GEOTECHNICAL FEASIBILITY REPORT

ROUTE 238 BYPASS – GROUP 5
HAYWARD, CALIFORNIA

Submitted to:
Mr. Kevin Briggs
City of Hayward
777 B Street, 2nd Floor
Hayward, CA 94541

Prepared by:
ENGEO Incorporated

March 18, 2016

Project No:
12843.000.000

GEOTECHNICAL
ENVIRONMENTAL
WATER RESOURCES
CONSTRUCTION SERVICES

Project No.
12843.000.000

March 18, 2016

Mr. Kevin Briggs
City of Hayward
777 B Street, 2nd Floor
Hayward, CA 94541

Subject: Route 238 Bypass – Group 5
Hayward, California

GEOTECHNICAL FEASIBILITY REPORT

Dear Mr. Briggs:

ENGEO has prepared this geotechnical feasibility report in support of your due diligence regarding the approximately 49-acre Group 5 site. The site is located between Carlos Bee Boulevard to the northwest and Harder Road to the southeast, just northeast of Route 238 (Mission Boulevard) in Hayward, California. This report is prepared as outlined in our proposal dated February 2, 2016.

The accompanying report contains a summary of our document review, conclusions, and preliminary recommendations for the geotechnical aspects related to potential development on the subject site. Based on our study, it is our opinion that development of the site is feasible from a geotechnical standpoint provided the preliminary recommendations included in this report are incorporated into project planning and development.

We are pleased to be of service to you on this project and look forward to consulting further with you and your design team.

Sincerely,

ENGEO Incorporated

REGISTERED PROFESSIONAL ENGINEER
JOSEF TOOTLE
No. 2677
GEOTECHNICAL
STATE OF CALIFORNIA

Eric M. Kiefer, GIT
emk/jjt/bvv

Josef J. Tootle, GE

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

ENGEO prepared this geotechnical feasibility report in support of your due diligence and potential future development in Hayward, California. This report was prepared as outlined in our proposal dated February 2, 2016. The City of Hayward authorized ENGEO to conduct the proposed scope of services, which included the following:

- Review of available geologic maps; and review of available on-line or in-house aerial photographs and historical topographic maps.
- Review of provided geotechnical and/or geologic studies.
- Assessment of geological hazards at each site and in the general area of the property.
- Site reconnaissance.
- Preparation of a report providing our preliminary findings and conclusions regarding the geotechnical aspects and feasibility of future development of the site.

This report was prepared for the exclusive use of The City of Hayward and their consultants for project planning and design. In the event that any changes are made in the character, design or layout of the development, we must be contacted to review the conclusions and recommendations contained in this report to determine whether modifications are necessary. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without our express written consent.

1.2 SITE LOCATION AND DESCRIPTION

The property comprises approximately 49 acres of land currently utilized as open space with approximately 20 existing single-family residences and 2 to 3 roads traversing the site in various locations. The subject property is located northwest of Harder Road, approximately 1,000 feet east of Route 238 (Mission Boulevard) and immediately southwest of California State University, East Bay (Figure 1).

The current topography of the site can generally be characterized as a moderately sloping hillside that ranges in elevation from approximately 160 feet in the northwest of the site to 440 feet at the top of the hill in the east of the property. The southwestern facing slope of the site has an inclination that is generally 4:1 (horizontal:vertical) but is as steep as 1:1 at localized areas. Two drainage swales were observed on the project site: one in the northeast portion of the site trends roughly 279 degrees and drains east to west, the second is in the southwestern portion of the site and trends roughly 165 degrees and drains north to south. Single-family residences occupy areas of site as well as the associated roads, landscaping, utilities and improvements.

1.3 PROJECT DESCRIPTION

Based on the information provided, we understand that the City of Hayward is interested in acquiring the Group 5 parcel from CalTrans, with plans of selling it for future development. It is our understanding that at this time no plans showing potential grading or structure concepts have been developed.

1.4 REVIEW OF EXISTING INFORMATION

As part of our scope for this feasibility report, we reviewed relevant information regarding geotechnical and geological aspects of the site. We reviewed the following information:

- Aerial photographs from various years starting in 1946 (see references for details).
- Available historic topographic maps from various years starting in 1899 (see references for details).
- Available published geologic maps and reports (see references for details).

1.4.1 Site Background and Aerial Photograph Review

The original topography of the site appears to have been modified by grading based on historical aerial photographs as well as historical topographic maps. Local grading appears to have taken place sometime between 1939 and 1950. Many of the residences (and associated grading) appear between 1950 and 1966 (based on historical topographic maps). Vegetation at the site generally consists of seasonal grasses with scattered trees and brush. It appears that active grading was occurring in the 1946 photographs. The grading appears to be associated with roadways, placement of the water tank, and some of the single-family residences adjacent to the site. The water tank, appears to have been constructed sometime between 1957 and 1958 according to aerial photographs and historic topographic maps. The majority of the houses built on site were constructed sometime between 1960 and 1966. Also in a similar time frame, CSU – East Bay, and the road cut for Harder Road were cut/graded and constructed. It is likely that undocumented fill material is present in the area of the existing roads as well as with the existing houses. The site has been used as open space, and is currently zoned as residential by the City of Hayward

2.0 GEOLOGY AND SEISMICITY

2.1.1 Regional Geology

The site is located within the Coast Ranges geomorphic province of California. The Coast Ranges province is typified by a system of northwest-trending, fault-bounded mountain ranges and intervening alluvial valleys. More specifically, the site is located in the East Bay Hills south of Castro Valley and just east of the East Bay Plain.

Bedrock in the Coast Ranges consists of igneous, metamorphic and sedimentary rocks that range in age from Jurassic to Pleistocene. The present physiography and geology of the Coast Ranges are the result of deformation and deposition along the tectonic boundary between the North American plate and the Pacific plate. Plate boundary fault movements are largely concentrated along the well-known fault zones, which in the area include the San Andreas, Hayward, and Calaveras faults, as well as other lesser-order faults.

2.1.2 Site Geology

According to published maps covering the site by Dibblee (1980) and Crane (1988), the majority of the site is underlain by greenstone of the Franciscan Complex (Figure 3). The greenstone (metabasalt) is dark gray to black, massive, aphanitic, and can locally be slightly serpentinized. This unit is associated with the Franciscan assemblage and makes up much of the southwest portion of the property. The Franciscan assemblage is Late Jurassic to Cretaceous in age and is composed of submetamorphosed marine sedimentary and mafic igneous rocks (Dibblee, 2005). Dibblee (2005) also maps the bedrock in the northern most extent of the site as Knoxville Formation – marine clastic, lithified, clay shale and conglomerates from the late Jurassic to early Cretaceous (based on fossil evidence). This particular unit on site is the clay shale unit – a dark brownish gray, bedded, micaceous clay shale which includes thin interbeds of olive brown fine-grained graywacke, sandstone, and brown dolomite. The eastern portion of the site is underlain by Leona Rhyolite and gabbro-diabase of the Coast Range Ophiolite Complex – an igneous complex which is probably intrusive, from the late Jurassic. The Leona Rhyolite (Lawson, 1914), was formerly interpreted as late Cenozoic, but has since been radiometrically dated as late Jurassic. The gabbro-diabase is black, medium to fine-grained, massive, of mafic minerals and aged as late Jurassic.

A Quaternary landslide was mapped in the northwestern portion of the site by Dibblee (1980), just north of the water tank. Nilsen (1975) does not map this landslide, however review of historical aerial photographs and site reconnaissance shows that shallow landslides are fairly common along the hillsides. All of the bedding measured regionally in the area is striking roughly northwest–southeast and dipping varyingly between moderate and steep towards the northeast from around 35 to 70 degrees. The closest measured attitudes on this site; however, are roughly east-west and dipping steeply (70 degrees) to overturned. Exposures of these bedrock units were generally observed to be weak to very weak, closely fractured to crushed and highly weathered, displaying either a reddish brown or reddish yellow iron oxide staining.

2.1.2.1 Artificial Fill

As described previously, artificial fill is likely present below the existing roads and associated with some of the existing structures (Figure 2). Without subsurface exploration, we are not able to accurately characterize the fill or determine its thickness. Based on our review of historical photographs and topographic maps and site observations, we estimate that the fill is on the order of a few feet up to 20 feet in thickness.

2.1.2.2 Colluvium

Native soil deposits such as colluvium are likely present in the low-lying drainage/canyons of the property. The thickness of these deposits is unknown. Colluvium is a soil deposit formed from downslope movement and deposition of residual soil by such processes as slope wash, sloughing/shallow sliding, and creep. In the vicinity of the site, colluvium typically consists of silty clay with some sand and scattered rock fragments. Colluvium is of particular concern because it may be susceptible to both instability and compressibility.

2.1.2.3 Alluvium

Based on the published maps, the site does not appear to be underlain by alluvial deposits. Alluvial deposits in the general region are described as gravely and clayey sand or clayey gravel that fines upward to sandy clay (Graymer, 1997). These deposits typically display various degrees of sorting.

2.1.2.4 Landslides

Previous landslide mapping by Nilsen (1975) shows no landslides located at the site (Figure 4). However, Dibblee (1980) does show a slump on his map of the Hayward Quadrangle. According to the State of California Seismic Hazard Zones Map the site is located within a zone designated as susceptible to earthquake-induced landslides. Likewise, during our field reconnaissance we mapped several potential landslides along the hillside (Figure 2). These landslides were observed throughout the site and appeared to be of varying depth and size.

2.1.3 Faulting and Seismicity

The site is located adjacent to the Hayward fault zone, and portions of the property lie within a designated State of California Earthquake Fault Zone (Figure 5). The Hayward fault is considered an active right lateral fault and continues to creep along various segments. It is likely that fault related surface rupture will occur along the Hayward fault in the vicinity of the property.

In October 1868, a magnitude 6.8 earthquake occurred along the southern segment of the Hayward fault. As the earthquake occurred before the existence of seismographs, the epicenter is unidentified. Most of what is known about the earthquake is based on eyewitness accounts. Surface rupture was reported from Fremont to Berkeley, and damage was reported as far north as Santa Rosa and as far south as Gilroy and Santa Cruz (Brocher, 2008).

Because of the presence of nearby active faults[1], the Bay Area Region is considered seismically active. Numerous small earthquakes occur every year in the region, and large (greater than Moment Magnitude 7) earthquakes have been recorded and can be expected to occur in the

[1] An active fault is defined by the California Geological Survey as one that has had surface displacement within Holocene time (about the last 11,000 years) (SP42 CGS, 2007).

future. Figure 7 shows the approximate location of active and potentially active faults and significant historic earthquake epicenters mapped within the San Francisco Bay Region. Based on the 2014 update of the national seismic hazards maps, the table below shows the nearest known active faults capable of producing significant ground shaking at the site.

TABLE 2.1.3-1
Known Active Faults Capable of Producing Significant Ground Shaking at the Site

Fault Name	Distance from Site (miles)	Maximum Moment Magnitude (Elsworth)
Hayward-Rogers Creek	0.1	7.3
Calaveras	7.6	7.0
Mount Diablo Thrust	12.4	6.7
Concord-Green Valley	17.3	6.8
Monte Vista-Shannon	18.3	6.5
San Andreas	18.4	7.9
Greenville	19.0	7.0
San Gregorio	25.8	7.5

The Uniform California Earthquake Rupture Forecast (UCERF3, 2014) evaluated the 30-year probability of a Moment Magnitude 6.7 or greater earthquake occurring on the known active fault systems in the Bay Area, including the Calaveras fault. The UCERF generated an overall probability of 72 percent for the Bay Area as a whole, a probability of 14.3 percent for the Hayward fault, 7.4 percent for the Calaveras fault, 6.4 for the Northern San Andreas fault, and 3.5 percent for the Concord-Green Valley fault

2.1.4 Groundwater

Monitoring wells (data obtained from various public reports via GeoTracker, 2011-2015) in the vicinity of the site appear to indicate that local groundwater may occur between 27 to 48 feet bgs (below ground surface). The State of California Geologic Survey (CGS) supports this data but adds that the Hayward Fault acts as a ground-water barrier in this region. On the western side of the fault the groundwater is much deeper (greater than 50 feet where San Lorenzo Creek crosses the fault). On the eastern side of the fault, groundwater tends to be 10 to 30 feet in the flatland areas (Davis, 2003).

2.1.5 USDA Soil Survey

According to the United States Department of Agriculture (USDA) Soil Survey the site is underlain by a single soil type: Diablo clay. This soil makes up 85 percent of the site composition with 15 percent minor constituents (Clear Lake, and Altamount). The soil is noted to have a moderate corrosion potential for concrete and a high corrosion potential for steel. The shallow excavation (5 to 6 feet) rating is "somewhat limited" on the basis of slope, unstable excavation walls, dust, and clay content. The Plasticity Index for Diablo Clay is estimated at 27, inidcating that it is susceptible to shrink and swell due to moisture variation. It should be noted that all of the data compiled by the USDA are estimates and approximations and actual values should be obtained with site specific exploration.

3.0 SITE RECONNAISSANCE

ENGEO conducted a site reconnaissance on Wednesday, March 9, 2016. From our review of existing information, we conducted our site reconnaissance with a focus on slope stability, identification of fill and/or graded areas and confirmation of rock types. We compiled our observations on a site topographic map presented as Figure 2.

Slope stability is a major concern in any hillside development area. We observed areas of local instability with minor raveling on steeper slopes located in the road cuts and along drainages. In addition, during our reconnaissance we observed several locations of probable landslides throughout the site, but especially in the northern portion of the site. These landslides seem to be of varying widths and depths varying from shallow to potentially deep-seated. We also observed distress to roadways along the paved areas and roadways, especially along Bunker Hill Blvd. This is likely related to slope creep and possible settlement of the existing fill present at the site. Fill was also observed around several of the existing structures on site. Of particular note were the houses on the downslope side of Bunker Hill Court, which appeared to have a fill slope at the rear of the house up to 30 feet in height. All observed creeks/drainages encountered contained flowing water at the time of the site visit.

3.1 OBSERVED GROUNDWATER CONDITIONS

No groundwater seepage or other indication of near surface groundwater was observed during our reconnaissance. Fluctuations in groundwater levels occur seasonally and over a period of years because of variations in precipitation, temperature, irrigation, or other factors.

4.0 PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

From a preliminary geologic and geotechnical standpoint, the study area is generally suitable for potential development, provided that the preliminary recommendations included in this report, along with other sound engineering practices, are incorporated in the design and construction of the project. The primary geologic and geotechnical considerations for this project are:

- Considerable ground shaking from an earthquake of moderate to high magnitude generated within the San Francisco Bay Region.
- The presence of landslides and slope stability.
- The likely presence of undocumented fills of the existing roads and structures on site.
- Moderately to highly expansive soils.
- Ground rupture along a splay of the Hayward fault.

- Nearby areas have been mapped with the presence of serpentinite, a rock with the potential of Naturally Occurring Asbestos (NOA). Although no serpentinite was visible (or mapped historically) on site, large earth-moving operations may disturb these NOAs.

4.1 UNDOCUMENTED/DOCUMENTED FILLS

As discussed, minor existing fills are present at the site. The existing artificial fills are located along the roads and beneath existing structures. We do not have documentation of fill placement. Non-engineered fills can undergo consolidation that results in settlement under additional loads that is difficult to predict. Because of the potential for settlement and slope instability, it is typically recommended that these historic fills be removed and replaced as engineered fill.

4.2 LANDSLIDES AND SLOPE STABILITY

As discussed, the site is located on a hillside with a southwest-facing slope. Slope stability is a major concern in any hillside development area. Evidence of sloughing and shallow to deep-seated slope failures were observed on the existing slopes throughout the site during our site reconnaissance. An evaluation of these areas of the property should be performed, and the slopes overall stability should be evaluated. Recommendations for mitigation of landslide hazards should be provided in a design-level exploration for the proposed project. Mitigation options typically include removal and replacement as engineered fill, avoidance of the area or construction of structural retention systems to protect upslope areas.

4.3 SEISMIC HAZARDS

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking, ground lurching, and liquefaction. The following sections present a discussion of these hazards as they apply to the site.

4.3.1 Ground Rupture

The site is partially located within a State of California Earthquake Fault Hazard Zone and splays of the Hayward fault are potentially traversing parts of the property (Figure 5). Per Special Publication 42, any future project that falls under the Alquist-Priolo Earthquake Fault Zoning Act, and lies within the portions of the property located within a State of California Earthquake Fault Hazard Zone, would require future subsurface exploration (e.g. excavation of fault trenches) to assess the potential for fault surface rupture. Building exclusion zones and fault setbacks along active fault traces should be anticipated at the site.

4.3.2 Ground Shaking

An earthquake of moderate to high magnitude generated within the San Francisco Bay Region could cause considerable ground shaking at the site, similar to that which has occurred in the past. To mitigate the shaking effects, all structures should be designed using sound engineering judgment and the latest California Building Code (CBC) requirements, as a minimum.

4.3.3 Liquefaction

Liquefaction is a phenomenon in which saturated, loose or medium dense, cohesionless soils are subject to a temporary, but essentially total, loss of shear strength because of pore pressure build-up under the reversing cyclic shear stresses associated with earthquakes. The low lying portions of the property (i.e. the drainages) may be susceptible to liquefaction. On this basis, the potential for liquefaction in the drainages in the site should potentially be evaluated with subsequent subsurface exploration.

4.3.4 Lateral Spreading

Lateral spreading is lateral displacement of sloping ground as a result of pore pressure buildup or liquefaction in a shallow, underlying soil deposit during an earthquake. Lateral spreading, as a result of liquefaction, occurs when a soil mass slides laterally on a liquefied layer, and gravitational and inertial forces cause the layer and the overlying non-liquefied material to move in a downslope direction. The magnitude of lateral spreading movements depends on earthquake magnitude, distance between the site and the seismic event, thickness of the liquefied layer, ground slope or ratio of free-face height to distance between the free face and structure, fines content, average particle size of the materials comprising the liquefied layer, and the density of the soil materials. Because the potential for liquefaction may be present in the drainages on site, the potential for lateral spreading may also be present and should be evaluated during subsurface exploration of the site.

4.3.5 Earthquake-Induced Landslides

Ground shaking associated with earthquake events can trigger landslides in weak geologic materials, caused by a wide range of mechanisms. Due to the presence of mapped landslides at the site, and the overall inclination of the subject slopes, the potential for earthquake-induced landslides is considered high (Figure 6). This geologic hazard can be mitigated by various methods including but not limited to removal of potentially unstable materials and replacement as engineered fill or construction of engineered fill buttresses.

4.4 EXPANSIVE SOILS

Expansive soils shrink and swell as a result of moisture changes. This can cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations. Structures can be supported on structural reinforced mat foundations that are designed to accommodate shrinking and swelling subgrade soils. Based on the USDA soil survey and site observations, moderately to highly expansive soils potentially overlay the project site.

Successful construction on expansive soils requires special attention during grading. It is imperative to keep exposed soils moist by occasional sprinkling. If the soils dry, it is extremely difficult to remoisturize the soils (because of their clayey nature) without excavation, moisture conditioning, and recompaction.

Conventional grading operations, incorporating fill placement specifications tailored to the expansive characteristics of the soil, and use of a mat foundation (either post-tensioned or conventionally reinforced) are common, generally cost-effective measures to address the expansive potential of the foundation soils. Based upon our initial findings, the effects of expansive soils are expected to pose a low impact when properly mitigated.

5.0 PRELIMINARY SITE RECOMMENDATIONS

5.1 EXISTING FILL REMOVAL

We recommend removal of all existing undocumented fill within future grading limits or beneath future improvements to competent native soil or engineered fill. The lateral extent and depth of fill in areas identified to contain undocumented fill should be determined during future site exploration.

5.2 COLLUVIUM AND LANDSLIDE REMOVALS

We recommend removal of all existing colluvium and landslide debris within future grading limits.

5.3 ACCEPTABLE FILL

Onsite soil and rock material is suitable as fill material provided it is processed to remove concentrations of organic material, debris, and particles greater than 8 inches in maximum dimension. It also should be stated again that serpentinite zones are mapped in the region (although they are not mapped on the surface at the site). Serpentine may contain Naturally Occurring Asbestos (NOA) which requires special processing and mitigation during grading. If areas of serpentinite are exposed during grading operations (which can be determined by an ENGEO geologist) the suitability of the material as fill may be revised. Serpentinite, if encountered, would only occur in areas underlain by Franciscan assemblage rocks, it would not be expected to occur within Knoxville Formation rocks.

5.4 SLOPES

5.4.1 Gradients

For planning purposes, slope gradients for proposed graded slopes greater than 8 feet high should not be steeper than 3:1 (horizontal:vertical); slopes inclined steeper than 3:1 may require geogrid reinforcement. In addition, cut slopes may require reconstruction of the exposed slope as engineered fill if adverse conditions are encountered during excavation.

5.4.2 Fill Placed on Existing Slopes

We recommend keying and benching where fills are placed on original grade with a gradient of 6:1 or steeper.

For planning purposes, a keyway should be constructed inward from the toe of the new fill slope. The keyways should extend below original grade into firm competent soil/rock, as determined by the Engineering Geologist/Geotechnical Engineer. Slope the keyway bottom at least 2 percent downward toward the heel of the keyway. Keyway dimensions should be evaluated by the Engineering Geologist/Geotechnical Engineer based on actual soil/rock conditions observed during construction. Typical keyway details are provided in Figure 9.

Benches should be excavated into the existing slope (to remove loose soil/rock) as filling proceeds. Bench depths should be evaluated by the Engineering Geologist/Geotechnical Engineer depending on actual conditions observed during construction. Bench widths will vary depending on the original slope grade and actual bench depth.

Subsurface drainage systems should be installed in all keyways and swales or natural drainage areas. In addition, lot subdrains should be installed at the toe of cut or fill slopes above residential lots.

5.4.3 Slope Setbacks

Since no development plan yet exists for the site, it is difficult to determine the appropriate setback from the slope top. In general, for planning purposes we recommend that buildings be set back from the top of slope in accordance with CBC requirements (a minimum of 1/3 the height of the slope or a maximum of 40 feet). Alternatively, deep foundations such as pier-and-grade-beam foundations should be anticipated for buildings close to the top of slopes.

5.4.4 Fault Zone Setbacks

Without additional site specific information, permanent structures should be located outside the State of California Fault Hazard Zone. To reduce this offset, a fault study should be performed.

5.5 PRELIMINARY FOUNDATION RECOMMENDATIONS

Based on our study, depending on the future development, structures may be supported on a ridged mat foundation such as a Post-tensioned mat foundations, conventional footings in combination with non-expansive import, or pier-and-grade beam with raised floor.

5.6 ADDITIONAL RECOMMENDATIONS

Based upon our findings and assuming that the project proceeds into the next phase of development, additional geotechnical studies will be necessary. These studies will include:

- A geotechnical exploration and report for the proposed development. The site exploration should include both exploratory borings and test pits, as appropriate. The exploration is necessary to characterize site-specific subsurface conditions, collect soil samples for laboratory analysis, and determine site-specific recommendations for construction. In particular, the portions of the property falling within the Earthquake Fault Zones will have to be trenched to determine the location of the active fault.

- A review of final construction plans and specifications, including grading plans, foundation plans and calculations for conformance with our recommendations.

Although these studies were not included in our current scope of services, we believe that they are important in expediting approval by governing agencies and achieving cost-effective construction. We will be pleased to provide an estimate for these additional services once final plans are available.

6.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report presents preliminary geotechnical recommendations for conceptual planning for the project discussed in Section 1.3. 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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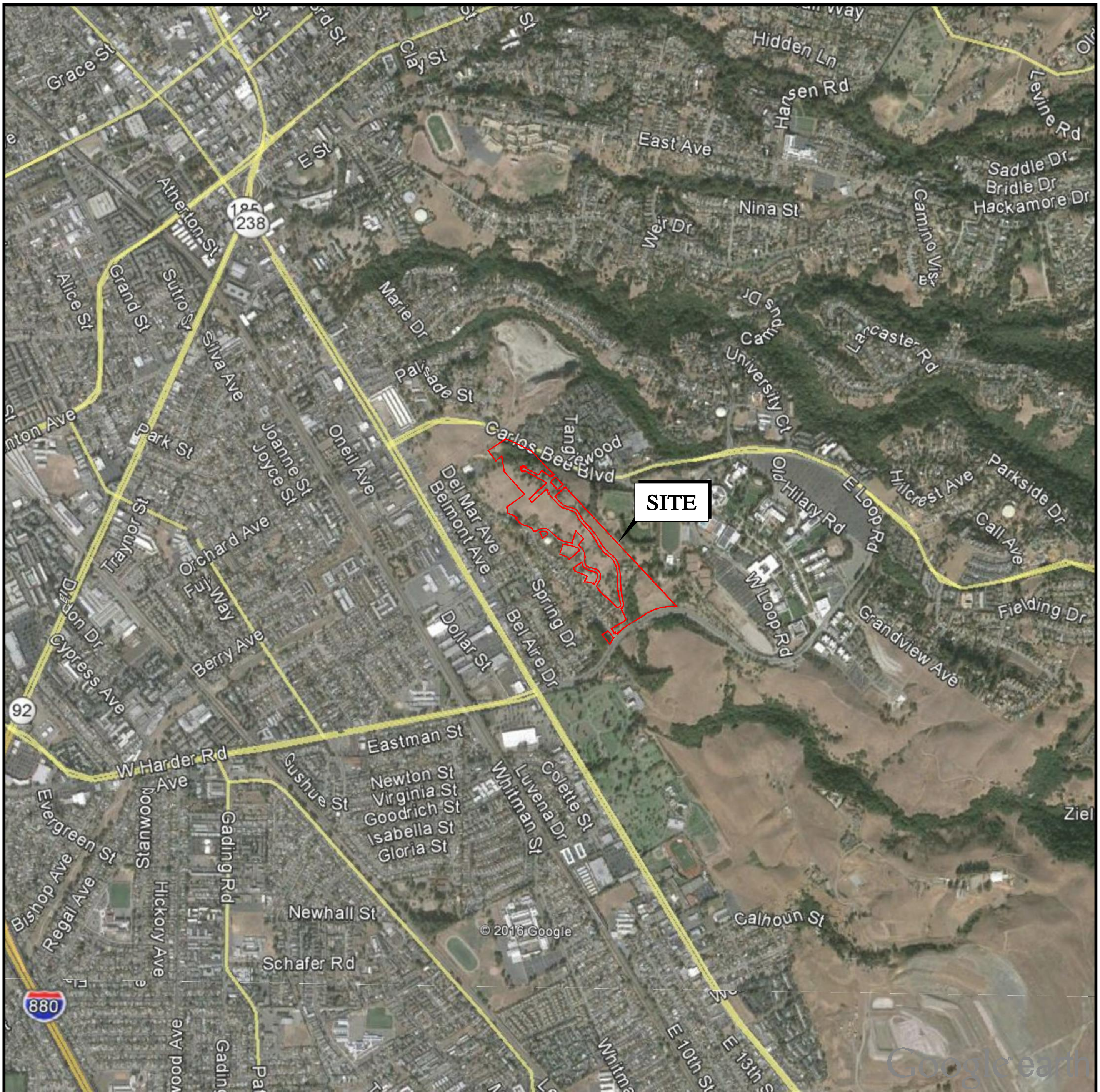
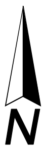
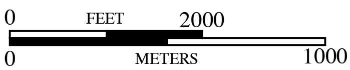
FIGURES

FIGURES







BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE

ENGEO Expect Excellence	VICINITY MAP ROUTE 238 BYPASS - GROUP 5 HAYWARD, CALIFORNIA	PROJECT NO.: 12843.000.000 SCALE: AS SHOWN DRAWN BY: LL CHECKED BY: JJT	FIGURE NO. 1

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A5\12843000000-A5-1-VicMap-0316.dwg Plot Date: 3-18-16 llee

ORIGINAL FIGURE PRINTED IN COLOR

EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

LANDSLIDE WITH DIRECTION SHOWN

GEOLOGIC CONTACT

SOIL CREEP

N

0 FEET 400

0 METERS 200

BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE

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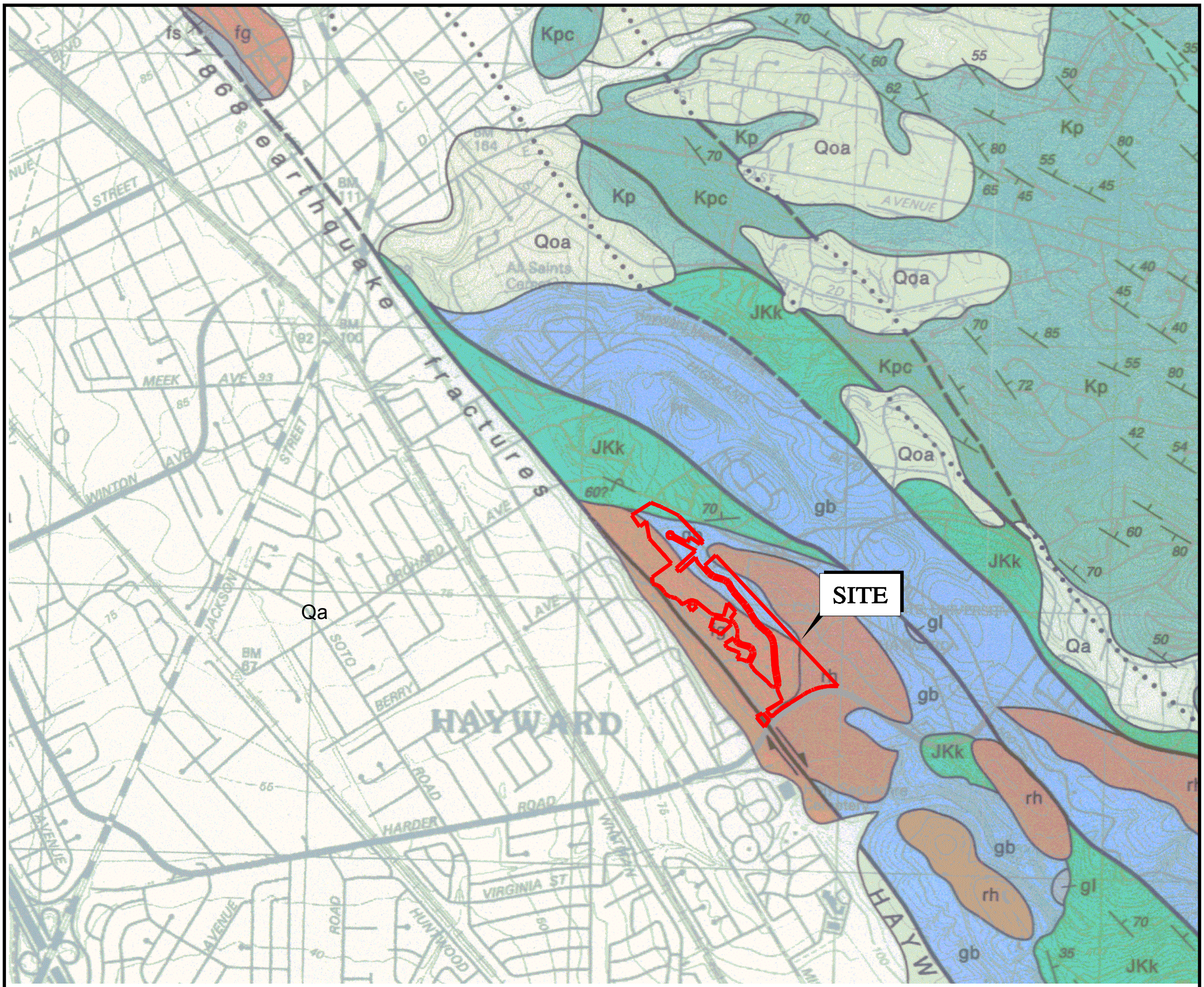
SITE PLAN
ROUTE 238 BYPASS - GROUP 5
HAYWARD, CALIFORNIA

PROJECT NO.:	12843.000.000
SCALE:	AS SHOWN
DRAWN BY: LL	CHECKED BY: JJT
FIGURE NO.	2

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A5\12843000000-A5-2-SitePlan-0316.dwg Plot Date: 3-18-16 llee

ORIGINAL FIGURE PRINTED IN COLOR



EXPLANATION

GEOLOGIC CONTACT-DASHED WHERE GRADATIONAL OR APPROXIMATELY LOCATED

FAULT-DASHED WHERE INFERRED, DOTTED WHERE CONCEALED, QUERIED WHERE EXISTENCE IS DOUBTFUL. SAWTEETH ARE ON UPPER PLATE OF LOW ANGLE THRUST FAULT.

AXIS OF FOLD

ANTICLINE SYNCLINE

STRIKE AND DIP OF STRATA

INCLINED VERTICAL OVERTURNED

Qa	ALLUVIUM
Qoa	ALLUVIUM
kp	CLAY SHALE
kpc	CONGLOMERATE
JKk	KNOXVILLE FORMATION
rh	LEONA RHYOLITE
sp	VOLCANIC ROCK
gb	GABBRO-DIABASE
fg	GREENSTONE

N

0 FEET 2000

0 METERS 1000

BASE MAP SOURCE: DIBBLEE, 2005

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REGIONAL GEOLOGIC MAP

ROUTE 238 BYPASS - GROUP 5

HAYWARD, CALIFORNIA

PROJECT NO.:	12843.000.000
SCALE:	AS SHOWN
DRAWN BY: LL	CHECKED BY: JJT
FIGURE NO.	3

EXPLANATION

LANDSLIDE DEPOSIT. ARROWS INDICATE GENERAL DIRECTION OF DOWNSLOPE MOVEMENT. QUERIED WHERE UNCERTAIN

Qal ALLUVIAL DEPOSIT

Qt ALLUVIAL TERRACE DEPOSIT. QUERIED WHERE UNCERTAIN

COLLUVIAL DEPOSIT AND/OR SMALL ALLUVIAL FAN DEPOSIT

Qaf ARTIFICIAL FILL

BEDROCK. QUERIED WHERE IDENTIFICATION UNCERTAIN

QUARRY OR GRAVEL PIT

N

0 FEET 2000

0 METERS 1000

BASE MAP SOURCE: NILSEN, 1975

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REGIONAL LANDSLIDE MAP

ROUTE 238 BYPASS - GROUP 5

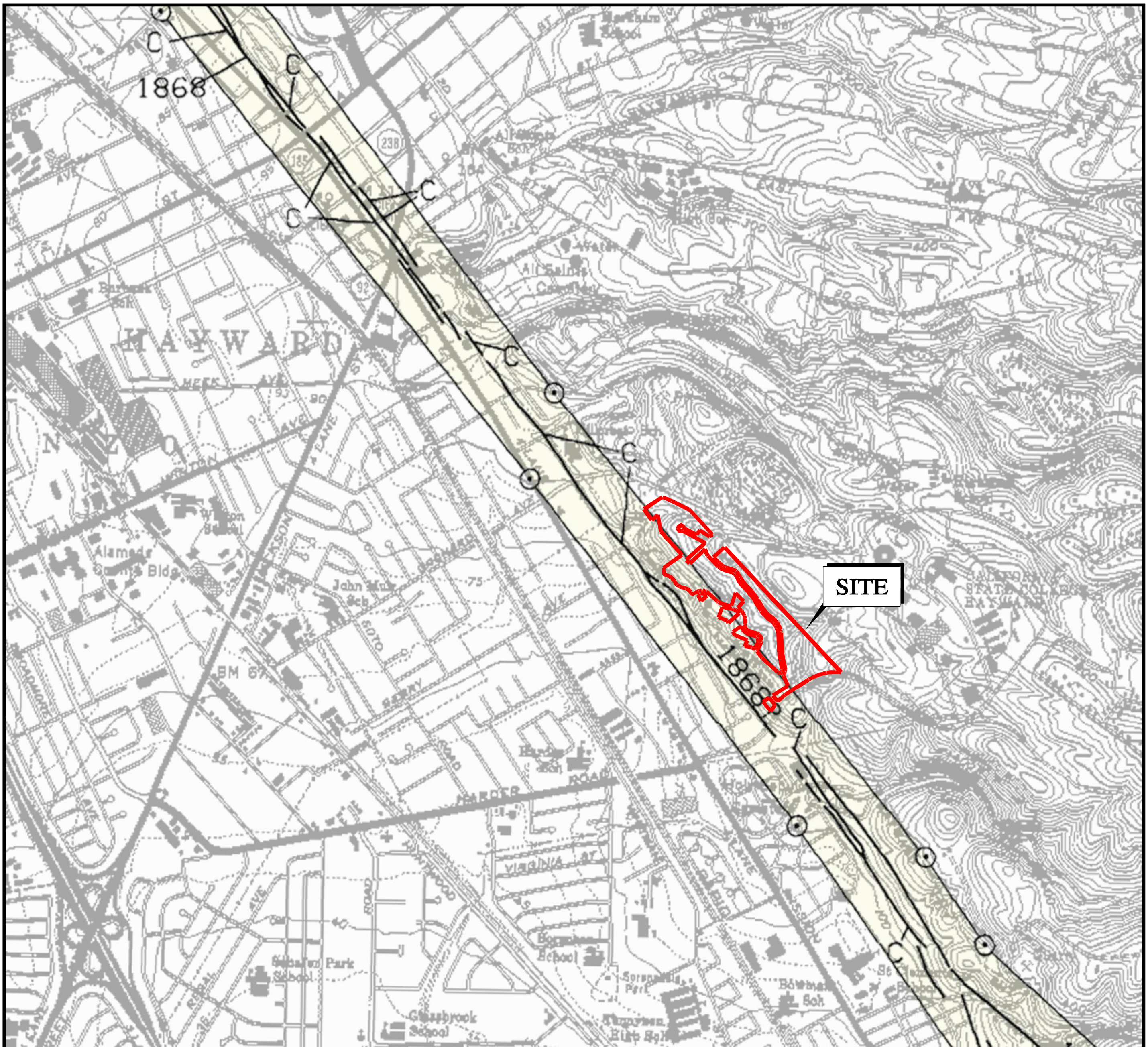
HAYWARD, CALIFORNIA

PROJECT NO.: 12843.000.000	
SCALE: AS SHOWN	
DRAWN BY: LL	CHECKED BY: JJT

FIGURE NO. 4

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A5\12843000000-A5-4-LANDSLIDEMAP-0316.dwg Plot Date: 3-18-16 llee

ORIGINAL FIGURE PRINTED IN COLOR



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

N

0 FEET 2000
0 METERS 1000

BASE MAP SOURCE: CDMG, 1993

ENGEO Expect Excellence

EARTHQUAKE FAULT ZONE MAP

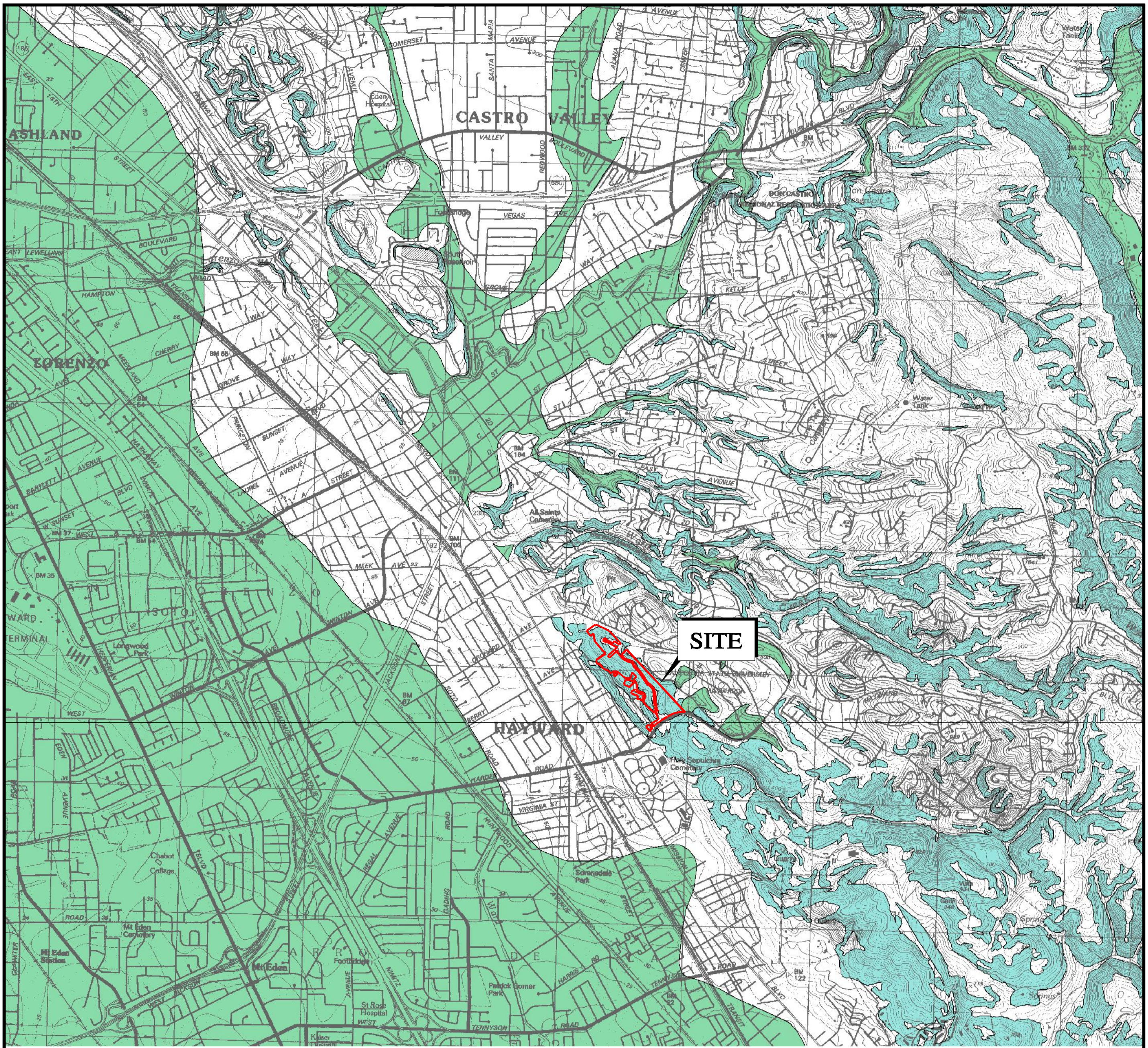
ROUTE 238 BYPASS - GROUP 5

HAYWARD, CALIFORNIA

PROJECT NO.: 12843.000.000	FIGURE NO. 5
SCALE: AS SHOWN	
DRAWN BY: LL	CHECKED BY: JJT

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A5\12843000000-A5-5-EARTHQUAKEFAULTZONE-0316.dwg Plot Date: 3-18-16 llee

ORIGINAL FIGURE PRINTED IN COLOR



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

N

0 FEET 4000
0 METERS 2000

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

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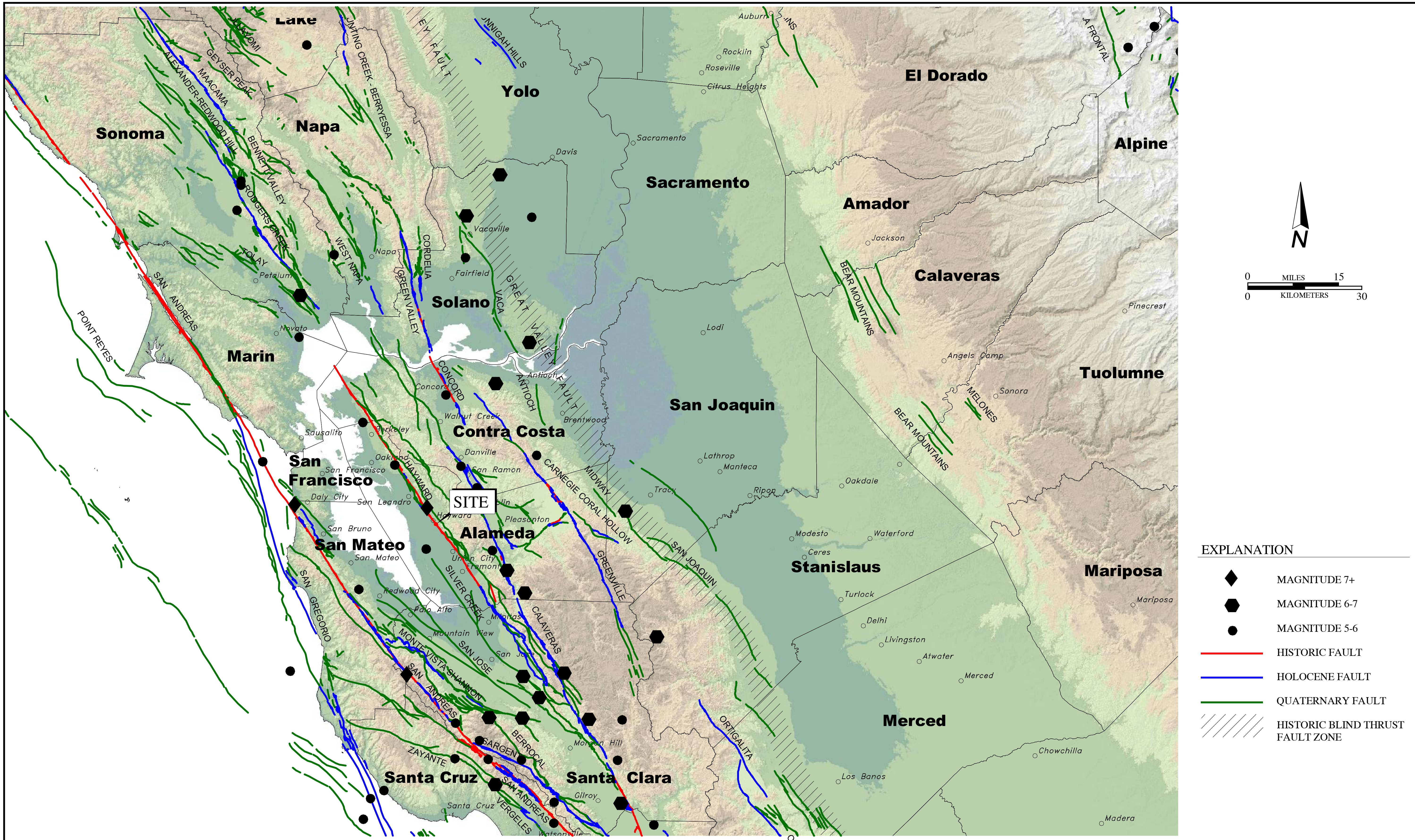
SEISMIC HAZARD ZONES MAP	PROJECT NO.: 12843.000.000		FIGURE NO.
ROUTE 238 BYPASS - GROUP 5	SCALE: AS SHOWN		6
HAYWARD, CALIFORNIA	DRAWN BY: LL	CHECKED BY: JJT	

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A5\12843000000-A5-6-HAZMAP-0316.dwg Plot Date: 3-18-16 llee

ORIGINAL FIGURE PRINTED IN COLOR



BASE MAP SOURCE:
COLOR HILLSHADE IMAGE BASED ON THE NATIONAL ELEVATION DATASET (NED) AT 30 METER RESOLUTION
U.S.G.S. QUATERNARY FAULT DATABASE, NOVEMBER, 2010
U.S.G.S. HISTORIC EARTHQUAKE DATABASE (1800–2000)

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REGIONAL FAULTING AND SEISMICITY ROUTE 238 BYPASS - GROUP 5 HAYWARD, CALIFORNIA	PROJECT NO.: 12843.000.000		FIGURE NO
	SCALE: AS SHOWN		7
	DRAWN BY: LL	CHECKED BY: JJT	

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A5\12843000000-A5-7-FAULTMAP-0316.dwg Plot Date: 3-18-16 llee

ORIGINAL FIGURE PRINTED IN COLOR

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A5\12843000000-A5-8-USDASOIL-0316.dwg Plot Date: 3-18-16 llee

EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

DIABLO CLAY

N

BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE

0 FEET 500

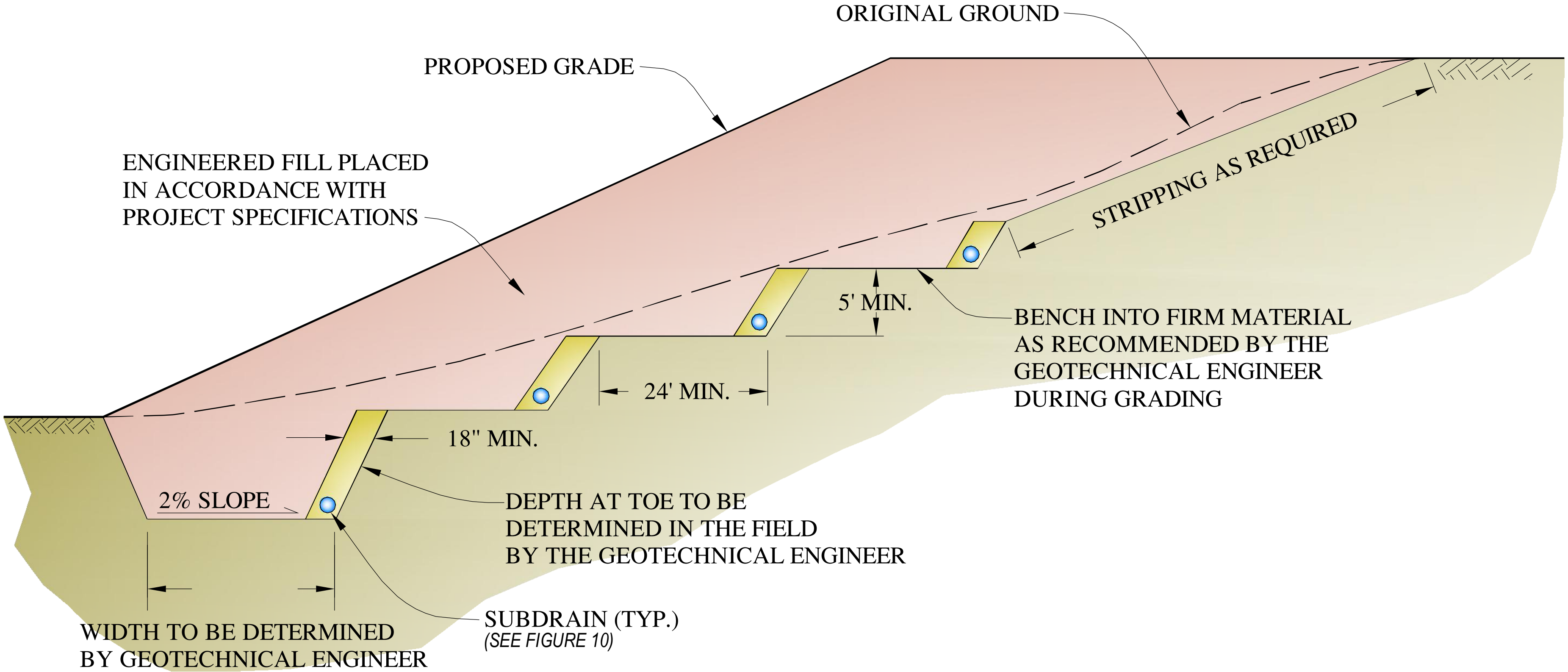
0 METERS 250

ENGEO Expect Excellence

USDA SOIL SURVEY ROUTE 238 BYPASS - GROUP 5 HAYWARD, CALIFORNIA	PROJECT NO.: 12843.000.000 SCALE: AS SHOWN DRAWN BY: LL CHECKED BY: JJT	FIGURE NO. 8

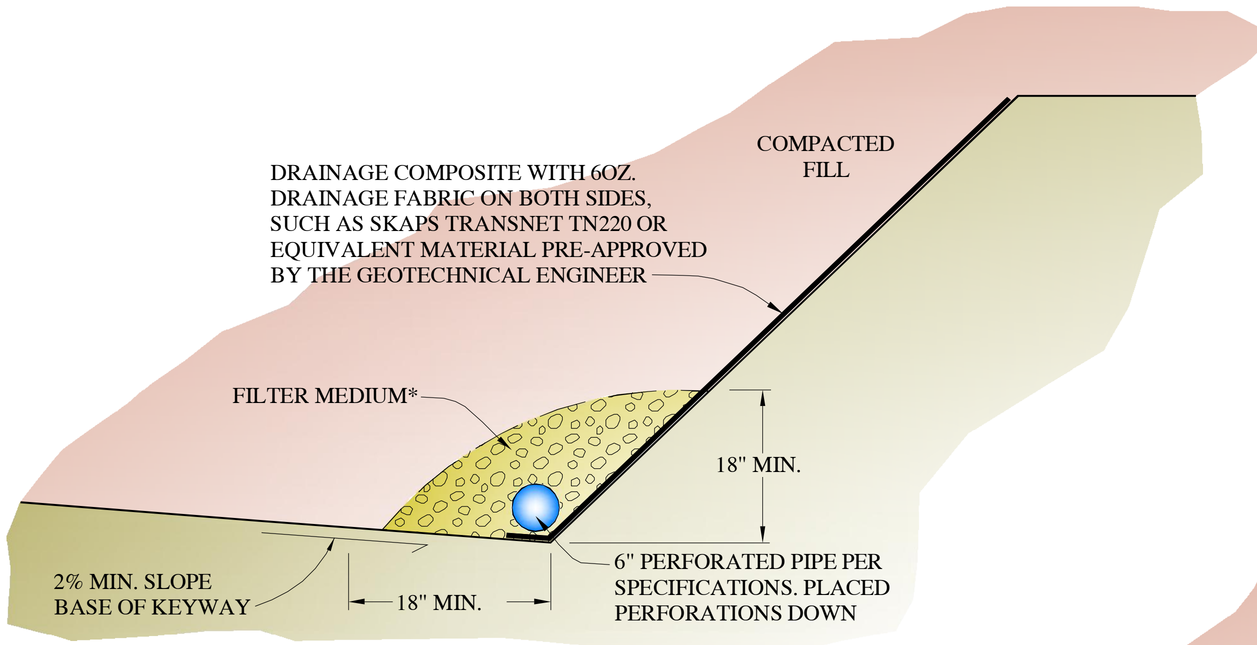
ORIGINAL FIGURE PRINTED IN COLOR

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A5\12843000000-A5-9-KEYWAYDTL-0316.dwg Plot Date:3-18-16 llee

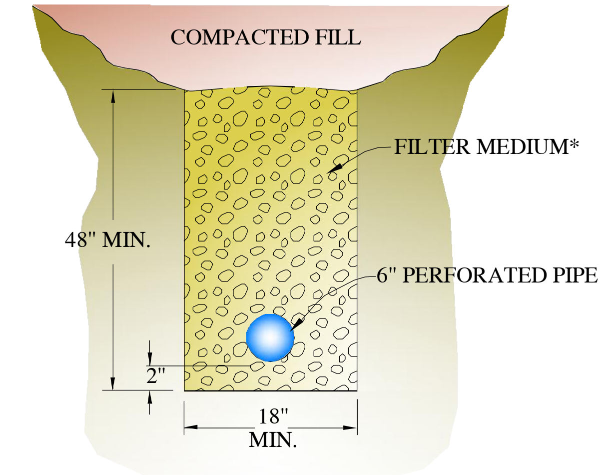


ENGEO Expect Excellence	TYPICAL KEYWAY DETAIL ROUTE 238 BYPASS - GROUP 5 HAYWARD, CALIFORNIA	PROJECT NO.: 12843.000.000 SCALE: NO SCALE DRAWN BY: LL CHECKED BY: JJT	FIGURE NO. 9

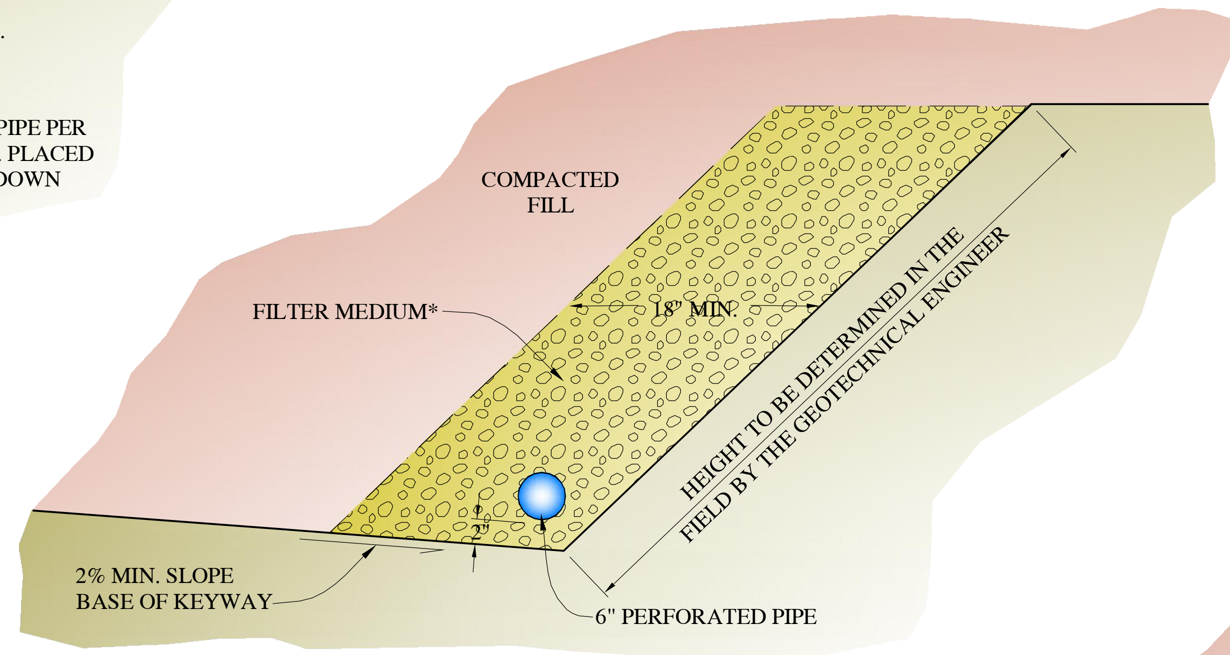
ORIGINAL FIGURE PRINTED IN COLOR



KEYWAY SUBDRAIN - OPTION 1



SWALE SUBDRAIN



KEYWAY SUBDRAIN - OPTION 2

*FILTER MEDIUM

ALTERNATIVE A

CLASS 2 PERMEABLE MATERIAL

MATERIAL SHALL CONSIST OF CLEAN, COARSE SAND AND GRAVEL OR CRUSHED STONE, CONFORMING TO THE FOLLOWING GRADING REQUIREMENTS:

SIEVE SIZE	% PASSING SIEVE
1"	100
3/4"	90–100
3/8"	40–100
#4	25–40
#8	18–33
#30	5–15
#50	0–7
#200	0–3

ALTERNATIVE B

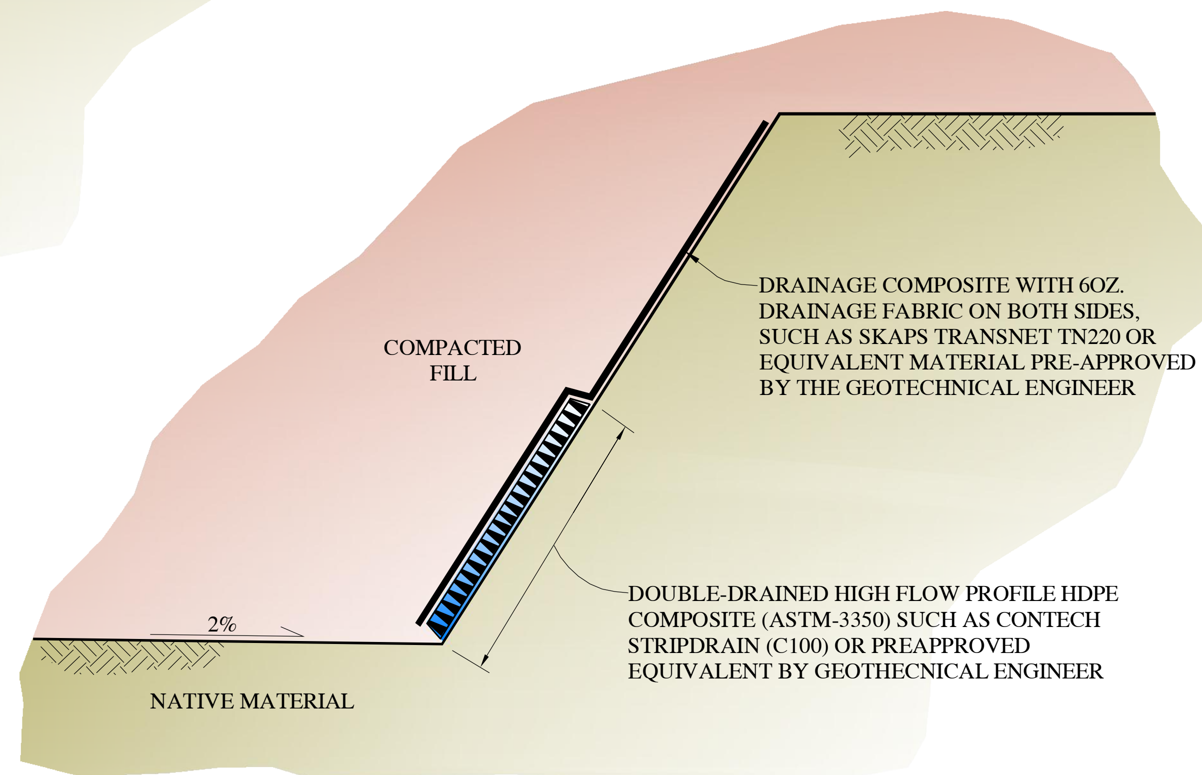
CLEAN CRUSHED ROCK OR GRAVEL WRAPPED IN FILTER FABRIC

ALL FILTER FABRIC SHALL MEET THE FOLLOWING MINIMUM AVERAGE ROLL VALUES UNLESS OTHERWISE SPECIFIED BY ENGEO:

GRAB STRENGTH (ASTM D-4632)	180 lbs
MASS PER UNIT AREA (ASTM D-4751)	6 oz/yd^2
APPARENT OPENING SIZE (ASTM D-4751)	70-100 U.S. STD. SIEVE
FLOW RATE (ASTM D-4491)	80 gal/min/ft
PUNCTURE STRENGTH (ASTM D-4833)	80 lbs

NOTES:

1. ALL PIPE JOINTS SHALL BE GLUED
2. ALL PERFORATED PIPE PLACED PERFORATIONS DOWN
3. 1% FALL (MINIMUM) ON ALL TRENCHES AND DRAIN LINES



ALTERNATE KEYWAY SUBDRAIN - OPTION 3

(FOR DEPTHS LESS THAN 30 FEET)

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TYPICAL SUBDRAIN DETAILS
ROUTE 238 BYPASS - GROUP 5
HAYWARD, CALIFORNIA

PROJECT NO.: 12843.000.000	FIGURE NO. 10
SCALE: NO SCALE	
DRAWN BY: LL	CHECKED BY: JJT