SKYLINE BLUFFS
DALY CITY, CALIFORNIA

GEOTECHNICAL FEASIBILITY REPORT

SUBMITTED TO
Mr. Eamon O'Marah
Harbinger Development
103 Central Street
Wellesley, MA 02482

PREPARED BY
ENGEO Incorporated

February 12, 2019

PROJECT NO.
8438.001.000

ENGEO
Expect Excellence

Project No.
8438.001.000

February 12, 2019

Mr. Eamon O’Marah
Harbinger Development
103 Central Street
Wellesley, MA 02482

Subject: Skyline Bluffs
Daly City, California

GEOTECHNICAL FEASIBILITY REPORT

Dear Mr. O’Marah:

With your authorization, we prepared this geotechnical feasibility report for the Skyline Bluffs property in Daly City, California. We understand that proposed mixed-use development at the site is planned, including a multi-story hotel, conference retreat center and associated site improvements. This report contains the result of our preliminary characterization and assessment of subsurface conditions and geologic hazards based on our review of available published and unpublished geologic maps, review of stereo-paired historic aerial photographs, previous geotechnical studies in site vicinity, and review of available literature. We performed a site reconnaissance; however, the current scope of services did not include subsurface exploration at the site.

The main geotechnical and geologic concerns for the planned development at this site include long-term stability of slopes and steep bluffs extending from site down to the ocean where coastal erosive conditions are known to trigger active landslide movement, existing large-scale landslide areas adjacent to property in similar geologic formations, local deposits of soft or weak soils, potentially unstable portions of the site with increased risk of instability, and/or possible landslide hazards if subject to static (long-term) and seismic (short-term) conditions.

To further characterize and evaluate geotechnical hazards at the site and overall global stability of the property, we recommend that a subsurface exploration program be performed which includes a combination of deep exploratory borings and trenches at the site, laboratory soil testing and geotechnical slope stability analysis. This program would be useful to define stability risks, structural setbacks, and specific geotechnical engineering recommendations for site grading and development, remedial grading measures, foundations, and drainage for the proposed construction.

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

Nadine Periat, PG

Theodore P. Bayham, GE, CEG

Jeanine Ruffoni, PE

Philip J. Stuecheli, CEG

np/tpb/jr/pjs/jf

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this geotechnical feasibility assessment is to review site conditions in addition to available geotechnical and geologic information and maps to characterize geotechnical hazards and provide preliminary recommendations for the planned development concept. The scope of our services has included:

- Review of available geologic information and reports listed in the References.
- Review of stereographic aerial images obtained between the 1930s and the present.
- Review of historic oblique aerial images from the California Coastal Records Project, covering the site area from the early 1970s to 2013.
- Examination of LiDAR imaging of the site area from 1998, 2010, and 2016.
- A visual geologic reconnaissance of the site.
- Preparation of a site-specific geologic map of the site using the 2016 LiDAR base topography and three geologic cross sections based on available geologic publications.
- Performance of preliminary slope stability analyses on a cross section constructed through the highest bluff section adjacent to the site. Estimate average shear strength of geologic materials based on back calculation using a published cross section from the early development of the nearby Lynvale Court landslide.
- Provide a preliminary minimum recommended slope setback based on review of historic bluff performance and back-calculated parameters.
- Recommend fieldwork and analyses for future design level studies.
- Preparation of this feasibility report summarizing our findings of potential geologic hazards and potential corrective measures for the contemplated development.

We prepared this report for the exclusive use of Harbinger Development and their consultants for evaluation of this project. In the event that any changes are made in the character, design or layout of the development, we must be contacted to review the preliminary conclusions and recommendations contained in this report to determine whether modifications are necessary.

1.2 SITE DESCRIPTION

The site includes five parcels: Assessor's Parcel Numbers (APN) 002-011-040, 002-011-050, 002-011-060, 002-011-120, and 002-011-130. The two northern parcels (002-011-040 and 002-011-050) are currently occupied by horse stables. The remaining parcels are vacant land. The site is bounded to the east by Olympic Way, a frontage road for Skyline Blvd, to the north by open lands owned by the Olympic club, to the south by vacant land, and to the west by a bluff leading down to Thornton State Beach below (Figure 1).

Land use east and south of the site is residential and open space/ parklands. To the north, land is open space, residential, and the Olympic Club golf course.

No specific development plans were provided for our review; however, we understand through conversations with Harbinger Development that a multi-story hotel is planned for the northern two parcels, and a conference/ retreat center is planned for the southern three parcels.

The site is relatively flat and lies at an elevation of approximately 220 feet above mean sea level. Topography drops steeply to the west beyond the bluff by approximately 130 feet into a graben between the bluff and a landslide terrace elevated approximately 40 feet above the graben. To the west of the landslide terrace, topography drops approximately 130 feet to the beach below.

2.0 REVIEW OF EXISTING INFORMATION

2.1 HISTORY OF LANDSLIDING IN VICINITY

The coastline along Daly City and Pacifica has a history of catastrophic landslides resulting in failed developments and abandoned infrastructure. This section highlights several significant events that occurred in the site vicinity.

In the late 1800s, the Ocean Shore Railway Company started construction of a rail line from San Francisco to Santa Cruz. During the 1906 earthquake, the Merced Formation along Mussel Rock (approximately 1.5 miles south of the site) failed and over 4,000 feet of the railroad fell with the cliff into the ocean. The developers of the railroad rebuilt the track, but went bankrupt in 1921, largely due to the high annual cost of ongoing landsliding related repairs at Mussel Rock.

In 1936, the California State Highway Commission constructed a highway in the former railroad bed from Thornton Beach to Mussel Rock. The highway was closed frequently for landsliding and road slumping repairs associated with the Merced Formation (Heiser 2010). The road was ultimately abandoned in 1957 after a magnitude 5.3 earthquake caused multiple landslide related road failures (Sloan 2005).

In 1949, large-scale tract-housing developments were built in Daly City and Pacifica along Highway 35, including the area above the scarp of the Mussel Rock Landslide. Eleven homes built above the landslide scarp were immediately relocated after they began sliding downhill, and as of 2005, the building pads were visible over 50 feet downhill of the original locations. In 2000, after numerous repairs and loss of several houses, the City of Daly City purchased and demolished 21 homes at risk (Sloan 2005). Similar accounts took place and are still in progress in Pacifica, to the south.

In 1974, Caltrans prepared a study of damage to the roadway on the former railroad bed about 1,700 feet south of the site below Lynvale Court and the end of Skyline Drive. According to the study, slope cracking and movement was noted in 1972 in Lynvale Court and the end of Skyline Drive about 100 feet east of the bluff face. Eventually, about 50 feet of Lynvale Court was lost and four houses were removed. In February 2004, a storm caused further erosion along the neighborhoods of Skyline Drive, Lynvale Court and Rosalyn Court, resulting in one home being removed from Skyline Drive (Fradkin, Philip L, 2011).

During the El Nino storms of 1982-1983, about 130 feet of the John Daly Extension Road, which formerly led to a parking area directly below the property on the landslide terrace, were lost to landslide movement and subsequent gully erosion. The road to the parking lot on the landslide terrace dropped approximately 7 meters due to movement on the Thornton Beach Landslide (Lajoie and Mathieson, 1998).

During the 1989 Loma Prieta Earthquake, a relatively large, seismically triggered bluff failure occurred in the slopes west of Palisade Drive, about 3,500 feet south of the site.

FIGURE 2.1.1: Large (approximately 4-acre) Seismically Induced Bluff Failure West of Palisade Drive, 1989

Following El Nino storms in 1998, significant slumping and landsliding on the Olympic Club Golf Course directly north of the site resulted in abandonment of a large portion of the course. The scarp of the Thornton Beach Landslide in this area extends to Skyline Boulevard (Liebhardt, 2002 and Bonilla, 1960).

In December 2003, the Northridge Bluff Landslide (1 mile south of the site) failed, sending 500,000 cubic meters of Merced Formation approximately 100 meters into the ocean. None of the geotechnical investigation reports performed for the City of Daly City or coastal retreat estimates from aerial photography led to predictions of this failure (Johnson & Marcum, 2004).

2.2 GEOLOGIC MAPS AND REPORTS

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. Uplift is evidenced near the coast through the presence of marine terraces.

As depicted in Figure 2, regional geologic mapping by Bonilla, M.G. (1998) characterizes the site as underlain by surficial deposits consisting of Holocene to Pleistocene aged dune sands (Qd) on the northern portion of the property, and the late Pleistocene Colma Formation (Qc) on the southern portion of the property. The Colma Formation, present as a thin, surficial deposit at the site, consists of friable well-sorted fine to medium sand containing a few beds of silt, clay and gravel. Beneath the dune sands and Colma Formation is the Plio-Pleistocene aged Merced Formation (QTm) which consists of weakly consolidated, medium gray to yellowish orange friable to firm sand, silt and clay with minor amounts of gravel, lignite and volcanic ash. The Merced Formation outcrops on the bluff on the west border of the site. Landslide deposits (Ql) are mapped at the base of the bluff, extending to the beach.

The landslide deposits below the bluff on the site's western boundary are known as the Thornton Beach Landslide, a deep rotational landslide within the Merced Formation that spans from just south of the site within Thornton State Park to Fort Funston. Researchers have estimated that the depth of the landslide is approximately 140 feet below sea level (Bonilla 1960). The mass of the landslide block is currently acting as a gravity buttress at the base of the bluff on the site's west boundary, which extends 130 feet above the landslide graben.

2.3 SEISMICITY

The site is not located within a State of California Earthquake Fault Hazard Zone (1982) for active faults, and no known faults cross the site. The nearest fault is the San Andreas Fault, which is located roughly 0.27 mile northeast of the site (Figure 4) at the closest point.

Numerous small earthquakes occur every year in the San Francisco Bay Region. Larger earthquakes have been recorded and can be expected to occur in the future. The most common nearby active faults within 25 miles of the site and their estimated maximum earthquake magnitudes based on the USGS fault database are provided in the following table. The State Mining and Geology Board define an active fault as one that has had surface displacement within Holocene time (about the last 11,000 years) (Hart and Bryant, 1997). Figure 4 shows the approximate location of active and potentially active faults and significant historic earthquakes mapped within the San Francisco Bay Region.

TABLE 2.3-1: Regional Faults

FAULT NAME	APPROXIMATE DISTANCE (miles)	ESTIMATE OF MAXIMUM MOMENT MAGNITUDE (Ellsworth)
San Andreas Fault	¼	7.94
San Gregorio	4	7.50
Hayward-Rodgers Creek	17	7.33
Monte Vista-Shannon	17¾	6.5

The site has not been evaluated by the State of California Geologic Society for liquefaction or landslide hazards. The Association of Bay Area Governments (ABAG) has not yet mapped the site area for liquefaction hazards. ABAG has mapped the area west of the site as “mostly landslide” and potential rainfall induced debris flow source.

2.4 HISTORICAL AERIAL AND OBLIQUE PHOTOGRAPHY REVIEW

We reviewed stereo-paired aerial photographs of the site dated 1935 through 2001 (Figures 5A through 5G) and oblique photographs from the California Coastal Records project from 1972 to 2013 (Figures 6A and 6B). Review of these images indicates that in 1935 the site and an area on the landslide terrace below the site to the west appears to have been used as agricultural land. The existing stables were built between 1935 and 1943, in addition to structures on the southern two parcels. Improvements on the southern two parcels were removed between 1943 and 1965. A paved parking area was constructed on the landslide terrace west of the property between 1946 and 1965, with entry from John Daly Blvd. The parking area on the landslide terrace was demolished in 1983. According to various news article archives, the extension of John Daly Blvd. leading to the parking area was destroyed in a landslide in the 1982-1983 El Nino storms, and was not repaired. The aerial images show that much of the coastal bluff was sporadically vegetated prior to the early 1990s. In the 1993 aerial image, erosion and landslide failures in the coastal bluff appear to have accelerated, and erosion and landslide recession have continued to the present day.

2.5 HISTORICAL TOPOGRAPHIC MAP AND LIDAR IMAGERY REVIEW

We reviewed historical USGS topographic maps dated 1852 through 2014. Little information was obtainable from review of the topo maps regarding bluff recession rates due to scale and mapping resolution.

LiDAR data from 1999, 2010 and 2016 was used to reconstruct three cross sectional views of the northern, middle and southern portions of the bluff west of the site which. These cross sections are depicted in Figure 4. The northern and southern cross-sections indicate that significant bluff retreat has taken place in the landslide blocks, likely due to wave action. In the northern section, near the well-documented complex landsliding at the former Olympic Golf Club, a portion of the landslide, approximately 80 feet long was eroded between 1999 and 2010.

2.6 COASTAL BLUFF EROSION AND STABILITY

Rates of retreat along this section of the coast are often complicated to establish due to the combination of constant bluff retreat due to sea level rise and uplift, with episodic landsliding events during El Nino storms and earthquakes (Johnsson, 2003). LiDAR data from 1999, 2010, and 2016 were used to reconstruct cross sections of the bluff in three locations shown on Figure 4. These years were relatively inactive in terms of major storm events and earthquakes. The northern section shows erosion of an approximately 80-foot-wide block of landslide between 1998 and 2010 attributed to an episodic landslide event on the former southern section of the Olympic Golf Course, which failed during the 1998 El Nino storm event, while the two southern sections across the site show a rate of retreat of approximately 1.2 feet/year. This is similar to rates of retreat measured across the California Coast (Griggs, 2003).

The bluffs just north of the site appear to be less stable than those at the site, evidenced by deformation during the 1998 El Nino event. In the bluffs at the site, bedding attitudes were observed striking relatively parallel to the bluff, and dipping between 24 and 70 degrees into the bluff. It should be noted that although efforts were made to obtain bedding attitudes in the landslide scarp, dips measured in this Cliffside might be affected by rotational movements associated with sliding. Previous studies have hypothesized that the Merced formation is unstable in cliffs with shallowly dipping strata, and relatively stable where the dip is moderate to steep into the hill (Bonilla 1960, Liebhardt 2002).

3.0 SITE RECONAISSANCE

3.1 SITE TOPOGRAPHY AND OBSERVATIONS

The site appears to be relatively flat, with only slight topographic variations. One erosion swale area was noted on the bluff in the southern portion of the site, which is approximately 100 feet across and 5 feet deep in the center (Figure 4). The bluff edge is defined by a slight lip, which approximately 1 foot higher in elevation that the eastern portion of the property. The bluff slopes down steeply at a gradient of approximately 1.3:1 to a relatively flat topographic trough formed by the back-rotation of the Thornton Beach Landslide block. A walking path is present crossing the bluff extending down to the trough area. The trough area is heavily vegetated and frequented by hikers who access the many trails along the landslide and bluff areas. The trough is bounded to the west by a terrace elevated about 40 feet above the trough, which is the rotated Thornton Beach Landslide block. The western edge of the terrace drops steeply down approximately 125 feet to the beach below at a gradient of approximately 1:1. A former drainpipe or water line is observed protruding from the side of the bluff in the northern portion of the site. It appears that the drainpipe was ultimately cut, with one side remaining on the bluff and the other side on the ground, downhill of the walking path.

3.2 SITE GEOLOGY

Loosely consolidated brown to orange tan sands were observed in the upper approximately 20 feet of the bluff, which are interpreted to be the Colma Formation, as mapped by Bonilla (1998). Few pebble layers were present and used to measure bedding at approximately 340 degrees, dipping 23 degrees to the east/northeast. At approximately 20 feet down the bluff, a change was noted from tan-orange sands to brown-tan silty sands and clay stringers. This change is believed to represent the contact between the Colma Formation and the Merced Formation. Sediments of the Colma and Merced were extremely friable, with no competent sections observed outcropping on the bluff. Minor landslides and slumps cover most portions of the bluff face. Toward the northern portion of the site, westward dipping bedding can be observed in a minor landslide scarp. A spring was noted along the pedestrian pathway near the base of the same landslide.

A sheared clay layer was observed within the Merced Formation approximately 30 feet down the bluff which appeared to strike at 220 degrees and dip 24 degrees to the northwest. While obtaining true bedding planes in the Merced is difficult, this clay layer did not appear to follow bedding attitudes in surrounding soils and may represent an exposed landslide slip surface.

4.0 PRELIMINARY SLOPE STABILITY ANALYSIS

4.1 SCOPE

In order to form preliminary conclusions regarding the stability of the bluff face bordering the west side of the site, we performed a limited analysis based on the assumptions described below. The purpose of the analysis was to assess the potential risk of significant and large-scale bluff failures that could threaten improvement proposed at the site. Slope stability analyses were performed using the program SLIDE 6.0 produced by Roc Science. Limited equilibrium slope stability analyses for circular failure surfaces were performed using the Spencer (1967) and GLE-Morgenstern-Price methods. We performed the following analyses:

- Back-analysis of a cross section prepared by Caltrans in 1974, that documented the surface extent and depth of initial ground movements in the Lynvale Court landslide as well as groundwater levels at the time of the study. The purpose of back analysis was to estimate a generalized shear strength for the interbedded sands and clays of the Merced Formation.

- Static (non-seismic) analysis of Cross Section C-C' (see Figure 4), which approximately coincides with the interpretive cross section E-E' previously prepared by Bonilla (1960). The purpose of the static slope stability analysis at Section C-C' was to evaluate the relative stability of the existing 100'- 140' high bluff west of the site.

4.2 LIMITATIONS OF ANALYSES

Due to the lack of site-specific geotechnical information, our analysis was based on the following assumptions:

- Groundwater elevations were assumed to be similar to those observed at Lynvale Court.

- The Merced Formation was analyzed using an assumed average shear strength based on back analysis.

- Slope stability was analyzed for static (non-seismic) conditions only. A meaningful seismic slope stability analyses will require site-specific subsurface soil and groundwater information and laboratory testing.

4.3 BACK ANALYSIS OF LYNVALE COURT LANDLSIDE AND SHEAR STRENGTH ESTIMATES

Caltrans (1974) performed a geotechnical exploration at the Lynvale Court landslide that included geotechnical borings sampling and measurement of inclinometers. A cross section from the Caltrans report was reproduced in (Liebhardt 2002). The cross section depicts the landslide subsurface soil and groundwater conditions approximately at the time that slope movements began in 1972.

Based on the published cross section, we "back-analyzed" estimated rock strength properties for the Merced Formation using the Generalized Hoek-Brown (1980) criterion. Bedrock lithology and properties were estimated based on published descriptions of the Colma and Merced Formations (Bonilla, 1960) and on bedrock exposures observed during our site reconnaissance. For our back analysis, we assumed that the landslide base was occurring in a weak clay layer observed in borings. Based on these methods we estimated the following design soil and rock strengths:

TABLE 4.2.1: Estimated Shear Strength Parameters

SOIL DESCRIPTION	EFFECTIVE FRICTION ANGLE ϕ (degrees)	COHESION (psf)
Colma Formation	35	0
Landslide basal surface (Residual strength)	15	0
Merced Formation (Generalized Average Strength)	Generalized Hoek-Brown: Intact Rock Strength = 50,000 psf s = 0.000419 m_b = 0.575 a = 0.52	

Notes: The slope stability output file for the Lynvale Landslide is included as Section L-L' in Appendix A.

4.4 SLOPE STABILITY ANALYSES CROSS SECTION C-C'

We constructed Cross Section C-C' at the southern edge of the property to estimate relative slope stability at the highest portion of the bluff fronting the property. Geologic interpretations are based on published information from Bonilla, (1960). As noted above and depicted on Figure 4, the bluff face is currently mantled with shallow to moderate depth surficial landslides and slope wash. Based on the assumptions described above, the calculated static factor of safety is below 1.5 for the land within a distance of approximately 150 feet east from the top of the bluff. The results of slope stability analyses of Section C-C' are depicted in the slope stability output file in Appendix A.

5.0 CONCLUSIONS AND RECOMMENDATIONS

As described above, the steep coastal bluffs eroded into the Merced Formation have a long history of developing landslides related to coastal erosion, seasonal rainfall events, and seismic ground shaking. The level areas of the site do not display obvious evidence of deep landslide activity over the period of time that topographic and photographic evidence are available. However, several observations made during site reconnaissance may be subtle indications of past ground deformation at the top of the bluff. These include the closed depression area in the southern portion of the site, which may be a precursor to a landslide tension crack; and the potential slide plane noted approximately 30 feet down the bluff.

The lower portion of the existing bluff faces is currently buttressed by the existing mass off the deep-seated Thornton Beach Landslide. Continuing erosion of the landslide block (at an approximate rate of 1.2 feet per year) will eventually lead to renewed movement of the deep-seated landslide.

Based on these observations, it is our preliminary conclusion that the property is subject to loss of portions of the western bluff face due to two possible processes:

- The existing steep exposed bluff face could be subject to relatively large landslides on a scale similar to the nearby Lynvale Court and John Daly Road Extension landslides triggered by rainfall events or seismic ground shaking. It is also subject to more gradual recession caused by continued activity of the existing shallow landslides and gully erosion. The Lynvale Court landslide extended back about 100 feet from the original coastal terrace edge and was reported to be over 160 feet deep.

- Over longer time scales, recession of the coastal bluff by wave erosion and landslide activity will eventually result in reactivation of the Thornton Beach landslide and loss of the buttressing effect from the landslide mass. The time frame for this type of event is not easily estimated because the subsurface conditions within the landslide are not known, and the rate of recession is affected by periodic larger scale block failures that remove large portions of the bluff in single events. If the buttressing effect from the landslide is lost, there will be a potential for much larger slope failures in the bluff face immediately west of the site. Evaluation of such a possible larger slope failure was not feasible based on the limited available information and would require additional studies as described below.

5.1 PRELIMINARY SLOPE SETBACK RECOMMENDATIONS

Preliminary slope stability analyses of Cross Section C-C' result in hypothetical circular failure surfaces that are of similar depth and geometry. Based on these preliminary analyses, at least 150 feet of the ground east of the top of the existing bluff should be considered potentially unstable and subject to slope failures. If a significant bluff failure occurs, it will likely be necessary to protect adjacent improvements from additional regression by constructing some form of structural retention measure such as a soldier pile wall or and anchored soil nail wall. We therefore recommend that, for preliminary planning purposes, you consider leaving an additional 50-foot-wide undeveloped zone that will allow access between the bluff and improvement for construction of supplemental stabilization measures. Based on these considerations, we recommend a minimum 200-foot-wide setback from the top of the bluff for any significant improvements such as habitable structures, major utilities, and essential access roadways. As noted above, our analyses were limited to static (non-seismic) conditions. The design-level geotechnical report will need to consider seismic slope stability as well as static slope stability. As describe above, the preliminary and simplified assumptions made for this study do not provide a basis for performing a technically reasonable seismic slope stability analysis. If you decide to proceed with site development planning, it will be necessary to perform a more comprehensive geotechnical study including subsurface investigations and supplemental analyses. We provide a preliminary supplemental investigation scope below.

5.2 SUPPLEMENTAL GEOTECHNICAL INVESTIGATION SCOPE

A supplemental geotechnical exploration for the proposed development would be focused on collecting data that would allow better characterization of subsurface conditions including:

- Depth to groundwater and/or saturated zones within the bedrock across the site.

- Borings to explore subsurface stratigraphy, and inclination and dip direction of layers within the Coma and Merced Formations.

- Surface trench excavation to examine the near-subsurface soils for evidence of previous ground cracking or fissures that could be evidence of past bluff extension and tension cracking.

- Collection of representative samples of bedrock materials for laboratory testing such as measurement of shear strength, grain size, plasticity and unit weight.

- Construction of detailed geologic cross sections based on subsurface investigations.

- Supplemental slope stability analyses based on the cross sections to evaluate static and seismic slope stability and to estimate potential slope deformations as recommended in State guidelines described in the California Geological Survey Special Publication SP117A.

We anticipate that a supplemental exploration would include at least two 300-foot-long exploratory trenches extending from the top of the bluff, and a number of continuous-core borings extending to depths of approximately 200 to 300 feet below ground surface. Selected deep-core borings would be logged with a downhole televiewer camera system to measure in-situ bedding and joint inclinations. In addition to these explorations, we anticipate that additional shallow borings will be required for the design of building foundations and improvements, based on a detailed development plan. If desired, we can provide a detailed scope and fee estimate for a supplemental exploration.

6.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report presents geotechnical recommendations for design of the improvements discussed in Section 1.2 of this report for the site in Daly City, California. If changes occur in the nature or design of the project, we should be allowed to review this report and provide additional recommendations, if necessary. 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.

This preliminary report is based upon available data from adjacent sites, discovered at the time of preparation of ENGEO's report. This document must not be subject to unauthorized reuse that is, reusing without written authorization of ENGEO. Such authorization is essential because it requires ENGEO to evaluate the document's applicability given new circumstances, not the least of which is passage of time. Actual field or other conditions will necessitate clarifications, adjustments, modifications or other changes to ENGEO's documents. Therefore, ENGEO must be engaged to prepare the necessary clarifications, adjustments, modifications or other changes before construction activities commence or further activity proceeds. If ENGEO's scope of services does not include on-study area construction observation, or if other persons or entities are retained to provide such services, ENGEO cannot be held responsible for any or all claims arising from or resulting from the performance of such services by other persons or entities, and from any or all claims arising from or resulting from clarifications, adjustments, modifications, discrepancies or other changes necessary to reflect changed field or other conditions.

SELECTED REFERENCES

Bonilla, M. 1960. Landslides in the San Francisco South Quadrangle, California. U.S. Geological Survey Open File Report.

Bonilla, M. G., 1998. Preliminary geologic map of the San Francisco South 7.5' quadrangle and part of the Hunters Point 7.5' quadrangle, San Francisco Bay area, California, U.S. Geological Survey Open File Report 98-354.

Caltrans, 1974, Report on Geotechnical Investigation, of Road 04-Sm-1 (abandoned) at Thornton Bluffs, State of California, Department of Transportation, Division of Construction and Research, Transportation Laboratory, December 4, 1974.

Lajoie, K. R. and Mathieson, S. A., 1998. 1982-83 El Niño Coastal Erosion: San Mateo County, California, May 6, 1998

Liebhardt, Martin D. 2002. The Thornton Beach State Park deep rotational landslide in Daly City, California, Masters Thesis, San Jose State University, May 2002.

.

Griggs, G., Runyan, K. 2003. Cliff Erosion and Bluff Retreat Along the California Coast. Institute of Marine Sciences, Department of Earth Sciences, University of California, Santa Cruz.

Johnsson, Mark J. 2003, Memorandum: Establishing Development Setbacks from Coastal Bluffs, California Coastal Commission.

Johnson, P., and D. Marcum, 2004. The Northridge Bluff Landslide: Rapid Bluff Retreat Associated with a Major Coastal Landslide in Daly City, California in Schaefer, V. R., Schuster, R. L., and Turner, A. K., eds., Conference Presentations, First North American Landslide Conference, Association of Environmental and Engineering Geologists Special Publication No. 23, p. 1694-1706.

Sloan, Doris. 2005. Down to the Sea Again, in Bay Nature, January 1, 2005.

Bryant, W. and Hart, E., 2007, Special Publication 42, “Fault-Rupture Hazard Zones in California”, Interim Revision 2007, California Department of Conservation.

Gilpin Geosciences, Inc., Engineering Geologic Evaluation, Vista Grande Basin Alternatives, Thornton State Beach/ Fort Funston, Daly City/ San Francisco, California, November 1, 2007.

Heiser, Shawn Christopher, 2010. Living on the Edge: Environmental History at Mussel Rock, Daly City, California, Masters Thesis, San Francisco State University, May 2010.

Fradkin, Philip L. 2011. The Left Coast, California on the Edge, University of California Press.

AERIAL IMAGES REVIEWED

Paciic Aerial Surveys;

Flight AV 248, Line 2 Frames 10 and 11, Flown 1935
Flight AV 248, Line 1 Frames 9 and10, Flown April 28, 1975
Flight AV 4415, Line 10 Frames 10 and 11, Flown August 27, 1993
Flight AV 7091, Line 2 Frames 10 and 11, Flown August 27, 1993
Flight AV 4415, Line 10 Frames 17 and 18, Flown August 17, 2001

Cartwright Aerial Surveys, Flight 65, Frames 130 and 131, Flown May 17, 1965

Flight DDB frame 2B 193, Flown October 11, 1943

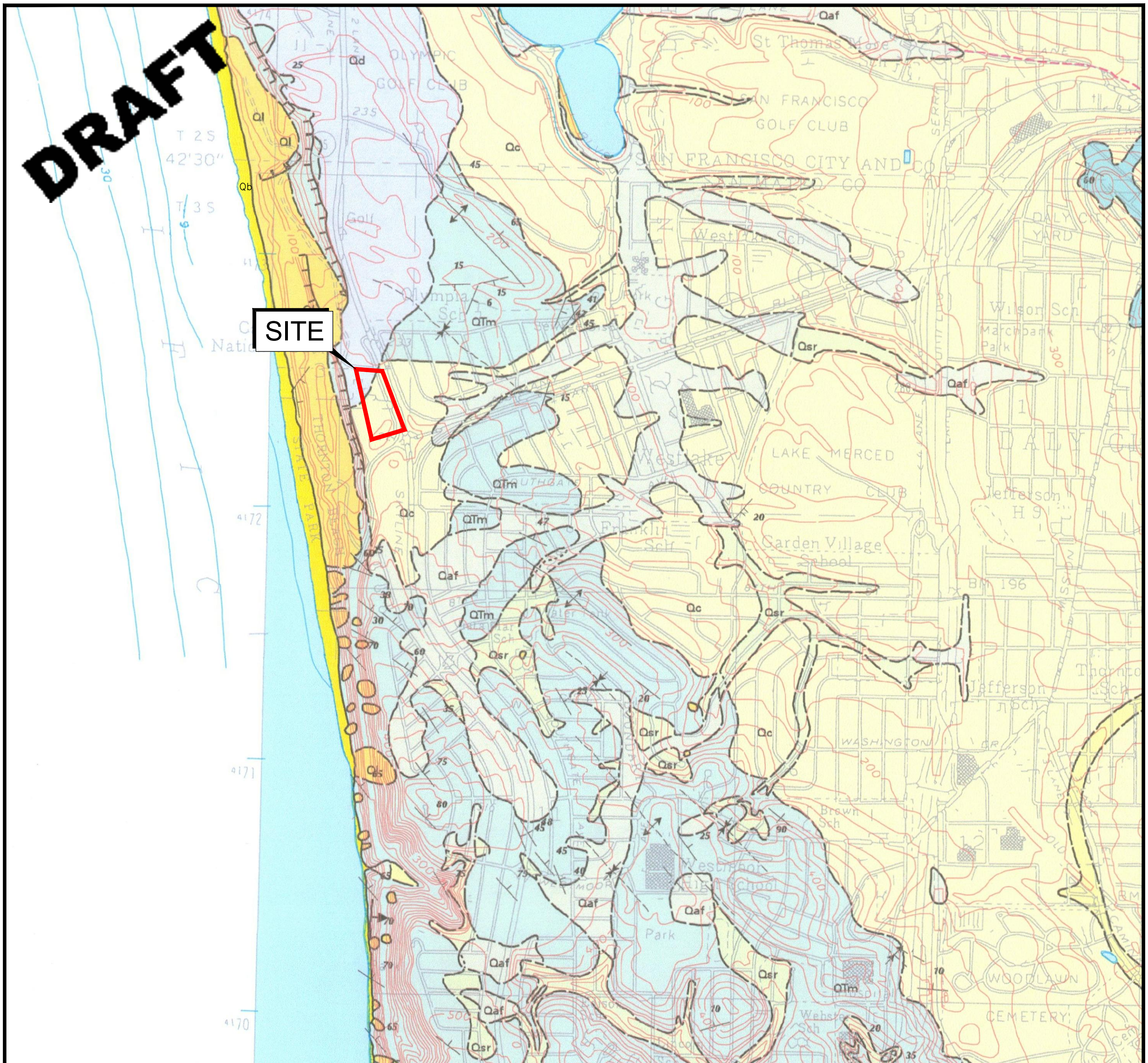
FIGURES

BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE

ENGEO Expect Excellence	VICINITY MAP 2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000 SCALE: AS SHOWN DRAWN BY: LL CHECKED BY: PJS	FIGURE NO. 1

C:\Users\llee\appdata\local\temp\AcPublish_8340\8438001000-SKYLINE_BLUFF-1-VICMAP-0119.dwg Plot Date:1-28-19 llee

ORIGINAL FIGURE PRINTED IN COLOR



N

0 2000
FEET

EXPLANATION

Qaf	ARTIFICIAL FILL
Ql	LANDSLIDE DEPOSITS
Qb	BEACH DEPOSITS
Qd	DUNE SAND
Qsr	SLOPE DEBRIS AND RAVINE FILL
Qc	COLMA FORMATION
QTm	MERCED FORMATION

BASE MAP SOURCE: BONILLA, 1980

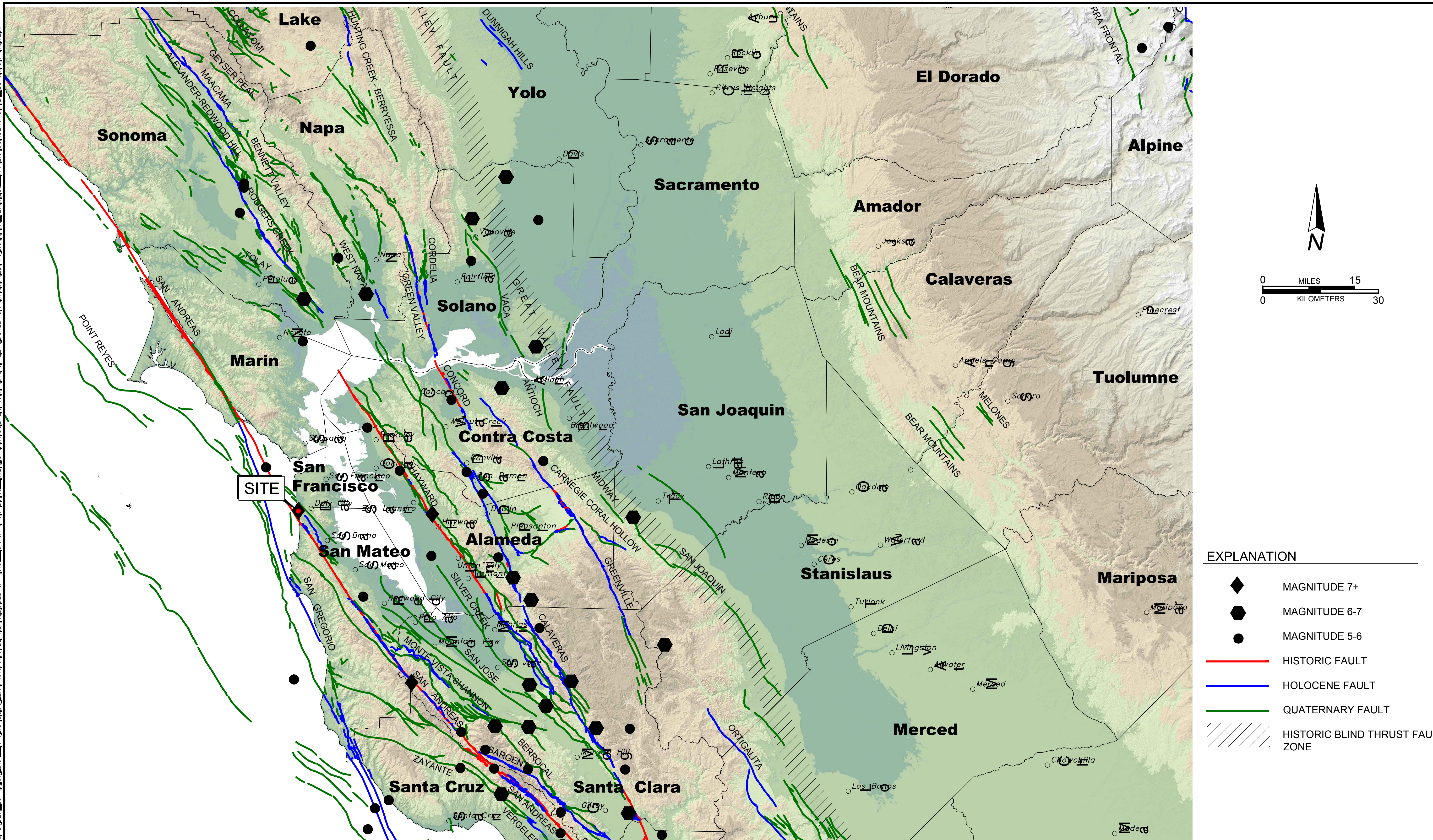
ENGEO
Expect Excellence

REGIONAL GEOLOGIC MAP
2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION
DALY CITY, CALIFORNIA

PROJECT NO.: 8438.001.000		FIGURE NO. 2
SCALE: AS SHOWN		
DRAWN BY: LL	CHECKED BY: PJS	

C:\Users\llee\appdata\local\temp\AcPublish_8340\8438001000-SKYLINE_BLUFF-2-GEOMAP-0119.dwg Plot Date:1-28-19 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)

ENGEO Expect Excellence

REGIONAL FAULTING AND SEISMICITY
2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION
DALY CITY, CALIFORNIA

PROJECT NO.: 8438.001.000
SCALE: AS SHOWN
DRAWN BY: LL
CHECKED BY: RJS
FIGURE NO. 3
ORIGINAL FIGURE PRINTED IN COLOR

N

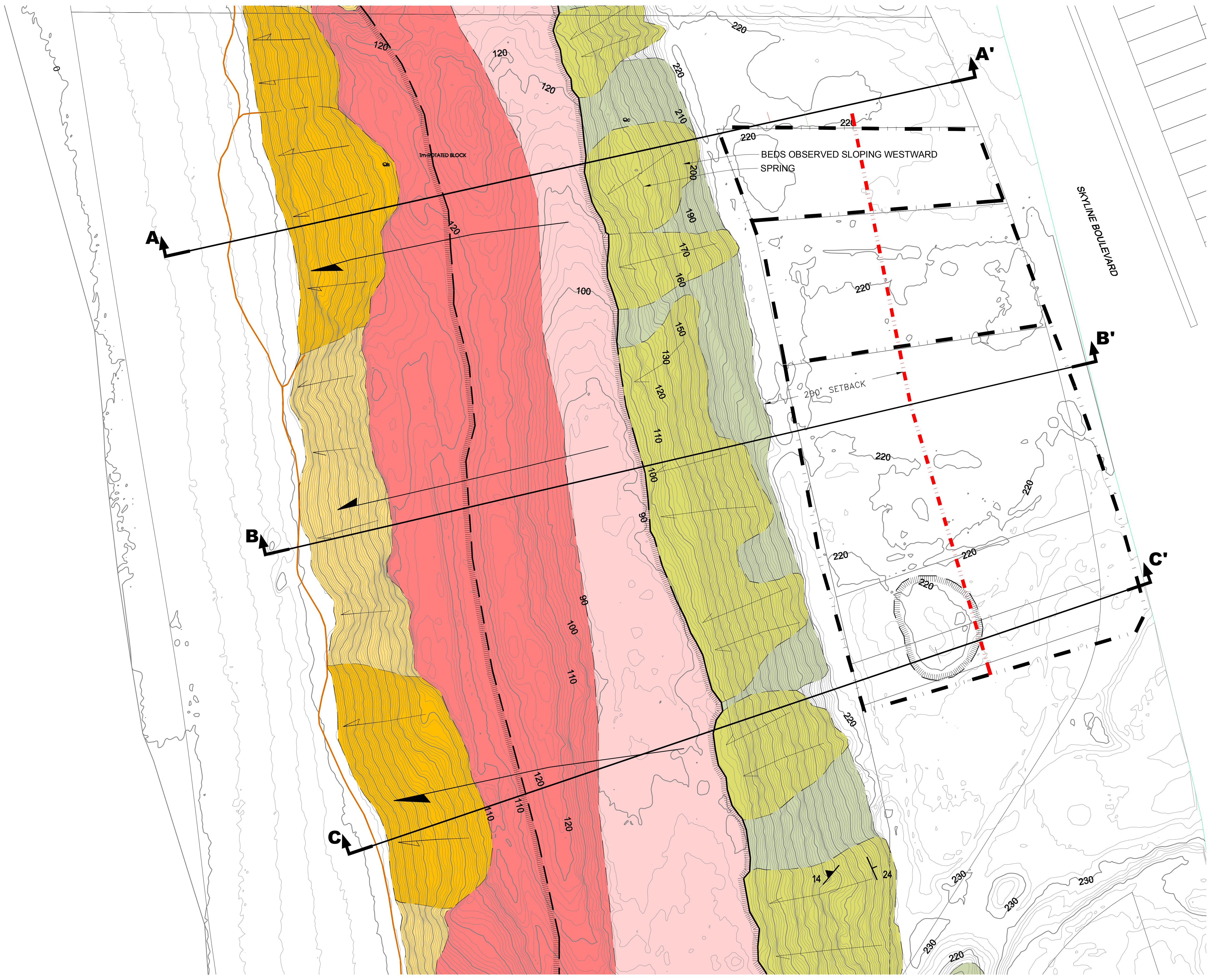
0 200
FEET

MAP BASE SOURCE: PACIFIC AERIAL SURVEYS AV248 7 12 1935

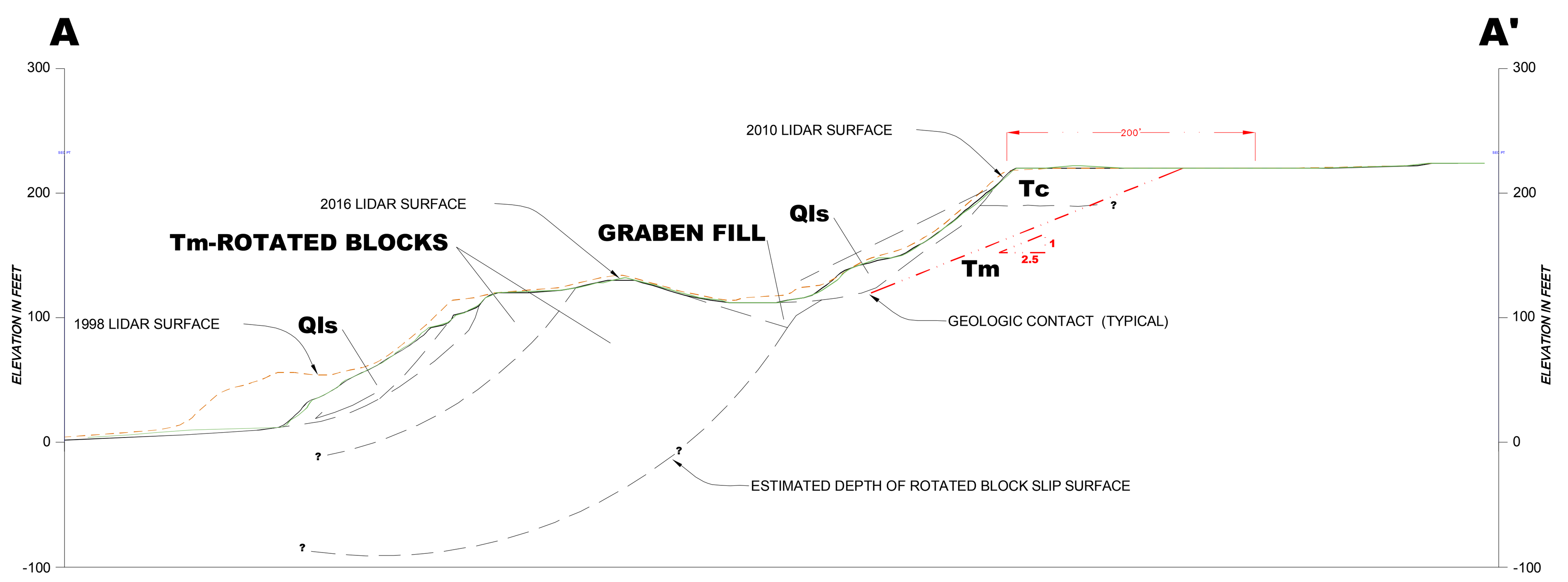
ENGEO Expect Excellence	1935 AERIAL IMAGE 2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000 SCALE: AS SHOWN DRAWN BY: PJS / CHECKED BY: PJS	FIGURE NO. 5A

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-PHOTOSEQ-5A-0219.dwg

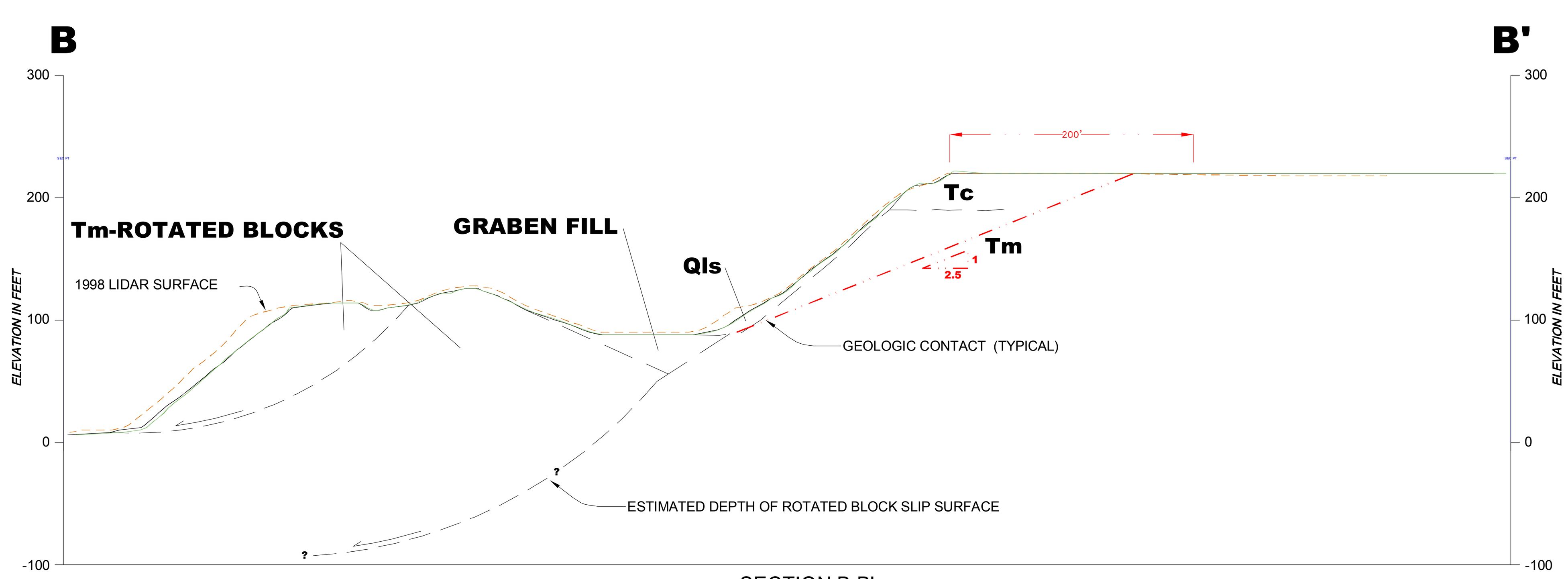
ORIGINAL FIGURE PRINTED IN COLOR



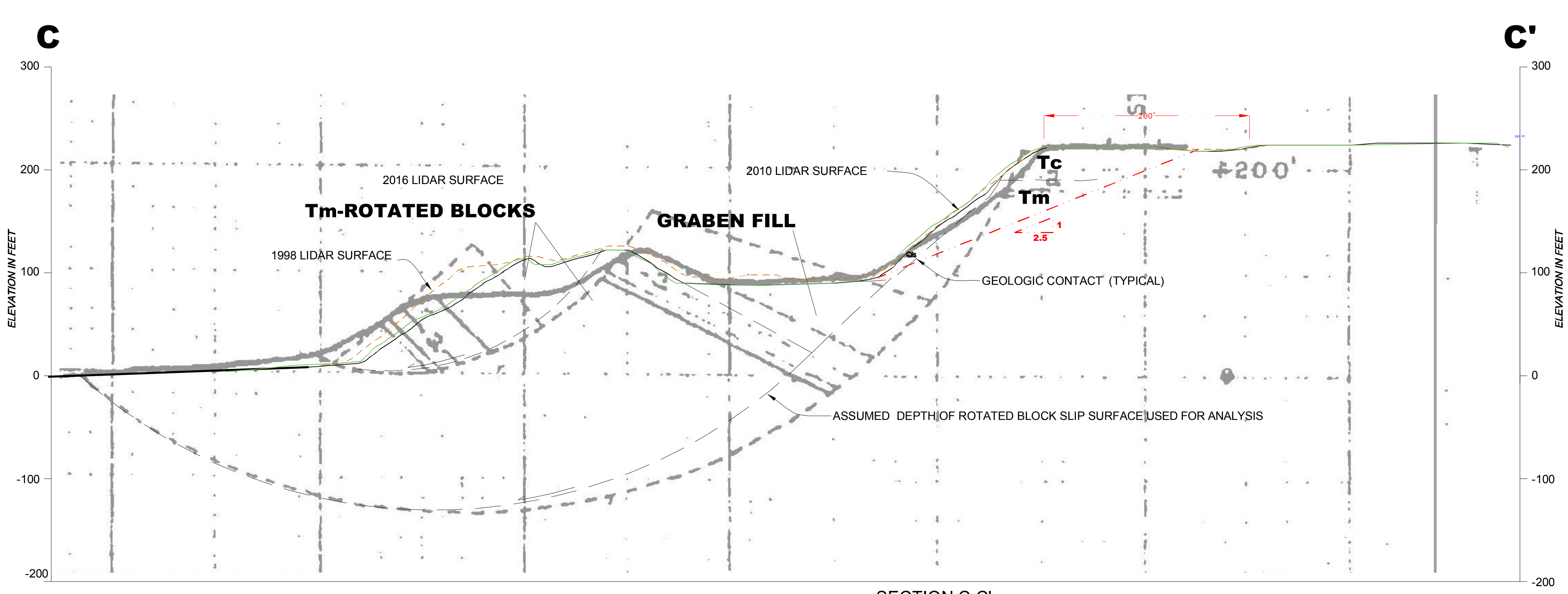
SITE PLAN
1" = 100'



SECTION A-A'
1" = 100'



SECTION B-B'
1" = 100'



SECTION C-C'
1" = 100'

NOTE: IMAGE BACKLIDAR FROM BONILLA, 1960, SECTION E-E'

EXPLANATION

- SLOPE WASH AND SURFICIAL LANDSLIDES (LANDWARD BLUFF)
- ACTIVE SURFICIAL LANDSLIDE (LANDWARD BLUFF)
- ACTIVE DEEP LANDSLIDE (COASTAL BLUFF)
- ACTIVE LANDSLIDE (COASTAL BLUFF)
- GRABEN FILL DEPOSITS, DEEP-SEATED BLOCK LANDSLIDE
- DEEP-SEATED LANDSLIDE BLOCK
- CLOSED DEPRESSION
- Tc — COLMA FORMATION (UNCEMENTED TO WEAKLY CEMENTED SAND)
- Tm — MERCED FORMATION (WEAKLY CEMENTED SAND AND CLAYSTONE)
- Qc — SLOPEWASH AND SURFICIAL LANDSLIDES
- Qls — LANDSLIDE
- GEOLOGIC CONTACT
- LIDAR SURFACE, 2010
- LIDAR SURFACE 1998
- LIDAR SURFACE 2016
- APPROXIMATE BASE OF SHORELINE BLUFF, 1998)
- 14 — SHEAR PLANE
- 24 — INCLINED

100
0
0 100
SCALE IN FEET

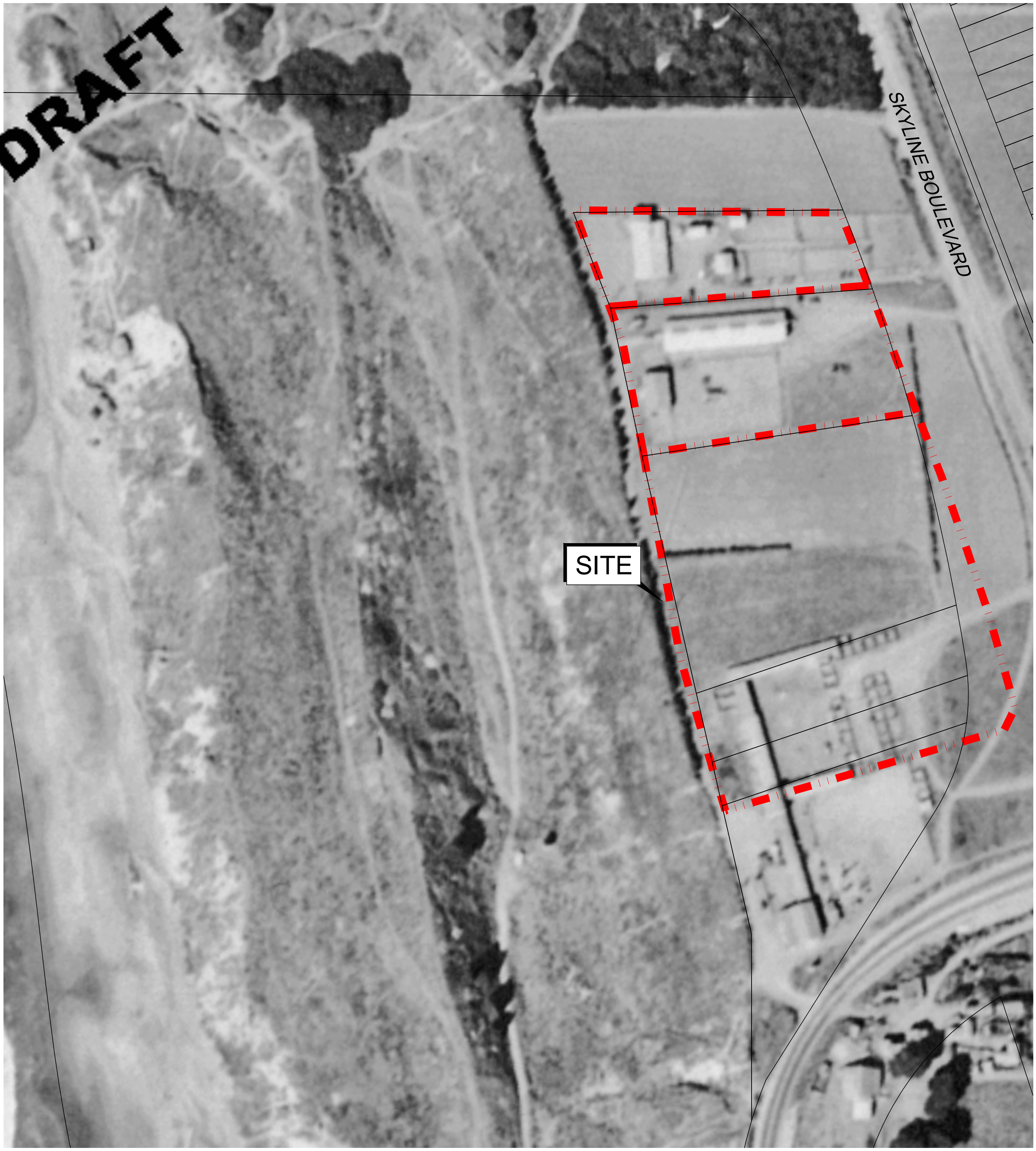
BASE MAP SOURCE: UNKNOWN

ENGEO Expect Excellence

SITE PLAN AND CROSS SECTION
2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION
DALY CITY, CALIFORNIA

PROJECT NO.: 8438.001.000
SCALE: AS SHOWN
DRAWN BY: LL
CHECKED BY: PJS
FIGURE NO. 4

ORIGINAL FIGURE PRINTED IN COLOR



N

0 200
FEET

MAP BASE SOURCE: DDB-1943_2B-193

ENGEO Expect Excellence	1943 AERIAL IMAGE 2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000 SCALE: AS SHOWN DRAWN BY: PJS CHECKED BY: PJS	FIGURE NO. 5B

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-PHOTOSEQ-5B-0219.dwg

ORIGINAL FIGURE PRINTED IN COLOR

N

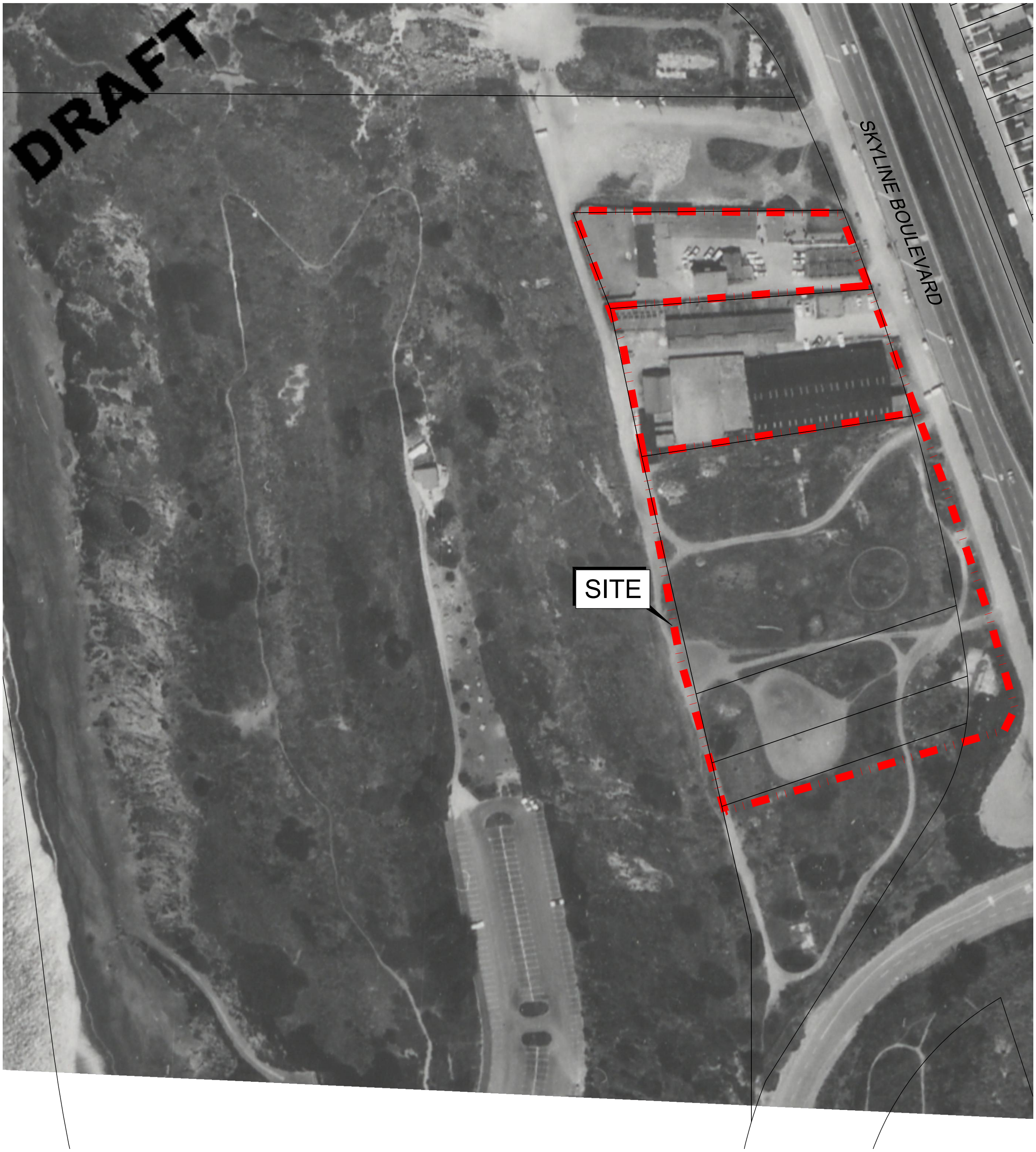
0 200
FEET

MAP BASE SOURCE: CAS 65-130 12 63 5-17-1965

ENGEO Expect Excellence	1965 AERIAL IMAGE 2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000 SCALE: AS SHOWN DRAWN BY: PJS CHECKED BY: PJS	FIGURE NO. 5C

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-PHOTOSEQ-5C-0219.dwg

ORIGINAL FIGURE PRINTED IN COLOR



MAP BASE SOURCE: PACIFIC AERIAL SURVEYS, AV1188 1 9 4-28-1975

ENGEO Expect Excellence	1975 AERIAL IMAGE 2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000		FIGURE NO. 5D
		SCALE: AS SHOWN		
		DRAWN BY: PJS	CHECKED BY: PJS	

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-PHOTOSEQ-5D-0219.dwg

ORIGINAL FIGURE PRINTED IN COLOR

MAP BASE SOURCE: PACIFIC AERIAL SURVEYS, AV7091 2 17 8-17-2001

ENGEO
Expect Excellence

1993 AERIAL IMAGE

2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION

DALY CITY, CALIFORNIA

PROJECT NO.: 8438.001.000	
SCALE: AS SHOWN	
DRAWN BY: PJS	CHECKED BY: PJS

FIGURE NO.
5E

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-PHOTOSEQ-5E-0219.dwg

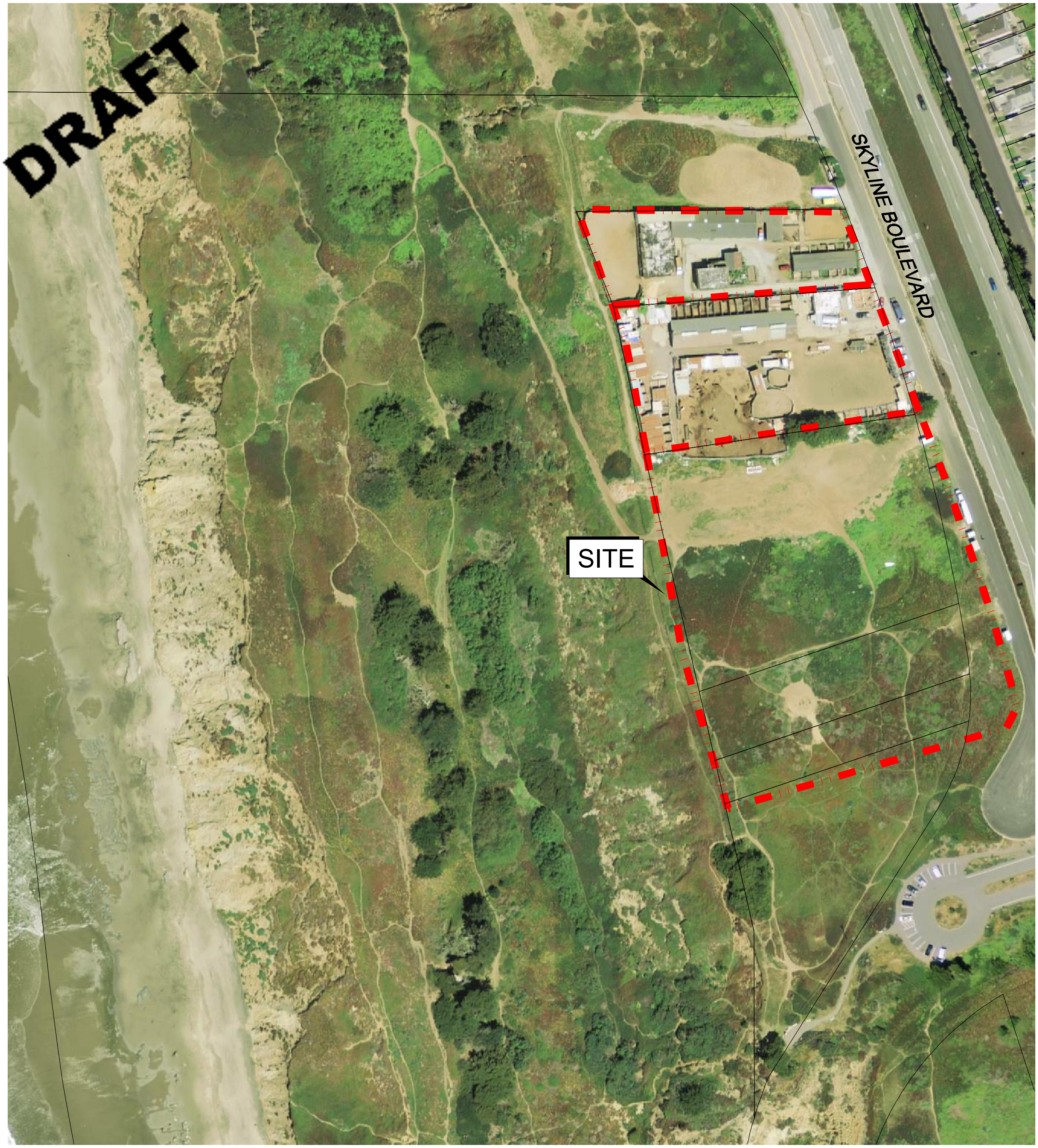
ORIGINAL FIGURE PRINTED IN COLOR

MAP BASE SOURCE: PACIFIC AERIAL SURVEYS, AV7091 2 17 8-17-2001

ENGEO Expect Excellence	2001 AERIAL IMAGE 2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000 SCALE: AS SHOWN DRAWN BY: EJ CHECKED BY: PJS	FIGURE NO. 5F

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-PHOTOSEQ-5F-0219.dwg

ORIGINAL FIGURE PRINTED IN COLOR



MAP BASE SOURCE: USGS ORTHOPHOTO, 2011

ENGEO Expect Excellence	2011 AERIAL IMAGE 2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000 SCALE: AS SHOWN DRAWN BY: PJS CHECKED BY: PJS	FIGURE NO. 5G

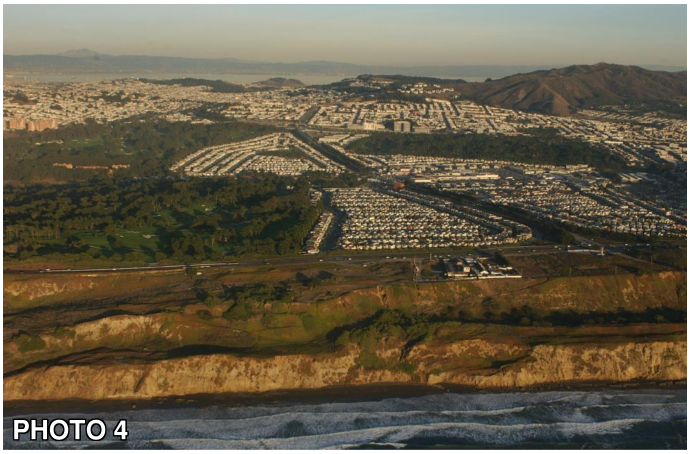
G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-PHOTOSEQ-5G-0219.dwg

ORIGINAL FIGURE PRINTED IN COLOR

1972

1979

1987



2002

2004

OBLIQUE IMAGES FROM TO CLAIFORNIA COASTAL RECORDS PROJECT

ENGEO
Expect Excellence

HISTORIC OBLIQUE IMAGES

2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION

DALY CITY, CALIFORNIA

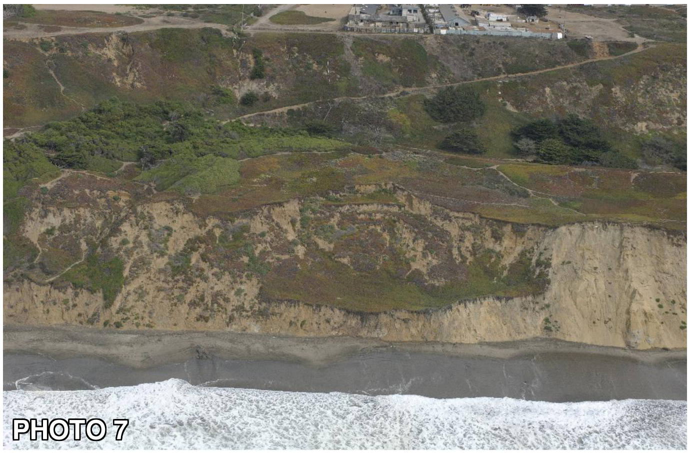
PROJECT NO.: 8438.001.000	
SCALE: NO SCALE	
DRAWN BY: PJS	CHECKED BY: PJS

FIGURE NO. 6A

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-6-SitePhotos-0219.dwg

ORIGINAL FIGURE PRINTED IN COLOR

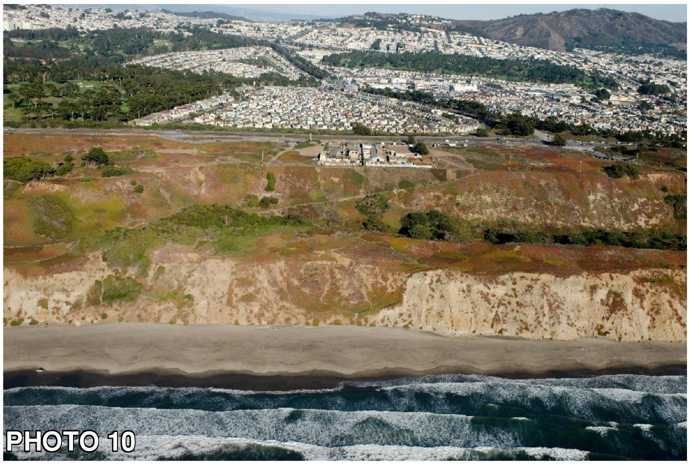
2005



2008

2009

2010



2013

OBLIQUE IMAGES FROM TO CLAIFORNIA COASTAL RECORDS PROJECT

ENGEO Expect Excellence

HISTORIC OBLIQUE IMAGES 2152 SKYLINE BOULEVARD - LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000		FIGURE NO. 6B
	SCALE: NO SCALE		
	DRAWN BY: PJS	CHECKED BY: PJS	

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-6-SitePhotos-0219.dwg

ORIGINAL FIGURE PRINTED IN COLOR

JOHN DALY BLVD EXTENSION AND PARKING LOT, 1972

JOHN DALY BLVD EXTENSION AREA, 2013

LYNVALE COURT LANDSLIDE, 2013

OBLIQUE IMAGES FROM TO CLAIFORNIA COASTAL RECORDS PROJECT

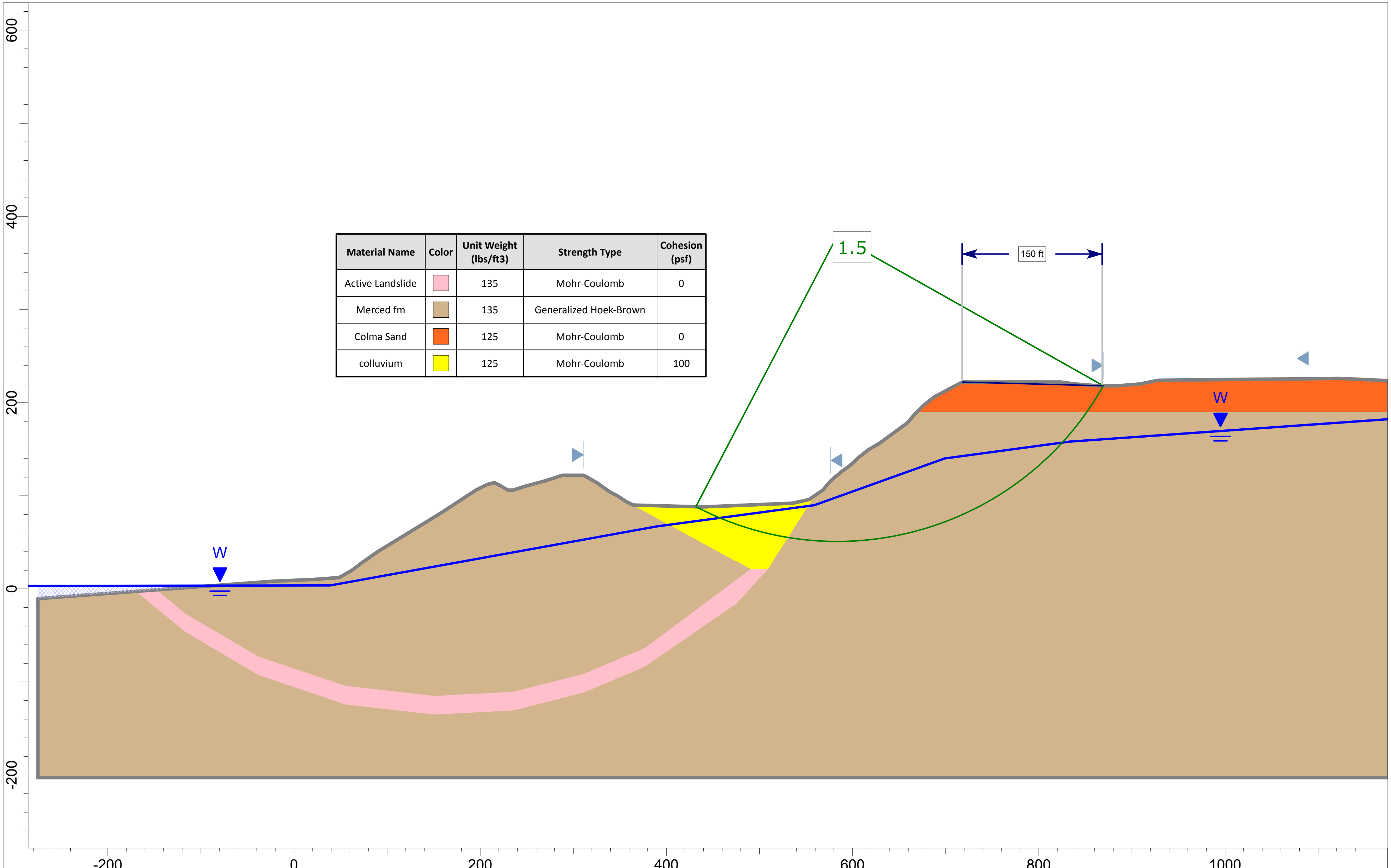
ENGEO Expect Excellence	HISTORIC OBLIQUE IMAGES 2152 SKYLINE BOULEVARD LANDSLIDE EVALUATION DALY CITY, CALIFORNIA	PROJECT NO.: 8438.001.000 SCALE: NTS DRAWN BY: XXX CHECKED BY: XXX	FIGURE NO. 6C

G:\Drafting\DRAFTING2_Dwg\8438\001\012819-SKYLINE_BLUFF\8438001000-SKYLINE_BLUFF-6-SitePhotos-0219.dwg

ORIGINAL FIGURE PRINTED IN COLOR

APPENDIX A

SLOPE STABILITY OUTPUT

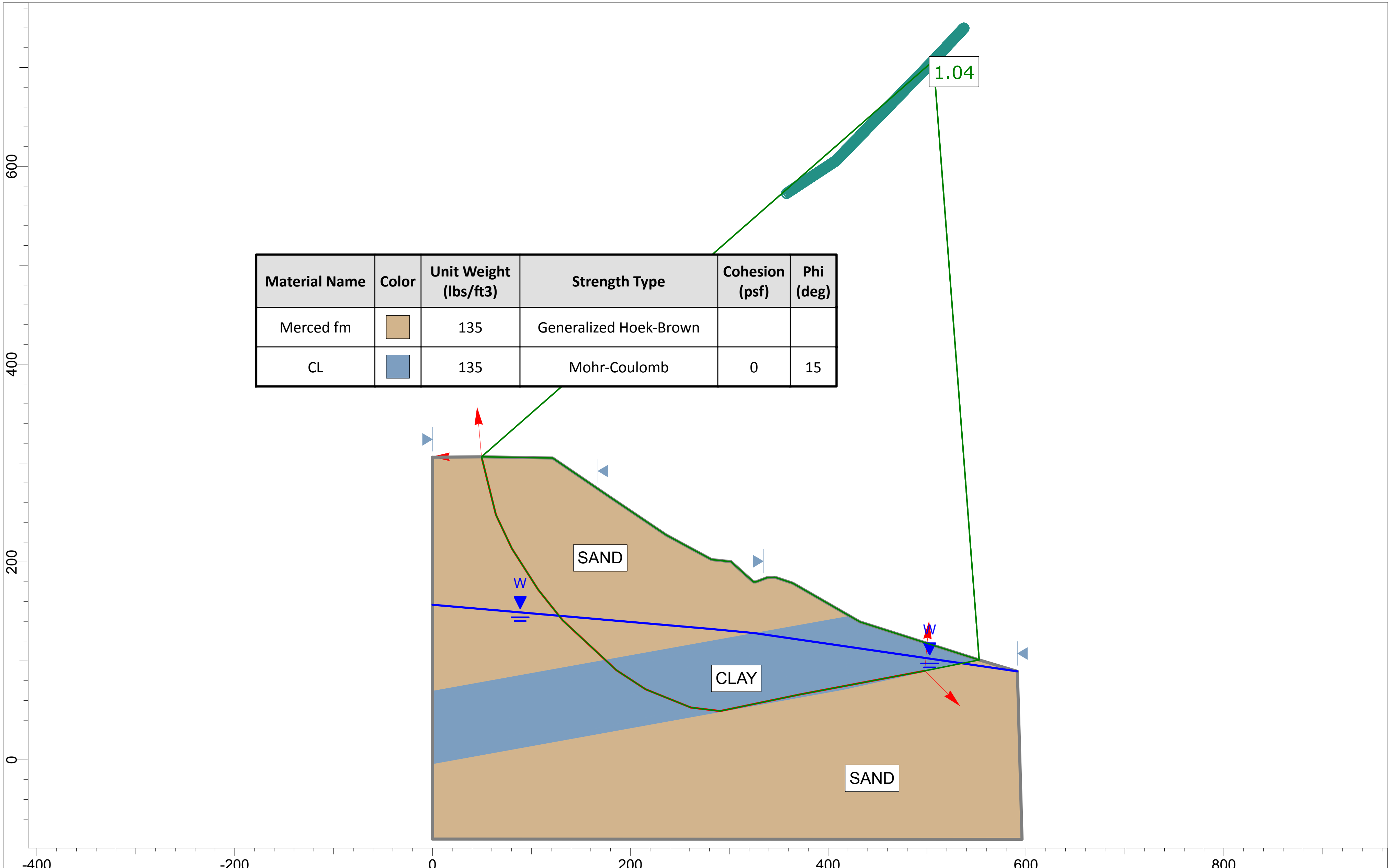


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)
Active Landslide	(pink)	135	Mohr-Coulomb	0
Merced fm	(tan)	135	Generalized Hoek-Brown	
Colma Sand	(orange)	125	Mohr-Coulomb	0
colluvium	(yellow)	125	Mohr-Coulomb	100

ENGEO
Expect Excellence

SLIDEINTERPRET 8.021

Project	SECTION C-C' : Skyline Bluffs		
Scale 1:1700	*Author* PS	*Project No.* 8438.001.000	
Date February 7, 2019	*Condition* Static Analysis		



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Merced fm		135	Generalized Hoek-Brown		
CL		135	Mohr-Coulomb	0	15

ENGEO
Expect Excellence
SLIDEINTERPRET 8.021

Project	SECTION L-L' : Lynvale Landslide, 1972

Scale	1:1600	*Author*	PS	*Project No.*	8438.001.000
Date	February 7, 2019	*Condition*	Back Analysis