4.3 GEOLOGY AND SOILS

This section of the EIR discusses existing geologic and soils related conditions and the natural and manmade drainage conditions within and in the vicinity of the project site. The section also identifies potential geologic impacts including exposure to the effects of ground-shaking, liquefaction, expansive soils, erosion, and changes to drainage patterns, and includes a summary of coastal hazards, including storm surge, wave runup, sea level rise over the next 100 years, and tsunami.

The section is based on the technical reports provided by the applicant including:

- Geologic Conditions at the Loperena Property, Studio Drive, Cayucos, California, Assessor's Parcel Number 064-253-07; Cleath and Associates, May 2, 2006
- Geotechnical Investigation, Proposed Residence, Lot 41, Studio Drive, Cayucos, California; GSI Soils, Inc., January 12, 2007
- Addendum to Report of Geologic Conditions at the Loperena Property, Studio Drive, Cayucos, California Assessor's Parcel Number 064-253-07 (Cleath and Associates, May 2, 2006); Cleath and Associates, January 12, 2007
- Memorandum: Summary of Conclusions and Recommendations of Cleath and Associates Study of Geologic Conditions at the Loperena Property, Studio Drive, Cayucos, California, Assessor's Parcel Number 064-253-007, May 2, 2006; Cleath and Associates, March 30, 2007
- Response to Comments Prepared by Mr. Michael R. Jencks on Loperena Engineering Geology Report; Cleath and Associates, September 26, 2007
- Updated Geotechnical Investigation Proposed Residence Lot 41 Studio Drive Cayucos, California; GSI Soils, Inc., December 27, 2011
- Engineering Evaluation Studio Drive Residence Cayucos APN 064-253-007 County of San Luis Obispo, CA; Shoreline Engineering, January 2012
- Updates to Engineering Geology Reports for the Proposed Loperena Residence, Lot 41, Studio Drive, Cayucos, California; Cleath-Harris Geologists, Inc., June 25, 2012
- Update #2 to Engineering Geology Reports for the Proposed Loperena Residence, Lot 41, Studio Drive, Cayucos, California; Cleath-Harris Geologists, Inc., September 19, 2012
- Loperena, County of San Luis Obispo Responses to Supplemental Geotechnical Peer Review for EIR Preparation, 8/21/12; Shoreline Engineering, September 20, 2012
- Response to Supplemental Geotechnical Peer Review, Loperena Residence Lot 41 Studio Drive Cayucos, California; GSI Soils, Inc., October 1, 2012
- Mean High Water Definition NW end of Studio Drive San Luis Obispo County, California Assessor's Parcel No. 064-253-007; Volbrecht Surveys, undated

Additional information reviewed during preparation of this EIR includes public and agency comments submitted to the County, and the following document prepared by the County Geologist:

- Memo from Brian Papurello, Review Geologist, Re: Loperena Residence – DRC 2005-00216, Studio Drive (APN 064-253-007), Cayucos Area of San Luis Obispo County, California, April 13, 2007.

These reports have been independently peer reviewed by a Registered Civil Engineer who specializes in coastal engineering, a Certified Engineering Geologist, and a Registered Geotechnical Engineer, as documented in the following:

- Discussion of Coastal Hazards and Wave Runup, Northwest and Immediately Adjacent to 2612 Studio Drive (APN 064-253-07), Cayucos, San Luis Obispo County, California; GeoSoils Inc., March 14, 2011

- Technical Report: Geotechnical and Coastal Hazards Review, Loperena Minor Use Permit/Coastal Development Permit APN 064-253-07, Studio Drive, Cayucos San Luis Obispo County, California; Cotton, Shires and Associates, Inc., May 2011

- Supplemental Geotechnical Peer Review for Environmental Impact Report Preparation; Cotton, Shires and Associates, Inc., August 21, 2012

- Second Supplemental Geotechnical Peer Review for Environmental Impact Report Preparation; Cotton, Shires and Associates, Inc., October 31, 2012

The reports are incorporated into this EIR by reference, and copies are available at the County Department of Planning and Building.

4.3.1 Existing Conditions

4.3.1.1 Regional Setting

Terrain

The general area surrounding the project site is characterized by coastal features, including beachfront adjacent to relatively low coastal and fluvial bluffs that range in elevation from approximately 30 to 50 feet. Nearby moderately to steeply sloping foothills northeast of Highway 1 rise to elevations ranging from 300 to 500 feet. The project site is unique in that it is situated near the broad mouth and alluvial valley of Old Creek, and the property appears to physically sit atop and/or straddle a bedrock remnant of the fluvial bluff that is now mostly buried by artificial fill materials. The elevation of the project site ranges from slightly less than 10 feet on the active beach to 26 feet along the southerly property line. Above the beach, a bedrock outcropping extends to approximately 17 feet in elevation where it is capped by soils, and slopes generally west to northwest at roughly a 2:1 gradient. The remainder of the property slopes northwest at 2.5:1 to 5:1 gradients. Within the County right-of-way along Studio Drive, an approximately 10-foot-high 2:1 gradient fill slope descends west-southwest from the pavement toward the east property line. Including the County right-of-way, the project site elevation reaches approximately 31 feet at Studio Drive.

Development History

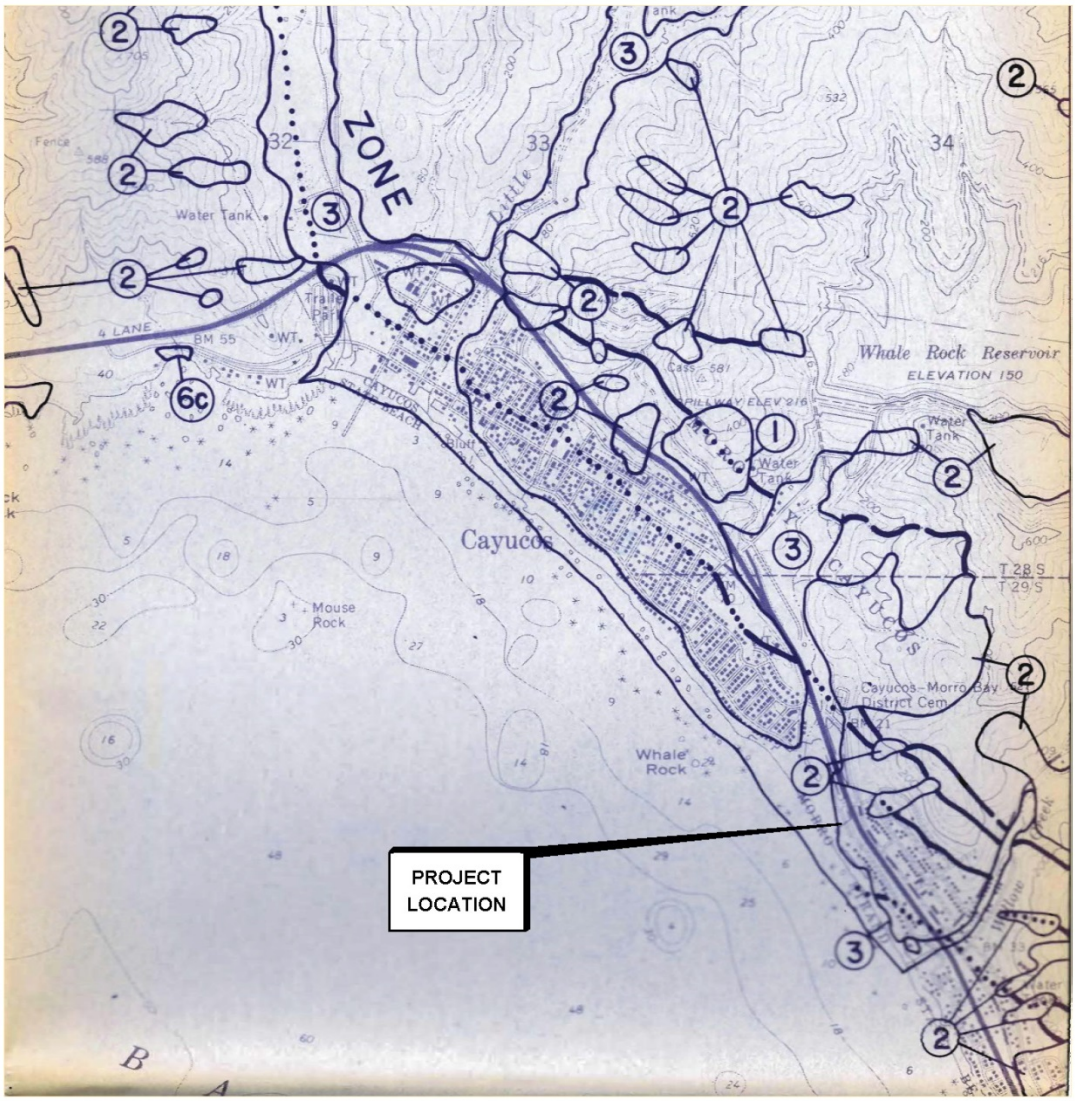
In 1937, Cabrillo Highway (currently Highway 1) was a primitive road located to the east of its present location, along what are now Ocean Boulevard and Cabrillo Avenue. Studio Drive ran parallel to the coastline but did not exist in the current location. It returned northeast back to the highway approximately 200 feet south of the present property frontage. Development in the area was very sparse. A northwest-, west-, and southwest-facing rock outcrop occupied the elevated portion of the project site, descending north to the slightly elevated alluvial plain of Old Creek, and descending west-southwest to the beach above the tidal zone. The northwest-facing portion of the outcrop faced the mouth of Old Creek, while the southwest portion faced the ocean as it does today. The lowland area immediately north of the project site appeared to contain alluvial sediments in the broad valley of Old Creek. The area between the project site and the active creek channel (in 1937), and inland of the active beach, contained a low, broad, slightly vegetated shore-parallel ridge (dune). By 1949, Cabrillo Highway had been realigned slightly west within the Old Creek drainage, including a new bridge over Old Creek. By 1959, most of the lots on the west side of Studio Drive were developed. Construction on Whale Rock Reservoir had commenced inland on Old Creek, and was reportedly completed in April 1961 (City of San Luis Obispo 1998).

Aerial photographs from 1963 document major changes, including the realignment and widening of Cabrillo Highway west toward Studio Drive, and the extension of Studio Drive approximately 450 feet northwest where it then returned back to the main highway. This construction resulted in significant fills being placed across the aforementioned rock outcropping to construct the Studio Drive extension, and significant fills built across the alluvium in the valley of Old Creek to support the highway. The northerly five ocean-ward properties on Studio Drive, including the project site and those at 2612 through 2618 Studio Drive, south of the project site, were still undeveloped in 1963; these properties were developed by 1972. A dirt parking lot was graded south of and adjacent to the active channel of Old Creek, near the beach. The property immediately south of the project site, at 2612 Studio Drive, was developed sometime between 1979 and 1986, based on review of aerial photos. Some fill may have been pushed north onto the project site during grading and construction of the adjacent properties to the south prior to 1986.

Geologic Setting

The project site is located on an active beach and adjacent terrace at the edge of the Pacific Ocean at Estero Bay just north of the Los Osos Valley. The elevated portion of the site sits atop or slightly straddles the buried edge of a fluvial bluff on the south side of the mouth of the Old Creek drainage. Elevations at the site (i.e., including the County right-of-way up to Studio Drive) range from slightly less than 10 feet to approximately 31 feet above present sea level, measured in North American Vertical Datum of 1988 (NAVD88). The site is located in the Southern Coast Ranges Geomorphic Province. This province is bounded on the east by the San Andreas Fault, on the south by the Santa Ynez Mountains (Western Transverse Ranges Geomorphic Province), on the west by the Continental Borderland offshore, and on the north by the Northern Coast Ranges. Lettis (2004) has defined the southern region of the Southern Coast Ranges along the coast (which includes the site) as the Los Osos Domain. This domain is characterized by west-northwest to north-northwest trending mountain ranges and valleys with parallel fault systems bounded on the south by the Santa Ynez River Fault (Western Transverse Ranges), on the north and east by the Oceanic-West Huasna Fault Zone (Santa Lucia Mountains and San Rafael Mountains of the Southern Coast Ranges), and on the west by the Hosgri Fault Zone (Offshore Santa Maria Domain within the Continental Borderland).

Figure 4.3-1. Regional Geologic Hazard Map



EXPLANATION

1	Young Landslides (Aerial photo and field examinations)
2	Quaternary Landslides (Hall, 1974; Hall and Prior, 1975)
3	Unconsolidated alluvium (Hall and Prior, 1975). These are areas where a shallow groundwater table probably exists, and therefore have the potential for seismically induced liquefaction
4	Faults: solid line where well located, dashed line where inferred, dotted line where concealed (Hall and Prior, 1975; Hall, 1974; Jennings, 1977; Wagner, 1974)
6c	Unique geologic features of scientific and/or educational value

0 2000 ft 4000 ft

1"= 2000'

Reference: Kilbourne and Sholin, 1980, CDMG, OFR 80-6, Plate 1a, Geology for Planning, Cayucos 7.5 Minute Quadrangle

COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

REGIONAL GEOLOGIC HAZARD MAP
Loperena Property
APN 064-253-07, Studio Drive
CAYUCOS, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
SS	1" = 2000'	SC0099
APPROVED BY	DATE	FIGURE NO.
MP	May 2011	1

The mountains and valleys in the area of the site include the Santa Lucia Mountains, Los Osos Valley, and San Luis Mountains. The area is characterized by west-northwest trending reverse faults and tight, almost parallel folding of rocks assigned to Franciscan Melange (generally greywacke, shale, greenstone, and serpentine rock types). These rocks are typically chaotically fractured. Other geologic units in the area include Coast Range Ophiolite (Serpentine) found within the Franciscan Complex and Mesozoic Great Valley Sequence. Quaternary marine terrace and older alluvium deposits overlie these rocks along the coast in the vicinity of the site. These units are relatively thin where mapped at the subject site, and likely represent the last sea-level highstand (wave-cut platform at the base of the marine terrace deposits).

Landslides are present within the Franciscan Complex rocks in the area, including a massive deep-seated ancient landslide located approximately 2,000 feet up-canyon from the site, along Old Creek near the Cayucos Morro Bay Cemetery, and a large earthflow landslide, the toe of which occurs approximately 400 feet northeast of the site across Highway 1 (refer to Figure 4.3-1).

Seismic Setting

The project site is located within an area of high seismicity. The nearest and controlling faults, with respect to site ground shaking, are: Hosgri Fault, located approximately 8.1 miles west of the site; Los Osos Fault, located approximately 11.1 miles south of the site; and San Luis Range Fault, located approximately 14 miles east of the site. There are several northwest trending, parallel fault systems in the region, including the San Andreas Fault (refer to Figure 4.3-2). The closest is the Cambria Fault, which is mapped within 1 kilometer of the site and the trend of which projects near the site (Lettis 2004). Other faults near the site are the Hosgri-San Simeon Fault Zone, Los Osos Fault Zone, Edna Fault, San Miguelito Fault, Oceanic-West Huasna Fault, East Huasna Fault, and Rinconada Fault. The 6.5-magnitude San Simeon earthquake, which occurred on December 22, 2003, apparently caused a peak ground acceleration (expressed as “g”) of approximately 0.16g at the site (California Integrated Seismic Network). The Fault Location Map (refer to Figure 4.3-2) depicts the site location relative to the aforementioned faults.

The Oceanic Fault is the nearest fault to the site with documented evidence of recent seismic activity, including a 4.4-magnitude earthquake in June 2009 and the 6.5-magnitude San Simeon earthquake in December 2003 (Cleath-Harris Geologists 2012). The San Simeon earthquake was caused by reverse faulting, and was centered approximately 22 miles north of the project site. This fault is the northwestern segment of the Oceanic-West Huasna Fault zone that trends north-northwest approximately from the Santa Maria River to San Simeon for approximately 100 kilometers. The Oceanic Fault segment is located near the city of San Luis Obispo and extends north to San Simeon. The California Geologic Survey has not yet established a slip rate (distance of slip per year) for this fault. Based on the Probabilistic Seismic Hazard Analysis (PSHA) conducted to determine design-basis earthquake parameters for the project, the design-basis ground motion of the site is 0.29g (Cleath and Associates 2006).

Deterministic Analysis

Table 4.3-1, below, provides the results of the deterministic analysis conducted by Cotton, Shires and Associates, including the major earthquake sources, the distances from the sources to the site, the maximum moment magnitudes, and the peak horizontal ground accelerations (PGA) that are anticipated at the site.

Table 4.3-1. Seismic Deterministic Analysis Results for the Project Site

Fault Source	Distance (mi/km)	Moment Magnitude[1]	Peak Horizontal Accelerations (g)[2]
Hosgri	8.0/12.8	7.5	0.352
Los Osos	9.1/14.6	7.0	0.348
San Luis Range	14.9/23.9	7.2	0.240

[1]Based on "Probabilistic Seismic Hazard Assessment for the State of California" by CDMG, DMG Open-File Report 96-08.
[2]Based on attenuation relationships developed by Abrahamson and Silva, 1997, Horizontal - Rock as determined using the computer program EQFAULT by T.F. Blake (1989, and updated 2004).

Source: Cotton, Shires and Associates, 2011

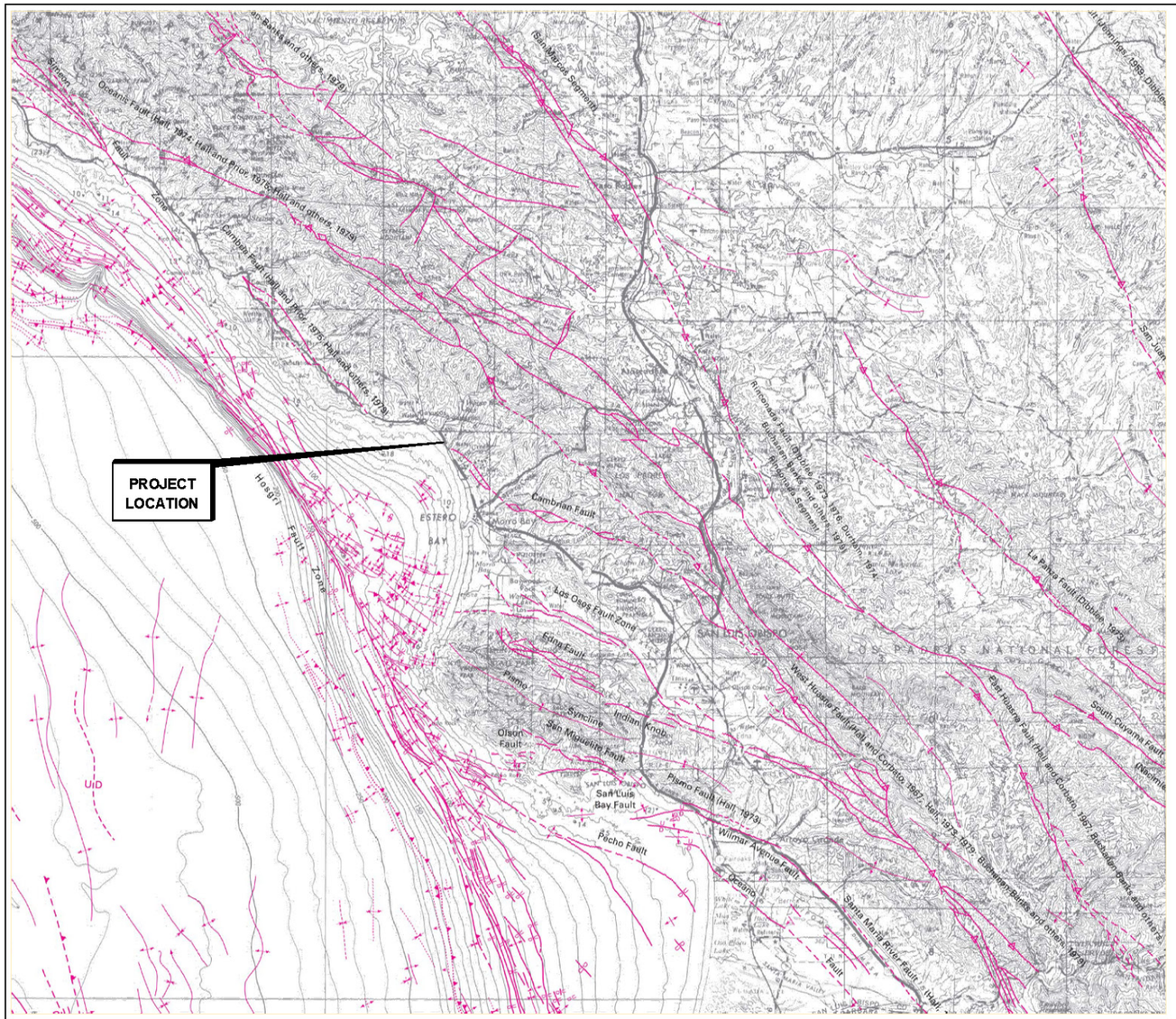
Probablistic Analysis

A probabilistic analysis was performed by Cotton, Shires and Associates, Inc. using the computer program FRISKSP (T.F. Blake 1988, updated 2004) and incorporated moment magnitudes from the California Division of Mines and Geology (CDMG) publication "Probabilistic Seismic Hazard Assessment For The State of California" (DMG Open File Report 96-08) and attenuation relationships by Abrahamson and Silva (1997 – Horizontal Rock). The results of the probabilistic analysis indicate an appropriate Design Basis Earthquake (10% probability of exceedance in 50 years, or a 475-year return interval, which is generally used for residential and commercial buildings) PGA of 0.24g. This is lower than the 0.29g value reported in the applicant's submitted report (Cleath and Associates 2006), possibly due to differences in attenuation relationships used.

Taking into account the above earthquake moment magnitudes and the results of the deterministic and probabilistic approaches, the project area could experience a PGA as high as 0.35g (equal to the deterministic value calculated for an earthquake on the Hosgri Fault for the site).

For geotechnical hazard analyses (e.g., liquefaction and seismically-induced settlement) requiring ground motion estimates, the applicant's geotechnical engineering consultant conservatively utilized a PGA of 0.60g based on a magnitude 7.2 earthquake on the Hosgri Fault in their updated geotechnical investigation for the project (GSI Soils 2011).

Figure 4.3-2. Regional Fault Location Map



EXPLANATION

OFFSHORE REGION*

U/D — Active or potentially active high angle fault (sea-floor projection of fault tip where blind or buried)—Deforms early/late Pliocene (2.8–3.4 Ma) unconformity or younger deposits or surfaces; U/D (Up/Down) indicates relative sense of displacement, bar indicates dip direction; dashed where approximately located

Active or potentially active low angle fault (sea-floor projection of fault tip or leading edge of ramp where blind or buried)—Deforms early/late Pliocene (2.8–3.4 Ma) unconformity or younger deposits or surfaces; teeth indicate dip direction; dashed where approximately locate

Active or potentially active antiecline axial trace (sea-floor projection where buried)—Arrow indicates direction of plunge; dashed where approximately located

Active or potentially active syncline axial trace (sea-floor projection where buried)—Arrow indicates direction of plunge; dashed where approximately located

Active or potentially active monocline axial trace (sea-floor projection where buried)—Arrow indicates direction of plunge; dashed where approximately located

Inactive fault (bold) or fold (light)—Does not deform early/late Pliocene (2.8–3.4 Ma) unconformity; where this unconformity and (or) younger sediments are absent as a result of erosion, structures are mapped as potentially active

ONSHORE REGION*

Active fault trace—Deforms deposits or surfaces ≤500,000 ka; dashed where approximately located

Potentially active fault trace—May deform deposits or surfaces ≤500,000 ka; dashed where approximately located

Inactive active fault trace—Does not deform deposits or surfaces ≤500,000 ka; dashed where approximately located

Anticline axial trace—Arrow indicates direction of plunge; solid where active or potentially active; dotted where inactive

Syncline axial trace—Arrow indicates direction of plunge; solid where active or potentially active; dotted where inactive

Monocline axial trace—Solid where active or potentially active; dotted where inactive

*Note: See text for discussion of mapping techniques and age criteria used to identify fault activity.

Reference: Lettis, 2004, USGS, Scientific Investigations Map 2812, Bulletin 1995-AA

COTTON, SHIRES AND ASSOCIATES, INC. CONSULTING ENGINEERS AND GEOLOGISTS		
REGIONAL FAULT LOCATION MAP **Loperena Property** **APN 064-253-07, Studio Drive** **CAYUCOS, CALIFORNIA**		
GEO/ENG BY **SS**	SCALE **Approx 1" = 6 mi**	PROJECT NO. **SC0099**
APPROVED BY **MP**	DATE **May 2011**	FIGURE NO. **2**

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4.3.1.2 Project Site Setting

Soil Conditions

The soil type mapped for the project site is Cropley clays, 2 to 9% Slopes (Soil Unit 128) (U.S. Department of Agriculture [USDA] 1984). This very deep, moderately drained, gently sloping to moderately sloping soil is found on alluvial fans and plains. It is formed in alluvium weathered from sedimentary rocks. Typically the surface layer is dark gray, very dark gray, and light brownish gray clay approximately 36 inches thick. When the soil is dry, large cracks extend to a depth of 40 inches or more. Permeability of the unit is slow, and the available water capacity is high. Surface water runoff is slow to medium, and the hazard of water erosion is slight to moderate. The Cropley clay has a high shrink-swell potential.

Surface Conditions

The project site is bounded by Studio Drive and the County right-of-way on the east, an existing residence (2612 Studio Drive) to the south, and Morro Strand State Beach to the north and west. An engineering geologic map (Appendix C, Plate 1) was prepared based upon site observations and document review, and illustrates the distribution of earth materials exposed at the ground surface. The western portion of the property contains beach sand. A bedrock outcropping consisting of greywacke sandstone with minor shale interbeds is exposed between approximate elevations of 10 and 17 feet in the center of the property. The greywacke sandstone bedrock is moderately weathered, hard to very hard, and closely fractured. The thin shale beds are soft, intensely fractured, and eroded out (forming indentations in the outcrop) relative to the adjacent resistant sandstone. Numerous joints and joint sets were mapped with joint spacings as narrow as 4 inches. Relict bedding planes mapped within the bedrock have strikes ranging from N58ºW to N75ºW and dips ranging from 85ºNE to vertical. Landward of the bedrock outcropping, the site is covered by an apron of undocumented fill that is covered with extensive iceplant growth. The fill deposits appear to thin immediately north of the site, where they cap older alluvium sediments and possibly dune sediments. A fill slope ascends from the east property line up to the pavement of Studio Drive. An interpretation of the distribution of earth materials at the site is illustrated on Plate 1, Geologic Map (refer to Figure 4.3-3 and Appendix C). Generalized cross-sections (refer to Figures 4.3-4 and 4.3-5 and Appendix C) extending from Studio Drive through the beach was prepared to illustrate an interpretation of subsurface conditions based upon geologic mapping and review of the applicant's consultant's exploration data.

A narrow, natural drainage swale conveys runoff discharging from the existing concrete overside drain from Studio Drive. The overside drain collects drainage from the ocean-ward side of Studio Drive. This drainage swale trends around the northeast corner of the project site and descends toward the beach immediately to the north. Erosion in the swale appears to have been accelerated by foot traffic from people accessing the beach. A thin veneer of fill appears to cap older alluvial sediments in this area, based on observations of soils exposed in the swale. North of the swale, the older alluvial sediments may be overlain by thin dune deposits (the low shore-parallel ridge described in the aerial photograph review). Drainage on the landward side of Studio Drive is collected in a concrete drainage ditch located between the ocean-ward shoulder of Highway 1 and Studio Drive. The drainage ditch trends northwest and ties into a concrete pipe that runs beneath Studio Drive, outletting on the back-beach area north of the project site.

Figure 4.3-3. Engineering Geologic Map

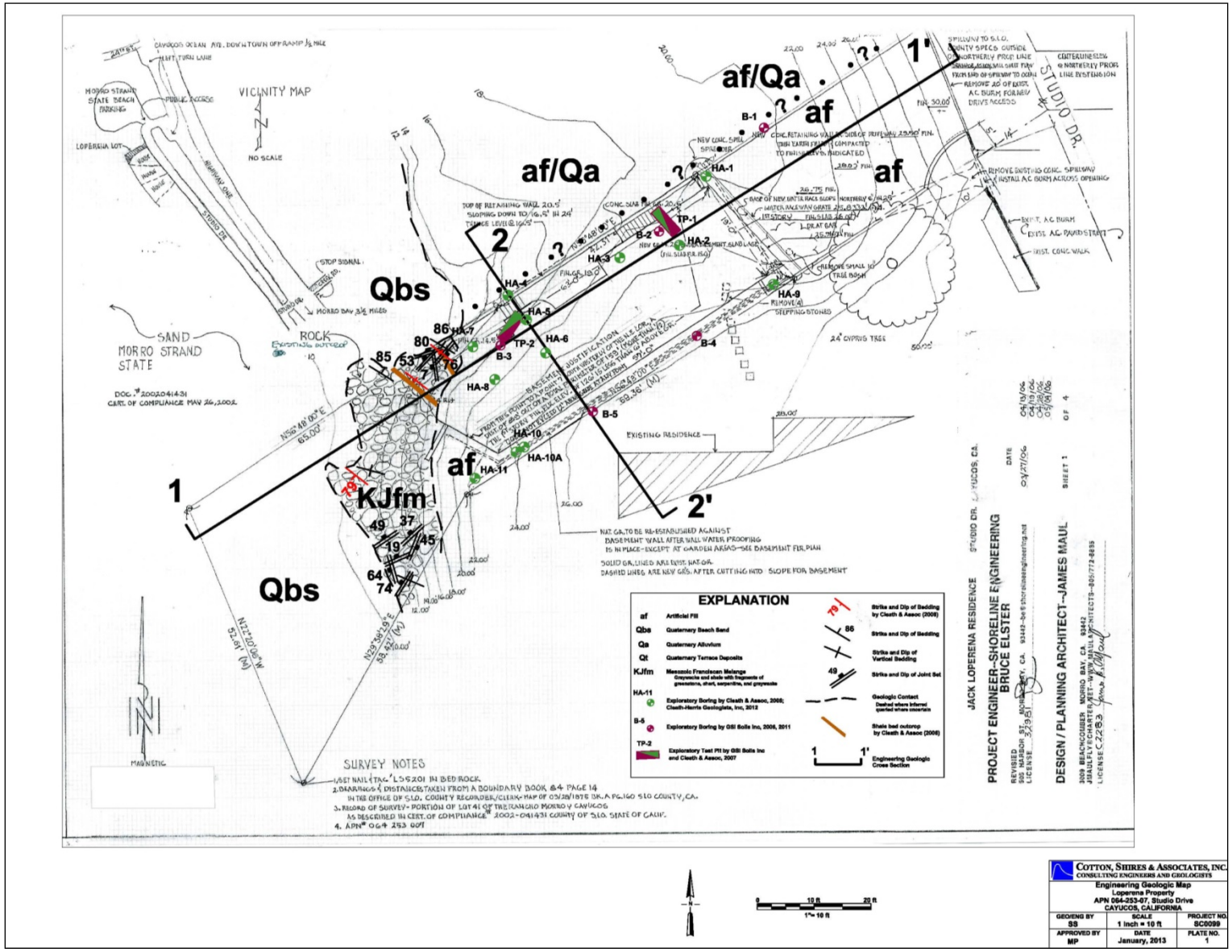

Figure 4.3-4. Engineering Geologic Cross Section 1-1'

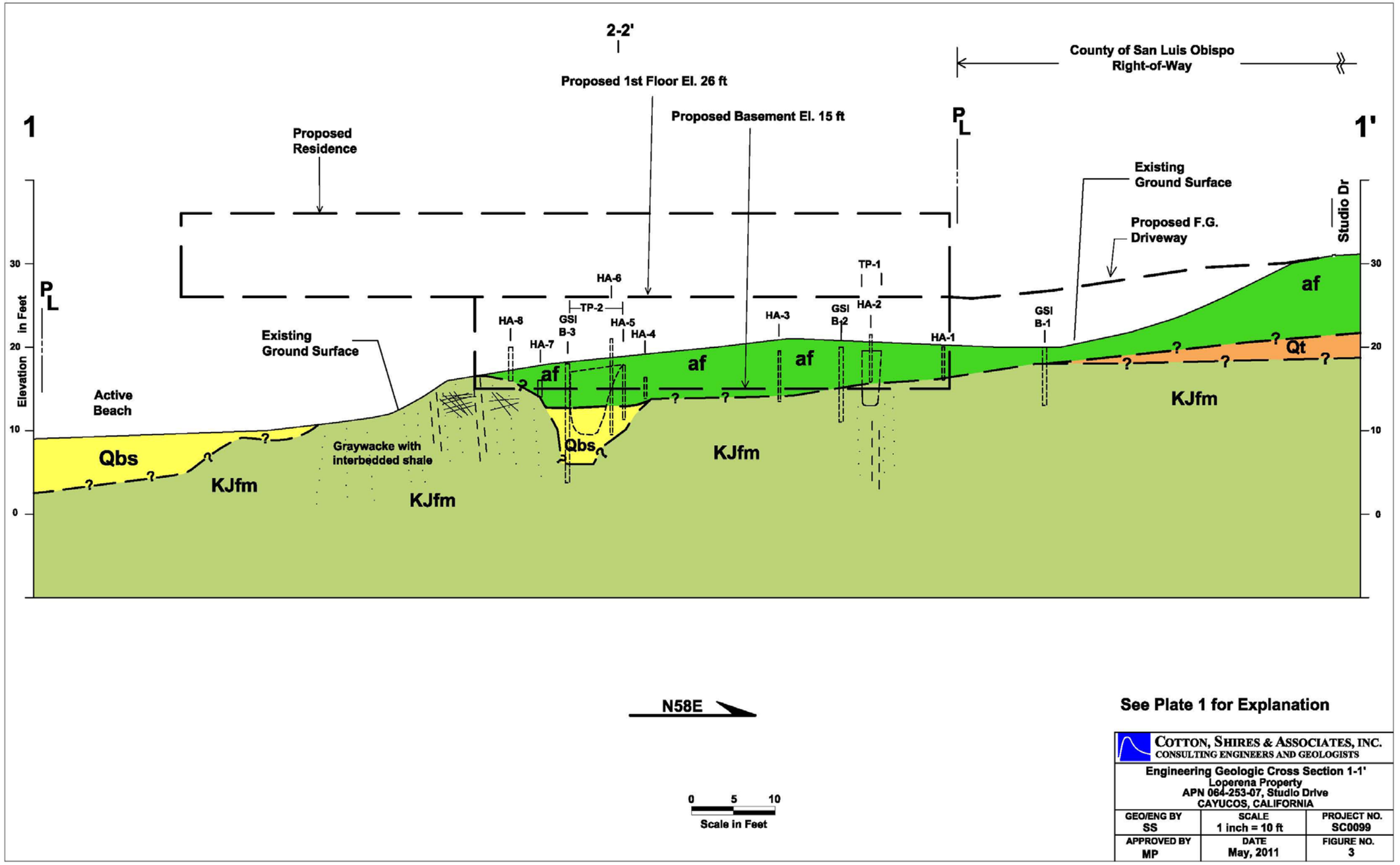

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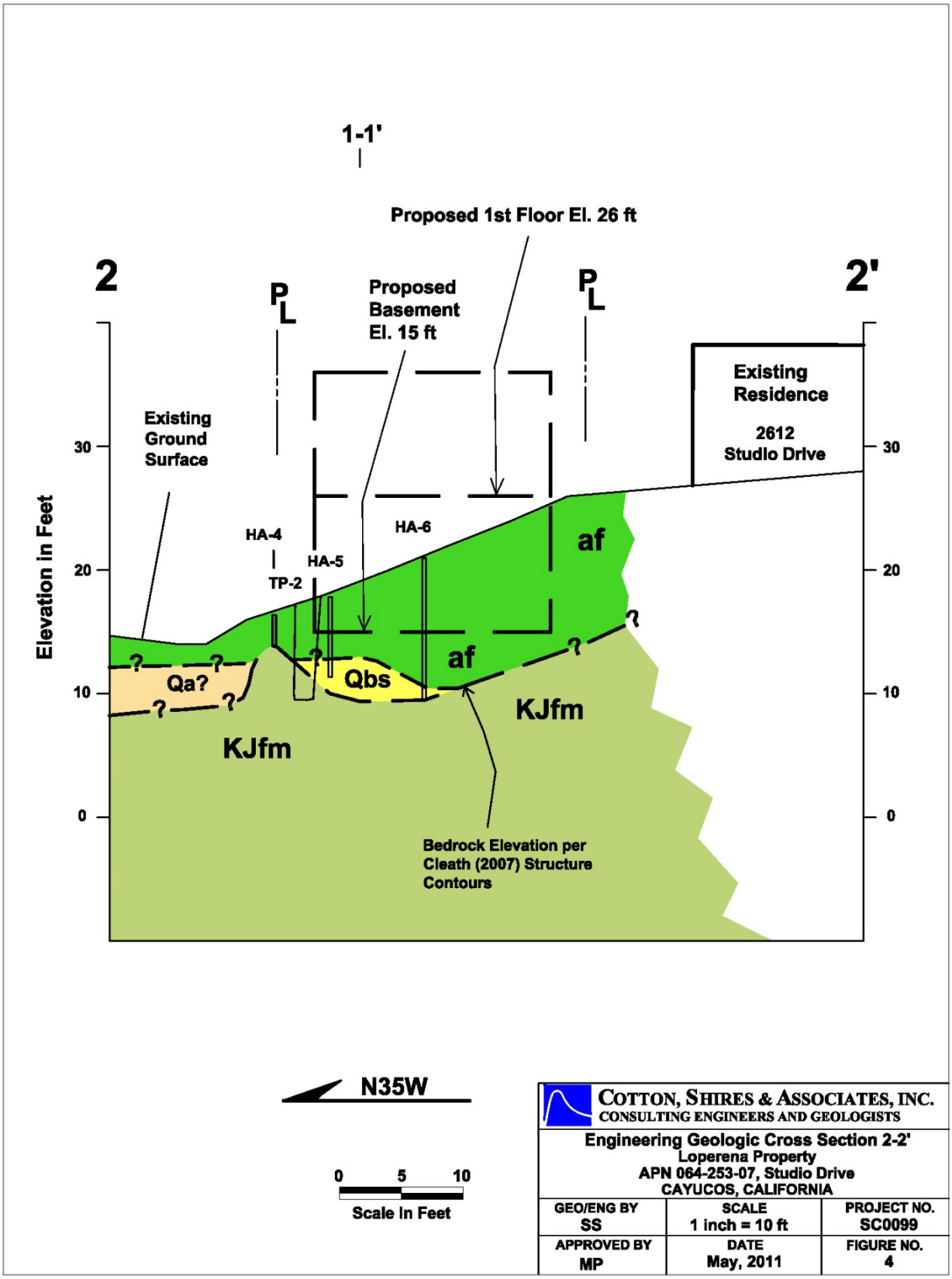
Figure 4.3-5. Engineering Geologic Cross Section 2-2'



Subsurface Conditions

Much of the landward portion of the site is underlain by one or two generations of undocumented artificial fill deposits in the near surface. These materials range in thickness from 4.5 to 10.5 feet and consist of sandy clays, clayey sands, and silty sands in a generally loose condition. Debris consisting of trash, plastic, woodchips, and roots was common in the upper 3 to 5 feet. Loose beach sand was encountered beneath the fill in Cleath Borings HA-5 and HA-6, Cleath/GSI Borings TP-2, and GSI Boring B-3 in what appears to be a narrow remnant "cove" that is open to the north (refer to Appendix C). A horizon of dense clayey sand to very stiff sandy clay was encountered beneath the fill in GSI Borings B-1 and B-2. The sandy clay horizon in B-2 is likely weathered mudstone bedrock. The clayey sand horizon in B-1 may be either a terrace deposit or weathered bedrock. Bedrock consisting of hard/indurated greywacke sandstone with thin soft shale interbeds underlies the undocumented fill and possible terrace deposits, but was barely penetrated by the subsurface exploration.

Based on borings conducted along the southern property boundary, fill materials were observed to: 4.5 feet in depth in GSI Boring B-4 (sandy clay), 5 feet in depth in GSI Boring B-5 (sandy clay), 5 feet in depth in Cleath-Harris Boring HA-9 (silt, sand, and gravel), 3 feet in Cleath-Harris Borings HA-10 and HA-10A (mostly sandy clay to clay), and 4.5 feet in depth in Cleath-Harris Boring HA-11 (sandy clay to clay). Clayey gray to dark brown angular sandstone clasts were observed beneath the fill material. These sandstones were interpreted to make up a thin, weathered, and broken veneer at the top of resistant sandstone bedrock. The depth of refusal was interpreted to be the top of or very near the top of the sandstone bedrock. In GSI Borings B-4 and B-5, 2 feet and 1.5 feet of very dense olive brown clayey sandstone (bedrock) was penetrated, respectively.

Groundwater Conditions

Groundwater was not encountered during subsurface investigations; however, perched water conditions in the upper 5 feet above dense bedrock are anticipated during wet winter months. It is anticipated that groundwater is present in the beach sand at or very slightly above sea level. Groundwater may also occur within terrace deposits, which are mapped capping bedrock along Studio Drive on a regional geologic map (Hall, et al. 1975), but which appear to pinch out at or near the site. Based on further subsurface investigation, terrace deposits were not encountered within the site (Cleath-Harris Geologists 2012).

Fluctuations in groundwater levels typically occur from variations in rainfall, irrigation, flooding, and other factors, and groundwater levels may be different at other times and locations than the exploration performed at the subject site. The most critical groundwater concerns for the project include potential perched groundwater within surficial soils capping the bedrock, and the potential for encountering groundwater in drilled shafts for the proposed pier foundations during construction.

4.3.1.3 Coastal Bluff Interpretation

Based upon review of available data and a sequence of aerial photographs dating back to 1937, from a geological perspective, the landward portion of the site sits atop or slightly straddles a bedrock remnant of a fluvial bluff that is now mostly buried by artificial fill materials. As noted above, 1937 aerial photographs show a northwest-, west-, and southwest-facing rock outcrop occupied the elevated portion of the project site, descending north to the slightly elevated alluvial plain of Old Creek, and descending west-southwest to the beach above the tidal zone. The northwest-facing portion of the rock outcrop is approximately perpendicular to

the general trend (approximately N40ºW) of the shoreline at the mouth of Old Creek. This outcropping extended inland approximately 300 feet (beneath the present alignment of Highway 1), before turning to an approximate N15ºW trend (refer to Figure 4.3-6). This feature extending 300 feet inland represents the northerly edge of a wavecut platform that is present throughout Cayucos, including both sides of the Old Creek drainage. The platform would continue north, were it not for the presence of Old Creek meeting the ocean at this location. As such, it is reasonable to conclude this portion of the outcropping was formed by fluvial erosion processes (and possibly mass-wasting processes) from the ancestral flow of Old Creek at a time when the creek was entrenched along the southerly side of the creek valley. Evidence for southerly entrenchment in the creek valley includes the massive ancient landslide 2,000 feet up-canyon that displaced the creek approximately 400 feet west—hence the southerly entrenched creek likely removed lateral support in the paleocanyon of Old Creek (i.e., during the last late-Pleistocene glacial stage when eustatic sea level was lower), triggering the landslide. Therefore, the top of the 300-foot-long outcropping, which is oriented perpendicular to the shoreline, is considered to be an inland bluff in the geomorphic sense.

The site topography and aerial photographs indicate that the ocean-ward remainder of the rock outcropping gradually curves to face west and ultimately slightly southwest at the southerly property line of the project site. The west- to southwest-facing portion of the rock outcropping, which is at about a 45º angle to the active shoreline, represents a transition between fluvial bluff-forming/erosion processes and coastal bluff-forming/erosion processes. Along this segment, fluvial processes, and possibly mass-wasting processes, were more influential in the geologic past, when the active channel of Old Creek was entrenched on the southern side of the valley, and/or when the creek was topographically lower during a lower stand of eustatic sea level. Coastal erosion processes are more prevalent today, as it is clear that wave action does reach the outcropping in storm surf conditions. This “transition” section of the rock outcropping extends south of the project site approximately 100 feet, to a point on the property at 2614 Studio Drive. Beyond this point, the landform generally trends about S47ºE and appears wholly influenced by coastal erosion processes and represents true “coastal” bluff in the geomorphic sense.

The California Code of Regulations (CCR) Title 14, Section 13577 (h)(2) is the only part of the Coastal Act that defines what a bluff edge is. The last part of this code section deals with termination of a coastal bluff line versus a canyon or inland bluff line. Specifically, the section states:

> *“The termini of the bluff line, or edge along the seaward face of the bluff, shall be defined as a point reached by bisecting the angle formed by a line coinciding with the general trend of the bluff line along the seaward face of the bluff, and a line coinciding with the general trend of the bluff line along the inland facing portion of the bluff. Five hundred feet shall be the minimum length of bluff line or edge to be used in making these determinations.”*

The 500-feet rule was inserted to ensure that a reasonable length of bluff was used to differentiate between a coastal bluff and an inland facing bluff (Mark Johnsson 2011, pers. comm.). The difficulty in applying these criteria to the project site rests with establishing the general trend of the fluvial/inland bluff along a distance of 500 feet. As noted above, the northwest-facing portion of the rock outcropping is seen in the 1937 photograph extending at least 300 feet inland from its ocean-ward end on the project site, along a trend of approximately N50ºE, which is perpendicular to the shoreline. Beyond this point the inland bluff turns to an approximate N15ºW trend following what is now Cabrillo Avenue (refer to

Figures 4.3-6 and 4.3-7). Any reasonable interpretation of a "general trend" for the inland bluff, following the Coastal Commission's guidelines (whether it be the aforementioned 300-foot segment from the ocean-ward tip of the rock outcropping, or an average trend of the first 500 lineal feet extending inland from the ocean-ward tip of the rock outcropping) will all result in a determination of the coastal bluff terminus being located southeast of the project site. In this particular case, the 300-foot segment of inland bluff is sufficient for differentiation insofar as it is perpendicular to the shoreline and is thus inland-facing.

In summary, based on our interpretation and application of the California Coastal Commission guidelines for 14 CCR 13577, the project site is not located on a coastal bluff.

Alternate Interpretation

During preparation of the Initial Study for the project, the County received correspondence including an alternate interpretation and delineation of the "coastal bluff", including the following:

- Haro, Kasunich and Associates, Inc., November 12, 2007, Review of Residential Development On Coastal Bluff and Supporting Geologic and Geotechnical Reports Prepared for Development, Loperena Property, APN 064-253-007, Lot 41, Studio Drive, Cayucos, San Luis Obispo County, California; *contained as Exhibit A in* Sinsheimer Juhnke Lebens & McIvor, LLP, April 16, 2009, Letter Re: Loperena MUP/CDP: DRC2005-00216 – Attachment to Request for Review of Proposed Amended Mitigated Negative Declaration and Notice of Determination;

- Earth Design, April 16, 2009, Letter RE: April 2, 2009 Amended Initial Study-Loperena Minor Use Permit; *contained as Exhibit C in* Sinsheimer Juhnke Lebens & McIvor, LLP, April 16, 2009, Letter Re: Loperena MUP/CDP: DRC2005-00216 – Attachment to Request for Review of Proposed Amended Mitigated Negative Declaration and Notice of Determination; and

- Haro, Kasunich and Associates, Inc., March 13, 2012, Review of Additional Documents, Residential Development on Coastal Bluff, Loperena Property, APN 064-253-007, Lot 41, Studio Drive, Cayucos, San Luis Obispo County, California; *enclosure in* Sinsheimer Juhnke McIvor & Stroh, LLP, Letter Re: Loperena Environmental Impact Report, Studio Drive, Cayucos, APN 064-253-007, ED06-317, DRC 2005-00216.

A significant underlying basis for the code and policy compliance issues cited by Haro, Kasunich and Associates, Inc. (HKA) in their 2007 and 2012 reviews, is their opinion that the project site is located on a coastal bluff. This opinion appears to be based on their interpretation of coastal bluff termini presented in Figure 1, "Coastal Bluff Line", of their 2007 and 2012 correspondence, presented on a 2007-era photograph. CSA reviewed the "Coastal Bluff Line" interpretation presented in HKA's Figure 1 (2007, 2012) and determined that HKA's interpretation is inappropriate because their "Seaward Facing Bluff Line" drawn through the project site and extending hundreds of feet north, is drawn along an artificial fill slope constructed pre-1963 for the extension of Studio Drive. Furthermore, their "Inland Bluff" is drawn along an artificial fill slope constructed across the alluvial valley of Old Creek pre-1963 for the expansion and realignment of Old Cabrillo Highway (CA-1). We believe it is inappropriate to consider that manmade features such as artificial fill prisms graded for roadway developments comprise "bluffs". An analysis to determine the terminus of a natural feature, such as a coastal bluff, should not be based upon manmade topographic features.

Furthermore, it should be clear upon review of the inland bluff feature delineated on Figures 4.3-6 and 4.3-7, that these artificial fill prisms constructed circa 1960 were not present in 1937. HKA (2007, page 1) stated that: "Where a coastal bluff curves landward to become a canyon bluff, the terminus of the coastal bluff line is the location where the seaward facing portion of the bluff turns and faces inland." This statement is consistent with CSA's coastal bluff interpretation, which is based in part on an inland bluff location that is now concealed both beneath and northeast of the property. Following the Coastal Commission's guidelines, CSA determined through analysis that the coastal bluff terminates immediately south of the project site.

CSA's detailed analysis of this topic (CSA, 2011, Section 3.4 Coastal Bluff Interpretation) is incorporated into this EIR analysis. This work included review of historic aerial photographs dating back to 1937 (see CSA, 2011, Section 2.2 Development History), and included consultation with the California Coastal Commission staff, review of their guidelines for CCR Title 14, Section 13577, and conducting an independent analysis to determine the terminus of the coastal bluff. CSA found, based on their interpretation and application of the CCC guidelines for CCR Title 14, Section 13577, that the project site is not located on a coastal bluff.

4.3.1.4 Flooding and Drainage

Flooding and Drainage

Since the completion of Whale Rock Dam and Reservoir in April 1961, the potential flood hazard on Old Creek has been substantially reduced. The dam captures water from a 20.6-square-mile watershed. Between 1961 and 1998, Whale Rock dam spilled eight times (City of San Luis Obispo 1998), but it is apparent that none of these events resulted in flood inundation at the project site. The site is located within the flood inundation zone in the event of failure of Whale Rock Dam (County of San Luis Obispo, Safety Element Dam Inundation Maps 2000); however, this factor is not a restriction to development.

The project site is not located within a 100-year flood hazard zone according to the San Luis Obispo Local Hazard Mitigation Plan (November 2005, Revision 1). Based on review of the current Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for Cayucos, the area proposed for development is located above and outside the AE/VE hazard zone. The AE zone is defined as "areas subject to inundation by the 1-percent-annual-chance flood event" and the VE zone is defined as "areas subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. Properties within the AE and VE zone are subject to flood insurance purchase requirements and floodplain management standards (FEMA 2012). On the project site, the AE/VE zone is approximately equivalent to elevation 12.92 feet NAVD88. The proposed basement finish floor elevation of 15 feet NAVD88 is approximately 2.08 feet higher than the AE/VE flood elevation.

With regard to local drainage conditions, runoff from the ocean-ward side of Studio Drive, drains down a concrete overside drain and discharges at the toe of the fill slope supporting Studio Drive. This discharge, as well as any runoff from incidental rainfall within the County right-of-way, reaches a natural drainage swale that flows around the northeast corner of the project site and ultimately discharges on the beach.

Figure 4.3-6. 1937 Aerial Photo Features

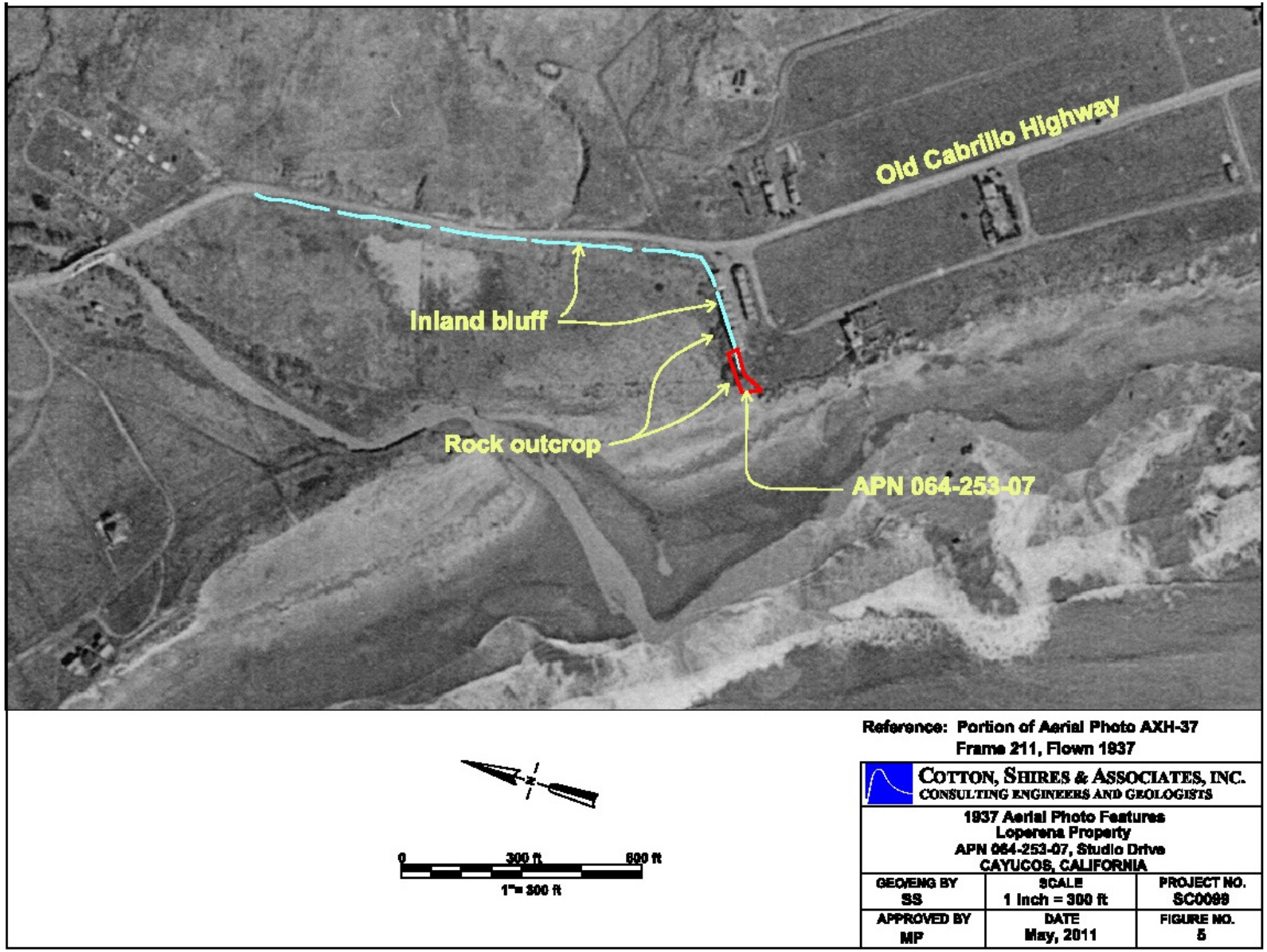
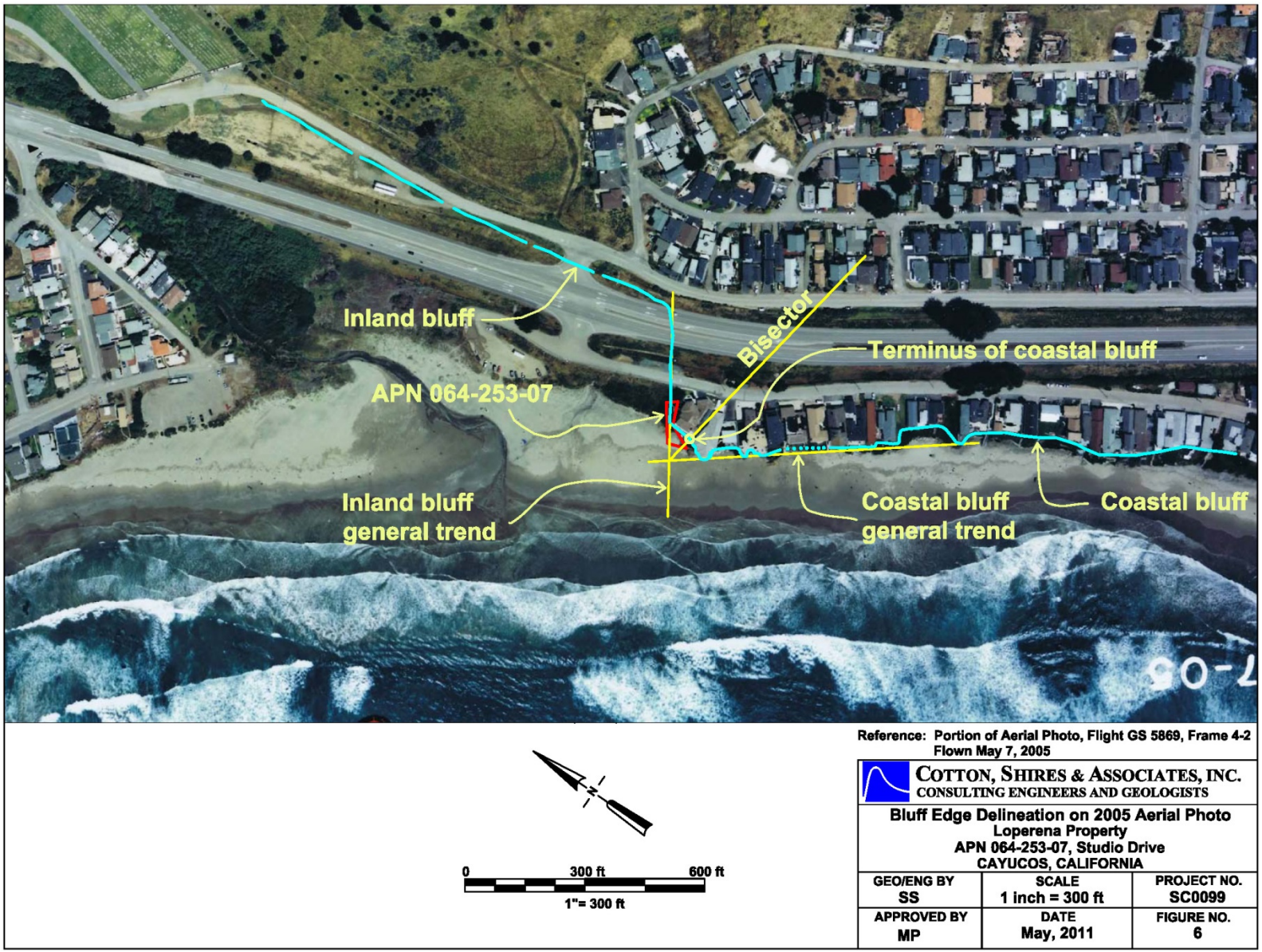


Figure 4.3-7. Bluff Edge Delineation



Coastal Hazards

The documents submitted by the project applicant that address coastal hazards for the project include reports by Cleath and Associates (2006, 2007b), and other information submitted by the applicant including Table 2, Summary of Elevations from the FEMA Flood Insurance Study for San Luis Obispo County, California (revised February 4, 2004). These documents present the following information with regard to coastal hazards:

- The greywacke sandstone outcrop forms a buttress providing protection from wave action for the landward portion of the site (Cleath and Associates 2006).

- Wave runup is expected to reach the sandstone outcrop during spring tides and high tides associated with storm surf conditions (Cleath and Associates 2006).

- A site specific study in 1981 estimated a coastal erosion rate of 0.6 in/year for the sandstone materials exposed in the outcrop (Cleath and Associates 2006).

- The 100-year and 500-year tsunami runup elevations are 9.5 feet and 24.2 feet respectively based on regional information (County of San Luis Obispo Safety Element 1998; Cleath and Associates 2006, 2007b). We presume these elevations are NGVD29, because the basis for the elevations is a study conducted in 1978.

- Cleath and Associates (2007b) indicated that a storm surge of 4.5 meters (~14.5 feet) is the design runup factor that should be used in reference to flooding and inundation standards in the County Code. Cleath-Harris Geologists (2011, pers. comm.) indicated the basis for this information was Houston and Garcia (1978) and Kilbourne and Mualchin (1980).

- The portion of the 2004 FEMA Flood Insurance Study submitted by the applicant identifies the nearest calculated wave runup elevations, at Cayucos Creek and Little Cayucos Creek, as being 11.4 feet and 20.0 feet for 100-year and 500-year events, respectively.

Following peer review of the above documents, a site-specific coastal hazards study was prepared by David W. Skelly, Professional Engineer (PE) (GeoSoils, Inc. 2011, 2013), and is included in Appendix C of this EIR. The report includes a worst-case analysis of wave runup conditions incorporating a potential sea level rise of 2.5 feet over the next 100 years. The report evaluates four different potential oceanographic hazards at the project site: shoreline erosion, flooding hazard due to water level changes in the ocean, breaking wave elevation, and wave runup.

As noted above, the elevation within the project parcel ranges from about +10 feet on the beach area to +30 feet at Studio Drive. The majority of the parcel is at or above +20 feet in elevation. The site is fronted by a bedrock outcropping (graywacke sandstone) from about elevation +17 feet NAVD88 to the beach at about elevation +10 feet NAVD88, which serves as a form of natural shore protection.

Waves and Water Levels

Waves of all periods approach the Cayucos shoreline; however, almost all of the energy is contained in the medium and long period waves (approximately 5 to +20 seconds). These waves can approach from the north, the west, and south. As waves travel into shallower and shallower water, the wave crest is bent and becomes nearly parallel to shore, and the wave heights are modified depending on whether waves are being focused or de-focused at a particular location along the shoreline. This process is called refraction and it is dependent upon the bathymetry (underwater terrain), and the wave height, period, and direction.

The California Department of Boating and Waterways in partnership with the U.S. Army Corps of Engineers (USACE) maintain wave recording buoys throughout the central California coast in the Coast Data Information Program (CDIP). The closest long term continuous wave recording buoys to the site are CDIP Buoy 076 located near Diablo Canyon and CDIP Buoy 157 at Point Sur. The record of extreme waves for this region from these buoys covers as far back as 1978 with extreme waves in excess of 35 feet and with periods in excess of 20 seconds recorded during the 1982-83 El Niño winter. The National Oceanographic and Atmospheric Administration (NOAA) National Ocean Survey (NOAA 2011) operational tidal data station closest to Cayucos is located at Port San Luis (Station 9412110). The tidal datum elevations for 1983-2001 are shown in Table 4.3-2 below.

Table 4.3-2. Tidal Datum Elevations

Tidal Description	Elevation (feet)
Highest Water January 18, 1973	7.57
Mean Higher High Water	5.25
Mean High Water	4.54
NGVD29	2.93
Mean Low Water	0.96
NAVD88	0.0
Mean Lower Low Water	-0.08

Source: GeoSoils, 2011; NOAA 2011

Oceanographic Design Parameters

There are several factors that are important to the analysis of the vulnerability of a residence along the shoreline. Some of the factors are based upon the existing topography/bathymetry and elevation of the proposed structure at the site. The site is within Estero Bay with relatively slight slopes to deep water (GeoSoils 2011). The offshore elevations range from 0.0 to approximately -60 feet NAVD88, and are relatively flat at 1/100 (vertical/horizontal). The beach fronting the site is relatively flat and the rock outcropping fronting the site rises from +10 feet to about +17 feet NAVD88 in about 15 feet horizontal distance. Other factors are based upon extreme oceanographic conditions or the coincidence of several extreme conditions. In order to determine design wave characteristics for the runup and breaking wave elevation analysis,

GeoSoils determined the design water level, which accounts for the future rise in sea level over the life of the structure (75 to 100 years).

In order to estimate sea level rise at the project location, GeoSoils considered a range of estimates identified by the California Ocean Protection Council (COPC), California Coastal Conservancy, and U.S. Army Corps of Engineers (USACE). A reasonably conservative estimate of sea level rise over the next 100 years is 2.5 feet (GeoSoils, 2013). The highest recorded water elevation on record in the vicinity of Cayucos (Port San Luis) is 7.57 feet NAVD88. This actual high water record covers the 1982-83 severe El Niño. This elevation includes all oceanographic effects (short-term) on sea level except the long-term sea level rise prediction. If 2.5 feet is added to this +7.6 feet NAVD88 elevation, the future design maximum sea level is 10.1 feet NAVD88.

The coastal hazards study identified the maximum scour depth at the toe of the outcropping, which enables determination of the actual water depth at the toe of the outcropping and breaking wave elevation under the design water level conditions. The design scour elevation is estimated based upon the erodibility of the materials at the shoreline. A conservative estimate of the scour elevation at the toe of the rock outcropping is about 3.1 feet NAVD88. This is reasonable based upon the visual presence of bedrock at the back shore area. Using the maximum still water elevation and the maximum scour of 3.1 feet NAVD88 yields a total water depth of about 7.0 feet at the eroded beach toe (the rock outcropping). This represents the worst possible wave runup conditions reaching the site over the next 100 years.

Waves from distant storms have pounded the coastline of Cayucos several times within the last few centuries. However, these extreme waves break further offshore and lose a significant portion of their energy before they reach the shoreline. Once a wave reaches a water depth that is about 1.28 times the wave height, the wave breaks and runs up onto the shore. The design wave height is the maximum unbroken wave at the toe of the rock outcropping. The total water depth would be 7.0 feet, which would yield a design wave height of about 5.5 feet.

As waves approach the shoreline and the site, they break and water rushes up the rock outcropping, and towards the proposed development. Wave runup is defined as the vertical height above the still water level to which a wave will rise on a structure (the rock outcropping) of infinite height. Overtopping is the flow rate of water over the crest of the outcropping (about elevation +17 feet NAVD88) as a result of wave runup. Wave runup and overtopping for an extreme tsunami event is calculated using the USACE Automated Coastal Engineering System (ACES). The overtopping estimates provided in the coastal hazards study are corrected for the effect of onshore winds (refer to Appendix C). The wave, wind, and water level data used as input to the wave runup and overtopping application will be the extreme wave height of 5.5 feet, a period of 18 seconds, with the water level at highest recorded water level, corrected for future sea level rise.

There are three different potential oceanographic hazards identified at this site: shoreline erosion, flooding, and waves.

Erosion Hazard

In an effort to determine typical changes in the shoreline position, aerial photographs from the early 1970s to 2010 were reviewed. Due to the hard rock nature of the shoreline material, there has been very little erosion or retreat of the shoreline over the last four decades. In 2006, the USGS prepared the National Assessment of Shoreline Change Part 3: Historical Shoreline

Change and Associated Coastal Land Loss along Sandy Shorelines of the California Coast, which concluded that the shoreline in front of this site was relatively stable over the long term.

The HKA 2007 and 2012 letters cite USGS Open-File Report 2007-1133 and state that it indicates that cliff retreat rates in the vicinity of the proposed project site are 0.5 to 0.9 feet per year. HKA opines that the site is subject to coastal erosion. Review of cliff retreat rates vs. distance along shore presented in Figure 27 of USGS OFR 2007-1133 indicates that, at a minimum, the scale at which the cliff retreat data is presented does not allow for interpretation of a cliff retreat rate over the extremely narrow (25 feet) width of the site. Furthermore, CSA determined through analysis that the project site is not located on a coastal bluff; rather, the property is situated atop a bedrock remnant of the inland bluff adjacent to the mouth of Old Creek. The property is clearly set back significantly landward of the general trend of the coastal bluff, which terminates immediately southeast of the subject property. In terms of the cliff retreat rate cited, this was likely determined at properties south of the subject property that actually are situated atop a coastal bluff. The topic of coastal erosion hazard, including the effects of sea level rise is addressed in the EIR analysis.

Flooding Hazard

The flooding hazard discussed in this specific section is due to water level changes in the ocean. The primary hazard due to flooding from ocean waters would be due to a super-elevation of the ocean (storm surge). The NOAA National Ocean Survey (NOAA 2011) operational tidal data station closest to Cayucos is located at Port San Luis (Station 9412110). As noted above, the future design maximum sea level is 10.1 feet NAVD88. This would be considered in excess of a 100-year recurrence interval water level.

Wave Runup

Wave runup may reach elevation +15 feet NAVD88 over the next 100 years under infrequent, extreme design oceanographic conditions. Wave runup will actually be a pulse of water and not a continuous or sustained flow over time. An extreme tsunami may also reach this elevation.

4.3.2 Regulatory Setting

4.3.2.1 Federal and State Regulations

The Alquist-Priolo Earthquake Fault Zoning Act was developed by the State to regulate development near active faults and mitigate the surface fault rupture potential and other hazards. The Act identifies active earthquake fault zones and restricts building habitable structures over known active or potentially active faults.

Water quality protection is regulated by the Federal National Pollutant Discharge Elimination System (NPDES) Program established by the Clean Water Act. The EPA establishes stormwater permit requirements based on compliance with a NPDES permit. Discharges of stormwater associated with construction activity that results in a disturbance of one acre or more of total land area requires a NPDES General Permit for Discharges of Stormwater Associated with Construction Activity. This permit requires developers to implement best management practices (BMPs) to prevent the discharge of sediment-laden or otherwise contaminated water offsite. The site-specific plan to implement BMPs is called the Stormwater Pollution Prevention Plan (SWPPP). The plan must include a description of soil stabilization and sediment load control methods that would be implemented to minimize erosion and sediment loading during construction of the project. The SWPPP also includes descriptions of

post-construction BMPs. The State administers stormwater permits through the SWRCB and its local RWQCB (Central Coast Region). The proposed project would disturb less than one acre; therefore a SWPPP will not be required.

4.3.2.2 Local Regulations

County of San Luis Obispo Estero Area Plan

Shoreline development standards in the Estero Area Plan include the following (Areawide Standard I-4):

> ***Bluff Setbacks**. The bluff setback is to be determined by the engineering geology analysis required in I.1.a. above adequate to withstand bluff erosion and wave action for a period of 100 years. In no case shall bluff setbacks be less than 25 feet. Alteration or additions to existing development that is non-conforming with respect to bluff setbacks that equals or exceeds 50 percent of the size of the existing structure, on a cumulative basis beginning July 10, 2008, shall not be authorized unless the entire structure is brought into conformance with this setback requirement and all other policies and standards of the Local Coastal Plan. On parcels with legally established shoreline protective devices, the setback distance may account for the additional stability provided by the permitted seawall, based on its existing design, condition, and routine repair and maintenance that maintain the seawall's approved design life. Expansion and/or other alteration to the seawall shall not be factored into setback calculations.*

As noted above, the project site is not located on a coastal bluff.

In the event the artificial fill material was considered to be a coastal bluff, the 25-foot setback line would be located approximately 40 feet from the northeast property line (along Studio Drive) leaving approximately 1,000 square feet for development (not including the driveway within County road right-of-way). The footprint of the proposed structure including the basement would extend beyond this point by approximately 28 feet. The intent of the bluff setback is to ensure that a proposed structure could withstand erosion for a minimum timeframe of 100 years without shoreline protection. As proposed, the project would not require shoreline protection, meeting the intent of the measure.

County of San Luis Obispo Coastal Zone Land Use Ordinance

Specific CZLUO sections pertaining to Geology, Soils, and Drainage are described below. The project would be required to comply with these sections.

Blufftop Setbacks

Section 23.04.118 of the CZLUO requires that new development or expansion of existing uses on blufftops be designed and set back from the bluff edge a distance sufficient to assure stability and structural integrity and to withstand bluff erosion and wave action for a period of 75 years without construction of shoreline protection structures that would, in the opinion of the Planning Director, require substantial alterations to the natural landforms along bluffs and cliffs. A site stability evaluation report shall be prepared and submitted by a certified engineering geologist based upon an onsite evaluation that indicates that the bluff setback is adequate to allow for bluff erosion over the 75 year period according to County established

standards. This language is superseded by the Estero Area Plan, Shoreline Development standard. As noted above, the project site is not located on a coastal bluff.

In the event the artificial fill was considered to be a coastal bluff, the project as proposed would not meet the setbacks identified in the CZLUO and Estero Area Plan, and a Variance would be considered pursuant to Section 23.01.045 of the CZLUO. Approval of a Variance requires adoption of the following findings, which could be supported by the EIR analysis and existing supportive evidence in the record:

(i) The variance authorized does not constitute a grant of special privileges inconsistent with the limitations upon other properties in the vicinity and land use category in which such property is situation; and

(ii) There are special circumstances applicable to the property, related only to size, shape, topography, location, or surroundings, and because of these circumstances, the strict application of this title would deprive the property of privileges enjoyed by other property in the vicinity that is in the same land use category; and

(iii) The variance does not authorize a use that is not otherwise authorized in the land use category; and

(iv) The variance is consistent with the provisions of the Local Coastal Program; and

(v) The granting of such application does not, under the circumstances and conditions applied in the particular case, adversely affect public health or safety, is not materially detrimental to the public welfare, nor injurious to nearby property or improvements.

Grading Standards

Sections 23.05.022 through 23.05.039 of the CZLUO establish standards for grading and excavation activities to minimize hazards to life and property; protect against erosion and the sedimentation of watercourses; and protect the safety, use, and stability of public rights-of-way and drainage channels. Additional standards for grading within a Sensitive Resource Area (SRA) are in § 23.07.160 et seq. The project site is not located within a SRA.

Erosion and Sedimentation Control Plan

Section 23.05.036 of the CZLUO addresses methods to minimize erosion and sedimentation impacts. When required, the plan is prepared by a civil engineer to address both temporary and long-term impacts.

Drainage Control

Section 23.05.040 et seq., of the CZLUO contains the County's standards for the control of drainage and drainage facilities to minimize the harmful effects of storm water runoff and to protect neighboring and downstream properties from drainage problems resulting from new development. These standards include:

- Requirements pertaining to the design and construction of drainage systems;
- Requirements pertaining to the maintenance of offsite natural drainage patterns;
- Requirements pertaining to location of development in the coastal area; and,
- Restrictions on development in areas subject to flood hazards.

4.3.3 Thresholds of Significance

The County thresholds of significance are based on the criteria set forth in Appendix G of the CEQA Guidelines. According to those criteria, a project would result in a significant geology, soils, or drainage-related impact if it would:

1. Result in exposure to or production of unstable earth conditions, such as landslides, earthquakes, liquefaction, ground failure, land subsidence or other similar hazards.

2. Be within a California Geological Survey "Alquist-Priolo" Earthquake Fault Zone.

3. Result in soil erosion, topographic changes, loss of topsoil or unstable soil conditions from project-related improvements, such as vegetation removal, grading, excavation or fill.

4. Change rates of soil absorption, or amount or direction of surface runoff.

5. Include structures located on expansive soils.

6. Change the drainage patterns where substantial on- or offsite sedimentation/erosion or flooding may occur.

7. Involve activities within the 100-year flood zone.

8. Be inconsistent with the goals and policies of the County's Safety Element relating to Geologic and Seismic Hazards.

9. Preclude the future extraction of valuable mineral resources.

4.3.4 Impact Assessment and Methodology

Potential geologic, soils, and drainage impacts were evaluated based upon review of project plans, a peer review of the engineering geologic and geotechnical engineering reports prepared by the applicant's consultants, an independent technical report prepared by Cotton, Shires and Associates, a coastal hazards and wave runup study prepared by GeoSoils, Inc. and field review of the project site.

4.3.5 Project-specific Impacts and Mitigation Measures

4.3.5.1 Exposure to or Production of Unstable Earth Conditions

Seismic ground shaking associated with a large earthquake on one of several nearby and regional faults (the Oceanic, Hosgri, Los Osos, and San Luis Range faults) is considered to be a high potential hazard for the project area. Peak ground accelerations up to 0.35g could potentially affect structures at the site in the future. The project site was positioned on the USGS Seismic Hazard Maps for a 2% probability of exceedance in 50 years to determine the maximum considered earthquake spectral response accelerations. The Code-required design acceleration coefficients for short periods (SDS) and at one-second (SD1) would be 0.980g and 0.491g, respectively; therefore, a site class C is recommended for structure design (GSI Soils, Inc. 2011).

Mitigation of seismic hazards due to strong ground motion is addressed through proper structural design in accordance with the applicable building codes (presently the 2009

International Building Code [IBC] and 2010 California Building Code [CBC] documents related to Earthquake Loads) at the time of building permit application. Seismically-induced ground failure mechanisms include: landsliding, liquefaction, lurching, differential compaction, lateral spreading, and dry sand settlement.

Landslides

The central coast region of California has not yet been mapped by the California Geological Survey under the Seismic Hazards Mapping Act program. No landslides have been mapped or found on the property. A large earthflow landslide terminates approximately 400 feet northeast of the site across Highway 1. The landslide and the project site are separated by over 400 feet of very low gradient topography that is overall flatter than 15:1 (horizontal:vertical). Significant portions of that horizontal distance are nearly level (e.g., the width of Highway 1). Consequently the potential for risk of landslides adversely impacting the site is considered to be low. Potential impacts related to landslides are *less than significant* (Class III), and no mitigation measures are necessary.

Earthquakes

As noted in Section 4.3.1.1 Existing Conditions, Regional Setting, Geologic Setting, fault systems are present in the region; however, no known active faults trend through the property. No topographic anomalies in the area are suggestive of faulting, and the potential for surface faulting and ground rupture at the site to be low. Therefore, potential impacts would be *less than significant* (Class III), and no mitigation measures beyond compliance with the CBC are necessary.

Earthquake-Induced Landsliding

The only significant slope that would exist at the site upon completion of the project is the fill slope descending from Studio Drive to the property; however, the plans indicate this slope will be filled over and supported by retaining walls; hence we consider the potential for seismically-induced landsliding to be low. Therefore, potential impacts would be *less than significant* (Class III), and no mitigation measures are necessary.

Liquefaction

Soil liquefaction is a phenomenon in which a saturated, cohesionless, near-surface soil layer loses strength during cyclic loading (such as typically generated by earthquakes). During the loss of strength, the soil acquires "mobility" sufficient to permit both horizontal and vertical ground movements. Soils that are most susceptible to liquefaction are clean, loose, saturated, uniformly graded, fine-grained sands that are generally located within 50 feet depth beneath the ground surface. Gravels with similar characteristics and non-plastic clays and silts have also been shown to be susceptible to liquefaction. Based on the potential presence of perched water conditions during wet winter months in the upper 5 feet of soils above the dense bedrock materials, the current potential for liquefaction is moderate to high.

This potentially significant impact can be successfully addressed and mitigated via implementation of typical geotechnical recommendations for site processing, grading, and/or foundation design. Therefore, the resulting liquefaction potential at the project site would be low, and would generally result in minor to cosmetic damage to the proposed structure, and total settlements would be approximately 0.5 inch (GSI Soils, Inc. 2012). This amount of settlement is considered tolerable for the proposed project, and is indicative of liquefaction in

the negligible category. Therefore, potential impacts can be mitigated to a *less than significant* level (Class II).

GS Impact 1 **The proposed residence would be exposed to the effects of liquefaction during a ground-shaking event.**

GS/mm-1 *Prior to issuance of a construction permit, the applicant shall submit grading and construction plans, which incorporate the recommendations identified in the Engineering Evaluation (Shoreline Engineering 2012) and Updated Geotechnical Investigation (GSI Soils, Inc.) dated December 27, 2011, specifically the recommendations identified in Section 5.2 – Preparation of the Building Pad, Section 5.3 – Structural Fill, Section 5.4 – Drilled Piers, Section 5.5 – Conventional Deepened Foundation, Section 5.6 – Slab Construction, and Section 5.9 – Surface and Subsurface Drainage.*

Residual Impact

In addition to compliance with existing building regulations identified in the CBC and County Ordinance, the applicant would comply with recommendations identified in the project-specific geotechnical report. Therefore, potential long-term impacts related to liquefaction hazard would be mitigated to a *less than significant* level (Class II).

Ground Lurching and Differential Compaction

The potential for lurching and differential compaction (densification) of the existing undocumented fill is considered to be high due to the generally loose nature of the soil. This potential impact can be mitigated by removal and/or removal and backfilling as structural fill (GSI Soils, Inc. 2011). Based on compliance with these project-specific recommendations, potential impacts can be mitigated to *less than significant* (Class II).

GS Impact 2 **The proposed residence would be exposed to the effects of ground lurching and differential compaction during a ground-shaking event.**

GS/mm-2 *Prior to issuance of a construction permit, the applicant shall submit grading and construction plans, which incorporate the recommendations identified in the Updated Geotechnical Investigation (GSI Soils, Inc.) dated December 27, 2011, and specifically the following:*

a. *All surface and subsurface deleterious materials shall be removed from the proposed building area and disposed of offsite. This includes, but is not limited to, any buried utility lines, loose fills, debris, building materials, and any other surface and subsurface structures.*

b. *Voids left from site clearing shall be cleaned and backfilled as recommended for structural fill.*

c. *Once the site has been cleared, the exposed ground surface shall be stripped to remove surface vegetation and organic soil.*

Residual Impact

In addition to compliance with existing building regulations identified in the CBC and County Ordinance, the applicant would comply with recommendations identified in the project-specific geotechnical report. Therefore, potential impacts related to ground lurching and differential compaction would be mitigated to a *less than significant* level (Class II).

Lateral Spreading

Conditions that typically induce lateral spreading include liquefaction of a subsurface layer or layers of soil, and site topography that contains an open topographic face which exposes the soil profile overlying the liquefiable layer(s). Both conditions potentially exist at the site but require further review by the project applicant's consultants. Based on the proposed foundation design, site grading, and confined condition of the sands near the center of the building pad, the potential for lateral spreading displacements would be negligible (GSI Soils, Inc. 2011). Therefore, based on the design of the project, potential impacts would be *less than significant* (Class III), and no mitigation beyond compliance with the CBC is necessary.

Dry Sand Settlement

Due to the limited depth of sand (approximately 6 feet) within the building pad area, dry settlements of these sands during seismic ground shaking is expected to be less than 0.5 inch. With the proposed grading, these settlements are anticipated to be less than 0.25 inch (GSI Soils, Inc. 2011). Therefore, potential impacts would be *less than significant* (Class III), and no mitigation beyond compliance with the CBC is necessary.

Land Subsidence

Land subsidence occurs when large amounts of groundwater have been excessively withdrawn from an aquifer. Water supply in Cayucos is provided by the Whale Rock Reservoir and Nacimiento Water Project. There is no identified Level of Severity for water supply in the Cayucos area (County of San Luis Obispo 2012), and the project site is not located within a designated groundwater basin. There is no evidence of land subsidence on or in the vicinity of the project site, and implementation of the project would not create a demand for water supply that would result in land subsidence. Therefore, no significant impact would occur.

4.3.5.2 "Alquist-Priolo" Earthquake Fault Zone

The project site is not located within an Alquist-Priolo Earthquake Fault Zone as defined by maps prepared by the California Geological Survey. Therefore, no significant impact would occur.

4.3.5.3 Soil Erosion, Topographic Changes, Loss of Topsoil, and Instability

Soil Erosion

Short Term. Implementation of the project will require grading and removal of sand, soil, and vegetation. Grading activities would disturb approximately 3,000 square feet of the 3,445-square-foot parcel, including 400 cubic yards of cut (foundation) and 150 cubic yards of fill (driveway). The average depth of cut would be 5 feet (minimum 1 foot, maximum 12 feet). Approximately 250 cubic yards of soil would be exported offsite. During construction, exposed soils may result in erosion during rain events, or wave runup. Compliance with the County CZLUO and implementation of project-specific erosion-control measures are necessary to retain soils onsite and avoid down-gradient sedimentation into the Pacific Ocean. Based on

compliance with existing regulations, and recommended mitigation measures, potential short-term impacts would be mitigated to a *less than significant* level (Class II).

GS Impact 3 Grading and excavation required for the construction of the project would result in significant, short-term, adverse impacts related to erosion and down-gradient sedimentation.

Implement BIO/mm-4, BIO/mm-5, and BIO/mm-6.

Residual Impact

In addition to compliance with the CZLUO, the applicant would comply with recommendations identified in the project-specific geotechnical report and mitigation specific to ground disturbance and onsite erosion control. Therefore, potential impacts related to erosion would be mitigated to a *less than significant* level (Class II).

Long Term. In the long term, the project would not create any changes that would result in significant soil erosion. The proposed drainage plan includes stormwater diffusers to slow down runoff during rain events and minimize the potential for storm-related beach erosion. Therefore, potential long-term impacts would be *less than significant* (Class III), and no mitigation beyond compliance with existing regulations is necessary. Long-term erosion related to sea level rise and wave runup is discussed below under Coastal Hazards.

Slope Stability

Short Term. Construction cuts for basement retaining walls may exceed 12 feet in depth on the south and east sides of the proposed residence. The potential for instability of temporary (construction) slopes is a significant concern, and there is a moderate to high potential for temporary slope instability impacting the project site and the adjacent property. To address this issue, the applicant proposes to retain temporary slopes with a shoring system consisting of soldier piles and steel plate lagging. The shoring system would be removed following permanent stabilization of the slope. Based on implementation of this strategy, and compliance with the recommendations presented in the *Updated Geotechnical Investigation* (GSI Soils, Inc. 2011), potential short-term impacts would be *less than significant* (Class II).

GS Impact 4 The creation of steep cut slopes during site preparation and grading associated with construction of the proposed residence would result in short-term slope instability.

GS/mm-3 *Prior to issuance of a construction permit, the applicant shall submit grading and construction plans, which incorporate the following: recommendations for slope stability identified in the Updated Geotechnical Investigation (GSI Soils, Inc.), dated December 27, 2011, specifically the recommendations identified in Section 5.10 – Temporary Excavations and Slopes; and Shoring Detail prepared by Shoreline Engineering (January 2012, updated September 20, 2012). Plans shall demonstrate how construction would be conducted such that no activity would compromise the neighboring structure. Construction of all site preparation and shoring activities shall be monitored by the project Engineer of Record, and daily monitoring reports shall be prepared and submitted to the County Department of Planning and Building on a weekly basis.*

Residual Impact

In addition to compliance with existing building regulations identified in the CBC and County Ordinance, the applicant would comply with recommendations identified in the project-specific geotechnical report. Therefore, potential short-term slope stability impacts would be mitigated to a *less than significant* level (Class II).

Long Term. Construction of the proposed driveway will result in structural fill placement against the existing 2:1 gradient fill slope of Studio Drive, with the fill being supported by retaining walls. Upon completion of the project, no significant slopes will exist that could pose a slope instability hazard to the property. Significant scour of beach sand due to heavy surf may temporarily create a steep bedrock slope ocean-ward of the existing bedrock outcropping. Provided the proposed residence is constructed on deepened pier foundations as proposed, temporary beach scour should not pose a slope instability hazard to the residence.

GS Impact 5 **Beach sand scour caused by heavy surf may periodically and temporarily create unstable slopes adjacent to the proposed residence.**

GS/mm-4 *Prior to issuance of a construction permit, the applicant shall submit grading and construction plans, which include the use of deepened pier foundations identified in the Engineering Evaluation (Shoreline Engineering, Inc.), dated January 2012, and Updated Geotechnical Investigation (GSI Soils, Inc.), dated December 27, 2011, specifically the recommendations identified in Section 5.2 – Preparation of Building Pad, Section 5.4 – Drilled Piers, and Section 5.5 – Conventional Deepened Foundation.*

Residual Impact

In addition to compliance with existing building regulations identified in the CBC and County Ordinance, the applicant would comply with recommendations identified in the project-specific geotechnical report. Therefore, potential long-term slope stability impacts would be mitigated to a *less than significant* level (Class II).

4.3.5.4 Change Rates of Soil Absorption or Runoff

As noted above, the project includes a drainage plan that would replace the existing County drain pipe with a new stormwater system. This system would change the direction of surface runoff from the street onto the beach, but would not be significantly different than the current situation. The project would create additional area of impervious surface, and includes a rain barrel and stormwater management system, consistent with the County's regulations and policies for Low Impact Development (LID). Based on the location, size, and design of the project, it would not significantly change the rates of soil absorption or amount and direction of surface runoff. Therefore, potential impacts would be *less than significant* (Class III), and no mitigation beyond compliance with existing regulations is necessary.

4.3.5.5 Expansive Soils

A single expansion index test was conducted by GSI Soils, Inc. (2007) on a sandy clay sample from Boring B-2 at 6 feet. The reported expansion index was 92, which indicates a high expansion potential. The material in B-2 at this depth is likely weathered mudstone bedrock. Based on the geotechnical report, onsite sand soils free of organic and deleterious material are suitable for use as non-structural fill below the select fill cap. Structural fill using onsite

inorganic soil or approved imported soil should be placed in layers, conditioned, and compacted, pursuant to engineer's specifications. Therefore, potentially significant impacts related to expansive soil can be mitigated to *less than significant* (Class II).

GS Impact 6 **The proposed residence would be constructed on soils with a high expansion potential, resulting in a potentially significant long-term impact.**

GS/mm-5 *Prior to issuance of a construction permit, the applicant shall submit grading and construction plans, which incorporate the recommendations identified in the Updated Geotechnical Investigation (GSI Soils, Inc.), dated December 27, 2011, specifically the recommendations identified in Section 5.1 – Clearing and Stripping, Section 5.2 – Preparation of Building Pad, and Section 5.3 – Structural Fill.*

Residual Impact

In addition to compliance with existing building regulations identified in the CBC and County Ordinance, the applicant would comply with recommendations identified in the project-specific geotechnical report. Therefore, potential long-term impacts related to expansive soil would be mitigated to a *less than significant* level (Class II).

4.3.5.6 Drainage-related Sedimentation/Erosion or Flooding

The applicant's proposed site drainage improvements would convey both Studio Drive runoff and driveway runoff to a drainage exit structure, which would outlet into a natural drainage swale. The natural drainage channel consists of highly erodible sands, and erosion in the channel has been accelerated by foot traffic from people accessing Morro Strand State Beach from Studio Drive. The swale would incorporate bollard style energy dissipators and a gravel/cobble invert, which are intended to reduce stormwater flow velocity and erosion potential. Rainfall from the residence roof is proposed to be collected by a roof gutter system and held in a cistern for gray water use and landscape irrigation.

Construction of the proposed impermeable concrete driveway would result in an increase in surface runoff onsite, which increases the potential for erosion in the natural drainage swale. This impact can be mitigated through appropriate civil engineering drainage design. CZLUO §23.05.050 requires a Drainage Plan for development located on a site adjacent to any coastal bluff, or if the project may change the offsite drainage pattern. Based on the location of the project on the beach-side of Studio Drive, and proposed changes to the existing stormwater system, a Drainage Plan would be required, which would be based on the preliminary drainage plan summarized above. The proposed project would not result in substantial onsite or offsite flooding, because stormwater would continue to flow west towards the Pacific Ocean (similar to existing conditions, which do not result in flooding), and would be filtered and dissipated by the proposed system. Based on review of the preliminary drainage plan, compliance with the CZLUO, and incorporation of mitigation identified below, potential long-term impacts would be mitigated to a *less than significant* level (Class II).

GS Impact 7 **The proposed stormwater drainage plan may result in erosion down-gradient of the proposed drain outlet.**

GS/mm-6 *Prior to issuance of grading and construction permits, the applicant shall submit a drainage plan for review and approval by the County Department*

of Public Works. The drainage plan shall be coordinated with the sedimentation and erosion control plan, be consistent with CZLUO §23.050.036 and 040, and specifically include engineered energy dissipators and controls that would limit peak runoff to pre-development levels.

Residual Impact

In addition to compliance with the County Ordinance, the applicant would comply with recommendations identified in the project-specific geotechnical report and mitigation identified above. Therefore, potential long-term impacts related to drainage would be mitigated to a *less than significant* level (Class II).

4.3.5.7 100-year Flood Zone

The project site is not located within a 100-year flood hazard zone, and the area proposed for development is located above and outside the AE/VE hazard zone which has a 100-year flood elevation of 10 feet (NGVD29), which is approximately equivalent to elevation 12.92 feet NAVD88. The proposed basement finish floor elevation of 15 feet NAVD88 is approximately 2.08 feet higher than the AE/VE flood elevation. Therefore, no significant impact would occur.

4.3.5.8 County's Safety Element Consistency

Applicable geology and soils-related goals and policies identified in the County's Safety Element include the following:

> ***Geologic and Seismic Hazards, Goal S-5:*** *Minimize the potential for loss of life and property resulting from geologic and seismic hazards.*

Based on compliance with the CBC, County Code, and incorporation of recommendations identified in the *Updated Geotechnical Investigation* (GSI Soils, Inc.), dated December 27, 2011, and *Engineering Evaluation* (Shoreline Engineering), dated January 2012, the project would be consistent with this goal.

> ***Geologic and Seismic Hazards, Policy S-21:*** *Slope Instability. The County acknowledges that areas of known landslide activity are generally not suitable for residential development. The County will avoid development in areas of known slope instability or high landslide risk when possible, and continue to encourage that developments on sloping ground use design and construction techniques appropriate for those areas.*

The project site is not located within an area of high landslide risk; however, short-term slope instability may occur during construction. Based on incorporation of recommendations identified in the *Updated Geotechnical Investigation* and *Engineering Evaluation*, which include use of a temporary shoring system to stabilize cut slopes during excavation and construction, the project would be consistent with this policy.

> ***Geology and Seismic Hazards, Policy S-23:*** *Coastal Bluffs. Development shall not be permitted near the top of eroding coastal bluffs.*

The project site is unique in that the underlying geology consists of a fluvial bluff, which has been buried under artificial fill. The Technical Analysis (Cotton Shires and Associates 2011), which is included in Appendix C (Geology and Soils Background Information) and incorporated

by reference in this EIR section, included an assessment of potential coastal erosion hazards, and did not identify any significant adverse effects or safety hazards related to coastal erosion. Therefore, the project is consistent with the intent of this policy.

> ***Geology and Seismic Hazards, Program S-63:*** *Require coastal bluff erosion studies to determine the rate or erosion and the resulting safe distance from the top of the bluff for development, in accordance with the LCP.*

Preparation of the EIR included a comprehensive analysis of potential erosion hazards, both short- and long-term. Based on the analysis, the project would not result in a safety issue related to erosion, thus meeting the intention of this Program.

> ***Geologic and Seismic Hazards, Implementation Measures, Standard S-56:*** *For developments in areas of known slope instability, landslides, or slopes steeper than 20 percent, the stability of slopes shall be addressed by registered professionals practicing in their respective fields of expertise.*

The applicant submitted technical reports and plans completed by registered engineers, and independently peer reviewed during the EIR analysis, consistent with this implementation measure.

> ***Geologic and Seismic Hazards, Implementation Measures, Standard S-59:*** *Development proposals will be required to mitigate the impacts that their projects contribute to landslides and slope instability hazards on neighboring property, and appurtenant structures, utilities, and roads; such as emergency ingress and egress to the property, and loss of water, power or other lifeline facilities.*

Based on incorporation of recommendations identified in the *Updated Geotechnical Investigation* and *Engineering Evaluation,* which include use of a temporary shoring system to stabilize cut slopes during excavation and construction, the project would be consistent with this implementation measure and would not destabilize areas adjacent to Studio Drive and the neighboring developed property to the south.

> ***Geologic and Seismic Hazards, Implementation Measures, Standard S-60:*** *Enforce current building code requirements and applicable ordinances and sections of the General Plan that pertain to development on sloping ground.*

The County requires compliance with the CBC, Estero Area LUE and LCP, and CZLUO, consistent with this implementation measure. Based on the technical reports peer reviewed and incorporated by reference into this EIR analysis, the project would be consistent with the Safety Element, and no significant impacts would occur.

4.3.5.9 Valuable Mineral Resources

The project site is not located in an area designated for mineral extraction, and no valuable minerals are known to occur onsite. Therefore, no significant impacts would occur.

4.3.5.10 Coastal Hazards

The potential coastal hazards associated with the proposed residential development include shoreline erosion, wave runup, and coastal flooding.

Erosion Hazard

The shoreline in front of the subject property has been relatively stable over the long term (USGS 2006). On the basis of the USGS study, aerial photograph review spanning 39 years, the elevation of the proposed development, and the presence of hard rock material between the shoreline and the proposed residence:

- there has been very little erosion or retreat of the shoreline over the last four decades;
- a 2.5-foot rise in sea level will likely not result in a significant impact on the erosion rate or the proposed residence; and,
- there is no potential significant marine erosion hazard at the site over the next 100 years.

Therefore, the potential for significant erosion due to sea level rise would not be significant in this location.

Oceanographic Flooding Hazard

The primary hazard due to flooding from ocean waters is storm surge. The highest recorded water elevation on record in the vicinity of Cayucos (Port San Luis) is 7.57 feet NAVD88 and includes all oceanographic effects on sea level except for long-term sea level rise predictions (NOAA 2011). Incorporating a potential sea level rise of 2.5 feet in the next 100 years, the future design maximum sea level would be 10.1 feet NAVD88, which is considered to be in excess of a 100-year recurrence interval water level. The proposed residence would be located at and above an elevation of 15.0 feet NAVD88; therefore, the site would not be adversely affected by flooding from the ocean over the next 100 years.

Breaking Wave Elevation

The project incorporates a cantilevered design. The proposed first floor would be located at elevation +26 feet NAVD88, and will extend a significant distance ocean-ward beyond the basement floor; therefore, the Coastal Hazards and Wave Runup report (GeoSoils, Inc. 2011, 2012) evaluated the potential maximum breaking wave crest elevation. The breaking wave elevation analysis calculated that the maximum wave crest elevation at the project site is approximately +14.5 feet NAVD88, which is well below the proposed cantilevered first floor elevation of +26 feet NAVD88. Therefore, the cantilevered portion of the structure would not be adversely affected by breaking wave forces.

Wave Runup Hazard

A wave runup analysis was performed under extreme (worst-case) design oceanographic conditions including storm surge, sea level rise of 2.5 feet over the next 100 years, and scour of the beach in front of the rock outcropping down to elevation 3.1 feet NAVD88, utilizing a design wave height of 5.5 feet. In this worst-case scenario, the maximum wave runup would be at elevation +22.7 feet NAVD88, and may reach the basement of the proposed residence at +15.0 feet NAVD88 over the next 100 years (GeoSoils, Inc. 2011). However, the runup is characterized as a pulse of water reaching the basement wall rather than a continuous or sustained flow over time. Based on calculations, the depth of the water overtopping the rock outcrop and reaching the residence would be approximately 0.14 foot deep. The runup analysis indicates that the velocity of the wave runup bore will not be sufficient to cause damage to the structure, assuming the basement wall is constructed of steel-reinforced

concrete; however, the structure will be subject to spray and splash from wave runup striking the rock outcropping. The rock outcropping at its average elevation of 17 feet NAVD88 would be overtopped by the design wave (5.5 feet) at a rate of about 0.27 cubic feet/second-feet. Based on this low height of water (0.14 foot) and relatively low velocity, the proposed project would not be adversely affected. In addition, based the initial low velocity, and reduction in wave height and velocity following potential contact with the proposed basement wall, any wave refraction would not adversely affect the adjacent property.

In addition to wave runup, the analysis considered exposure to tsunami. Based upon review of historical data and tsunami forecast modeling by the University of Southern California Tsunami Research Center, a 6.5-foot-high tsunami wave occurring at the project site would be a 500-year recurrence interval event. The wave runup analysis used a design wave height of 5.5 feet, which also represents a suitable site-specific tsunami runup at the site.

As proposed, the basement would be located at elevation 15 feet NAVD88, and basement concrete would be reinforced with steel; therefore, wave runup will not adversely impact the proposed residence over the next 100 years. An extreme tsunami may reach as high as the basement, but, for the reasons stated above, a tsunami will not adversely impact the residence. Based on the analysis presented above, and incorporated by reference from the coastal hazards and wave runup analysis report (GeoSoils, Inc. 2011, 2012), no significant impacts related to coastal hazards, including sea level rise, shoreline erosion, wave runup, and coastal flooding would occur, and the proposed residence would neither create nor contribute to erosion, geologic instability, or destruction of the site or adjacent area.

4.3.6 Cumulative Impacts

Implementation of the pending and approved projects listed in the cumulative development scenario would increase development in the immediate area. No projects requiring grading or construction would occur in the immediate vicinity of the project, and no existing adverse geologic or drainage conditions are present on or adjacent to the project site.

Additional development, including the proposed project, would increase the number of people and structures exposed to a variety of geologic and soils hazards within the County, including liquefaction, ground shaking, and temporary exposure to sea level rise and storm surge. Potential impacts related to geologic, soils, and seismic hazards are all site-specific, and mitigation measures are applied to each project to minimize the potential for significant geologic impacts. All development projects are required to comply with State and local regulations regarding grading and construction; therefore, no cumulative impacts related to these issues have been identified. Implementation of mitigation measures identified above, and compliance with existing regulations would mitigate impacts to *less than significant* (Class III), and no additional measures are necessary.