GEOTECHNICAL AND GEOLOGIC CONSTRAINTS ANALYSIS

MISSION BOULEVARD SPECIFIC PLAN
HAYWARD, CALIFORNIA

Submitted to:
Lamphier-Gregory
1944 Embarcadero
Oakland, CA 94606

Prepared by:
ENGEO Incorporated

Project No
8927.000.000

June 14, 2012

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Project No.
8927.000.000

June 14, 2012

Mr. Kevin Colin
Lampier-Gregory
1944 Embarcadero
Oakland, CA 94606

Subject: Mission Boulevard Specific Plan
Hayward, California

GEOTECHNICAL AND GEOLOGIC CONSTRAINTS ANALYSIS

Dear Mr. Colin:

This report presents a summary of geotechnical and geologic constraints for the Mission Boulevard Specific Plan areas in Hayward, California. The purpose of this report is to provide a basic outline of CEQA constraints and mitigation measures for the project EIR. The findings of this report are based on existing published sources and on review of aerial images.

If you have any questions or comments regarding this report, please call and we will be glad to discuss them with you.

Sincerely,

ENGEO Incorporated

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This report presents a summary of geologic constraints and CEQA mitigation measures for the Mission Boulevard Specific Plan area in Hayward, California.

The conclusions and recommendations presented in this report are preliminary in nature. This report was prepared for the exclusive use in the preparation of the Mission Boulevard Specific Plan EIR. In the event that any changes are made in the character, design or layout of the development, ENGEO should review the conclusions and recommendations contained in this report to determine whether modifications to the report and related conclusions are necessary. This document may be reproduced in its entirety in the context of preparation of the EIR submittal package. However, it may not be quoted or excerpted without the express written consent of ENGEO Incorporated.

1.2 PROJECT LOCATION AND DESCRIPTION

The Mission Boulevard Specific Plan area (SPA) encompasses approximately 600 parcels, 240 acres, and spans a total length of approximately two miles along two segments of Mission Boulevard in the City of Hayward, Alameda County as shown on Figure 1. The Specific Plan's northern segment extends from the northern City boundary (just north of Rose Street) south to A Street; the southern segment extends from Jackson Street south to Harder Road. Between these two segments, the Specific Plan excludes lands associated with the downtown of Hayward and subject to a separate Specific Plan, the "Downtown Hayward Design Plan" and related "Design Requirements and Requirements for Downtown Hayward. The topography within the SPA generally slopes to the west toward the San Francisco Bay. The eastern edges of the SPA locally border the Hayward hills, as shown on Figure 1. San Lorenzo Creek skirts the northern segment of the SPA, while Ward Creek passes through the southern portion of the SPA as it issues from its canyon in the Hayward Hills.

1.3 PROPOSED PROJECT

The Mission Boulevard Specific Plan (SPA) intends to provide opportunities for new development in the Mission Boulevard Corridor that respects the existing character of the area and its surroundings, including commercial uses, pedestrian-friendly neighborhoods that support public transportation, and a built form that will encourage such uses, and complements the natural and historic amenities existing in the Specific Plan area. The Specific Plan would not be implemented in distinct phases. Rather, the Specific Plan is intended to facilitate both private development projects as proposals for them may come forward, and public works projects as funding for such improvement becomes available for allocation to them.

2.0 GEOLOGY AND SEISMICITY

2.1 GEOLOGY

The SPA is located on the east Bay Plain at the foot of the Hayward Hills. The Hayward Hills are a tectonically uplifted block separated from the East Bay Plain by the active Hayward Fault. Other nearby active faults include the Calaveras Fault, located about 7.5 miles northeast of the site, and the San Andreas Fault, located about 18 miles southwest of the site. The locations of these faults and other significant active faults in the Bay Area are shown on Figure 2. The East Bay Plain is typically underlain at the surface by Late Quaternary alluvium and at depth by bedrock of the Great Valley Complex and the Franciscan Complex (Graymer 2000). Great Valley Complex rocks are exposed in the Hayward Hills east of the SPA, with tectonically intermixed with rocks of the Coast Range Ophiolite including Gabbro (Jgb) and pillow basalt, basalt breccia and minor diabase (Jpb) as shown on Figure 3.

The low-lying portions of the SPA area are underlain by young alluvial deposits associated with a large Holocene (less than 11,000 years old) alluvial fan complex formed where San Lorenzo and Ward creeks issue from the Hayward Hills. The alluvial fan sediments consist of inter-layered sands, silts and clays. Mapping by the CGS (2003) identifies the fan deposits as coarser sediments (Qhf) occur, and linear levee deposits (Qhl), as shown on Figure 4. Holocene alluvium can locally be susceptible to liquefaction where groundwater levels are high and loose lenses of sand or silt are present. Surface soils throughout the SPA are likely to be variable, but generally are fine-grained and of low to moderate plasticity.

Portions of the SPA east of Mission Boulevard extend on to sloping terrain, as shown on Figure 3. Slopes in this area are locally steep and much of the terrain has been previously graded for past development, to create roads and building pads. Graded areas contain both cuts and fills as well as cut and fill slopes. Many of these slopes are steeper than would be permitted by current grading codes and are not provided with drainage terraces to control erosion. Fills constructed in this area were also completed prior to modern grading standards and are likely to be compressible. Areas of natural slopes remain east of Mission Boulevard and south of Carlos Bee Boulevard, and in the parcels adjacent to the incised canyon of Ward Creek. Slope inclinations in these areas are moderate to steep, and there is an existing landslide in the area south of Carlos Bee Boulevard. Areas of potential earthquake-induced landslide hazards have been identified on State maps as describe below.

2.2 SEISMICITY

The regional seismicity of the Bay Area was recently evaluated by the Working Group on Northern California Earthquake Probabilities (WGCEP, 2007) in the Uniform Earthquake Rupture Forecast for California (UCERF 2). According to UCERF 2, the 30-year probability for a Magnitude 6.7 or greater earthquake in the Bay Area is approximately 63%. UCERF 2 estimates the 30-year probability for a Magnitude 6.7 or greater earthquake on the Hayward-Rogers Creek fault system to be 31%.

In 1868, the southern Hayward fault ruptured for an estimated length of about 30 miles extending from Fremont to Berkeley, with an estimated 6 feet of right-lateral strike-slip motion. This earthquake caused significant to very heavy damage in the relatively sparsely populated East Bay Plain, especially in the town of Hayward. Surface fault rupture was reported in the site vicinity, and it is believed that the trace of the 1868 surface rupture is located along the eastern side of the SPA as shown on Figure 5 (Smith, 1981, Lienkaemper et al., 2006). Ground shaking levels in the Hayward area were reported to be as high as IX to X on the Modified Mercalli Scale (Brocher, et al. 2008).

Based on the historic seismicity, the proximity of known active faults and the estimated earthquake probabilities for the Bay Area as a whole, it should be expected that the SPA will experience strong seismic ground shaking during the lifetime of the proposed improvements. The ground shaking hazard levels at the site are similar to those for most of the Bay Area.

2.3 STATE HAZARD MAPS

State law requires the CGS to establish regulatory zones (known as Earthquake Fault Zones) around the surface traces of active faults and to issue appropriate maps. An *active fault* is defined by the State Mining and Geology Board as one that has "had surface displacement within Holocene time (about the last 11,000 years)". State law prohibits the construction of habitable structures across active fault traces. Portions of the SPA lie within the Earthquake Fault Hazard Zone for the Hayward Fault. The active fault traces mapped by the State and the Earthquake Fault Zone boundaries are depicted on Figure 5. The CGS is also required to delineate liquefaction hazard zones and earthquake-induced landslide hazard zones. Small portions of the SPA lie within liquefaction and earthquake-induced landslide hazard zones as depicted on Figure 6.

2.4 HAYWARD FAULT

The Hayward fault zone extends from the region of Mission Peak, where it is thought to connect at depth to the Calaveras Fault, north to the San Pablo Bay, where it is thought to continue under the Bay and connect to the Rodgers Creek and Tolay faults. The Hayward Fault zone has accumulated over 60 miles of right-lateral slip during the last 12 million years and continues to have a Quaternary (long-term) slip rate of about 7 mm to 9 mm per year (Graymer et al., 2002, Lienkaemper and Borchardt, 1996). The main surface trace of the Hayward fault is creeping at a rate of about 4 mm to 6 mm per year (Lienkaemper et al., 2001).

Recently active traces of the Hayward Fault have been identified within the SPA by the USGS and the CGS (Lienkaemper, 2006, Smith 1981, 1982). According to Lienkaemper (2006), the fault traces along the east side of the SPA appear to be the main active traces of the Hayward fault. As described above, it is also believed that these traces are the location of surface fault rupture reported from the 1868 earthquake.

2.5 GROUNDWATER

Areas that are underlain by Holocene alluvial deposits, where depth to ground water is 40 feet or less, may be susceptible to liquefaction. The CGS has prepared a historic-high groundwater map as depicted on Figure 7. Regional groundwater contours on Figure 7 show historic-high water depths, as interpreted from borehole logs from investigations between 1955 and 2001. The Hayward Fault acts as a groundwater barrier, and as a result, depths to first-encountered water range from 10 to 20 feet east of the Hayward Fault to 30 to 50 feet below the ground surface west of the fault.

3.0 GEOLOGIC HAZARDS

Geologic hazards identified within the SPA are depicted on Figure 9. The following sections provide descriptions of potential CEQA impacts and mitigation measures.

3.1 SEISMIC SURFACE RUPTURE

Surface fault rupture in the event of an earthquake on the local segments of the Hayward fault could cause lateral ground displacements of magnitudes that would be catastrophic for any structures located directly across fault traces. Experience from recent earthquakes in California and around the world has shown that ground rupture and deformation associated with surface fault rupture is rarely confined to the immediate area of the main fault trace. Instead, it has been observed that a complex pattern of secondary fracturing and ground deformation typically forms around the main fault trace, sometimes relatively confined along the rupturing fault, or extending over a larger region. Surface displacement and distortion associated with secondary seismic surface rupture can be relatively minor or it can be large enough to cause damage to structures. According to State law, habitable structures cannot be constructed across active fault traces. The State has designated Earthquake Fault Hazard Zones around active fault traces that require site-specific studies to be performed prior to certain types of new construction, land subdivision or renovations within a designated zone, as designated in the California Public Resources Code.

3.2 SEISMIC GROUND SHAKING

An earthquake of moderate to high magnitude generated within the San Francisco Bay Region, especially along segments of the Hayward Fault, could cause strong to very strong ground shaking at the site, similar to that which has occurred in the past.

3.3 LIQUEFACTION, LATERAL SPREADING, GROUND LURCHING AND SEISMICALLY INDUCED DENSIFICATION

Liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary loss of shear strength because of pore pressure buildup under the cyclic shear stresses associated with earthquakes. Lateral spreading is a failure within a nearly horizontal soil zone, commonly associated with liquefaction, which causes the overlying soil mass to move towards a free face or down a gentle slope. Ground lurching can occur in soft, saturated clays and silts that are

subjected to strong ground shaking during earthquakes. Loose unsaturated sandy soils can also experience settlement due to densification during strong seismic shaking. As described above, portions of the SPA east of the Hayward Fault are within the State-designated liquefaction hazard zone for the Hayward Quadrangle. Portions of the SPA that are underlain by Holocene alluvium but are not within the liquefaction hazard zone, could still locally be subject to liquefaction-related hazards due to perched shallow groundwater conditions not identified by the State. Local areas could also be subject to seismically induced densification.

3.4 SLOPE STABILITY

Existing graded and natural slopes could be subject to landslides, surficial soil sloughing and erosion. Landslide movement can be triggered by changes in groundwater elevation due to rainfall, saturation by leaking utilities or impounded water, stream incision, man-made excavations of fill placement, as well as by seismic ground shaking. Landslide movement can cause large vertical and horizontal ground movements, ground warping and bulging, displacement of large masses of debris from slopes onto roads and structures, and blocking of stream courses.

3.5 EXPANSIVE SOILS

Figure 9.3 of the Hayward General Plan EIR shows much of the Project area is mantled by clayey soils of the Clear Lake-Omni series, which are expansive soils that have a high shrink-swell potential. Such soils, when exposed to natural seasonal or man-made moisture content changes, can damage structures and other improvements and utilities.

3.6 COMPRESSIBLE SOILS AND GROUND SUBSIDENCE

Previously graded areas in the SPA are locally underlain by man-made fills that are not documented and are unlikely to have been engineered and compacted in accordance with current geotechnical standards. Such fills may locally be compressible and could cause settlement under improvements in proposed new projects. There is no significant petroleum production or large-scale groundwater withdrawal for agriculture in the, Hayward area, so land subsidence related to these practices is not a hazard for the SPA

3.7 EROSION

Proposed new projects that will result in soil disturbance or new graded slopes could create soil erosion hazards. The impacts of soil erosion from graded areas can include deposition of excessive amounts of sediment in streams damage to graded slopes, improvements on slope and drainage facilities as well as damage to landscape improvements.

4.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report presents preliminary geotechnical recommendations for planning purposes. If changes occur in the nature or design of the project, we should be allowed to review this report and provide additional recommendations, if any. It is the responsibility of the owner to transmit the information and recommendations of this report to the appropriate organizations or people involved in design of the project, including but not limited to developers, owners, buyers, architects, engineers, and designers. The conclusions and recommendations contained in this report are solely professional opinions and are valid for a period of no more than 2 years from the date of report issuance.

We strived to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is expressed or implied. There are risks of earth movement and property damages inherent in building on or with earth materials. We are unable to eliminate all risks or provide insurance; therefore, we are unable to guarantee or warrant the results of our services.

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FIGURES

Figure 1: Vicinity Map
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FIGURES

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0 METERS 1000

BASE MAP SOURCE: MS STREETS AND TRIPS

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VICINITY MAP

HAYWARD SPECIFIC PLAN

HAYWARD, CALIFORNIA

PROJECT NO.: 8927.000.000		FIGURE NO.
SCALE: AS SHOWN		1
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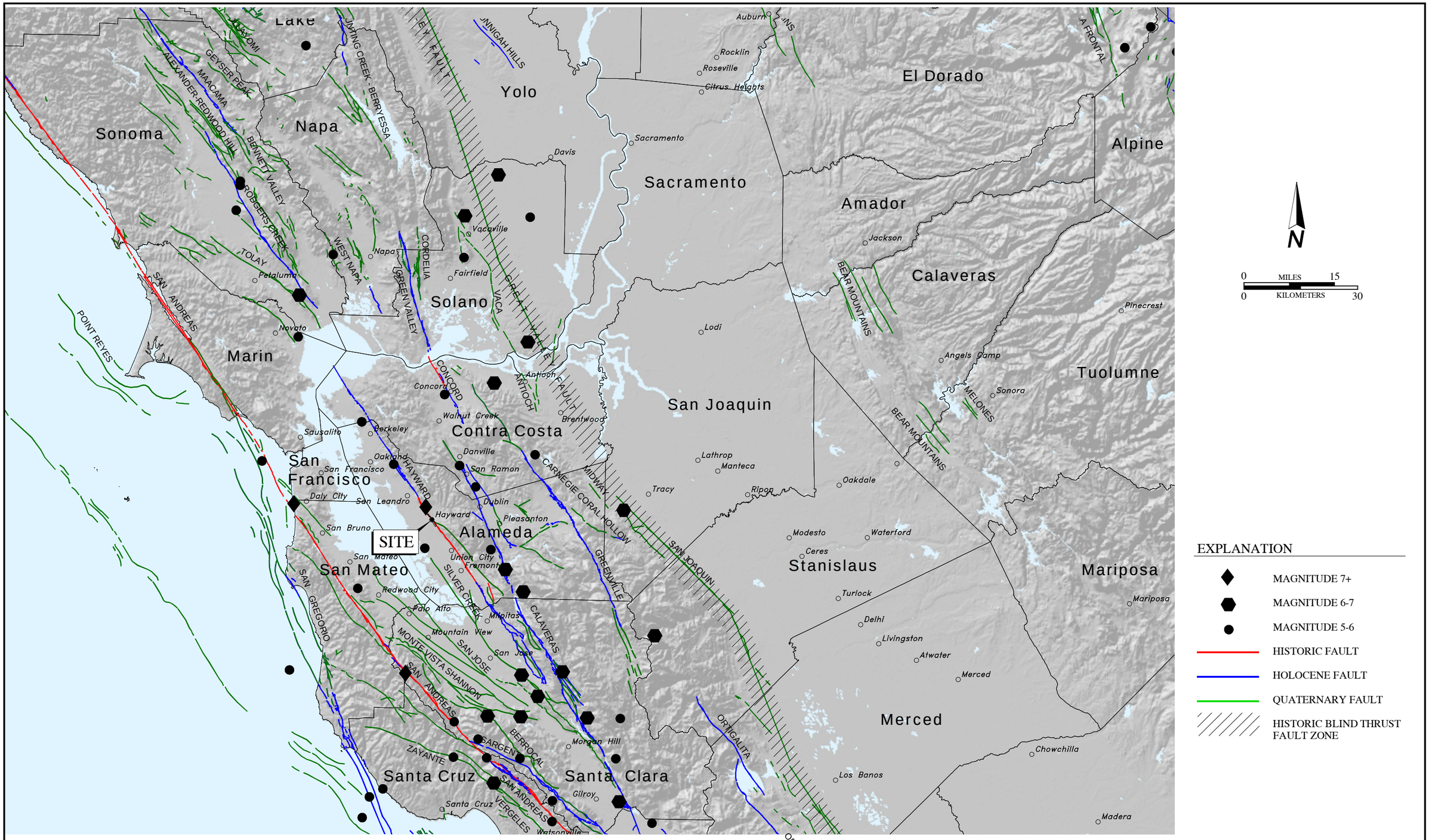

BASE MAP SOURCE:
U.S.G.S. 1-ARC SECOND S.R.T.M. DATABASE
U.S.G.S. QUATERNARY FAULT DATABASE, MARCH, 2006
U.S.G.S. HISTORIC EARTHQUAKE DATABASE (1800-2000)

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REGIONAL FAULTING AND SEISMICITY
HAYWARD SPECIFIC PLAN
HAYWARD, CALIFORNIA

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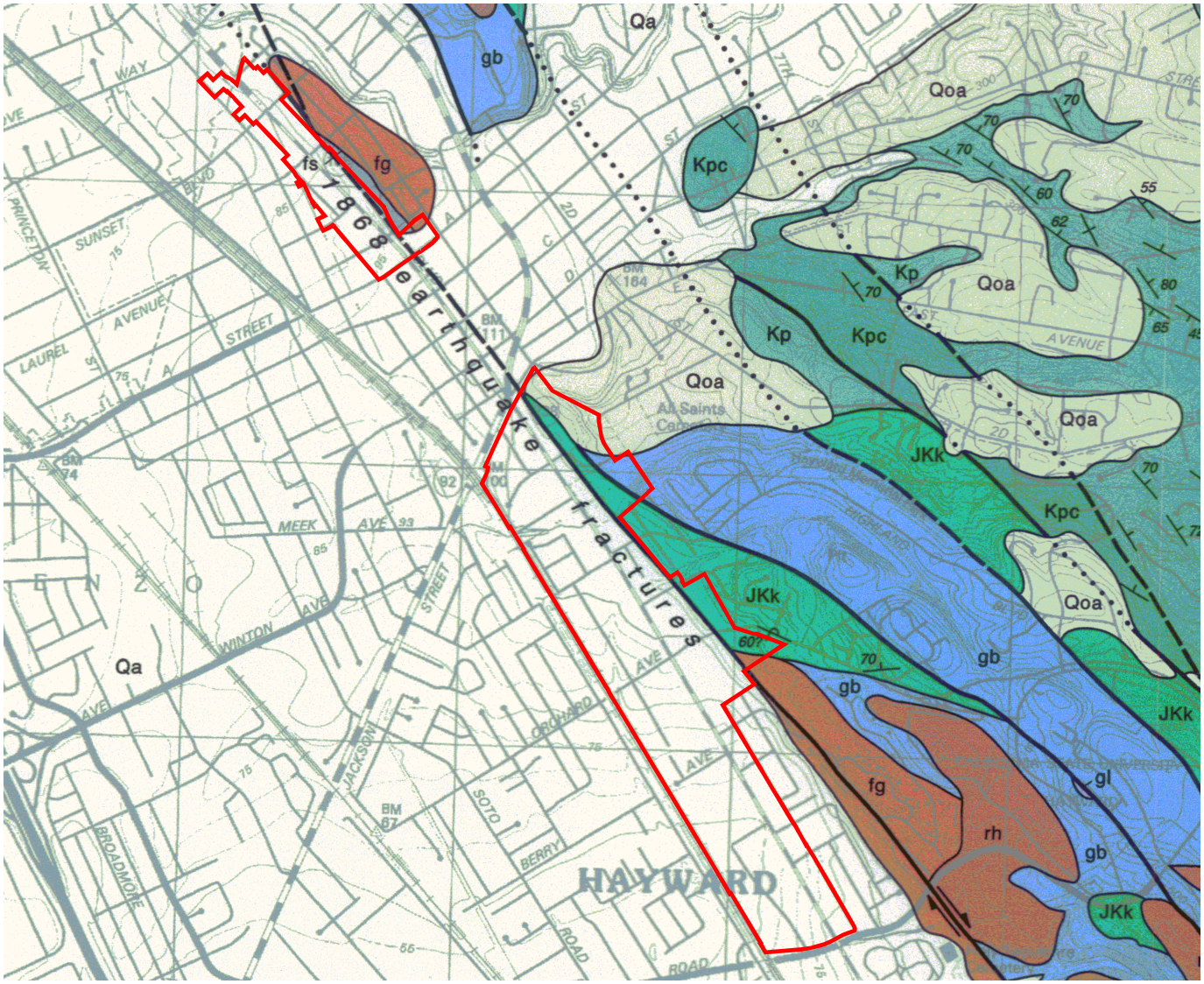

EXPLANATION

BEDROCK CONTACT-DASHED WHERE GRADATIONAL OR APPROXIMATELY LOCATED

FAULT-DASHED WHERE INFERRED, DOTTED WHERE CONCEALED, QUERIED WHERE EXISTENCE IS DOUBTFUL; DOUBLE ARROWS INDICATE STRIKE-SLIP MOVEMENT

STRIKE AND DIP OF STRATA

INCLINED VERTICAL OVERTURNED

Qa	ALLUVIUM
Qoa	OLDER ALLUVIUM
Kp	PANOCHE FORMATION - CLAYSTONE
Kpc	PANOCHE FORMATION - CONGLOMERATE
JKk	KNOXVILLE FORMATION - CLAY SHALE
rh	LEONA RHYOLITE
gb	GABRO DIABASE
fg	GREENSTONE
fs	GRAYWACKE

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BASE MAP SOURCE: DIBBLEE

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REGIONAL GEOLOGIC MAP

HAYWARD SPECIFIC PLAN

HAYWARD, CALIFORNIA

PROJECT NO.: 8927.000.000

SCALE: AS SHOWN

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FIGURE NO. 3

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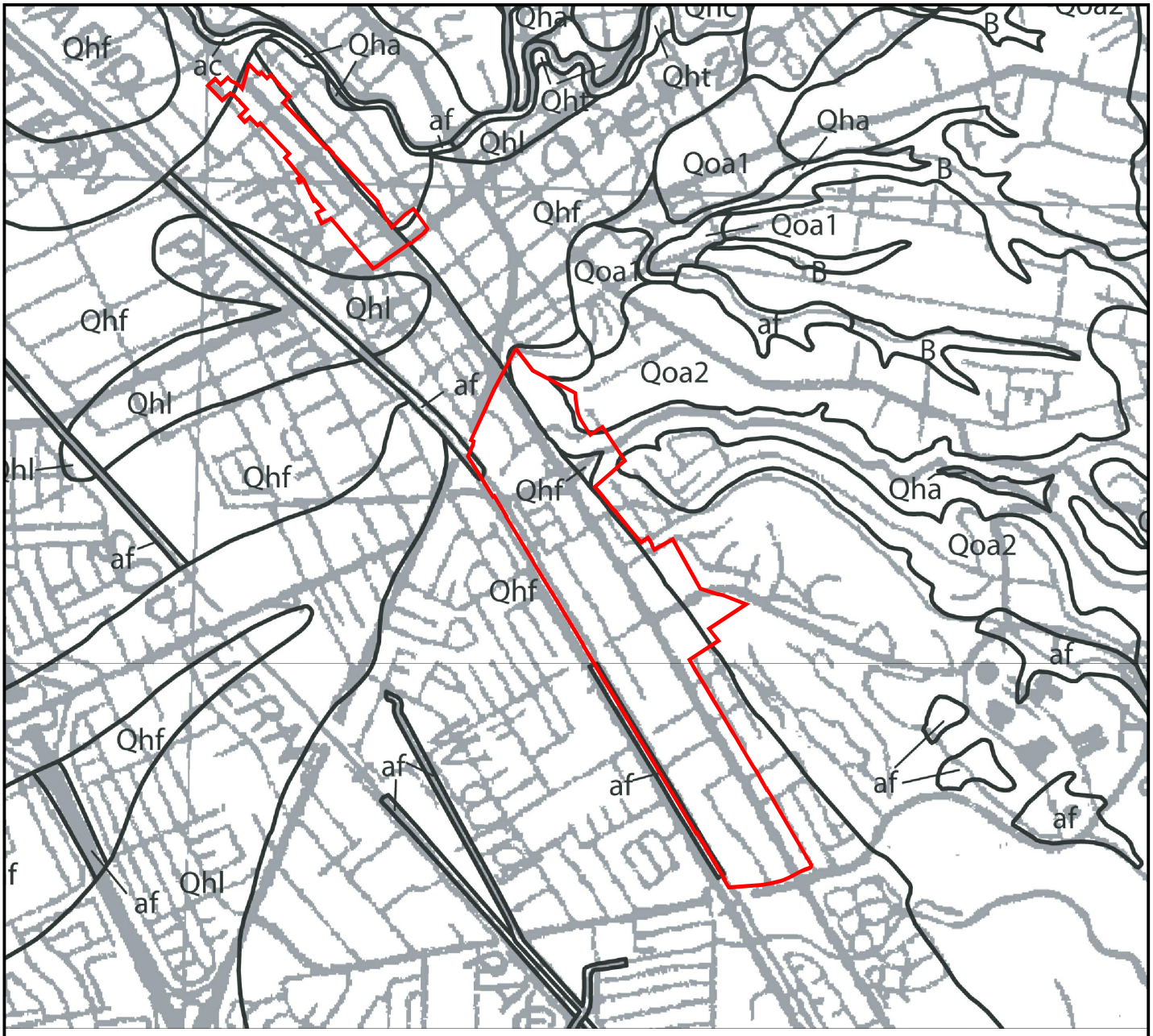

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EXPLANATION

af	MAN-MADE FILL
Qhf	HOLOCENE FAN DEPOSITS
Qhl	HOLOCENE FAN LEVEE DEPOSITS
Qoa	OLDER ALLUVIUM

BASE MAP SOURCE: CGS

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QUATERNARY GEOLOGY MAP

HAYWARD SPECIFIC PLAN

HAYWARD, CALIFORNIA

PROJECT NO.: 8927.000.000

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FIGURE NO. 4

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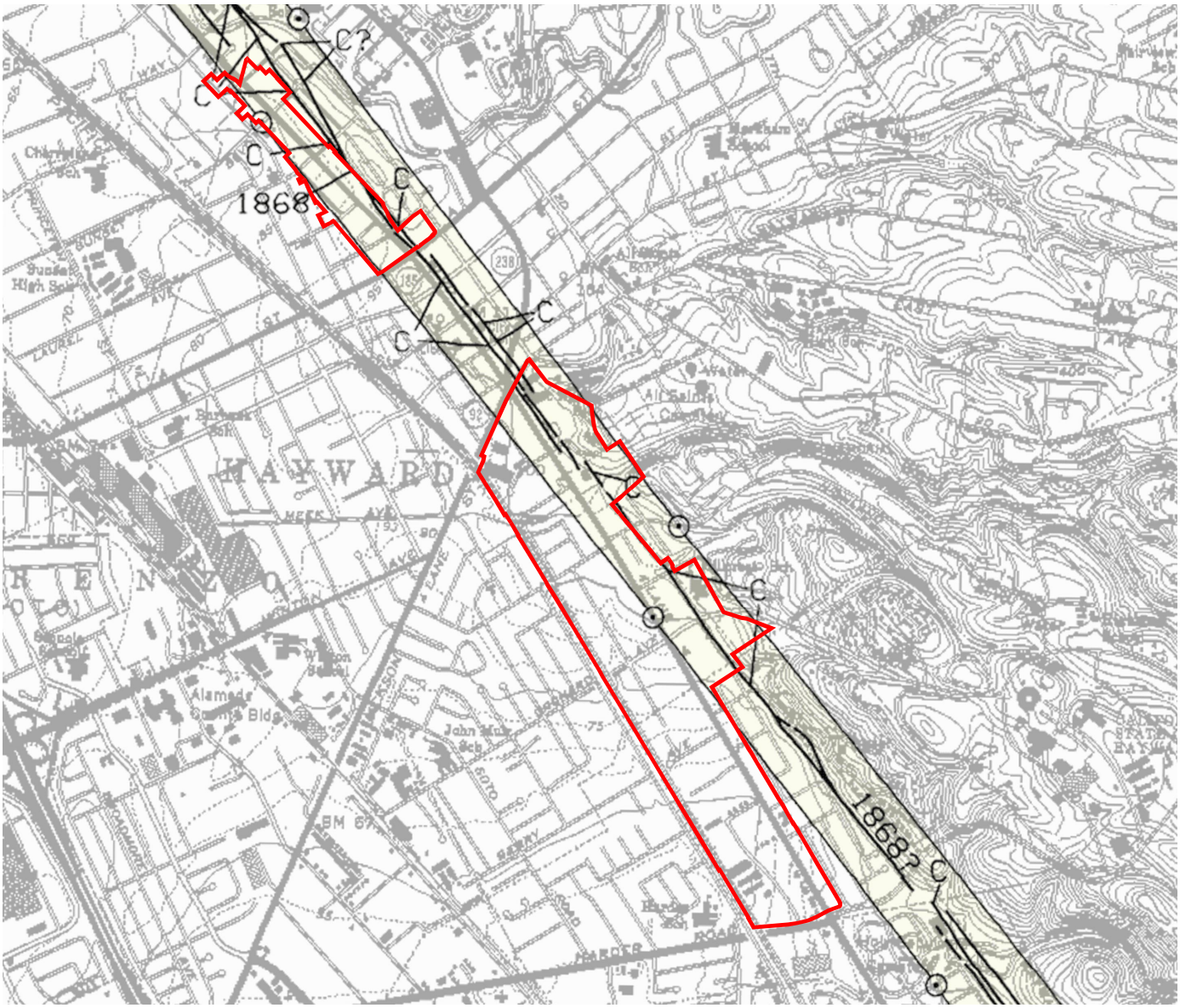

EXPLANATION

1906 C — FAULTS CONSIDERED TO HAVE BEEN ACTIVE DURING HOLOCENE TIME AND TO HAVE A RELATIVELY HIGH POTENTIAL FOR SURFACE RUPTURE; SOLID LINE WHERE ACCURATELY LOCATED, LONG DASH WHERE APPROXIMATELY LOCATED, SHORT DASH WHERE INFERRED, DOTTED WHERE CONCEALED; QUERY (?) INDICATES ADDITIONAL UNCERTAINTY. EVIDENCE OF HISTORIC OFFSET INDICATED BY YEAR OF EARTHQUAKE-ASSOCIATED EVENT OR C FOR DISPLACEMENT CAUSED BY CREEP OR POSSIBLE CREEP

EARTHQUAKE FAULT ZONE BOUNDARIES; DELINEATED AS STRAIGHT-LINE SEGMENTS THAT CONNECT ENCIRCLED TURNING POINTS SO AS TO DEFINE EARTHQUAKE FAULT ZONE SEGMENTS

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BASE MAP SOURCE: CALIFORNIA DIVISION OF MINES AND GEOLOGY, 1982

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EARTHQUAKE FAULT ZONE MAP

HAYWARD SPECIFIC PLAN

HAYWARD, CALIFORNIA

PROJECT NO.: 8927.000.000		FIGURE NO. 5
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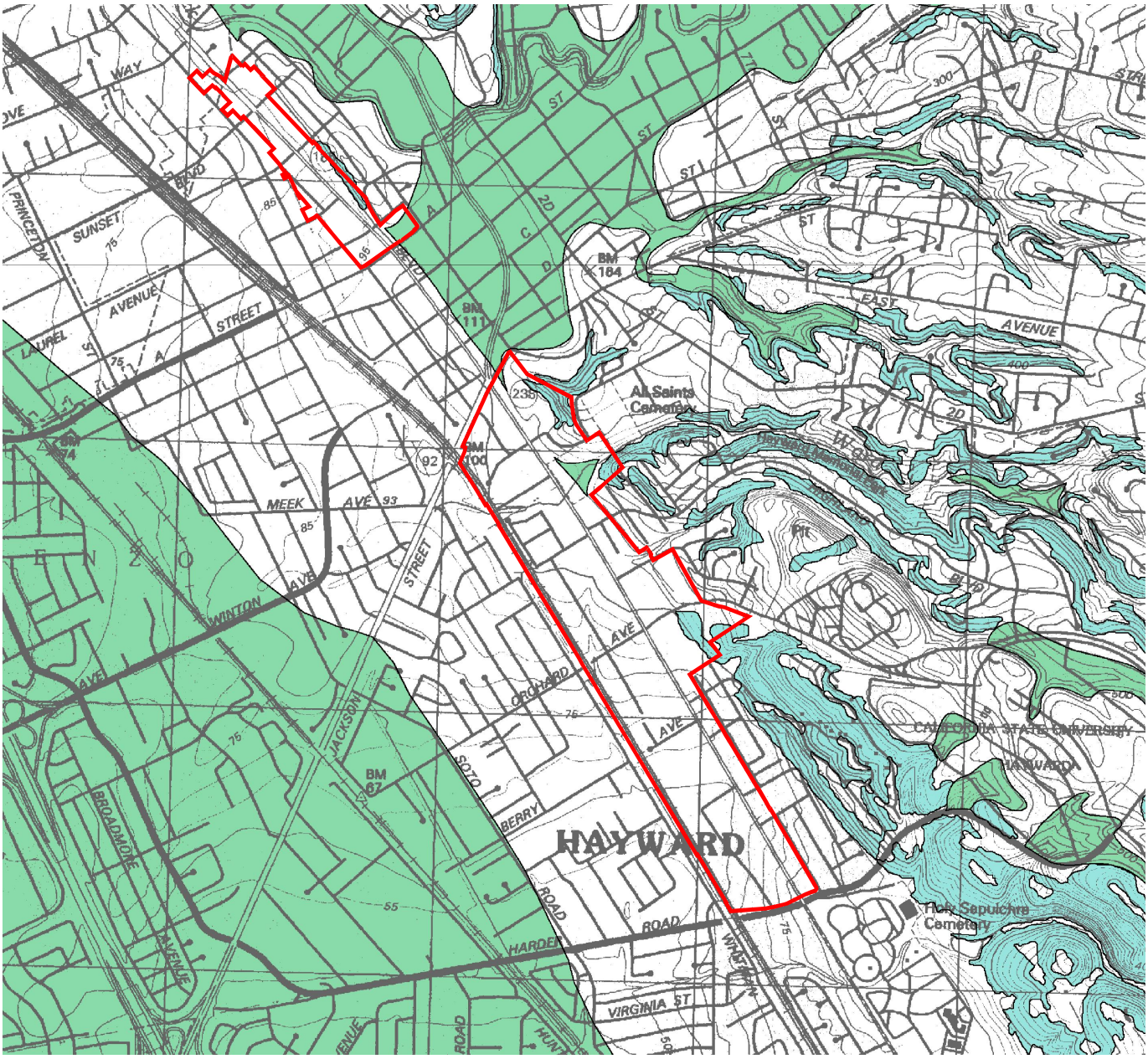

EXPLANATION

LIQUEFACTION

AREAS WHERE HISTORIC OCCURRENCE OF LIQUEFACTION, OR LOCAL GEOLOGICAL, GEOTECHNICAL AND GROUNDWATER 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 LANDSLIDES

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

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BASE MAP SOURCE: CALIFORNIA DEPARTMENT OF CONSERVATION, CALIFORNIA GEOLOGICAL SURVEY, 2006

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SEISMIC HAZARD ZONE MAP
HAYWARD SPECIFIC PLAN
HAYWARD, CALIFORNIA

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FIGURE NO. 6

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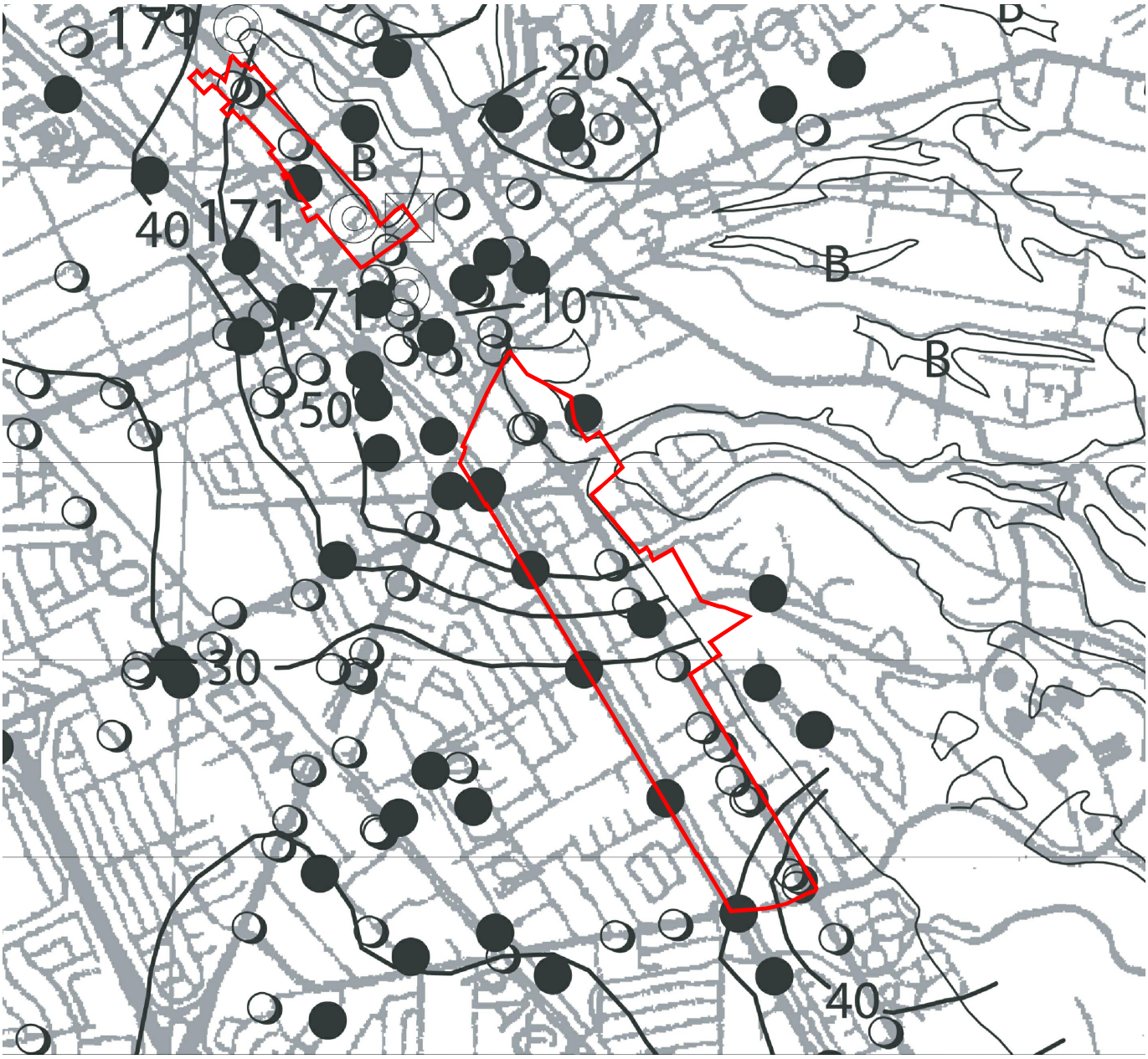

EXPLANATION

B — PRE-QUATERNARY BEDROCK

10 — DEPTH TO GROUND WATER, IN FEET (5, 10, 20 FOOT CONTOURS)

● — GEOTECHNICAL BOREHOLES USED IN LIQUEFACTION EVALUATIO

○ — GROUND-WATER LEVEL DATA PROVIDED BY THE CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

N

0 FEET 4000
0 METERS 2000

BASE MAP SOURCE: CALIFORNIA DEPARTMENT OF CONSERVATION, CALIFORNIA GEOLOGICAL SURVEY, 2003

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HISTORIC HIGH GROUNDWATER MAP
HAYWARD SPECIFIC PLAN
HAYWARD, CALIFORNIA

PROJECT NO.: 8927.000.000		FIGURE NO. 7
SCALE: AS SHOWN		
DRAWN BY: PC	CHECKED BY: RS	

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ORIGINAL FIGURE PRINTED IN COLOR

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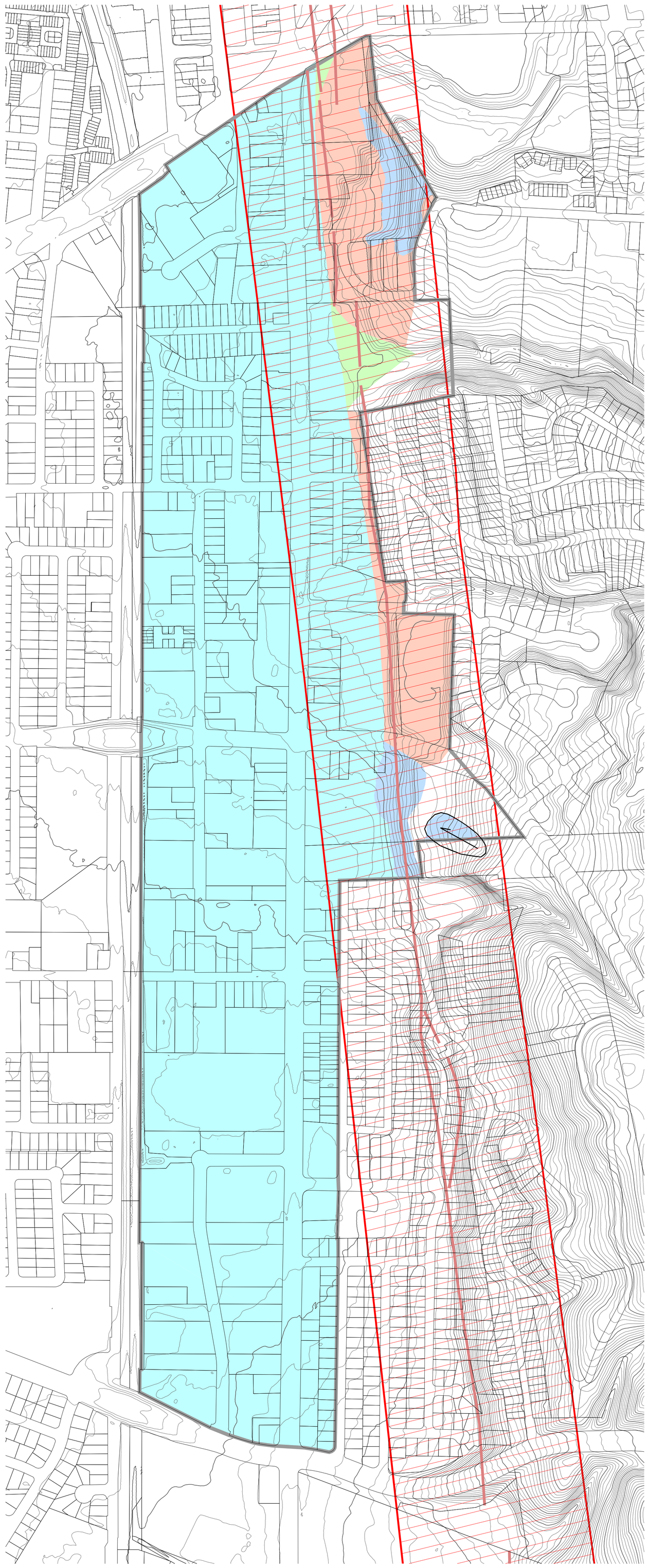

EXPLANATION

- APPROXIMATE LIMITS OF STATE EARTHQUAKE FAULT ZONE
- APPROXIMATE LOCATION OF STATE EARTHQUAKE FAULT ZONE TRACES
- APPROXIMATE LIMITS OF STATE SEISMIC HAZARD ZONE LIQUEFACTION HAZARD ZONE
- APPROXIMATE LIMITS OF STATE SEISMIC HAZARD ZONE EARTHQUAKE INDUCED LANDSLIDE HAZARD ZONE
- EXISTING LANDSLIDE
- APPROXIMATE LIMITS OF AREAS UNDERLAIN BY HOLOCENE ALLUVIUM
- APPROXIMATE LIMITS OF PREVIOUSLY GRADED CUT AND FILL HILLSIDE AREAS

N

0 FEET 300
0 METERS 150

BASE MAP SOURCE: USGS EROS DATA CENTER

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GEOLOGY AND SOILS HAZARD OVERLAY
HAYWARD SPECIFIC PLAN
HAYWARD, CALIFORNIA

PROJECT NO.: 8927.000.000
SCALE: AS SHOWN
DRAWN BY: PC CHECKED BY: RS

FIGURE NO. 8

ORIGINAL FIGURE PRINTED IN COLOR

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