned to the Knoxville Formation of Jurassic and Cretaceous age. The Knoxville rocks generally consist of shale and sandstone (Dibblee, 1980 and 2005; Ellen and Wentworth, 1995; Graymer and others, 1996; and Robinson, 1956).

Landslides

Many landslides have been mapped throughout hills within the site area. The U.S. Geological Survey has not mapped any landslides within or adjacent to the project site (Herd, 1978; and Nilsen, 1975). Additionally, other published geologic maps have not identified any landslides within or adjacent to the subject property (Dibblee, 1980 and 2005). Lastly, the site is not included within a State of California Seismic Hazards Zone for Earthquake-Induced Landslides (State Geologist, 2012; see Figure 2).

FAULTING AND SEISMICITY

Faults

The San Francisco Bay area is dominated by the northwest-trending San Andreas fault and related seismically active[1] faults, such as the Hayward – Rodgers Creek, Calaveras, Concord – Green Valley, and Greenville – Marsh Creek fault zones (Jennings and Bryant, 2010; see Figure 5). In the global context of plate tectonics, these major subparallel faults act as an enormous zone of shearing and deformation up to 50 miles wide along a transform plate boundary. Collectively, they accommodate approximately 39 mm/yr of slip between the Pacific and the North American tectonic plates, with most of the movement occurring along the San Andreas fault.

The west portion of the project site is within the Earthquake Fault Zone for the Hayward fault as established by the State of California for active faults (Hart and Bryant, 1997). The nearest trace of the Hayward fault zone as shown on the latest official map by the State of California (State Geologist, 2012) is approximately 300 feet to the west of the west property boundary (see Figure 2). An older version of the official State of California map as well as other fault maps published by the U.S. Geological Survey locate an additional fault trace within very close proximity to the west property boundary (Radbruch, 1967; Radbruch-Hall, 1974; and State Geologist, 1974).

There are other prominent faults mapped in the vicinity of the site, such as the northwest-trending East and West Chabot faults located more than 2,000 feet to the east (Dibblee, 1980 and 2005; Graymer and others, 1996; and Robinson, 1956). These other prominent fault traces are not currently considered seismically active (Hart and Bryant, 1997). No faults have been mapped as passing through the east portion of the project site that is located outside of the Earthquake Fault Zone for the Hayward fault on any of the published geologic maps reviewed for this evaluation (Dibblee, 1980 and 2005; and Robinson, 1956). Table 1 below lists the major faults controlling seismicity within 50 miles (80 km) of the site.

[1] An “active” fault is defined as one that has had surface displacement within Holocene time or about the last 11,000 years (California Code of Regulations, Title 14, Division 2, Appendix B, Section 3601).

Table 1: San Francisco Bay Area Faults with 50 Miles (80 km) of the Project Site (FRISKSP, 2004; WGCEP, 2003 and 2008)

Earthquake Generating Fault	Fault Length (km/mi)	Distance to Nearest Fault Segment from Site* (km/mi)	Upper Bound Earthquake Mw_{max}	Slip Rate (mm/yr)
Hayward (South)	53 / 33	0.09 / 0.05	6.9	9.0
Hayward (North)	35 / 22	9.5 / 5.9	6.9	9.0
Calaveras (North Calaveras Res)	45 / 28	12.7 / 7.9	6.8	6.0
Concord – Green Valley	56 / 35	26.5 / 16.5	6.9	6.0
Hayward (Southeast Extension)	26 /16	26.6 / 16.5	6.4	3.0
Monte Vista – Shannon	45 / 28	29.5 / 18.3	6.8	0.4
San Andreas (Peninsula)	85 / 53	29.4 / 18.3	7.1	17.0
San Andreas (1906)	190 / 118	29.4 / 18.3	7.9	24.0
Greenville	27 / 17	30.4 / 18.9	6.9	2.0
Great Valley 6	85 / 53	34.5 / 21.4	6.7	1.5
Calaveras (South Calaveras Res)	59 / 37	35.2 / 21.9	6.2	15.0
San Gregorio	110 / 68	40.9 / 25.4	7.4	7.0
Great Valley 7	45 / 28	41.1 / 25.5	6.7	1.5
Great Valley 5	28 / 17	46.5 / 28.9	6.5	1.5
San Andreas (North Coast)	45 / 28	49.1 / 30.5	7.6	24.0
Rodgers Creek	62 / 39	53.0 / 32.9	7.0	9.0
San Andreas (Santa Cruz Mts)	62 / 39	54.2 / 33.7	7.0	17.0
West Napa	30 / 19	58.0 / 36.0	6.5	1.0
Zayante – Vergeles	80 / 50	64.3 / 40.0	7.0	0.1
Great Valley 4	42 / 26	67.6 / 42.0	6.6	1.5
Point Reyes	47 / 29	74.1 / 46.1	6.8	0.3

* Distance to faults are based on latitude and longitude of the project site

Historic Earthquakes

The site is within the seismically active San Francisco Bay area where small earthquakes (Magnitude <4) are frequent, moderate earthquakes (Magnitude 4–6) are sometimes felt, and large earthquakes (Magnitude >6) occur, but are rare. The written record of documented earthquakes in California exists for only about the last 249 years, or since 1769 when the Spanish began to construct missions throughout California. From 1800 to 2000, over 600 moderate earthquakes and as many as 15 large earthquakes have occurred within 100 miles (161 km) of the project site (EQSEARCH, 2004, Stover and Coffman, 1993, and Toppozada and others, 2000). Table 2 lists the 15 large magnitude earthquakes that have occurred in historic time near the site.

Table 2: Large Earthquakes (M>6.0) within 100 miles (161 km) of the Project Site (EQSEARCH, 2004)

Epicenter Location	Date	Moment Magnitude	Distance* (km/mi)	Compass Direction to Epicenter
Hayward	October 21, 1868	6.8	5.0 / 3.1	North
SF Peninsula	June 1, 1838	7.0	29.7 / 18.5	West
North San Jose	November 26, 1858	6.1	23.4 / 14.6	South
San Francisco	April 18,1906	8.25	38.0 / 23.6	West
San Francisco	June 21, 1808	6.3	40.7 / 25.3	West
South Santa Cruz Mountains	October 8, 1865	6.3	42.9 / 26.7	South
Morgan Hill	April 24, 1984	6.2	50.2 / 31.2	South
Morgan Hill	July 1, 1911	6.6	53.8 / 33.4	South
Mare Island	March 31, 1898	6.2	66.4 / 41.3	North
Loma Prieta	October 18, 1989	7.0	71.5 / 44.4	Southwest
Vacaville	April 19, 1892	6.4	82.3 / 51.1	North
Winters	April 21,1892	6.2	94.3 / 58.6	North
Gilroy	June 20, 1897	6.2	89.2 / 55.4	Southeast
Pajaro Gap	October 18, 1800	7.0	102.5 / 63.7	South
Pacific Ocean	October 22, 1926	6.1	119.4 / 74.2	Southwest

* Distances to earthquake epicenters are based on latitude and longitude of the project site

Future earthquake prediction by the U.S. Geological Survey's Working Group on California Earthquake Probabilities (2003) suggests that there is a 62% chance of at least a magnitude 6.7 or greater earthquake occurring in the San Francisco Bay area before 2031. There is a 27% chance that this predicted earthquake will occur on the Hayward-Rodgers Creek fault zone (WGCEP, 2003 and 2008). The Hayward fault is considered by many geologists to be the likely source of the next large earthquake in the Bay Area. The following paragraphs focus on the Hayward fault and its seismic record.

<u>Hayward Fault Overview</u>

The Hayward fault is primarily a dextral-slip fault that extends from near Warm Springs in Fremont on the south to San Pablo Bay on the north. The total fault length is approximately 55 miles. The Hayward fault is moving very slowly or creeping aseismically along its entire length at an average rate of 4 to 5 mm/year (averaged along the fault over several decades). The average creep rate is about half the average long-term slip rate, which is approximately 9 mm/year (i.e., the rest of the slip occurs seismically during earthquakes). The width of the zone of active shearing varies, but is thought to be on the order of 100 to 200 feet (Lettis, 2001; Lienkaemper and others, 2002; Smith, 1981; and WGCEP, 2003 and 2008).

North of San Pablo Bay, the Hayward fault is thought to step to the right and link with the Rodgers Creek fault. The Rodgers Creek fault extends from San Pablo Bay to near Santa Rosa on the north, a distance of approximately 39 miles. This constitutes a combined length of approximately 93 miles for the Rodgers Creek-Hayward fault system.

The Hayward fault is divided into two segments generally based on seismicity. The southern Hayward fault, which is identified as the segment extending from near Warm Springs to near Montclair, has a fault length of approximately 33 miles, and it is capable of producing a Magnitude 6.9 earthquake. The northern Hayward fault, which is identified as the segment from near Montclair to San Pablo Bay, has a fault length of approximately 22 miles, and is capable of producing a Magnitude 6.7 earthquake. The San Francisco Bay area could experience a Magnitude 7.1 if the entire Hayward fault were to rupture in a single earthquake. Likewise, if the entire Rodgers Creek-Hayward fault system were to rupture in a single event, the resulting earthquake could be as large as a Magnitude 7.4 (WGCEP, 2003 and 2008).

The project site is closest to the Hayward Segment of the southern Hayward fault. Several traces of the Hayward fault zone have been mapped both to the east and west of the site (Dibblee, 1980 and 2005; Graymer and others, 1996; Herd, 1978; Lienkaemper, 1992; Radbruch, 1967; Radbruch-Hall, 1974; Robinson, 1956; and State Geologist, 1974 and 2012). The active creeping trace and likely the most prominent trace of the Hayward fault in the vicinity of the site is located approximately 300 feet to the west of the west property boundary (Lienkaemper, 1992; and State Geologist, 2012). There is evidence to suggest that another less prominent trace of the Hayward fault zone is located closer to the site. This other fault trace has been approximately located in backhoe trenches near the west property boundary by a private consulting firm working on the former Hillcrest School site in the late 1970s (Woodward-Clyde Consultants, 1978). This secondary fault trace appears on a previous version of the State of California official map of the Earthquake Fault Zone (State Geologist, 1974), but not on the most current map as shown on Figure 2.

Past and Future Seismicity along the Southern Hayward Fault

A paleoseismic study sponsored by the U.S. Geological Survey along the southern Hayward fault at Tyson's Lagoon in Fremont has revealed evidence of 12 large earthquakes over the last 2,000 years. The last 4 of these large earthquakes occurred within the last 500 years and have been dated to AD 1470, AD 1630, AD 1730, and AD 1868 through pollen analysis and radiocarbon dating of organic materials from fault scarp debris uncovered in backhoe trenches. The average recurrence interval for these large earthquakes on the southern Hayward fault was determined to be 161 $\pm$ 65 years for all 12 events and 138 $\pm$ 59 years for the last 5 earthquakes (Lienkaemper and others, 2002 and 2008). Alternatively, Lettis (2001) suggests that the recurrence interval for large earthquakes along the southern Hayward fault is on the order of 150 to 250 years.

On October 21, 1868 a Magnitude 6.8 earthquake occurred on the southern Hayward fault (see Table 2). This was the largest earthquake in historic time to occur on the Hayward fault, and it was the largest historic earthquake to shake the Bay Area until the 1906 San Francisco earthquake. The epicenter of the 1868 earthquake is thought to have been near the town of Hayward. The earthquake reportedly created a ground scarp that was as much as 12 inches high, extending from San Leandro on the north to Warm Springs on the south, a distance of approximately 20 miles. There is some evidence to suggest that the ground surface rupture continued further north to near Mills College. In the site vicinity, the approximate location of the ground rupture is thought to be as close as 300 feet to the west of the project site. Other reported damages from the 1868 earthquake close to the site suggest that there was liquefaction and landsliding along San Leandro Creek, approximately 1.3 miles northwest of the subject site (Lettis, 2001; Stover and Coffman, 1993; and Youd and Hoose, 1978).

REVIEW OF PREVIOUS FAULT EVALUATION REPORTS

We have researched, reviewed, and analyzed 13 geologic/geotechnical reports prepared by private consultants for nearby residential sites along the Hayward fault zone between 1970 and 2017. Our research extended at least 0.5 miles in both directions along the fault zone as shown on Plate 1. We obtained some of these fault investigation reports in the public files at the City of Hayward, and others were available in electronic format from the California Geological Survey (2003). These previous reports for the site area were selected because they all involve some method of subsurface exploration, such as trenching, to investigate the possibility of faulting. References for these previous fault investigation reports are listed in the back of this report. The results of our research are briefly summarized in Table 3 below.

Table 3: List of Previous Fault Evaluation Reports Reviewed Near the Project Site

Plate 1 Locale	Consulting Firm and Report Date	Distance from Site	Faults Found	Evaluation of Trench Logs / Comments
1	Woodward, Clyde & Associates, 1970	3,000 Feet Northwest	Yes	Agree
2	Hallenbeck-McKay & Associates, 1982	2,700 Feet Northwest	Yes	Agree
3	Darwin Myers Associates, 1984	2,700 Feet Northwest	Yes	Agree
4	Hallenbeck-McKay & Associates, 1974	2,700 Feet Northwest	No	Disagree / Bedrock Surface Stepped and Maybe Faulted
5	Woodward-Clyde Consultants, 1978	Adjacent to the West	Yes	Agree
6	GEI, 1987	1,200 Feet Southeast	No	Agree
7	Engeo, Inc., 2017	1,500 Feet Southeast	Yes	Agree
8	GEI, 1989	1,700 Feet Southeast	No	Disagree / Surficial Deposits Interrupted and Maybe Faulted
9	Terrasearch, 1980	2,100 Feet Southeast	No	Agree
10	Terrasearch, 1974	2,400 Feet Southeast	No	Agree
11	Judd Hall & Associates, 1975	2,500 Feet Southeast	No	No Trench – Only Seismic Line
12	Gasch & Associates, 1975	3,500 Feet Southeast	No	Agree
13	Merrill & Seeley, Inc., 1979	4,000 Feet Southeast	No	Disagree / Surficial Deposits Interrupted and Maybe Faulted

REVIEW OF HISTORIC AERIAL PHOTOGRAPHS

We have reviewed selected vertical stereo pairs of historic aerial photographs of the project site and vicinity for the years 1947, 1953, 1957, 1959, 1968, 1969, 1971, 1975, 1983, 1990, 1997, and 2002. The horizontal scales of the selected imagery ranged from 1:7,200 to 1:30,000. Reviewing multiple pairs of aerial photographs that have been taken at different altitudes is part of a comprehensive fault evaluation to identify geomorphic anomalies that could be attributed to active faulting. Our observations and interpretation of such fault-related geomorphic anomalies from the aerial photographic analysis are plotted on Plate 1. A complete list of photographs reviewed is provided in the back of this report.

Chronology of Development

The earliest aerial photographs reviewed from the 1940s and 1950s show the presence of Mission Boulevard with dense development along both sides. An early version of Carlos Bee Boulevard was also present as a relatively narrow paved roadway that makes a sweeping right turn up the hill as it passes the project site. The only other major roadways shown on these early aerial photographs in the vicinity of the project site are Central Boulevard to the southeast, which was present in its entire length; a short segment of Westview Way further to the southeast connected to Central Boulevard; and Berry Avenue, Delmont, and Delmar Avenues closer to Mission Boulevard.

The project site remained undeveloped through the late 1950s and appeared as a generally grass-covered field that was gently sloping toward the west along the north side of relatively narrow Carlos Bee Boulevard. The gently-sloping field, inclusive of the project site, was dissected by two drainages. The larger of the two drainages flowed west along the north side of Carlos Bee Boulevard. A smaller tributary joined the larger stream near the west property boundary of the project site. Both drainages were marked by dense vegetation and small trees as observed on the 1947, 1953, and 1957 aerial photographs.

The first major development near the site was on the Hillcrest School property located downhill and adjacent to the west property boundary of the project site. A large rectangular building pad was graded sometime between 1947 and 1953, based on our review of aerial photographs. It appears that the upper portion of the large level building pad nearest the project site was modified into a cut slope. Three of the four large existing structures at the Hillcrest School site are present on the 1953 aerial photographs. The fourth large building appears on the 1957 aerial photographs.

The project site as well as the remaining adjacent properties were developed in the late 1950s. The 1959 aerial photographs show that the property and the adjacent areas to the north and east had been graded and terraced into a series of building pads sometime between 1957 and 1959. For the first time, the streets surrounding the project site were present, including Overlook Avenue and Palisade Street. Homes appear on the building pads overlooking the project site for the first time. However, no homes existed within the site at this time. Also by 1959, Carlos Bee Boulevard was widened into the existing roadway by filling in the drainage that once flowed between the project site and original narrower Carlos Bee Boulevard alignment. The tribuary drainage that connected to this larger drainage near the west property boundary was also backfilled at this time as part of the overall development.

For the first time as seen on the 1968 aerial photographs, two houses appear within the project site. One is located at the corner of Overlook Avenue and Carlos Bee Boulevard and the second is located at the west end of the project site near the Hillcrest School. These two homes appear within the project site on the remainder of the aerial photographs reviewed including those from 2002. However, these structures were removed from the site sometime after 2002.

Fault Geomorphology

All of the aerial photographs reviewed show a prominent linear scarp that forms a well-defined break in the topography separating the valley plain from the hills within the site vicinity. This scarp has been mapped as the main trace of the Hayward fault zone located approximately 300 feet to the west of the west property boundary (see Figure 2 and Plate 1). On the aerial photographs that pre-date the development of the Hillcrest School site adjacent to the west of the project site, we identified another, although less prominent, linear scarp near the west property boundary that coincides with a secondary trace of the Hayward fault zone. These two subparallel faults defined an elongate terrace along the otherwise relatively steep hillslopes. The subject property sits along the upslope side of this elongate terrace.

With the exception of the linear scarp near the west property boundary, we did not observe any obvious lineaments, springs, abrupt vegetation changes, or any other geomorphic anomalies within the project site that could be attributed to active faulting from the Hayward fault zone. Our interpreted fault traces within the site vicinity from a review of the aerial photographs are plotted on Plate 1. We have also plotted some landslides observed on the aerial photographs located along the slope to the southeast of the project site on Plate 1.

EXPLORATORY TRENCH EXCAVATION

We geologically logged a single exploratory trench excavated within the west portion of the project site at the approximate location shown on Figure 3. The trench was oriented approximately perpendicular to the mapped trace of the Hayward fault zone (see Figure 3 and Plate 1). The trench was excavated using a backhoe with a 36-inch bucket. The excavation was approximately 175 feet long and up to 16.5 feet deep. The trench excavation was shored and benched for safety, the walls cleaned by hand, and a string line datum was used to log the trench.

We logged the north wall of the trench and produced a graphic log of the exposure at a scale of 1 inch = 2 feet (see Plate 2). After logging, we invited Mr. Lou Richardson, the City of Hayward peer reviewing geologist, to observe and comment on the trench exposures. Mr. Richardson visited the project site on January 7, 2018. He will also provide a review and written comments on this final report.

The trench excavation exposed a significant amount of artificial fill underlain by native soils. The native soils or colluvium was resting on top of sedimentary bedrock. No obvious signs of active faulting were identified within the bedrock exposures in the trench. Seepage was encountered as the excavation penetrated the bedrock. A copy of our graphic log from the trench is reproduced as Plate 2. Below is a brief summary of our observations and interpretations of the trench exposure with horizontal station references.

Descriptions of Earth Materials

Artificial Fill (AF): We encountered artificial fill materials along the length of the entire trench excavation that varied in thickness from 6 to 15 feet. The fill generally consisted of a mixture of silty to sandy clay with variable amounts of gravel and rock fragments. The fill was slightly moist to moist and generally in a firm to stiff condition. It appeared that the fill materials had been compacted in lifts owing to the characteristic layering pattern observed within the fill. The fill soils were observed to have been placed directly on either native colluvial soils or bedrock.

Native Colluvial Soils (Qcol): We observed a discontinuous layer of colluvium underneath the fill materials, resting on bedrock, throughout most of the length of the exploratory trench from Station 0 + 33 to Station 1 + 55. These native soils generally consisted of sandy clay with some minor soil development and associated clay films between grains. Where present in the trench, the layer ranged in thickness from a few inches to over 3.5 feet. We observed that some of the native soils had been removed prior to the placement of fill that accounted for the discontinuous nature of the deposit. This was highlighted on the trench log at Stations 0 + 60 and 1 + 17.

Weathered Knoxville Formation (JKkw): In portions of the trench, we identified a severely weathered bedrock layer directly below the native soils generally consisted of siltstone fragments with a sandy clay matrix. The contact with less weathered bedrock below was undulatory and we believe reflected the differential weathering between the weaker siltstone and the less resistant sandstone.

Knoxville Formation (JKk): The trench penetrated continuous sedimentary bedrock from Station 0 + 50 to Station 1 + 75. The bedrock at the east end of the trench generally consisted of siltstone with shaley interbeds. Sandstone became the dominant bedrock type in the west portion of the trench. The exposed bedrock was well cemented, well indurated, and severely fractured. The bedrock encountered in the trench was consistent with published descriptions of the Knoxville Formation of Jurassic to Cretaceous age (Dibblee, 1980 and 2005; Ellen and Wentworth, 1995; Graymer and others, 1996; and Robinson, 1956). Ground water was encountered within the bottom of the trench flowing through the bedrock fractures.

Bedding was well developed within the siltstone and sandstone bedrock. Bedding attitudes measured within the trench at various locations were striking from N74E to N75W and dipping northerly from 50 to 80 degrees (see Plate 2). This bedding orientation is consistent with that shown on published geologic maps (Dibblee, 1980 and 2005).

We did not identify any shear zones or other structural fabrics that would suggest active faulting had occurred within the exposed length of the bedrock in the trench from Station 0 + 50 to Station 1 + 75. At Station 0 + 50, the sandstone bedrock descended into the trench bottom. Rising ground water prevented deeper excavation in this area. The overlying colluvial layer extended further to the west to Station 0 + 33 before disappearing into the trench bottom.

Backfill of Excavation

After logging was complete, we backfilled the exploration with loosely compacted soils and rock cuttings excavated from the trench. The backfill should not be considered property compacted and should not be relied upon to support future construction within the site.

EVALUATION OF THE COLLECTED DATA

From our review or previous fault evaluation reports along the Hayward fault zone to the northwest and southeast of the project site, we conclude that the fault zone generally consists of two traces (see Plate 1). The most prominent fault trace is currently identified on the most recent official State of California Earthquake Fault Zone map (see Figure 2) and it is marked by a conspicuous linear scarp that separates the hills from the valley as observed on historic aerial photographs. This prominent fault trace is located approximately 300 feet to the west of the west property boundary for the project site.

The second fault trace is uphill to the east of the most prominent trace and it is likely located near the west property boundary of the project site. This fault trace was previously identified by Woodward-Clyde Consultants (1978) within the adjacent Hillcrest School site and by other consultants further northwest and southeast along the same trend as shown on Plate 1. This second trace has also been identified on published fault and geologic maps (Herd, 1978; and State Geologist, 1982).

The two subparallel fault traces form an elongate geomorphic bench or terrace along this flank of the East Bay Hills that locally ranges from 300 to 500 feet wide. This terrace provides an extensive and nearly level bench within an otherwise relatively steep hillslope terrain. Consequently, the elongate bench has been developed with residential streets and structures prior to the enactment of the Alquist-Priolo Fault Zone Act of 1972. The project site overlooks this geomorphic bench.

DISCUSSION AND CONCLUSIONS

Based on our review of data gathered for this evaluation, the nearest active trace for the Hayward fault zone is likely located near the west property boundary of the project site. From our review of aerial photographs, the project site is adjacent to and topographically above a tectonically uplifted fault block forming an elongate terrace between fault traces. The most prominent trace of the Hayward fault zone has been mapped approximately 300 to the west of the west property boundary (see Plate 1). Another fault trace has been identified near the west property boundary from previous work completed on the adjacent property (Woodward-Clyde Consultants, 1978; see Plate 1).

From our geologic interpretations and analysis of soil and rock exposures logged in the exploratory excavation, we conclude that no active faults pass through the exploratory trench excavation from Stations 0 + 50 to 1 + 75 where bedrock was exposed as shown on Plate 2. The depth of the bedrock below the existing ground surface between Station 0 + 00 and Station 0 + 50, the thickness of the overlying fill materials, and the rising ground water condition in the west portion of our exploratory trench made it unsafe to explore the underlying bedrock at this end of the trench.

We are unable to determine whether or not active fault traces may be present within the project site west or downhill of Station 0 + 50 from the exploratory trench and therefore, we have established a No Residential Construction Zone within the west portion of the project site as depicted on Figure 3. One of the fourteen proposed residential structures encroaches into this zone as shown on Figure 3 and this proposed structure will have to be shifted outside of the No Residential Construction Zone.

NO RESIDENTIAL CONSTRUCTION ZONE

Future residential construction shall not extend down the slope to the west beyond a line parallel with the east boundary of the Earthquake Fault Zone for the Hayward fault that coincides with Station 0 + 50 in the exploratory trench. The parallel line forming the east boundary of the No Residential Construction Zone is measured from the site plan at approximately 152 feet west of the northwest property corner and approximately 95 feet west of the southwest property corner. Figure 3 depicts the area in question and illustrates the dimensions of the zone.

Following the regulations established for structures intended for human occupancy (defined as 2,000 person/hours per year) under the Alquist-Priolo Earthquake Fault Zone Act of 1972, no structures for residential occupation are to be located within the No Residential Construction Zone shown on Figure 3. However, other support structures may be located within the No Residential Construction Zone provided these are not used for living spaces. Acceptable structures within the zone would include parking areas, detached garages, workshops, and sheds.

LIMITATIONS

The contents of this evaluation are based upon a review of available published and unpublished data referenced in this report; geologic logging of a single exploratory fault trench; and professional judgment based on such information. Although they are not anticipated for the subject site, we did not perform an evaluation or assessment or review any documents pertaining to any potential environmental hazards, such as hazardous materials or groundwater contamination that may be present within the property.

The proposed construction at the site should be designed, observed, and built by qualified professionals. We have no control over future development, construction, and occupancy on this property, and we make no representations regarding future conditions at the site. It is the property owners' responsibility to make this report and its contents available to the construction design team, and to future buyers of the property. Changes in site conditions and standard of practice can occur over time; consequently, the conclusions in this report should be reviewed after two years, and updated by this office, if necessary.

Thank you for the opportunity to provide our services on this project. If you have any questions regarding the contents of this report, please do not hesitate to call us at (510) 794-7495.

Sincerely,

EARTH FOCUS GEOLOGICAL SERVICES, INC.

Patrick L. Drumm, PG, CEG, CHG
Senior Engineering Geologist

CERTIFIED ENGINEERING GEOLOGIST
PATRICK L. DRUMM
CEG
NO.
1916
11-30-19
STATE OF CALIFORNIA

Attachments:

Figure 1 – Site Location Map

Figure 2 – State of California Earthquake Zones of Required Investigation

Figure 3 – Site Map Showing the Trench Location and No Residential Construction Zone

Figure 4 – Regional Geologic Map

Figure 5 – Regional Fault Map

Plate 1 – Fault Studies Compilation Map (oversize in pocket)

Plate 2 – Trench Log (oversize in pocket)

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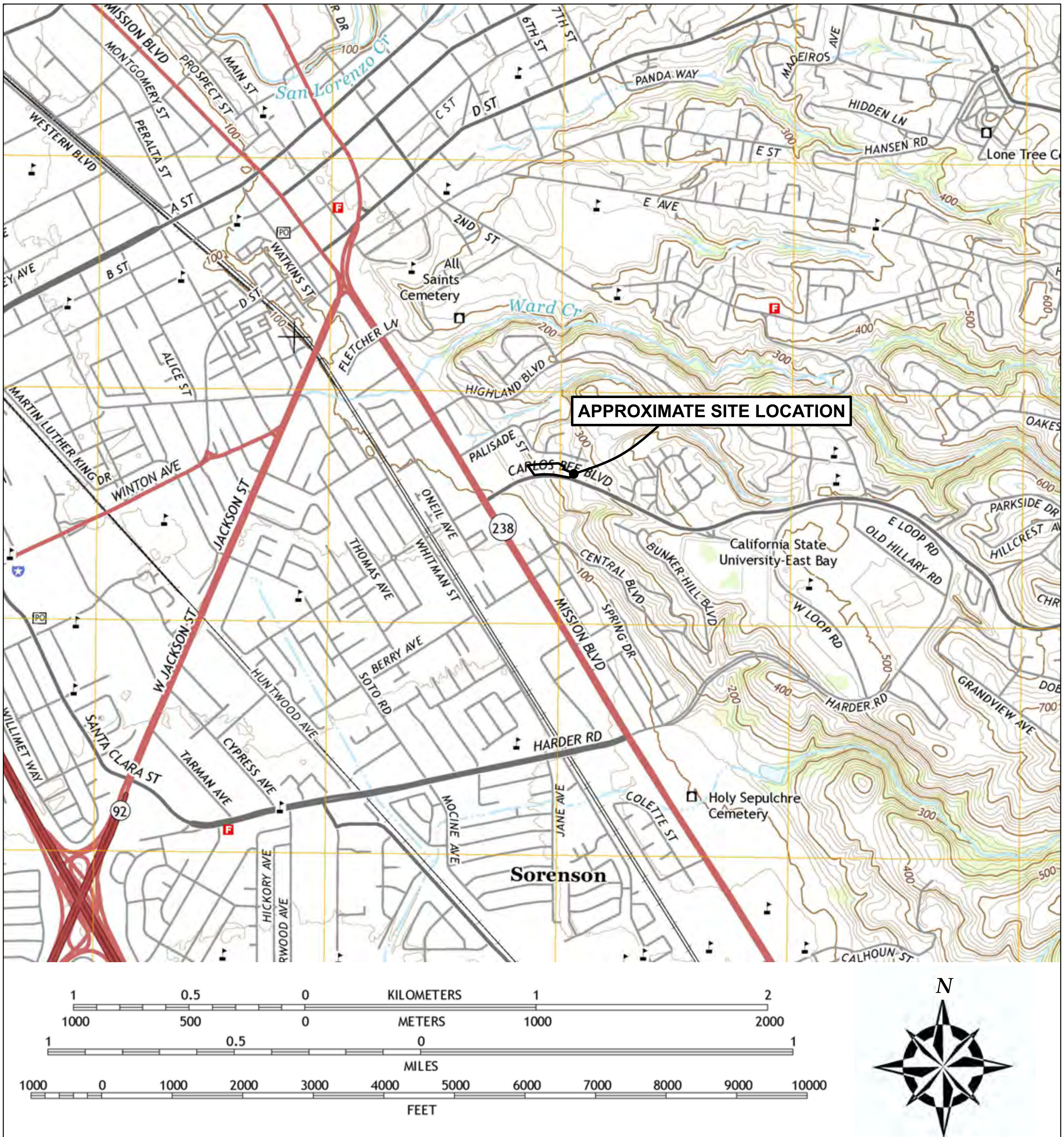
AERIAL PHOTOGRAPHS REVIEWED

Date	Flight Line	Frames	Scale	Type
03-24-47	AV-11	04-26 & 27	1:20,000	B & W Stereo
08-17-53	AV-119	21-26 & 27	1:10,000	B & W Stereo
05-03-57	AV-253	17-46 & 47	1:12,000	B & W Stereo
07-08-59	AV-337	09-55 & 56	1:9,600	B & W Stereo
04-22-68	AV-844	17-38 & 39	1:30,000	B & W Stereo
05-02-69	AV-902	08-40 & 41	1:12,000	B & W Stereo
05-18-71	AV-995	06-45 & 46	1:12,000	B & W Stereo
05-06-75	AV-1193	08-39 & 40	1:12,000	B & W Stereo
06-21-83	AV-2300	08-43 & 44	1:12,000	B & W Stereo
07-26-90	AV-3845	17-44 & 45	1:12,000	B & W Stereo
06-07-97	AV-5433	3-5 & 6	1:7,200	B & W Stereo
06-26-02	AV-8202	17-39 & 40	1:12,000	B & W Stereo

All photographs available for review at Quantum Spatial, Inc., in Novato, California

Attachment III



Map Source: U.S. Geological Survey, 2015, Hayward, California, 7.5′ Quadrangle, Map Scale 1:24,000.

Earth Focus
Geological Services, Inc.
www.earthfocusgeology.com

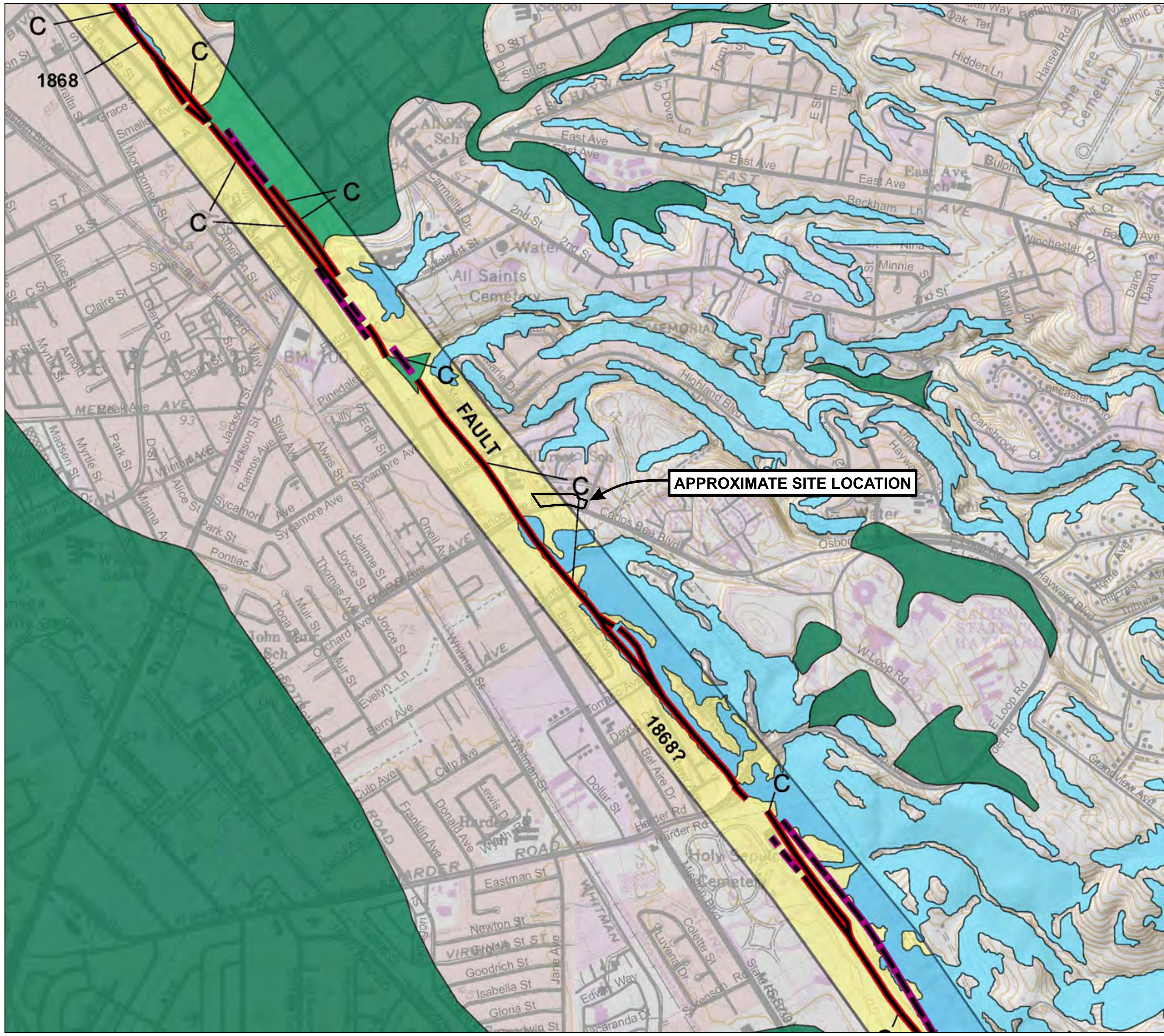
115 Orchard Drive
Fremont, CA 94536
Phone/Fax 510-794-7495

SITE LOCATION MAP

Fault Rupture Hazard Evaluation, Hayward Fault Zone
25036 to 25096 Carlos Bee Boulevard
Hayward, California

Project No. F17-01515	January 2018	Figure 1

Map Source: State Geologist, 2012, Earthquake Zones of Required Investigation, Hayward Quadrangle: California Geological Survey Official Map, Released September 21, 2012, Map Scale 1:24,000.



MAP EXPLANATION

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONES

Earthquake Fault Zones
Zone boundaries are delineated by straight-line segments; the boundaries define the zone encompassing active faults that constitute a potential hazard to structures from surface faulting or fault creep such that avoidance as described in Public Resources Code Section 2621.5(a) would be required.

Active Fault Traces
Faults considered to have been active during Holocene time and to have potential for surface rupture: Solid Line in Black or Red where Accurately Located; Long Dash in Black or Solid Line in Purple where Approximately Located; Short Dash in Black or Solid Line in Orange where Inferred; Dotted Line in Black or Solid Line in Rose where Concealed; Query (?) indicates additional uncertainty. Evidence of historic offset indicated by year of earthquake-associated event or C for displacement caused by fault creep.

1906 C ?

SEISMIC HAZARD ZONES

Liquefaction Zones
Areas where historical occurrence of liquefaction, or local geological, geotechnical and ground water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslide Zones
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

OVERLAPPING ALQUIST-PRIOLO AND SEISMIC HAZARD ZONES

Overlap of Earthquake Fault Zone and Liquefaction Zone
Areas that are covered by both Earthquake Fault Zone and Liquefaction Zone.

Overlap of Earthquake Fault Zone and Earthquake-Induced Landslide Zone
Areas that are covered by both Earthquake Fault Zone and Earthquake-Induced Landslide Zone.

Note: Mitigation methods differ for each zone – AP Act only allows avoidance; Seismic Hazard Mapping Act allows mitigation by engineering/geotechnical design as well as avoidance.

0 1 2 Miles

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 Feet

0 1 2 Kilometers

0 1000 2000 Meters

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Earth Focus Geological Services, Inc.
www.earthfocusgeology.com

115 Orchard Drive
Fremont, CA 94536
Phone/Fax 510-794-7495

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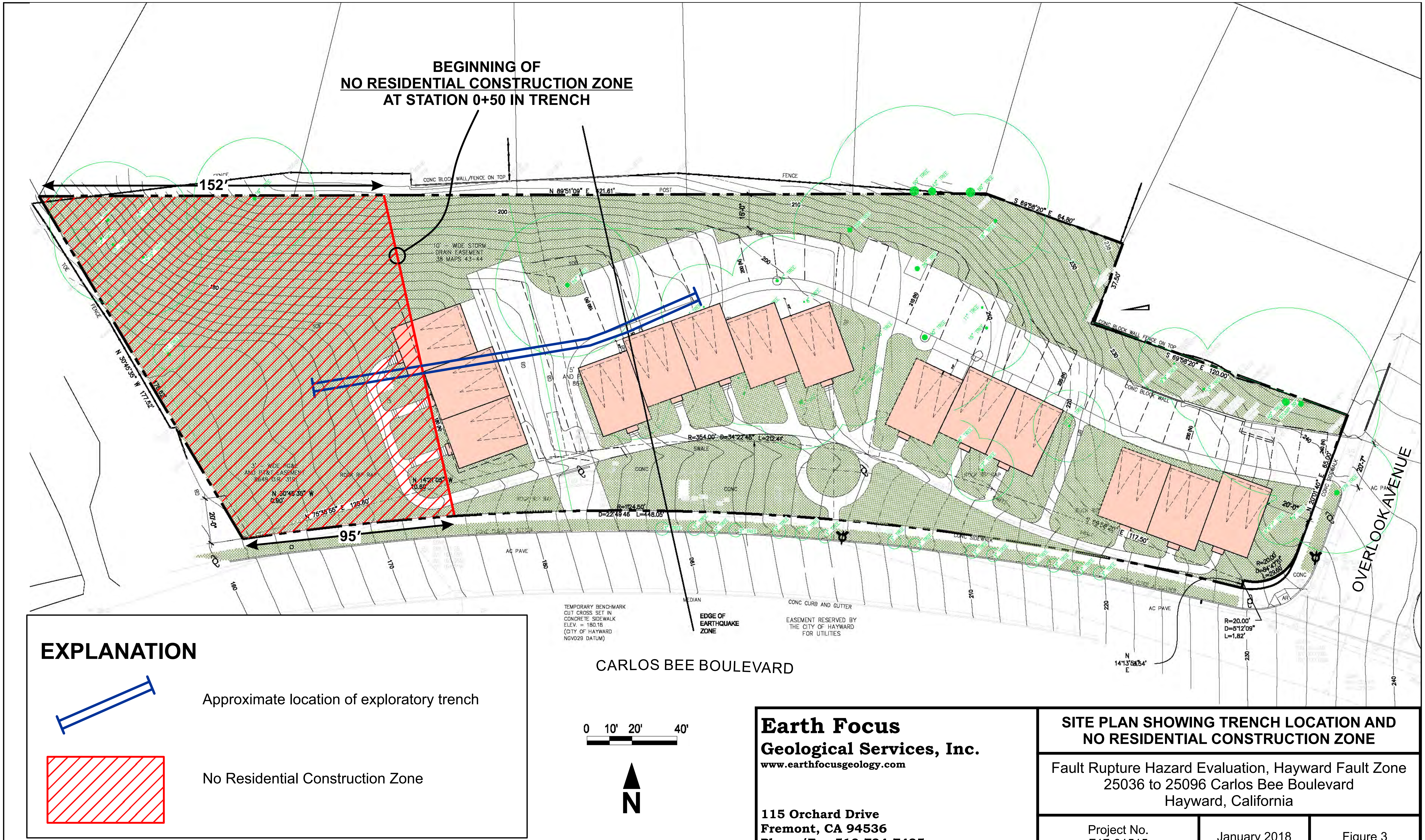
EARTHQUAKE ZONES OF REQUIRED INVESTIGATION

Fault Rupture Hazard Investigation, Hayward Fault Zone
25036 to 25096 Carlos Bee Boulevard
Hayward, California

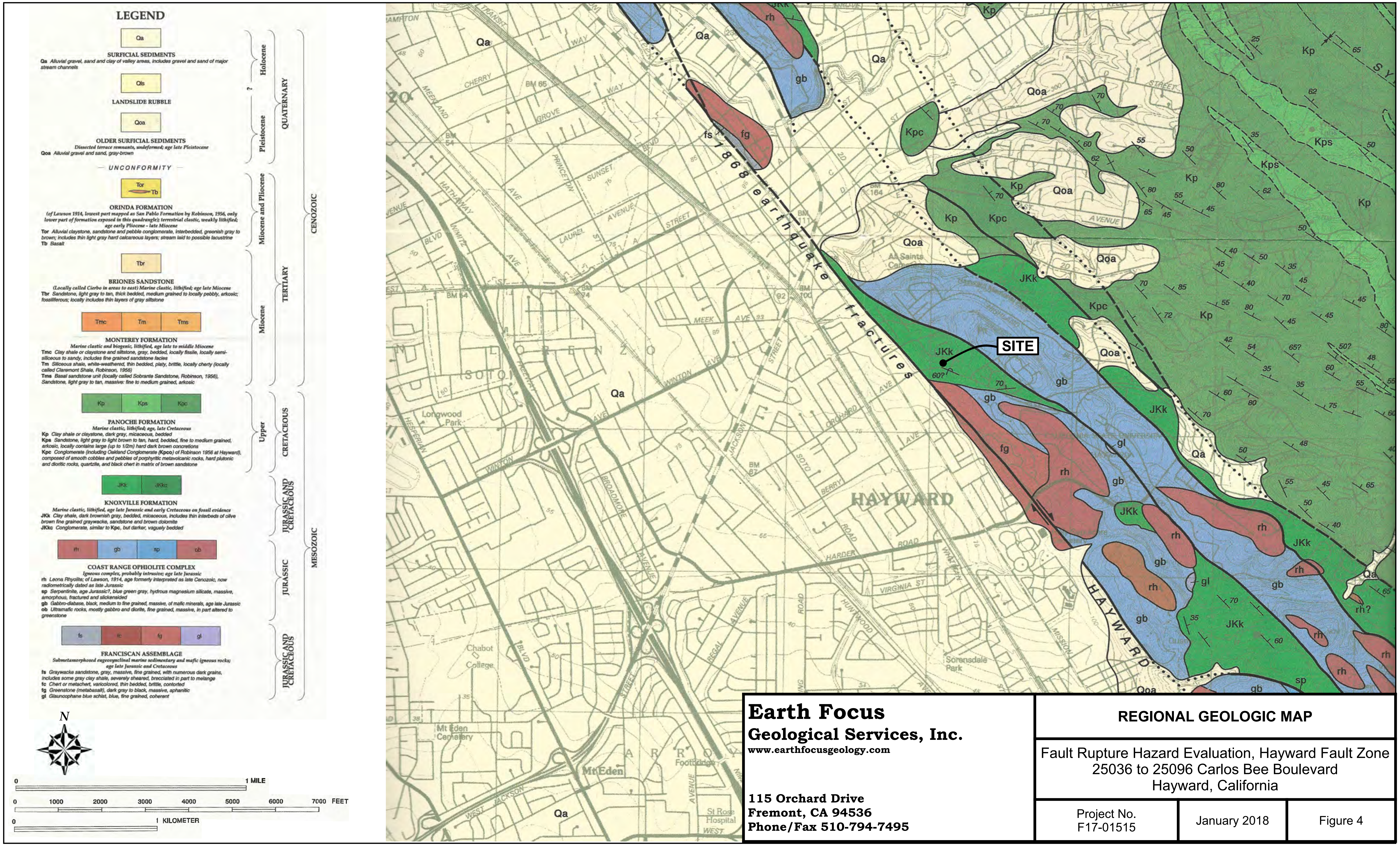
Project No. F17-01515	January 2018	Figure 2



Plan Source: Kodama Diseño, 2017, Site Plan - Path of Travel & Circulation, 25036 - 25096 Carlos Bee Blvd, Hayward, California (PUD Submittal, November 16, 2017).

Earth Focus Geological Services, Inc. www.earthfocusgeology.com 115 Orchard Drive Fremont, CA 94536 Phone/Fax 510-794-7495	**SITE PLAN SHOWING TRENCH LOCATION AND NO RESIDENTIAL CONSTRUCTION ZONE**	
	Fault Rupture Hazard Evaluation, Hayward Fault Zone 25036 to 25096 Carlos Bee Boulevard Hayward, California	
Project No. F17-01515	January 2018	Figure 3

Map Source: Dibblee, T.W., Jr., 2005, Geologic Map of the Hayward Quadrangle, Contra Costa & Alameda Counties, California: Dibblee Geology Center Map #DF-163, Map Scale 1:24,000.



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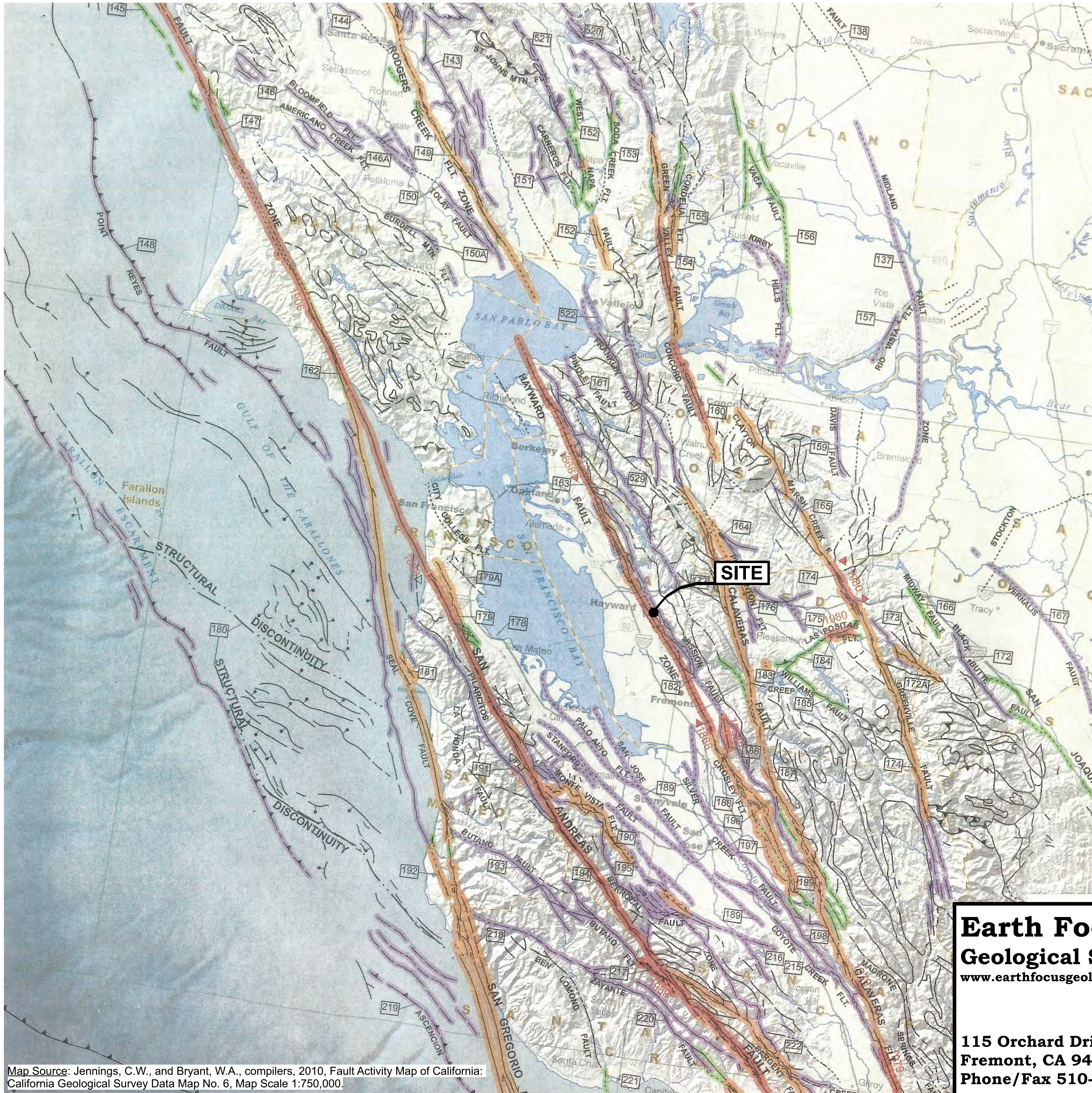
www.earthfocusgeology.com

115 Orchard Drive
Fremont, CA 94536
Phone/Fax 510-794-7495

REGIONAL GEOLOGIC MAP

Fault Rupture Hazard Evaluation, Hayward Fault Zone
25036 to 25096 Carlos Bee Boulevard
Hayward, California

Project No. F17-01515	January 2018	Figure 4



Map Source: Jennings, C.W., and Bryant, W.A., compilers, 2010, Fault Activity Map of California: California Geological Survey Data Map No. 6, Map Scale 1:750,000.

Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION: ON LAND	DESCRIPTION: OFFSHORE
Quaternary	Late Quaternary	Historic	200			Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
		Holocene	11,700			Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
		Pleistocene	700,000			Faults showing evidence of displacement during late Quaternary time.	Fault cuts strata of Late Pleistocene age.
	Early Quaternary		1,600,000*			Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Fault cuts strata of Quaternary age.
Pre-Quaternary			4.5 billion (Age of Earth)			Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.	Fault cuts strata of Pliocene or older age.

* Quaternary now recognized as extending to 2.6 Ma (Walker and Geissman, 2009). Quaternary faults in this map were established using the previous 1.6 Ma criterion.

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MILES

Earth Focus
Geological Services, Inc.
www.earthfocusgeology.com

115 Orchard Drive
Fremont, CA 94536
Phone/Fax 510-794-7495

REGIONAL FAULT MAP

Fault Rupture Hazard Evaluation, Hayward Fault Zone
25036 to 25096 Carlos Bee Boulevard
Hayward, California

Project No. F17-01515	January 2018	Figure 5

Plate 1 – Fault Compilation Map

Plate 2 – Trench Log

Base Map Source: Alameda County Assessor's Parcel Maps

EXPLANATION

SYMBOLS

Approximate location of exploratory trench

Approximate location of seismic line

12 Source of information (see list of Previous Fault Evaluation Studies below)

Location of surface fault trace; solid line indicates certainty, dashed line where approximate, questioned where not known

Approximate location of landslide identified from review of historic aerial photographs

PREVIOUS FAULT EVALUATION STUDIES

1. Woodward, Clyde & Associates, 1970
2. Hallenbeck-McKay & Associates, 1982
3. Darwin Myers Associates, 1984
4. Hallenbeck-McKay & Associates, 1974
5. Woodward-Clyde Consultants, 1978
6. GEI, 1987
7. ENGEO, Inc., 2017
8. GEI, 1989
9. Terrasearch, 1980
10. Terrasearch, 1974
11. Judd Hull & Associates, 1975
12. Gasch & Associates, 1975
13. Merrill & Seeley, Inc., 1979

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Geological Services, Inc.
www.earthfocusgeology.com

115 Orchard Drive
Fremont, CA 94536
Phone/Fax 510-794-7495

FAULT STUDIES COMPILATION MAP

Fault Rupture Hazard Evaluation, Hayward Fault Zone
25036 to 25096 Carlos Bee Boulevard
Hayward, California

Project No. F17-01515	January 2018	Plate 1

DESCRIPTION OF UNITS

Af Artificial Fill: Silty to Sandy Clay (CL/CH) with Variable Amounts of Gravel and Rock Fragments; Multiple Colors from Brownish White, Light to Dark Brown, and Bluish Black to Black; Slightly Moist to Moist; Firm to Stiff; Layered Appearance

Qcol Native Soils (Colluvium): Sandy Clay (CL); Dark Yellowish Brown (10YR 4/4); Moist; Firm; Some Scattered Roots; Minor Soil Development and Clay Films

JKkw Weathered Knoxville Formation: Predominately Siltstone Rock Fragments with Sandy Clay Matrix; Mottled Brownish Gray; Some Rock Fabric; Severely Weathered Bedrock

JKk Knoxville Formation: Siltstone with Shaley Interbeds and Sandstone with Siltstone Interbeds; Light Olive Gray (5Y 5/2) to Dark Yellowish Brown (10YR 4/2) with Rusty Red Staining on Fracture Surfaces; Well Cemented, Well Indurated and Hard; Well Bedded and Very Thin to Thick Bedded; Severely Fractured; Moderately Weathered

SYMBOLS

Geologic Contact: Longer Dashed Line where Sharp; Shorter Dashed Line where Gradational

0 + 50 Station Numbers at 5-Foot Horizontal Intervals

String Line Datum

The identification and extent of the geologic features depicted on this trench log are accurate representations of said features as they exist within the exposures of the exploratory trench, and they are accurate to the best of my knowledge.

CEG Number 1916

CERTIFIED ENGINEERING GEOLOGIST
PATRICK L. DRUMM
CEG NO. 1916
11-30-19
STATE OF CALIFORNIA

Earth Focus Geological Services, Inc.
www.earthfocusgeology.com
115 Orchard Drive
Fremont, CA 94536
Phone/fax 510-794-7495

TRENCH LOG		
Fault Rupture Hazard Evaluation, Hayward Fault Zone 25036 to 25096 Carlos Bee Boulevard Hayward, California		
Project No. S17-01515	January 2018	Plate 2

Attachment III