GEOTECHNICAL FEASIBILITY REPORT

ROUTE 238 BYPASS – GROUP 6
HAYWARD , CALIFORNIA

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

Prepared by:
ENGEO Incorporated

March 31, 2016

Project No:
12843.000.000

GEOTECHNICAL
ENVIRONMENTAL
WATER RESOURCES
CONSTRUCTION SERVICES

Project No.
12843.000.000

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

Subject: Route 238 Bypass – Group 6
Hayward, California

GEOTECHNICAL FEASIBILITY REPORT

Dear Mr. Briggs:

ENGEO has prepared this geotechnical feasibility report in support of your due diligence for the approximately 30-acre Group 6 site. The site is located between Carlos Bee Boulevard to the south and Highland Boulevard to the north, 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
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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 aerial photographs and historical topographic maps, both in-house and online, for the site and areas adjacent to the site.
- 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 property.

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 project site comprises approximately 30 acres of land currently utilized as open space and was a former quarry operation. The project site is located north of Carlos Bee Boulevard, south of Highland Boulevard and approximately 1,500 feet northeast of Route 238 (Mission Boulevard) and approximately 2,000 feet northwest of California State University, East Bay (Figure 1).

The current topography of the site can generally be characterized as a generally flat former quarry with elevations from approximately 290 feet in the northwest of the site to 300 feet in the southeast of the property. On the edges of the site there are moderate to steep cut faces left over from the quarrying operations. The southeastern high wall is the most significant of these, with an elevation of approximately 400 feet, with a cut slope of approximately 1.5:1 (horizontal: vertical). A drainage swale loops around from the southeast to the southwest bounding the north side of the property. The property is currently occupied by leftover quarry operations and associated abandoned infrastructure, including a few concrete slab foundations in the northwest.

1.3 PROJECT DESCRIPTION

Based on the information provided, we understand that the City of Hayward is interested in acquiring Group 6 parcel area from CalTrans with plans of selling it for future development. No plans have been developed at this time showing potential grading and structure concepts. We have assumed that cuts and fills for design grading of the site will most likely be necessary, as well as potential landslide mitigation and repair, and undocumented fill excavation and reprocessing (if any exists).

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 has been significantly modified by quarry operations based on historical aerial photographs as well as historical topographic maps. Quarry operations appear to have started between 1957 and 1958 based on historic aerials and topographic maps. The operations have removed an estimated 160 feet of material from the original existing hilltop to the present day elevation. The structures to the northwest appear to have been constructed sometime between 1960 and 1968. It is unclear when the structures were demolished, but it would appear as though it were sometime between 1980 and 1993. It is possible that undocumented fill exists below these structures. The site has been used as a quarry and open space. Vegetation at the site generally consists of sparse seasonal grasses with scattered trees and brush, with the drainage being heavily wooded.

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 (2005), the site is primarily underlain by late Jurassic gabbro-diabase associated with the Coast Range Ophiolite Complex and late Jurassic early Cretaceous Knoxville Formation (Figure 3). Dibblee (2005) maps the majority of the bedrock on site as gabbro-diabase which underlies roughly the northern two-thirds of the property. The Coast Range Ophiolite Complex is an igneous complex that was scraped off the ocean floor during subduction from the late Jurassic to early Cretaceous.

The southern third of the site, according to Dibblee, is underlain by 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 greywacke, sandstone, and brown dolomite. Dibblee (2005) maps an overturned bed within the Knoxville Formation near the southwestern boundary of the site.

During our site visit we observed “Leona Rhyolite” which was originally mistaken for a younger, volcanic unit, but later radiometric age dating confirmed that it is associated with the Coast Range Ophiolite Complex. The Leona Rhyolite is now interpreted as a keratophyre, a type of low-grade metamorphic rock that occurs on the ocean floor. We also observed portions of the site underlain by a greenstone. This greenstone (metabasalt) is dark gray to black, massive, aphanitic and can be slightly serpentinized locally; this unit is associated with the Franciscan assemblage. The Franciscan assemblage is described as Late Jurassic to Cretaceous in age and is composed of submetamorphosed marine sedimentary and mafic igneous rocks (Dibblee, 2005). Bedding mapped by Dibblee (2005), in the vicinity of the property, tends to strike northwest southeast with moderate to steep dips toward the northeast from around 40 to 85 degrees.

Exposures of these bedrock units were generally observed to be weak to moderately strong, moderately fractured to crushed and highly weathered to weathered, displaying a reddish brown iron oxide staining.

Mapping by Nilsen (1975) did not show landslides on the property. Quarry operations were already well underway by the time Nilsen performed his aerial photograph mapping. Review of historical aerial photographs and site reconnaissance shows evidence of several landslides in the surrounding vicinity both historically and recently.

2.1.2.1 Artificial Fill

As described previously, artificial fill may be present in the northwestern portion of the site below the existing slab foundations (Figure 2). Without subsurface exploration, we are unable to accurately characterize the fill or determine its thickness. Use for industrial purposes in previous decades, makes characterizations more unpredictable as building codes and common practices are often much different than current trends and regulations.

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). This does not preclude landslides from potentially occurring on the property in the future. Quarrying activities removed much of the historic hill, and therefore much risk and evidence of landslides, but failures – especially on the high walls – are still a very real possibility.

2.1.3 Faulting and Seismicity

The site is located adjacent to the Hayward fault zone; however, the property lies outside of a designated State of California Earthquake Fault Zone (Figure 5). The Hayward fault is considered an active fault with a general right-lateral sense of movement and continues to creep along various segments.

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

[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).

Moment Magnitude 7) earthquakes have been recorded and can be expected to occur in the 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	12.2	6.7
Concord-Green Valley	17.5	6.5
San Andreas	18.5	7.9
Monte Vista-Shannon	18.6	6.5
Greenville	18.9	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) around 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 Agricultrure (USDA) Soil Survey the site is potentially underlain by four soil types: Millsholm silt loam, Xerorthents-Los Osos complex, Altamont clay, and Diablo clay. 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. Due to the quarry activity that existed at the site, the Soil Survey map designated a large portion of the site are as “Urban land.”

2.1.5.1 Urban land

The unit 'Urban land' is designated to the majority of the property (roughly 87 percent). This is a generalized designation given to areas with miscellaneous urban uses. In this case the former use as a quarry means that much of the soil characteristics are not measured. The corrosion rates for "Urban land" are not recorded; Concrete – unknown, Steel – Unknown. Shallow excavations in this soil type are not rated. The Plasticity Index is not rated.

2.1.5.2 Millsholm silt loam (30 to 50 percent slopes)

This soil unit underlies approximately ten percent of the property. This soil unit is described as having a parent unit of "residuum weathered from sedimentary rock". It is noted to have a low corrosion rating for concrete and a moderate corrosion rate for steel. It has a very limited rating for shallow excavations (5 to 6 feet) based on depth to hard bedrock, slope, dust, and unstable excavation walls. The Plasticity Index (PI) is estimated at 4.2 – indicating a low susceptibility to shrink and swell due to variation in moisture content.

2.1.5.3 Altamont clay (15 to 30 percent slopes)

This soil unit underlies approximately two percent of the property. This soil unit is described as having a parent unit of "residuum weathered from sandstone and shale and/or residuum weathered from conglomerate". It is noted to have a low corrosion rating for concrete and a high corrosion rate for steel. It has a very limited rating for shallow excavations (5 to 6 feet) based on slope, unstable excavation walls, dust, and clay content. The Plasticity Index (PI) is estimated at 27.5 – indicating a high susceptibility to shrink and swell due to variation in moisture content.

2.1.5.4 Diablo clay (9 to 15 percent slopes)

This soil unit underlies approximately one percent of the property. This soil unit is described as having a parent unit of "residuum weathered from sandstone and shale". It is noted to have a moderate corrosion rating for concrete and a high corrosion rate for steel. It has a somewhat limited rating for shallow excavations (5 to 6 feet) based on slope, unstable excavation walls, dust, and clay content. The Plasticity Index (PI) is estimated at 30.0 – indicating a high susceptibility to shrink and swell due to variation in moisture content.

3.0 SITE RECONNAISSANCE

ENGEO conducted a site reconnaissance on 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 the steep slopes located in the high-walls surrounding the sites and along drainages. In addition, during our reconnaissance we observed locations of potential landslides in the southern portion of the site. These landslides seem to be of varying widths and depths but in general appear to be relatively shallow. Fill was also noted to potentially exist beneath the slab foundations towards the western portion of the site. 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. However, there were several pools of standing water scattered throughout the basin/quarry region of the site. It appeared as though these pools were a product of the collection of rainwater, not seepage. Fluctuations in groundwater levels occur seasonally and over a period of years because of variations in precipitation, temperature, irrigation, or other factors.

4.0 CONCLUSIONS AND PRELIMINARY 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:

- Slope stability.
- Considerable ground shaking from an earthquake of moderate to high magnitude generated within the San Francisco Bay Region.
- A potential for environmental contamination due to historic quarrying activities.
- Serpentinite, a rock with the potential of Naturally Occuring Asbestos (NOA), has been mapped in nearby areas. Although serpentinite was not observed during our site reconnaissance, nor has it been historically mapped on the property, there is possibility of NOA on site. Large earth-moving operations have the potential to disturb these NOAs.
- Moderatly to highly expansive soils.
- The likely presence of undocumented fills of the existing roads and structures on site.

4.1 UNDOCUMENTED/DOCUMENTED FILLS

As discussed, minor existing fills may be present at the site. 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, high-walls exist surrounding the majority of the property (especially the southeast high-wall). Slope stability is a major concern in any hillside development area. Evidence of sloughing and slope failures of unknown depth were observed on the existing slopes during our site reconnaissance. An evaluation of these areas of the property should be performed, and the overall stability of the slopes should be evaluated. Recommendations for mitigation of landslide hazards should be provided in a design-level exploration for the property. Mitigation options typically include removal and replacement as engineered fill, avoidance of the area, or construction of structural retentions 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 not located within a State of California Earthquake Fault Hazard Zone (Figure 5). In addition, because no active faults are mapped through the property, the potential for surface fault rupture at the site is considered low, but should be considered during design and construction of any proposed improvements.

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 State of California Seismic Hazard Zones Map does not show areas susceptible to liquefaction within the property (Figure 6). However, the potential for liquefaction in the drainage portions of the property should be evaluated using 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 property is not mapped as being susceptible to liquefaction, the potential for lateral spreading should be considered low, but 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 overall inclination of the subject slopes, the potential for earthquake-induced landslides is considered high. The site is designated in the State of California Seismic Hazard Zones Map as susceptible to earthquake-induced landslides (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, rock-nail walls, etc.

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.

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

The following preliminary recommendations may be used for planning purposes and further evaluate with a site-specific study.

5.1 EXISTING FILL REMOVAL

We recommend removal of all existing undocumented fill within future grading limits or beneath future improvement to competent native soil or engineered fill, as determined by the Engineering Geologist/Geotechnical Engineer. 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 where proposed improvements may be sensitive to vertical or lateral deformations.

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 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 require 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 (Figure 10). 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. For planning purposes, we generally recommend that buildings be set back from the top of slope in accordance with CBC requirements (a minimum of one-third 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.

5.5 PRELIMINARY FOUDATION 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, conventional footings in combination with non-expansive import, or pier-and-grade-beam foundation 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.

- 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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SELECTED REFERENCES

California Geological Survey Special Publication 117A (2008). Guidelines for Evaluation and Mitigating Seismic Hazards in California.

California Geological Survey Staff, (2003), Official Seismic Hazard Zone Map, Hayward quadrangle: California Geological Survey, Official Map of Seismic Hazard Zones , scale 1:24,000.

Davis, James; Department of Conservation – California Geological Survey (2003). Seismic Hazard Zone Report for the Hayward 7.5-Minute Quadrangle, Alameda County, California. Seismic Hazard Zone Report 091.

Dibblee, T.W. and Minch, J.A., (2005), Geologic map of the Hayward quadrangle, Contra Costa and Alameda Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-163, scale 1:24,000.

Dibblee, T.W., (1980), Preliminary geologic map of the Hayward quadrangle, Alameda and Contra Costa Counties, California: U.S. Geological Survey, Open-File Report OF-80-540, scale 1:24,000.

Field, E.H., Biasi, G.P., Bird, Peter, Dawson, T.E., Felzer, K.R., Jackson, D.D., Johnson, K.M., Jordan, T.H., Madden, Christopher, Michael, A.J., Milner, K.R., Page, M.T., Parsons, Thomas, Powers, P.M., Shaw, B.E., Thatcher, W.R., Weldon, R.J., and Zeng, Yuehua, 2013, Uniform California earthquake rupture forecast, version 3 (UCERF3) -- the time independent model: U.S. Geological Survey, Open-File Report OF-2013-1165, scale 1:16,700,000.

GeoTracker. http://geotracker.waterboards.ca.gov/

Graymer, R.W. (2000). Geologic Map and Map Database of the Oakland Metropolitan Area, Alameda, Contra Costa, and San Francisco Counties, California, USGS, Miscellaneous Field Studies 2342.

Graymer, R.W., Jones, D.L., and Brabb, E.E., (1998), Geologic map of the Hayward fault zone, Contra Costa, Alameda, and Santa Clara Counties, California: a digital database: U.S. Geological Survey, Open-File Report OF-95-597, scale 1:50,000.
-Hayward quadrangle.

Historic Aerials – Historic topographic maps, T1899, T1901, T1906, T1910, T1913, T1915, T1928, T1939, T1950, T1957, T1960, T1966, T1969, T1974, T1980, and T1997 http://www.historicaerials.com/

SELECTED REFERENCES (Continued)

Historic Aerials, 1946, 1958, 1960, 1968, 1980, 1987, 1988, 1993, 2000, 2002, 2005, 2009, 2010, and 2012.
http://www.historicaerials.com/

Jennings, C.W., (2010) Fault Activity Map of California, California Geologic Survey, Map No. 6.

Nilsen, T.H., (1975), Preliminary photointerpretation maps of landslide and other surficial deposits of 56 - 7.5 minute quadrangles, Alameda, Contra Costa, and Santa Clara Counties, California: U.S. Geological Survey, Open-File Report OF-75-277, scale 1:24,000.

U.S. Geological Survey and California Geological Survey (2006). Quaternary fault and fold database for the United States, accessed February 28, 2014, from USGS web site: http//earthquake.usgs.gov/hazards/qfaults/.

United States Department of Agriculture (USDA) (2016). Web Soil Survey. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. Natural Resources Conservation Service.

Witter C.W., Knudsen K.L., et al. (2006). Map of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, USGS Open File Report 06-1037, 2006.

FIGURES

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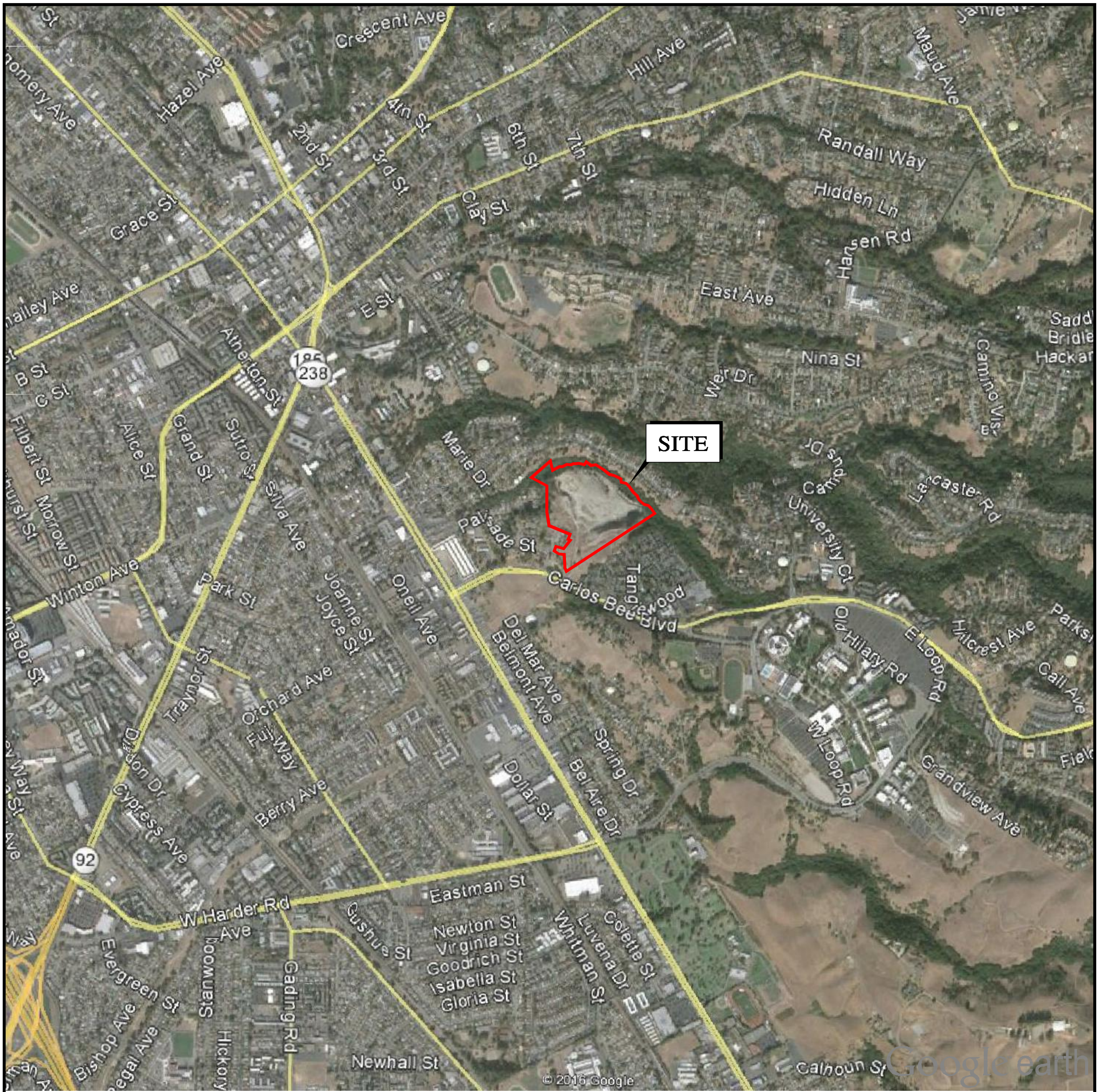
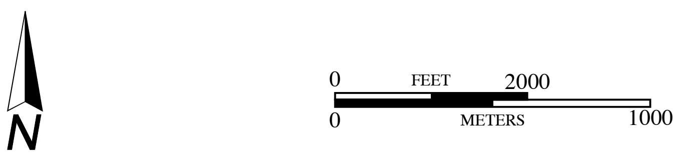


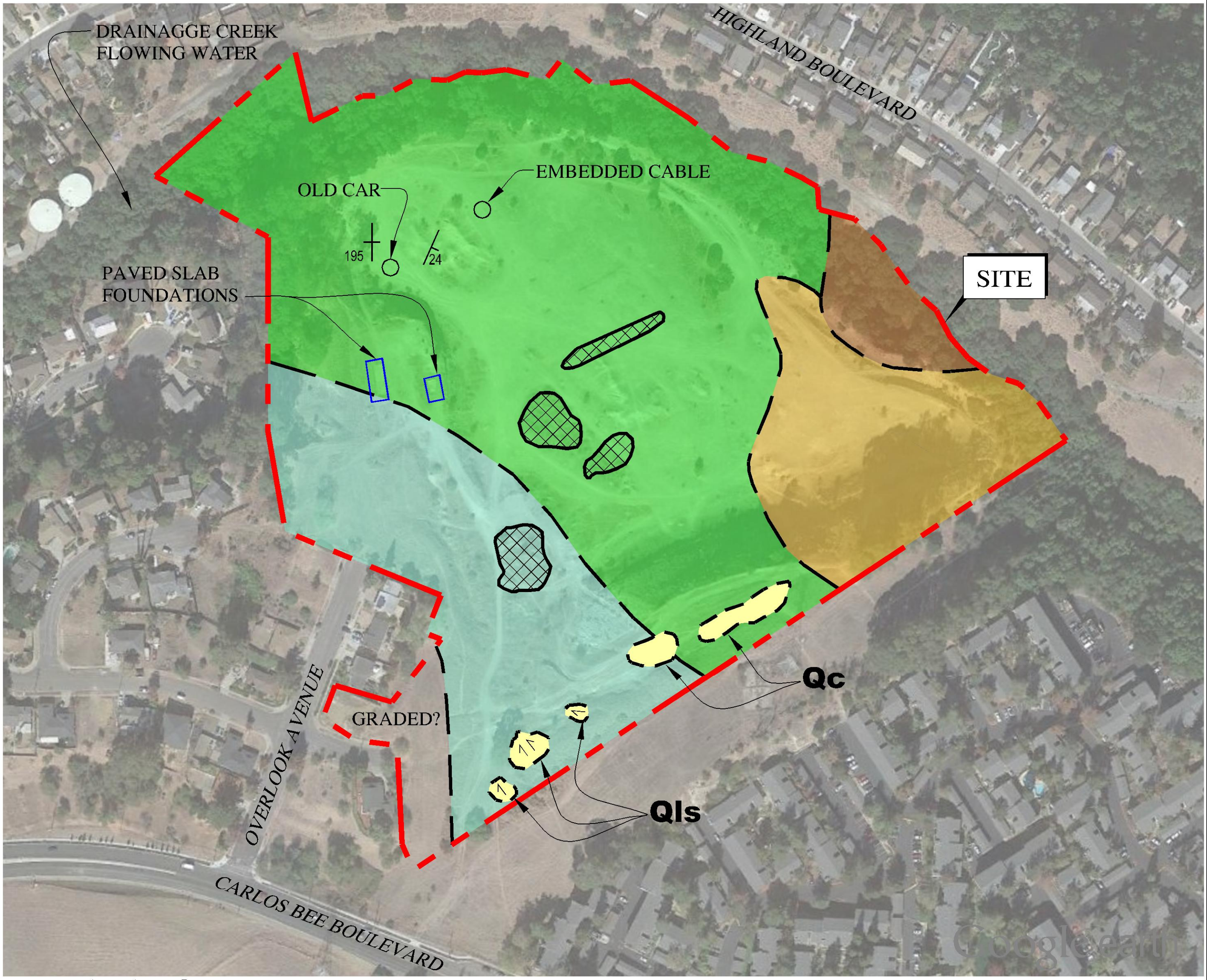


BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE

ENGEO Expect Excellence	VICINITY MAP ROUTE 238 BYPASS - GROUP 6 HAYWARD, CALIFORNIA	PROJECT NO.: 12843.000.000 SCALE: AS SHOWN DRAWN BY: SRP / CHECKED BY: JJT	FIGURE NO. 1

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A6\12843000000-A6-1-VicMap-0316.dwg Plot Date: 8-01-16 DBORDE

ORIGINAL FIGURE PRINTED IN COLOR



EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

Qls LANDSLIDE

Qc COLLUVIUM

KNOXVILLE FORMATION: WEAK TO MODERATELY STRONG, DARK BROWNISH GRAY TO BROWNISH GREEN, WEATHERED. MODERATE FRACTURE SPACING TO CRUSHED. MICACEOUS, CLAY SHALE, INCLUDES THIN INTERBEDS OF OLIVE BROWN FINE GRAINED GRAYWACKE, SANDSTONE AND BROWN DOLOMITE

COAST RANGE OPHIOLITE

KERATOPHYRE: STRONG TO WEAK PALE BLUISH GRAY APHANITIC MASSIVE ROCK. WEATHERS TO BROWNISH BLUE BROWNISH GREEN

GABBRO: STRONG TO MODERATELY WEAK, MASSIVE, BLACK, MEDIUM TO FINE GRAINED. WEATHERS TO MOTTLED LIGHT AND DARK GRAY. FRACTURE SPACING >1". JOINING COMMON

FRANCISCAN ASSEMBLAGE

GREENSTONE: STRONG TO WEAK, WEATHERS TO REDDISH YELLOW IRON OXIDES, JOINTING AND QUARTZ VIENING COMMON. DARK GREENISH GRAY TO BLACK, MASSIVE, APHANITIC

ASPHALT PILE

24 STRIKE AND DIP OF BEDDING

196 QUARTZ VEIN VERTICAL

N

0 FEET 300

0 METERS 150

BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE

ENGEO — Expect Excellence —

SITE PLAN
ROUTE 238 BYPASS - GROUP 6
HAYWARD, CALIFORNIA

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

FIGURE NO. 2

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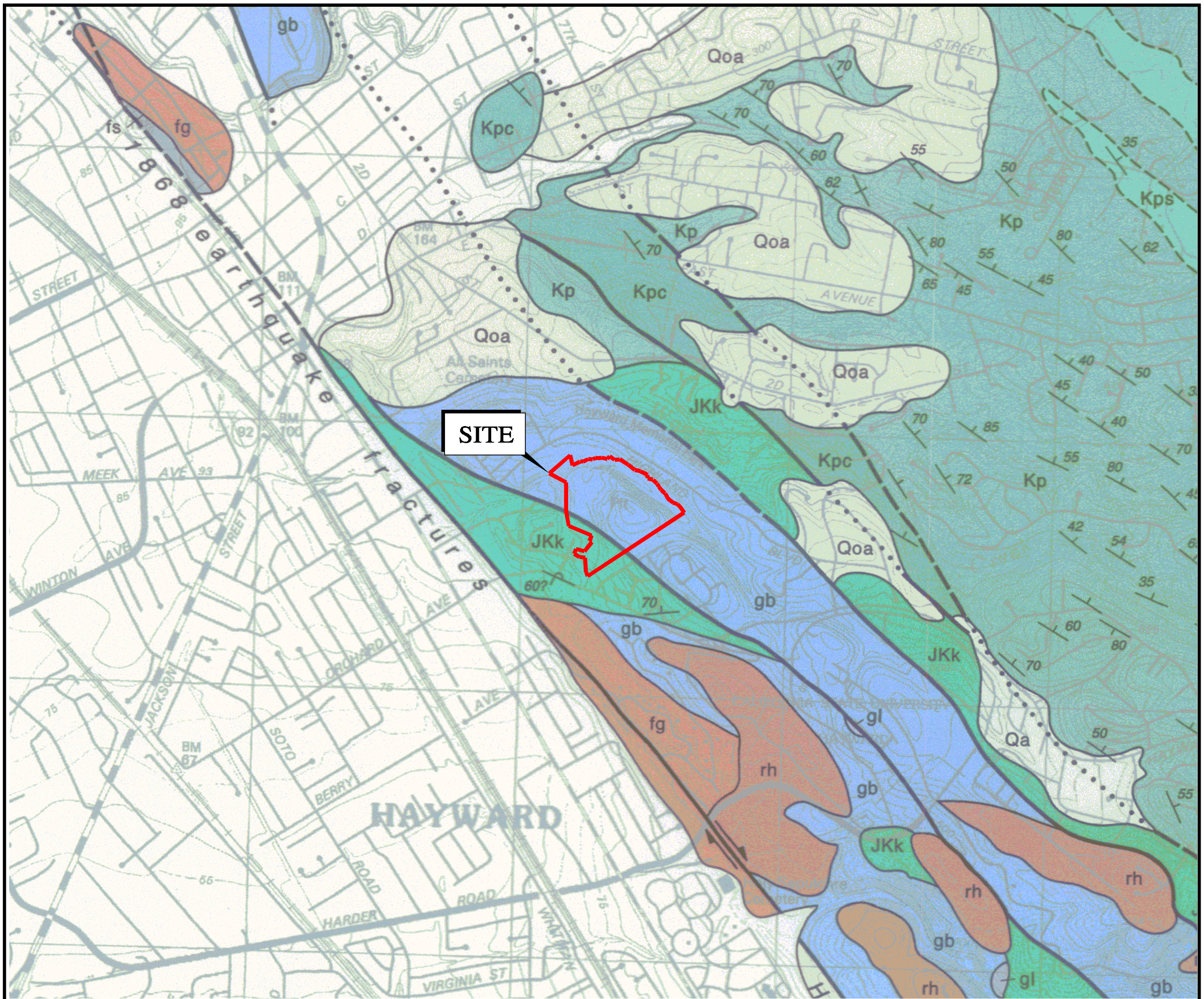
ORIGINAL FIGURE PRINTED IN COLOR



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
gb	GABBRO-DIABASE
fg	GREENSTONE

N

0 FEET 2000

0 METERS 1000

BASE MAP SOURCE: DIBBLEE, 2005

ENGEO — Expect Excellence —

REGIONAL GEOLOGIC MAP

ROUTE 238 BYPASS - GROUP 6

HAYWARD, CALIFORNIA

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

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ORIGINAL FIGURE PRINTED IN COLOR

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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Expect Excellence

REGIONAL LANDSLIDE MAP
ROUTE 238 BYPASS - GROUP 6
HAYWARD, CALIFORNIA

PROJECT NO.: 12843.000.000	FIGURE NO. 4
SCALE: AS SHOWN	
DRAWN BY: SRP	CHECKED BY: JJT

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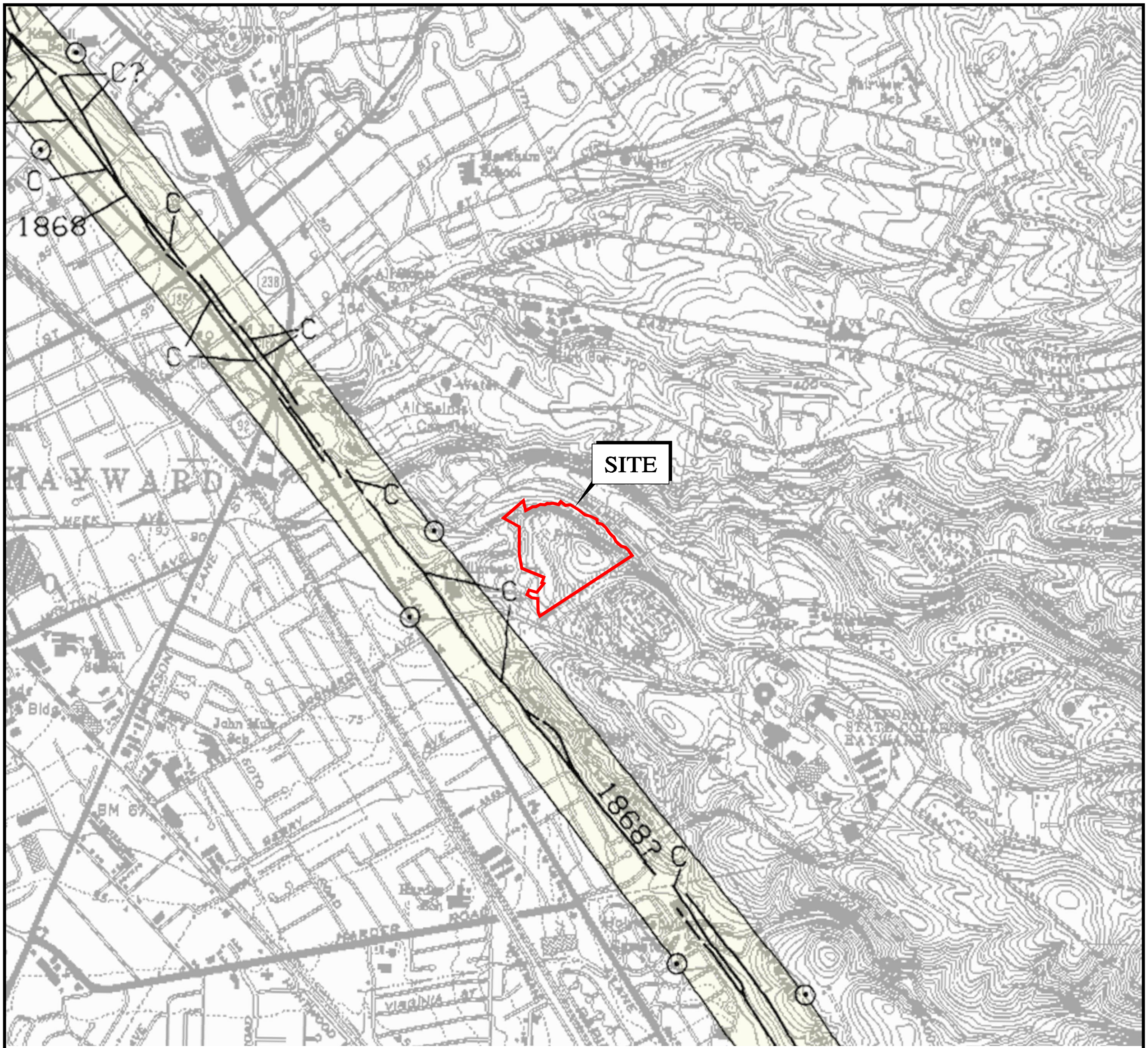

EXPLANATION

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

N

0 FEET 2000
0 METERS 1000

BASE MAP SOURCE: CDMG, 1993

ENGEO Expect Excellence	EARTHQUAKE FAULT ZONE MAP ROUTE 238 BYPASS - GROUP 6 HAYWARD, CALIFORNIA	PROJECT NO.: 12843.000.000		FIGURE NO. 5
		SCALE: AS SHOWN		
		DRAWN BY: SRP	CHECKED BY: JJT	

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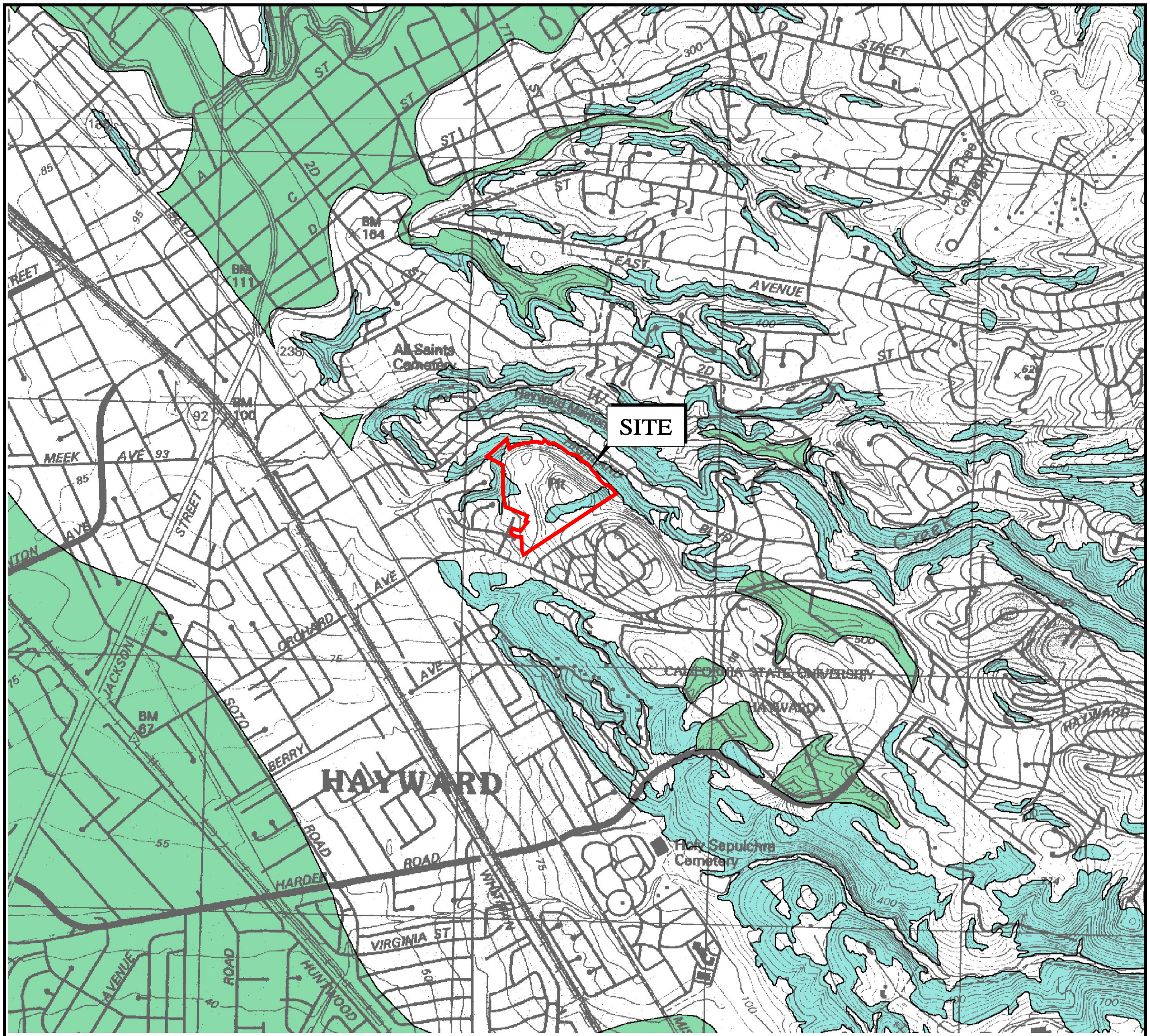
ORIGINAL FIGURE PRINTED IN COLOR



N

0 FEET 2000
0 METERS 1000

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

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

ENGEO Expect Excellence	SEISMIC HAZARD ZONES MAP ROUTE 238 BYPASS - GROUP 6 HAYWARD, CALIFORNIA	PROJECT NO.: 12843.000.000 SCALE: AS SHOWN DRAWN BY: SRP / CHECKED BY: JJT	FIGURE NO. 6

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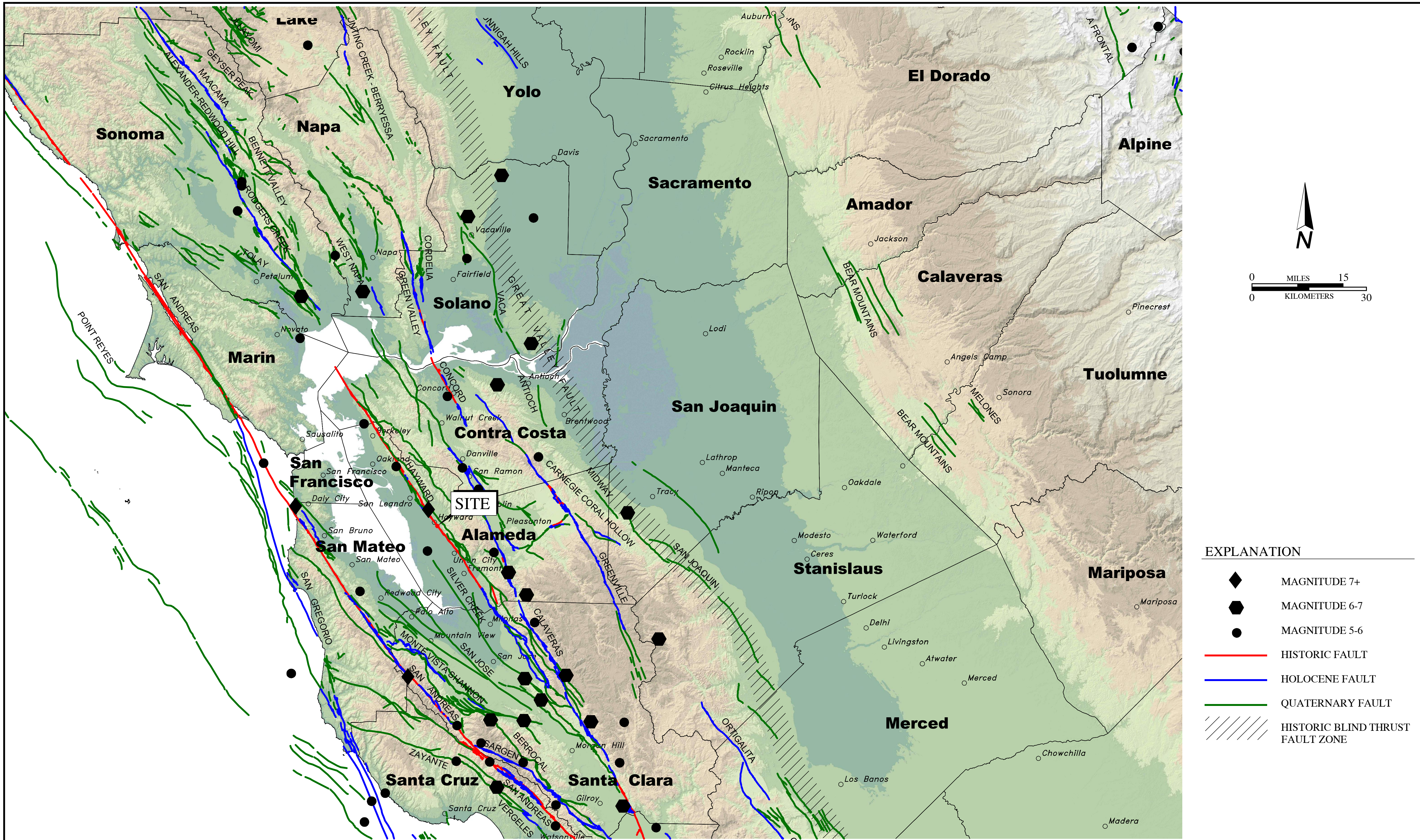
ORIGINAL FIGURE PRINTED IN COLOR



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 6 HAYWARD, CALIFORNIA	PROJECT NO.: 12843.000.000		FIGURE NO 7
	SCALE: AS SHOWN		
	DRAWN BY: SRP	CHECKED BY: JJT	

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ORIGINAL FIGURE PRINTED IN COLOR

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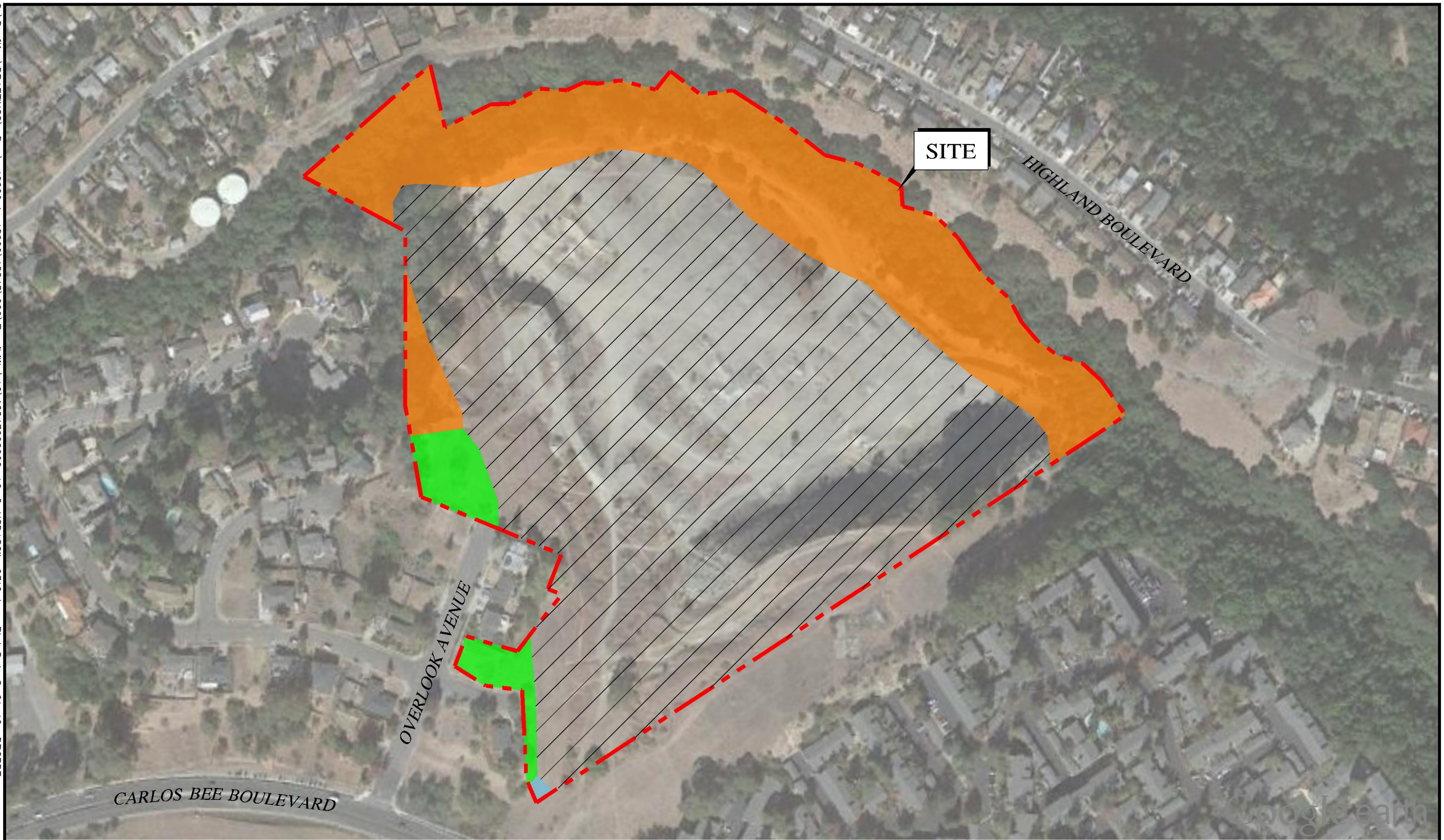

EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

MILLSHLOM SILT LOAM

DIABLO CLAY

ALTAMONT CLAY

URBAN LAND

N

BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE

0 FEET 300

0 METERS 150

ENGEO
Expect Excellence

USDA SOIL SURVEY

ROUTE 238 BYPASS - GROUP 6

HAYWARD, CALIFORNIA

PROJECT NO.: 12843.000.000	FIGURE NO. 8
SCALE: AS SHOWN	
DRAWN BY: SRP	CHECKED BY: JJT

ORIGINAL FIGURE PRINTED IN COLOR

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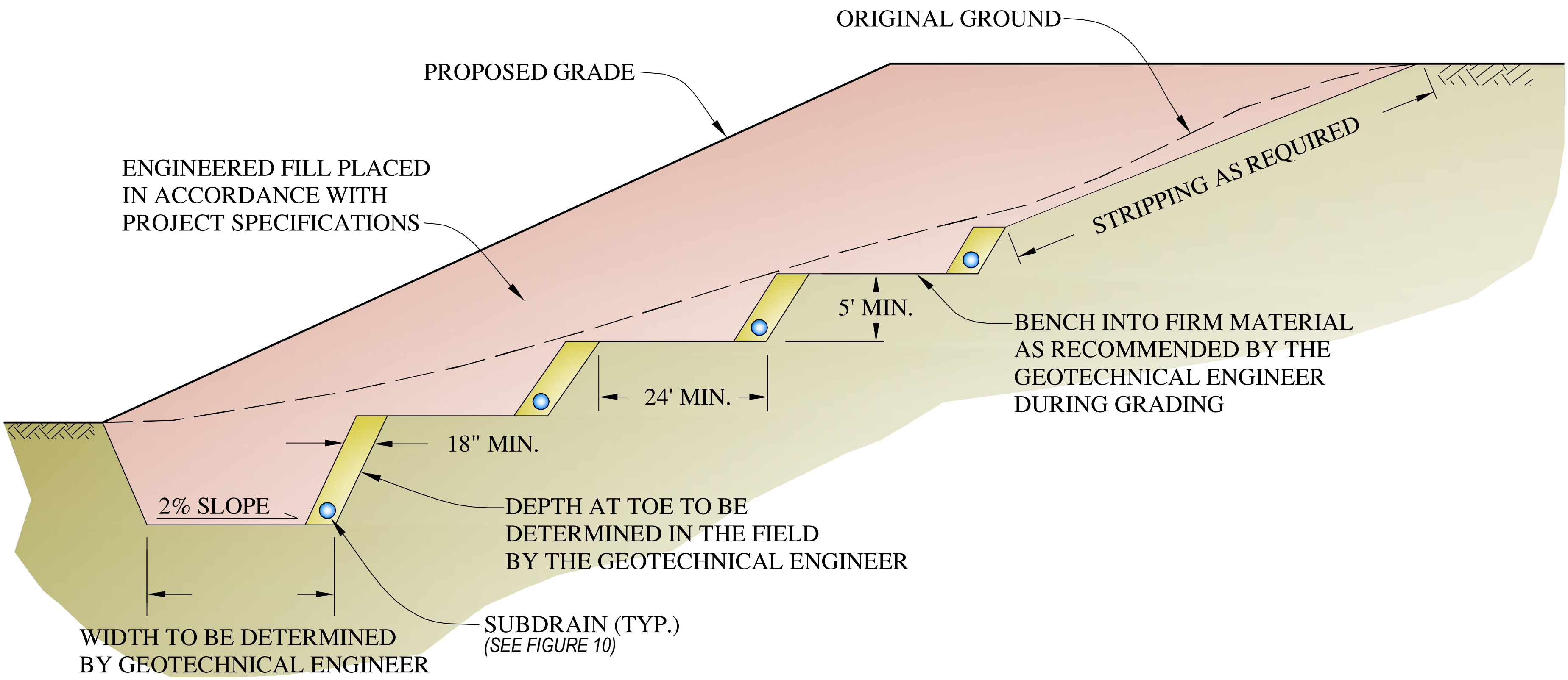
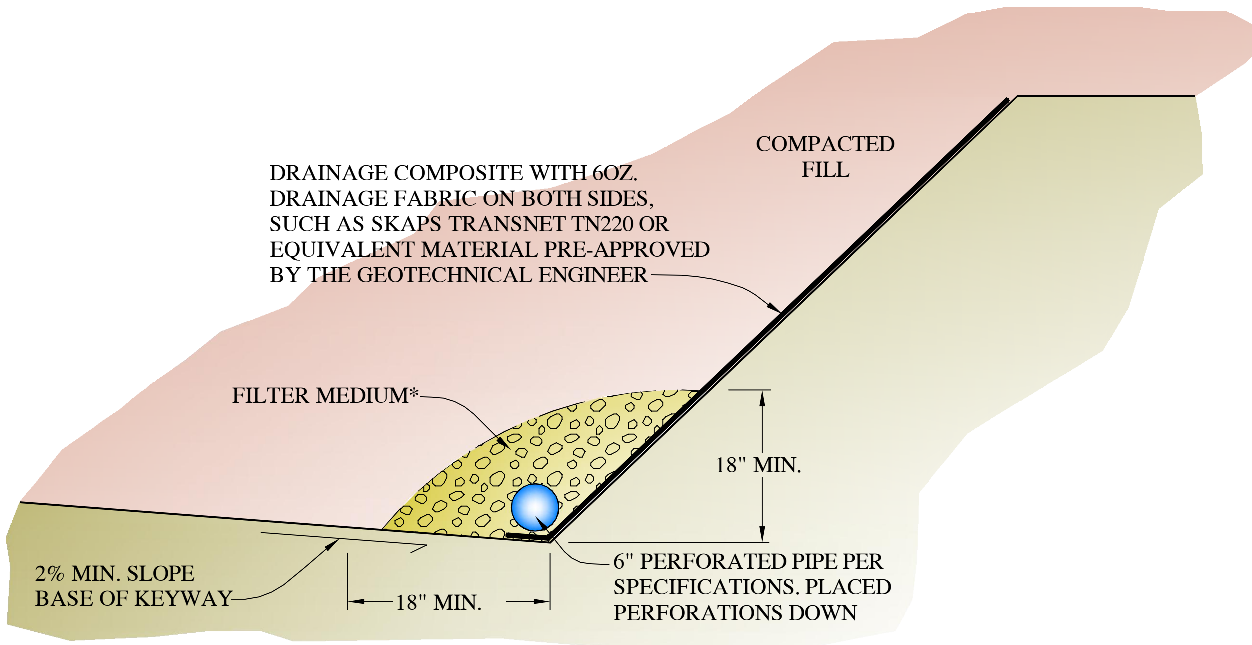


ENGEO Expect Excellence

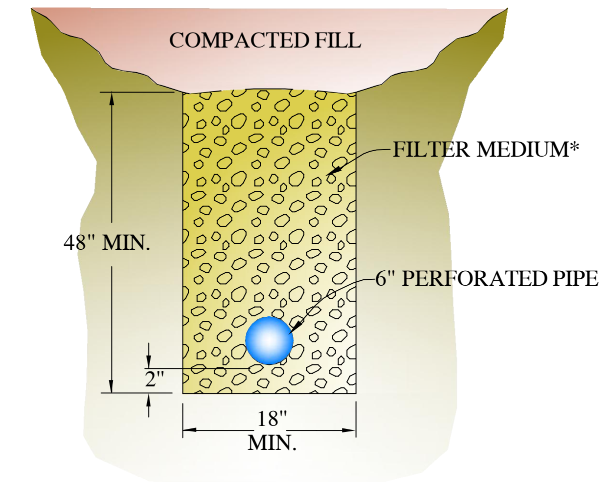
TYPICAL KEYWAY DETAIL
ROUTE 238 BYPASS - GROUP 6
HAYWARD, CALIFORNIA

PROJECT NO.: 12843.000.000	FIGURE NO. 9
SCALE: NO SCALE	
DRAWN BY: SRP	CHECKED BY: JJT

ORIGINAL FIGURE PRINTED IN COLOR



KEYWAY SUBDRAIN - OPTION 1



SWALE SUBDRAIN

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*

*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:

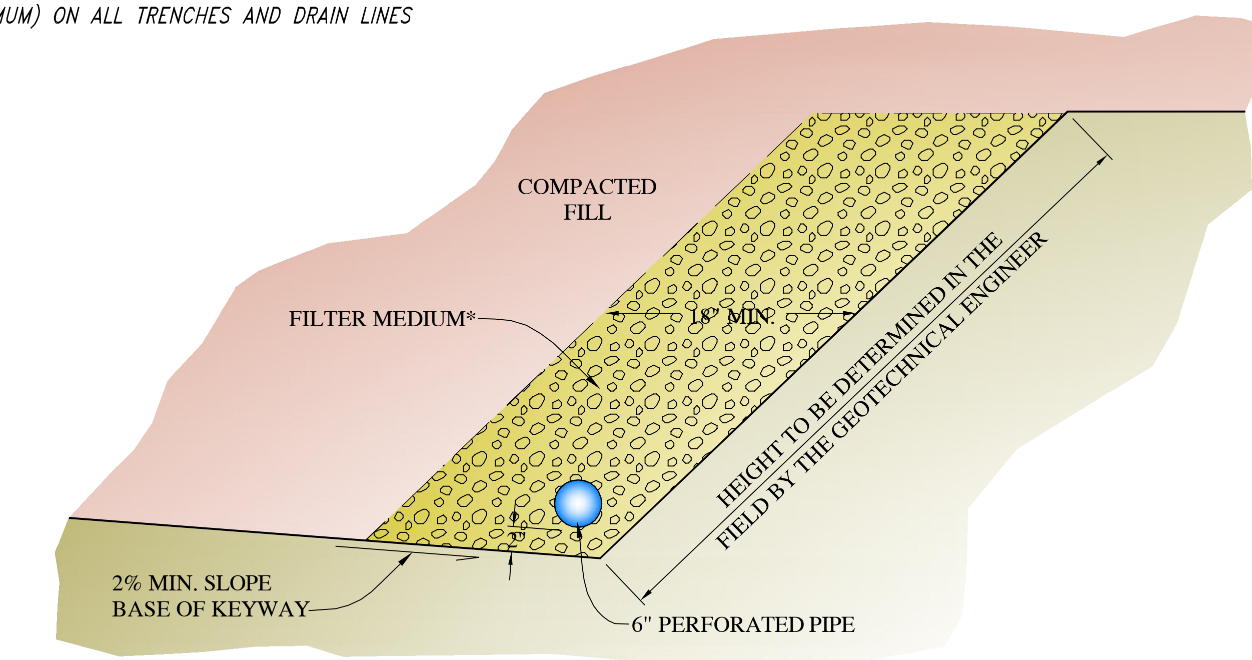
SIEVE SIZE	% PASSING SIEVE
1"	100
3/4"	90–100
3/8"	40–100
#4	25–40
#8	18–33
#30	5–15
#50	0–7
#200	0–3

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



KEYWAY SUBDRAIN - OPTION 2

ENGEO Expect Excellence

TYPICAL SUBDRAIN DETAILS
ROUTE 238 BYPASS - GROUP 6
HAYWARD, CALIFORNIA

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

G:\Drafting\DRAFTING2_Dwg_10000 to 12999\12843\000\Feasibility\A6\12843000000-A6-10-SUBDRAINDTL-0316.dwg Plot Date: 8-01-16 DBORDE

ORIGINAL FIGURE PRINTED IN COLOR