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GEOLOGICAL REPORT

FOR

40.050 ACRE REMAINDER TRACT IN RANCHO CORRAL DE TIERRA MONTEREY COUNTY, CALIFORNIA

August 16, 1999

Ref No.: 4112-01

Prepared For:

Newsome Construction and Development

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EXECUTIVE SUMMARY

The proposed project involves the minor subdivision of one 40.050 acre parcel into four lots.

The geologic material underlying the subject property has the potential for slope failure. Some of the slopes on the subject property appear to have failed in the past and it is possible that some of the slopes on the property might fail in the future. It is therefore extremely important to maintain adequate setbacks from any steep slopes on the property.

The subject property lies in a highly seismically active region. Although no active faults are known to cross the property, there are several major faults in the region, with the nearest active or potentially active fault, the Tularcitos, approximately two miles from the subject property. The Tularcitos fault has the potential capacity to produce a maximum credible earthquake (MCL) of Magnitude 6.75. The nearby San Andreas, King City-Reliz, and Palo Colorado-San Gregorio faults have the potential of producing a Magnitude 7.5 earthquake in the next fifty years that will probably generate moderate to severe ground shaking at the property.

Probable ground motion parameters at the site in the event of a large magnitude earthquake on the San Andreas fault are:

1) Median Peak Horizontal Ground Acceleration: 0.15 g
2) Duration of strong ground shaking: 16 to 30 seconds

No evidence of past liquefaction, lateral spreading, differential settling, or "ridgetop shattering" was observed on the subject properties. The potential flooding hazard at the property is low.

It is critical that a detailed, thorough geotechnical investigation be performed prior to the design or construction of any buildings. An adequate setback (50 feet minimum) should be maintained from the steep breaks in slope below any building sites. Any building must have a well-designed, site-specific, engineered foundation. Such a foundation is also crucial to surviving the strong shaking or settling that could be generated at the subject property during a large-magnitude earthquake and related ground movement.

INTRODUCTION

This report presents the findings, conclusions, and recommendations of a geological investigation for the above named site in Monterey County, California. The geologic report is designed to conform with guidelines of the California Division of Mines and Geology. This report is applicable only to the intended project site.

PURPOSE

The purpose of the geological investigation is to:

1. Evaluate the general geologic conditions at the proposed site by reviewing existing available published and unpublished geologic maps and studies performed by the United States Geological Survey, California Division of Mines and Geology, Monterey County Planning and Building Inspection Department, Monterey County Water Resources Agency and other reports and aerial photographs made available.

2. Identify geologic factors which could affect proposed land use.

METHOD AND SCOPE OF INVESTIGATION

The geologic investigation consisted of:

1. Review and compilation of available geologic data. The primary sources of geologic data for this report are Rosenberg (1993) and Dupré (1990).

2. Review of available aerial photographs of the site.

3. A field investigation of the site.

4. Preparation of report. This report was prepared to document the findings, conclusions and recommendations based upon the existing data.

PROJECT SITE AND TOPOGRAPHY

The property under study is located in Rancho Corral de Tierra in Monterey County (Figure 1). Access to the property is accessible from Los Laureles Grade road via a brief section of shared, private, paved road leading to a private unpaved road. The applicant proposes to subdivide the lot under study from the existing 40.050 acre parcel into four parcels.

The property is located on the northwest-facing slope of a ridge trending northeast-southwest. The property is bordered at the northeast corner by Los Laureles Grade road, approximately 1000 feet south of the summit of the road, and extends to the southwest along the upper slopes of the ridge. Below the property lines of the subject property, the slopes continue down to Coyote Gulch, which drains the slopes of the subject property in addition to slopes on several ridges to the north. An ephemeral stream runs through the bottom of Coyote Gulch.

Much of the property is covered with trees and shrubs, but some grassy areas are present on some of the upper slopes. As of the writing of this report, no structures were present on the subject property.

According to the Tentative Parcel Map prepared in 1999 by Salinas Valley Surveyors, of Salinas, California, elevations on the property range between approximately 1,050 and 1,375 feet above mean sea level.

The steepness of the slopes on the property ranges from fairly steep to very gentle. On the upper elevations of the property, slopes are fairly gentle. Slopes become abruptly steeper downslope on some areas of the property where the gentle upper slopes give way to steep-sided ravines.

Drainage on the property consists of surface runoff and subsurface flow and is controlled by topography and earth materials. In general, the slopes on the property drain in a northwesterly direction, down towards the ephemeral creek in Coyote Gulch. Portions of the proposed Lot 1 may drain in a northeasterly direction, towards Calera Canyon. Portions of the proposed Lot 3 may drain in a southerly direction, down into Juan de Matte Canyon. Ultimately, all of these canyons and gulches drain into the Carmel River. Regional drainage is towards the Carmel River to the south and west of the property.

The steep-sided ravines on the proposed Lots 3 and 4 may serve to concentrate runoff as it moves downslope into the ephemeral creek in Coyote Gulch. So long as these ravines are allowed to drain unimpeded, we do not anticipate any hazard to the property from water draining down these ravines, aside from the normal surficial erosion that results from the flow of concentrated water. Maintaining adequate vegetative cover will help minimize this potential problem. Drainage on proposed Lot 4 is especially critical, as abundant ferns were observed on this property, which suggests a relatively elevated water table. No manmade drainage improvements were visible on the property.

GEOLOGIC SETTING

Regional Geology

The subject property is located in the Sierra de Salinas, situated in the central section of the larger Coast Range geomorphic and geologic province. Tectonically, the Sierra de Salinas lies in a portion of the Coast Range known as the Salinian Block. The Salinian Block consists of Cenozoic age sedimentary rocks overlying older metamorphic and igneous rocks. The overall structural grain of the Salinian Block is oriented northwest-southeast. The Sierra de Salinas lies between the Salinas Valley to the north and Carmel Valley and the Santa Lucia Range to the south. Large and small scale faults and folds are characteristic of the Salinian Block.

Local Geology

The subject property is underlain by the Miocene age Monterey Shale formation. This formation consists of light gray to light brown, moderately to well-indurated, moderately to intensely fractured, moderately to intensely weathered siliceous and diatomaceous shale (Rosenberg, 1993).

According to Dibblee (1999), the subject property lies near the southern end of an anticlinal fold, with proposed Lot 3 straddling the hingeline of the fold, and proposed Lots 1 and 2 on the eastern limb and proposed Lot 4 on the western limb (Figure 2). The orientation of the fold axis on the subject property is approximately north-northwest/south-southeast. Where the fold axis extends beyond the subject property to the north, it curves steadily towards the west, eventually becoming oriented east-west and dipping in the direction of Carmel-by-the-Sea. Mapped bedding attitudes on the subject property are shallow, dipping five to seven degrees in a northerly direction and striking slightly south of west (Dibblee, 1999). Dibblee (1999) did not map any faults on the subject property.

Based on our investigation, we believe there may be evidence of past slope failures on the subject property. Dupré (1990) mapped a large, questionable landslide, mostly to the north and west of the subject property, but extending onto portions of proposed Lots 2, 3, and 4 (Figure 5). Dibblee (1999) mapped a less areally extensive version of this landslide, which does not extend onto the subject property. However, examination of the aerial photographs revealed possible evidence of some smaller, surficial landslides within the large, questionable landslide mapped by Dupré (1999). Some of these possible smaller landslides may extend onto proposed Lots 1, 2, and 3.

Both Dibblee (1999) and Dupré (1990) mapped a landslide on the eastern side of the ridge along Laureles Grade road, where a portion of the ridgeline is oriented roughly parallel to the road. The edge of this landslide lies quite close to the subject property, and the landslide may extend onto the subject property, into the far southeastern corner of proposed Lot 2.

Structural Geology

The Sierra de Salinas lies within the geologic and tectonic unit called the Salinian Block. The Salinian Block is an elongate, northwest trending segment of the Coast Ranges, bounded to the northeast and southwest by the San Andreas and San Gregorio-Sur Nacimiento fault zones, respectively (Greene, 1977). The Salinian Block is characterized by a basement of Paleozoic high grade metamorphic rocks and Cretaceous granitic rocks. Overlying these rocks is a sequence of dominantly marine sediments of Paleocene to Miocene age and nonmarine sediments of Pliocene to Pleistocene age (Page, 1970; Greene, 1977). The faults that partition the Salinian Block (see Figure 4), have generally been active throughout the latter third of the Cenozoic Era (approximately 15 million years ago to the present). Although these faults are, in general, part of a right lateral strike-slip fault system, they have also controlled the relative vertical movements between smaller structural blocks within the larger Salinian Block. The relative differences in vertical displacement between the smaller blocks have, in turn, controlled patterns of sediment accumulation for the late Tertiary and Quaternary sediments. The down-dropped basement blocks produced structural basins in which a relatively thick, and in some cases complete, Tertiary sequence accumulated. The upthrown basement blocks produced structural highs in which the Tertiary and Quaternary sedimentary deposits are thin or nonexistent.

Tectonic History

The faults that partition the Salinian Block, along with the San Andreas fault and its eastern branches, form a broad system of inter-related right lateral strike-slip faults that have dominated the tectonic history of western California since the middle of the Miocene Epoch (approximately 15 million years ago). Western California's system of right lateral strike-slip faults represents a segment of the boundary between the Pacific and North American crustal plates. For roughly the past 15 million years, the Pacific Plate has been slipping towards the northwest with respect to the North American Plate (Atwater, 1970; Graham, 1978). This movement is accommodated by right lateral strike-slip faulting. In California, most of the movement has been taken up by the San Andreas fault system, which has been more or less continuously active since the Mid-Miocene. However, the other faults in this broad system have also experienced right lateral slip, although the movement on any individual fault has been limited in duration and magnitude compared to the San Andreas fault. Several strike-slip faults cut the Salinian Block, some of which were active in the past and are now inactive, while others probably began slipping later and remain active today. In summary, the composite faulting history of this seismically active region has been extremely complicated.

REGIONAL SEISMICITY

California and the Monterey Area Coast Ranges have been subjected to considerable earthquake activity. The most severe historical earthquakes in the vicinity of the project site were the 8.3 Magnitude 1906 San Francisco event (USGS Prof. Paper 993, 1978), the 6.1 Magnitude 1926 Monterey Bay Earthquake (McCrory, 1977), and the 7.1 Magnitude 1989 Loma Prieta event (Plafker and Galloway, 1989). Although California's broad system of strike-slip faults has a complex history, only some of the fault traces present a seismic hazard to the proposed project. Consequently, the project area could experience seismic activity of various magnitudes emanating from one or more of the numerous faults or fault systems within the region. Active faults are those faults having experienced movement within the last 11,000 years(the Holocene period). Active faults may have the greatest potential for disturbance. Potentially active faults have had movement between 11,000 and 3,000,000 years ago (the Pleistocene period) and have had no movement within the last 11,000 years. Inactive faults have had no movement within the last three million years. The major faults are the San Andreas fault, the Monterey Bay fault zone and its onland extensions that include the Tularcitos-Navy fault, the Chupines fault, the King City-Reliz fault, the Palo Colorado-San Gregorio fault zone and the Zayante-Vergeles fault (Figure 3). These faults are either active or considered potentially active (Buchanan-Bank and others, 1978; Bullis, 1980; Jennings, 1975; Greene, 1977; Hall and others, 1974; Burkland and Associates, 1975). Each of the faults is discussed below.

Faults at The Proposed Project Site

Review of published maps (Dibblee, 1999; Greene, 1973) indicates that no faults have been mapped on the subject property. The nearest mapped fault is the Chupines fault, over three quarters of a mile to the north and east (Figure 4). The Chupines fault and other nearby faults are discussed individually in the sections that follow.

Aerial Photograph Examination for Faults at The Proposed Project Site

Seven sets of aerial photographs from 1949 through 1997 were examined for evidence of past faulting on the subject property. No evidence for past faulting was observed in any of the photographs.

San Andreas Fault

The San Andreas fault typically represents the major seismic hazard in California (Jennings, 1975; Buchanan-Banks and others, 1978). This fault system has experienced right lateral slip movement throughout the later part of the Cenozoic Era (the last 15 million years), and is currently considered very active. The San Andreas fault is divided into a series of individual segments, each having a characteristic earthquake magnitude, recurrence interval, and slip rate (Sykes & Nishenko, 1984; Lindh, 1983; Hall, 1984; Wesnousky, 1987; U.S. Geological Survey, 1988). There appear to be "characteristic" earthquakes associated with each segment of the fault, and each segment can be expected to experience an earthquake similar in size to others that have historically occurred along the same segment. The portion of the San Andreas fault closest to the property is the Creeping Section, located between Pajaro Gap near San Juan Bautista and Parkfield (Sykes & Nishenko, 1984; U.S. Geological Survey, 1988). This segment is characterized by a high fault slip rate (>3 mm per year) (Wallace, 1990) and persistent microseismic activity. Slightly further away is the Southern Santa Cruz Mountains Segment, which extends from San Jose to Pajaro Gap.

The average time between large magnitude earthquake events is referred to as recurrence time. The average recurrence time between earthquakes on the North Coast, San Francisco Peninsula and Southern Santa Cruz Mountains segments is summarized in Table 1. The average expected recurrence time is directly related to the magnitude of the "characteristic earthquake". The longer the average expected recurrence time, the larger the magnitude of the characteristic earthquake. The characteristic earthquake for the Creeping Segment, the portion of the San Andreas Fault System closest to the property, is a Magnitude 6.0. A Magnitude 6.5 is the characteristic earthquake for the Southern Santa Cruz Mountains Segment.

TABLE 1
SAN ANDREAS FAULTS
RECURRENCE TIMES AND CONDITIONAL PROBABILITIES OF EARTHQUAKES
From USGS Working Group, 1990

Fault Segment	Date of Most Recent Event	Expected Magnitude	Expected Recurrence Interval	Level Of Conditional Reliability	Level of Reliability (A) being most)
North Coast	1906	8	201-281	0.02	B
San Francisco Peninsula	1906	7	128-188	0.23	C
Southern Santa Cruz Mountains	1989*	7	84-100	0.01	B
Creeping Segment	1966	6	20-30	0.30	A

The probability of a large (Magnitude 7.0 or greater) earthquake occurring on the various segments of the San Andreas fault has been estimated using a time dependent increase in earthquake probability model (Plafker and Galloway, 1989; Lindh, 1983; Sykes and Nishenko, 1984; U.S. Geological Survey, 1988; Nishenko, 1989). This model is based upon the assumption that the potential for a large earthquake on a segment is initially small following a large earthquake and increases as a function of time. Prior to the 1989 Loma Prieta Earthquake, the U.S. Geological Survey (1988) predicted a 20 percent probability of a Magnitude 7.0 earthquake occurring on the San Francisco Peninsula segment and a 30 percent probability of a 6.5 Magnitude earthquake on the Southern Santa Cruz Mountains subsegment between 1988 and 2018. The recent 1989 Loma Prieta Earthquake probably relieved some stress along the portion between San Juan Bautista and San Jose. Because some stress has been released along this portion of the fault, it is considered likely that the probability of an additional large magnitude earthquake (Magnitude greater than 6.5) in the next 30 years along this segment has been considerably reduced. The probability of a large magnitude earthquake on the North Coast segment of the San Andreas fault, however, has most likely increased. The effect of the Loma Prieta earthquake on the Creeping Section is not known. The previous discussion applies only to large magnitude earthquakes capable of rupturing the entire fault segment. Small magnitude earthquakes can occur more frequently.

The maximum credible earthquake (MCE) is the largest magnitude earthquake a fault can generate within the presently understood tectonic environment, and is typically higher than the maximum probable earthquake (MPE). The likelihood of a Magnitude 8.0 (MCE) occurring on the San Francisco segment or the Southern Santa Cruz Mountain subsegment is considered very low (U.S. Geological Survey, 1988; U.S. Geological Survey, 1990). The foregoing data suggests the project area should incorporate into the planning a large Magnitude earthquake (7.5) along the Southern Santa Cruz Mountains segment of the San Andreas fault during the next fifty years. The data also suggests an extreme event of Magnitude 8.0 or higher is unlikely within the next fifty years.

The inexact science of probabilistic modeling of large magnitude earthquakes is currently being researched, analyzed and modified. The probabilities listed in the report and summarized in Table 1 are based on data collected prior to and since the Loma Prieta Earthquake. This event reduced the likelihood of seismic activity on the Southern Santa Cruz Mountains while increasing the likelihood of earthquakes on other segments.

Palo Colorado-San Gregorio Fault

The main trace of the Palo Colorado-San Gregorio fault (hereafter referred to as the San Gregorio fault) is located offshore about eleven and a half miles southwest of the proposed project. This fault is oriented sub-parallel to the San Andreas fault and stratigraphic offsets across the fault demonstrate right lateral strike-slip motion. The San Gregorio fault is considered highly active. Throughout its length, the San Gregorio fault zone shows stratigraphic evidence of late Pleistocene to Holocene displacement (Clark, et. al., 1984; Weber, et. al., 1979, Buchanan-Banks, et. al., 1978; Graham and Dickenson, 1978; Weber and LaJoie, 1974). In addition, historic seismic activity in the Monterey Bay region may also be attributed to the San Gregorio fault (Greene, 1977; Mitchell, 1928). Hamilton and others (1979) present data showing an average net slip through Neogene time (225 to 1.8 MYBP) of about 0.1 cm/year. They conclude this slow slip rate, with respect to the 1.4 cm/year slip rate on the San Andreas fault, indicates the San Gregorio fault is not the primary structural element of the translational plate boundary. They further conclude the San Andreas fault represents the principal plate boundary.

Greene (1977) uses an empirical relationship between fault half length and potential earthquake magnitude to suggest the San Gregorio fault zone is capable of Magnitude 7.2-7.9 earthquake activity. Weber and Cotton (1981) present evidence suggesting the recurrence interval for earthquakes producing ground rupture within the San Gregorio fault system is 6000 years or less. Wesnousky (1986) suggests the recurrence interval of a Magnitude 7.7 earthquake on the San Gregorio fault is about 824 years.

Tuttle (1985) studied seismicity patterns along the San Gregorio fault and noted that certain segments exhibited abnormally low seismic activity. He concluded that the segments from Santa Cruz to San Francisco, and from Monterey to Ragged Point, represented seismic gaps, which he theorized were capable of generating earthquakes of Magnitude 7.2 to 7.4. Tuttle (1985) also observed that the number of Magnitude 4 to 6 earthquakes increased during the twenty year periods preceding the 1926 Monterey Bay (M6.1) and the 1952 Bryson (M6.0) earthquakes.

Rosenberg (1993) noted that four recent earthquakes (Magnitudes 4.6 to 5.2) associated with the southern end of the Ragged Point segment occurred between 1984 and 1991. According to Rosenberg(1993), if Tuttle (1985) is correct in his hypothesis, a Magnitude 6 or larger earthquake is likely in the next decade. Plafker and Galloway (1989) noted a similar pattern of seismicity on the San Andreas fault before the 1989 Loma Prieta earthquake.

Monterey Bay Fault Zone and its Onland Extension

The Monterey Bay fault zone is six to nine miles wide and about twenty-five miles long. The marine portion of the fault zone consists of many en echelon faults identified using seismic reflections surveys (Greene, 1977). The largest earthquakes tentatively located on the Monterey Bay fault zone are two events measuring 6.1 on the Richter Scale in October 1926 (Greene, 1977). These events may have actually occurred on the nearby Palo Colorado-San Gregorio fault system (Greene, 1977). Another earthquake of Modified Mercalli Scale intensity of VII occurred in 1890 and could be attributed to the Monterey Bay fault zone (Burkland and Associates, 1975). The fault zone intersects the coast in the vicinity of Seaside and Fort Ord. At this point, several onshore fault traces have been tentatively correlated with offshore traces in the heart of the Monterey Bay fault zone (Greene, 1977; Clark and others, 1974; Burkland and Assoc., 1975). The Tularcitos, Monterey Bay, and Navy faults all lie along strike within the Salinian Block and are thought to form one continuous zone of faulting (McKittrick, 1987). If the Tularcitos-Navy fault continues into Monterey Bay and joins the southernmost of the relatively continuous offshore faults, total length would be greater than twenty-six miles, (Greene, 1990).

Whereas outcrop evidence indicates a variety of strike-slip and dip-slip movement associated with both onshore and offshore fault traces, earthquake studies suggest the Monterey Bay fault zone is predominately right lateral strike-slip in character (Greene, 1977; Dibblee, 1966). Several of the pertinent onshore faults are, from west to east, the Tularcitos, the Navy, the Chupines, and the King City-Reliz faults. These fault traces are much less active than the San Andreas and Palo Colorado fault zones. Based on this evidence, there is low probability that the onshore equivalent of the Monterey Bay fault zone will generate a large magnitude earthquake in the next fifty years.

Navy Fault

The Navy fault has been mapped from near the Naval Postgraduate School in Monterey southeast to Carmel Valley Road. Although the fault was not mapped across the Carmel River alluvium, it is postulated that because of the alignment of the Tularcitos fault with the Navy fault, they are the same fault. The Tularcitos fault has been mapped from Carmel Road (roughly two miles southeast of the end of the Navy fault) continuing southeast approximately eleven miles to the Jamesburg area.

The Navy fault juxtaposes younger Pleistocene Paso Robles Formation with the older Monterey Formation and displays geomorphic evidence suggestive of late Pleistocene or Holocene displacement (Clark and Others, 1974). McKittrick (1987) mapped the onland extensions of the Monterey Bay fault zone and did not extend the Navy fault to meet Carmel Valley Road. The Navy fault is considered active because it experienced at least one small earthquake (maximum 2.5 M) in historic time (Greene, 1977). The Navy fault trends south-eastward from Monterey Bay and is thought to be an extension of the Monterey Bay fault zone (Clark and others, 1974). An offset marine terrace represents the youngest Quaternary unit offset by the Navy fault and has an estimated age of approximately 320,000 years (McKittrick, 1987). Dupré (1990) has mapped a structural thrust or possible splay of the Navy fault in an alluvial stream channel.

Tularcitos Fault

The activity of the Tularcitos fault is uncertain. The Tularcitos fault has been variously described by researchers as potentially or possibly active (Rogers Johnson, 1987; Geomatrix report, 1985).

The Tularcitos fault is actually a zone, about a mile and a half wide, composed of several discontinuous, steeply dipping segments. Several locations along the fault zone suggest the possibility of late Pleistocene or early Holocene movement (McKittrick, 1987; Kingsley Associates, 1988; Rosenberg, 1993), but further study is needed to evaluate these possibilities. In several locations there is evidence to suggest that such movement has not occurred, including one where Pleistocene terrace deposits have clearly not been offset (Thorup, 1988). Clark and others (1974) suggest that the Tularcitos fault zone is not active. The Tularcitos fault proper is about 22 km long, and there are possible connections to the Navy and Monterey Bay fault zone making a total length of 42 km. The rupture length of one-half the total fault length is 21 km (Geomatrix, 1987). The median peak horizontal ground acceleration values associated with the postulated MCE of 6.75 is about 0.65 g (Geomatrix, 1985).

Laureles Fault

The Laureles fault is described as a northwest-striking, vertical fault separating Cretaceous, granitic rock and steeply dipping Miocene Marine sandstone. The fault is 6.5 km long and estimates of vertical displacement range from 180 to 300 meters (Rosenberg, 1993). The fault is approximately 2 (Greene et al., 1973; Dibblee, 1999) miles southwest of the subject property (Figure 4).

Cypress Point Fault

The Cypress Point fault is a northwest-trending, southwest dipping reverse fault. The Cypress Point fault is capable of generating smaller earthquakes, with less frequency than the San Andreas or Palo Colorado-San Gregorio fault zones. The oblique-slip Cypress Point fault has been traced over four miles onland, and may extend northwestward beneath Monterey Bay (Clark, et. al., 1974). The submerged segment may represent the southwestern-most boundary of the Monterey Bay Fault Zone (Greene, 1977). Several small earthquake epicenters are located in the vicinity of the Cypress Point fault (Greene, 1977). Most of these earthquakes occurred during an earthquake swarm between December, 1975, and February, 1976, (Coppersmith and Griggs, 1978). The activity of the Cypress Point fault is equivocal. The onland portion of the fault near Fan Shell Beach does not offset the contact between Quaternary marine terrace deposits and granodiorite (Buchanan-Banks and others, 1978; Clark, 1974). Offshore to the northwest along the trace of the Cypress Point fault, a fault offsets geologic units of Pleistocene Age (700,000-10,000 years b.p.) (Buchanan-Banks and others, 1978). The connection between this offshore fault and the Cypress Point fault northwest of Pescadero Point does not offset marine terrace deposits which indicates the fault has not experienced surface ground rupture for at least 10,000 years and possibly for several million years.

Chupines Fault

The Chupines fault is an east-west to northwest-trending fault with a generally up-to-the-north sense of displacement (Dibblee and Clark, 1973). The Chupines fault has not experienced any historical seismic activity, nor did Clark, et. al. (1974) find any evidence to suggest the fault is active. The Chupines fault dips 63 to 70 degrees to the south and may have 1000-feet of offset at the depth of the granitic basement rock. The Paso Robles Formation is offset only 6 to 10-feet and is downthrown to the south. The offset in the Paso Robles Formation indicates movement has occurred in the Pleistocene (Clark, et. al.,1974). Sieck (1964) postulated about 300 meters down-to-the-north vertical displacement of granitic basement rocks based upon a gravity survey he conducted. Therefore, either post-late Miocene faulting along the Chupines fault is minor, or deformation has been manifested primarily as folding rather than faulting (Bryant, 1985). Bowen (1969) mapped segments of the fault that do not offset late Pleistocene terrace deposits.

The Chupines has no known history of generating earthquakes during historic times, and is not considered a significant potential hazard to the subject property.

King City-Reliz Fault

An inferred section of the King City-Reliz Fault follows the southwest boundary of the Salinas Valley. This fault is thought to have 900 to 2,400 meters vertical displacement (Greene, et. al., 1973), and is considered capable of generating a 6.5 Richter Magnitude earthquake every twenty-five years (Burkland and Assoc., 1975). Buchanan-Banks, et. al. (1978) suggest the northernmost 30-35 miles of the King City-Rinconada fault was active in the Late Pleistocene.

The southeastern section of the King City-Reliz fault is considered potentially active based on offset Quaternary units, geomorphic evidence, and clusters of earthquake epicenters (Buchanan-Banks, et. al., 1978; Dibblee, 1966; Jennings, 1975). The King City-Reliz fault lies a little more than six miles northeast of the subject property. The Maximum Probable earthquake of Magnitude 6.75 would produce high ground accelerations due to the proximity of the fault.

Zayante-Vergeles Fault Zone

This northwest-southeast trending fault zone lies west of the San Andreas fault and extends fifty-one miles from the Watsonville lowlands into the Santa Cruz Mountains. The southern end of the Zayante-Vergeles fault zone merges with the San Andreas fault zone. The Zayante fault is primarily a normal fault (Clark and Reitman, 1973) accompanied by right lateral strike-slip movement (Hall, et. al., 1974; Ross, 1973). Stratigraphic and geomorphic evidence indicate the Zayante-Vergeles fault has undergone Late Pleistocene and Holocene movement (Buchanan-Banks, et. al., 1978). Some historic seismic activity is related to the Zayante fault (Griggs, 1973; Hall, et. al., 1974). The maximum credible earthquake (MCE) for the Zayante fault is between Magnitude 7.1 and 7.4. The recurrence interval is between 6500 years for a Magnitude 7.4 earthquake (Coppersmith, 1979) and 3100 years for a Magnitude 7.1 earthquake (Wesnousky, 1986). The maximum probable earthquake (MPE) is between Magnitude 5.9 and 6.7. The Zayante fault is considered moderately active, however, the potential for a large or major earthquake (M > 6.5) is far lower than the potential for the San Andreas fault or the San Gregorio fault.

The Zayante is capable of generating a maximum earthquake of Magnitude 7.+ with a recurrence interval of 6000 years (Coppersmith, 1979). One previous study of the Zayante-Vergeles fault indicated that it had not generated any noticeable earthquakes in historic time and should be considered potentially active (Coppersmith, 1979). The fault is now considered active by the California Division of Mines and Geology (CDMG). A prominent cluster of aftershocks including a Magnitude 5.0 occurred on the Zayante fault after the Loma Prieta earthquake (Benuska, 1990).

Stephani Fault

The Stephani fault was mapped by Fiedler (1944) as a northwest striking fault dipping 60 degrees NE that juxtaposed granitic basement rock against Miocene sedimentary rock near Camp Stephani, a little more than four and a half miles southeast of the subject property. Neel (1963) interpreted the Stephani fault as an unconformity. Rosenberg (1993) mapped the fault as questionable. Rosenberg (1993) cited the presence of intensely fractured Monterey shale along the contact with the granite as the only surficial suggestion of faulting, and east of the Carmel River he observed no evidence of faulting between the granite and Miocene marine sandstone. The Stephani has no known history of generating earthquakes, and is not considered a significant potential hazard to the subject property.

Cachagua Fault

Fiedler (1944) mapped the Cachagua fault as a near-vertical reverse fault, striking northwest and juxtaposing Miocene sandstones against pre-Cenozoic metamorphic basement rocks. He characterized the fault plane as a zone of broken and contorted schist roughly fifty feet wide and estimated vertical displacement at approximately 530 meters. Neel (1963) described the fault zone as being up to 200 feet wide. Fiedler (1944) mapped the Cachagua fault as being approximately seven and a half miles long, but theorized that the it could be over 25 miles long if it connected with other faults nearby.

The seismic history of the Cachagua fault is not known. In some areas along the fault it clearly has brought pre-Cenozoic schist into contact with Miocene marine sandstone, indicating

Pleistocene movement (Rosenberg, 1993). However, Quaternary stream terraces along some portions of the fault have not been offset (Rogers Johnson and Associates, 1985). Rosenberg (1993) stated that the Cachagua is probably inactive.

Active Fault Summary

The faults affecting the proposed project and the distances to the subject property are summarized in Table 2. The San Andreas fault is considered highly active and the fault most likely to generate a large magnitude earthquake within the next fifty years. Ground shaking parameters associated with an event along the San Andreas or Palo Colorado-San Gregorio should be used for design purposes. Because the numerous minor faults have not been very active during historical time, recurrence intervals for them are difficult to predict. In addition, because earthquake magnitude is directly related to fault length, the effect of these shorter faults will be masked by the San Andreas and Palo Colorado-San Gregorio faults. Based on deterministic methodology, these smaller potentially active or less active faults are not considered to represent a significant seismic hazard to site development relative to the San Andreas and Palo Colorado-San Gregorio faults. Table 2 summarizes the pertinent fault data.

TABLE 2
FAULT SUMMARY

Fault	Distance from Site (miles)	Activity Status	Estimated Recurrence Interval (years)	Characteristic Earthquake (Richter Mag.)
San Andreas (Southern Santa Cruz Mountains Segment)	26.5	Active (Historic)	136	6.5-7.0
San Andreas (Creeping Segment)	23.5	Active (Historic)	8.8	6.0
San Gregorio	11.5	Active (Historic)	824	7.7
Zayante-Vergeles	21	Active (Historic)	3,100	7.1
Monterey Bay	7.5	Active (Historic)	---	6.5
Tularcitos	2	Probably Active	---	---
Rinconada (King City-Reliz)	6	Potentially Active (Historic)	100	6.5
Laureles	<1	Not Active	---	---

Major Earthquakes

The epicenter of the October 17, 1989, Loma Prieta Earthquake (M=7.1) occurred approximately four miles north-northwest of Aptos, near the northern end of the Southern Santa Cruz Mountains subsegment at a depth of eleven miles below the ground surface. This is approximately thirty-five miles north of the proposed project. The fault plane in this area dips about 70 degrees to the southwest. Although no unequivocal surface ground rupture was evident, seismologic data suggest about forty miles of the fault ruptured at depth, extending from about one mile west of Lexington Reservoir to about five miles east of Watsonville. Preliminary geodetic data suggests a maximum of 67-inches right lateral motion and 51-inches of vertical thrust motion along the fault zone.

Modified Mercalli Intensity Scale estimates of the intensity of ground shaking as determined from observations of the Loma Prieta earthquake's effects on people, structures, and the earth's surface, indicate a relative intensity in the project area of VI (Plafker and Galloway, 1989).

The California Division of Mines and Geology network of accelerographs measured the local ground response during the Loma Prieta earthquake. Accelerations in the vicinity of the Loma Prieta earthquake's epicenter were measured to be between 0.55g-0.64g. The ground accelerations in Monterey were measured at 0.07g and ground accelerations at Lucia in southern Monterey County were measured at 0.06g. Ground motions in Salinas were measured at 0.12g, while ground motions in Moss Landing are estimated to have been 0.25g (Woodward-Clyde, 1989). The ground motions at the project site are estimated to have been between 0.06g and 0.15g near the site during this event (Plafker and Galloway, 1989). Several aspects of this earthquake were unusual for events associated with the San Andreas fault, including its relatively deep focal center, the reverse (vertical) component of displacement, the 70 degree, rather than near vertical dip of the slip surface and the lack of surface rupture for an event of this size.

The highest intensity of ground shaking affecting this site in historical times was from the 1906 Great San Francisco earthquake on the San Andreas fault. Fault rupture extended as far south as San Juan Bautista. 1906 earthquake intensities based on the modified Rossi-Forel scale were greater than comparable Loma Prieta Earthquake intensities in the project site area (Plafker and Galloway, 1989), (Youd and Hoose, 1978).

The term 'Maximum Credible Earthquake' (MCE) has been defined as the strongest earthquake that is likely to be generated along an active fault zone. The magnitude of the MCE is estimated from the geologic character (length, displacement, segmentation) of the fault and the earthquake history of the fault. Special geologic studies are needed, often with detailed field work, to develop the data needed to determine the most accurate MCE, and the results, in the best of studies, are susceptible to an error of about plus or minus 1/4 of a Richter magnitude. A Magnitude 8+ on the Palo

Colorado-San Gregorio or San Andreas approximates the MCE for this site. A Magnitude 7.5 on the King City-Reliz fault could also approximate the MCE. MCE magnitudes have been used for design purposes since they are independent of time restrictions. A 'Maximum Probable Earthquake' magnitude (MPE) is defined as the maximum which is likely to occur during a 100 year interval. A 7.5 Magnitude earthquake on the San Andreas of a 6.75 Magnitude earthquake on the Palo Colorado-San Gregorio fault approximates the maximum probable earthquake (MPE) for this site. Probability approaches to magnitudes using statistical techniques on necessarily limited data do contain statistical error, as well as bias errors due to lack of randomness. For design considerations, the most shaking that can be expected on the basis of MCE for faults within 100 km would be likely to originate from the Palo Colorado-San Gregorio or San Andreas fault.

SEISMIC HAZARDS

Seismic hazards in the vicinity of the proposed project can be placed in three general categories: (1) surface ground rupture, (2) seismic shaking, and (3) seismically induced ground failure which includes liquefaction. Each of these areas are individually discussed.

Surface Ground Rupture

Surface ground rupture occurs when fault movement breaks the ground surface. In general, fault related surface rupture occurs most commonly on, or in close proximity to, pre-existing active fault traces. It is therefore imperative to locate site improvements away from, and in particular not straddling, active fault traces. An examination of published maps and reports combined with an analysis of seven sets of aerial photographs between 1949 and 1997 did not reveal any evidence of a fault trace on the subject property. There is therefore a low probability of fault-related surface ground rupture at the proposed project site during the next fifty years.

Ground Shaking

Ground shaking is the soil column response to seismic energy transmission. Intensity of ground shaking and the potential for structural damage is greatly influenced by local soil conditions. In the event of a large magnitude earthquake on any of the nearby active or potentially active faults, ground shaking at the proposed project will range from moderate to severe.

Although there are several faults capable of generating ground shaking at the proposed project site, the most likely fault to generate intense ground shaking during the next fifty years will be from an earthquake of approximately Magnitude 7.5 on the San Andreas or a 6.75 earthquake on the Palo Colorado-San Gregorio fault system. The closest segment of the San Andreas fault is the creeping segment located approximately twenty-three and a half miles to the northeast. However, the nearby segment most likely to rupture and generate a large earthquake is the Southern Santa Cruz Mountains segment of the San Andreas fault system, approximately 26.5 miles to the north. We recommend a Magnitude 7.5 earthquake on the San Andreas fault or a 6.75 Magnitude earthquake on the Tularcitos fault be used for design purposes. Further, it is important that all structures be designed in accordance with the requirements set forth by county ordinance and within the Uniform Building Code's conditions (current edition).

Seismic shaking is a significant hazard present at this site. Seismic shaking at the proposed building site will be moderate to intense during the next major earthquake along the San Andreas fault, Palo Colorado-San Gregorio fault, or other fault systems in the Monterey Bay region. Ground motion parameters which allow a quantitative estimation of the actual motion include: horizontal acceleration, velocity and displacement vertical acceleration, duration of shaking; and high repeatable ground accelerations. Factors affecting ground motion are: magnitude, distance, geologic characteristics of rock along wave path, source mechanism, wave interference, and local soil conditions (Seed & Idriss, 1982). For design purposes, a median peak horizontal ground acceleration of 0.15g should be used (Campbell, 1981). Repeatable horizontal ground acceleration estimates for the project site vary between researchers. The Seed and Idriss attenuation curves are the most commonly used curves although data from the 1983 Coalinga, 1984 Morgan Hill, and 1989 Loma Prieta earthquakes are not included. Seed and Idriss curves tend to yield the lowest accelerations. Krinitzsky and others (1988) attenuation curves predict the highest ground acceleration at the site. The 0.10g, repeatable ground acceleration value is based on empirical, assumed, and modeled data. The minimum probable repeatable ground acceleration should be treated as approximately two-thirds of the attenuated mean peak horizontal ground acceleration estimate (Ploessel and Slossen, 1974). It is possible that the project area may experience accelerations different than deterministic and empirical estimates.

TABLE 3
DURATION OF GROUND SHAKING

Richter Earthquake Magnitude	Duration of Strong Shaking
5	3 to 6
6	6 to 12
7	16 to 30
7.5	25 to 50

The duration of strong shaking is dependent on magnitude. Dobry, et. al. (1978) have suggested a relationship between magnitude and duration of "significant" or strong shaking expressed by the formula: $\log D = 0.432 M - 1.83$ (where D is the duration and M is the magnitude). On the basis of the above relationship, the duration of strong shaking associated with a Magnitude 7 earthquake is estimated to be about seventeen seconds. A range of shaking duration (16-30 seconds) will probably more accurately reflect the site response over the project lifetime. Table 3 (Dobry and others, 1978) gives estimates of the typical range in duration.

Because of the numerous inherent uncertainties, ground motion parameters must be estimated. There is no unanimity among investigators. It has also been suggested that the common practice of using well defined surface fault segments instead of the entire length of the fault zone or fault system for estimating maximum earthquakes can lead to underestimating earthquake potential, (Freeman and Fuller, 1986). In addition, it is likely that a significant portion of the damaging earthquakes that occur in the coming decades will occur on faults whose potential is poorly understood today (Lindh, 1983).

Ground Failure

The occurrence and extent of the different types of ground failure are related to the intensity and duration of the shaking caused by an earthquake, as well as local soil conditions.

Documentation of historic ground failure resulting from the 1906 San Francisco Earthquake does not identify any ground failure at the site. In the 1906 event, the closest recorded ground failures were in Spreckels and the Salinas Valley, approximately five miles or more from the subject property (Youd and Hoose, 1978). These failures, restricted to the river margins, included ground settlement, landslides, sand boils and lateral spreading. Along the Monterey Bay shoreline (approximately eight miles or more to the west or northwest), there was ground settlement and lateral spreading.

At the time of the 1906 San Francisco earthquake this site was undeveloped and it is possible that minor earthquake effects would have not have been documented. However, areas of ground failure resulting from the 1989 Loma Prieta Earthquake in Monterey County are generally coincident with 1906 event. As no ground failures were reported on the subject property during the 1989 earthquake, it is possible that no significant failures occurred during the 1906 earthquake.

The California Bureau of Mines and Geology (Note 42) considers four types of ground failures: 1) liquefaction, 2) lateral spreading, 3) landslides and slope instability hazards, and 4) settlement and differential compaction.

Liquefaction

Liquefaction is the sudden loss of soil strength due to increased pore water pressures caused by the reorientation of soil particles during seismic shaking. Three requirements are needed for an area to be susceptible to liquefaction; 1) the underlying soil must be of low relative density, 2) the soil must be granular, and 3) ground water should be close to the ground surface.

Locations of ground failure resulting from soil liquefaction during the Loma Prieta earthquake were generally coincident with similar areas of ground failure during the 1906 earthquake. Fourteen of the eighteen areas which liquefied in the 1906 earthquake, liquefied in the Loma Prieta earthquake (John Tinsley and Bill Dupré, personal communication, 1990). Liquefaction occurred around the margin of San Francisco Bay in sandy, manmade fills and near Monterey Bay from Santa Cruz to Salinas in both late Holocene and active flood plain deposits of the principal river valleys and in spits, bars, and tidal channels of smaller coastal drainages (O'Rourke, 1989), (Plafker and Galloway, 1989), (Greene, et. al., 1989). No liquefaction was reported by any of these investigators along the Carmel River.

Bedrock at the subject property is the Monterey Formation (Dibblee, 1999; Dupré, 1990). The Monterey Formation is generally not prone to experiencing liquefaction, and according to Dupré (1990) the liquefaction potential is very low for the property.

Lateral Spreading

Lateral spreading is the horizontal movement of soil masses caused by seismic shaking. Usually such movement is towards an open face and occurs along a weakened strata of saturated soils.

Because of the shallow soil depth on most of the subject property, the hard, dense nature of the earth materials underlying the surface soils, and the ease with which rainfall is likely to drain off most of the slopes, it is unlikely that a strata of saturated soil would develop on the property.

On proposed Lot 4, the presence of abundant ferns in an area of hummocky slopes suggests that the water table on those slopes may be relatively elevated. It is therefore possible that conditions on the proposed Lot 4 could be conducive to some lateral spreading of earth materials during certain times of the year, depending on rainfall. If lateral spreading were to occur on the lower slopes of the proposed Lot 4, or on slopes below the property line, it is possible such spreading could contribute to destabilization of the upper slopes on the property.

Landslides and Slope Instability Hazards

Landsliding is defined as the downward and outward movement of slope-forming materials composed of natural rock, soils, artificial fills or combinations of these materials (Varnes, 1958). Most of the landslides in the Coastal Ranges have moved as slumps, earthflows, or a combination of the two.

The geologic material underlying the subject property has the potential for slope failure. Observations in the field and on aerial photographs (see following sections) indicate that part of the slope on the subject property may have failed in the past. Dupré (1990) mapped a large questionable landslide on the south side of Coyote Gulch. This landslide is mapped as extending onto the subject property, mainly proposed Lots 3 and 4, but possibly the very far western portions of Lots 1 and 2, also (Figure 5). Dibblee (1999) also mapped a landslide on the south side of Coyote Gulch, but covering a smaller area, and not extending onto the subject property (Figure 2). Our aerial photograph investigation and site visit indicate that there is field evidence to suggest that Dupré's interpretation may be a closer approximation of the extent of past landslides on the subject property, although we also noted evidence that suggests some earth movement may have taken place in areas on Lots 1 and 2 which was not noted by either Dupré (1990) or Dibblee (1999).

Aerial Photograph Examination

Seven sets of stereo aerial photographs from 1949 through 1997 were examined for evidence of past slope instability. Possible evidence for past landsliding was observed in several areas on each set of photographs examined.

On proposed Lot 3, the upper slopes of the steep-sided ravine that leads down to the bottom of Coyote Gulch exhibit a bowl-shaped appearance that is typical of landslide scarps. This bowl-shaped area extends onto proposed Lot 2, at its far southern tip. Further north on proposed Lot 2, at a slightly lower elevation, there is another, less-pronounced bowl-shaped swale on the slope. This swale morphology is again typical of a landslide scarp. This swale extends onto proposed Lot 1. Downslope of this swale, on proposed Lots 1 and 2, is a relatively flat bench. This bench may well be the remains of the slide mass that moved downslope, leaving the steep-sided, bowl-shaped scarps above. Further to the north on proposed Lot 1, on the northern side of the ridge, there is another swale with a slight bowl-shape, and a bench below. These features may be indicative of another past landslide.

The bowl-shaped swale at the head of the ravine on proposed Lot 3 lies within the large questionable landslide mapped by Dupré (1990), as does the southern portion of the bench below the swale.

The eastern portions of proposed Lots 1 and 2 lie along a subsidiary ridgeline of the main ridge on which the subject property lies. This subsidiary ridgeline is oriented north-south, and on the eastern side of the ridgeline, both Dibblee (1999) and Dupré (1990) mapped a landslide which moved downslope to the east and north. The steep slopes just below the summit of this ridge are clearly a landslide scarp. The far eastern portion of proposed Lots 1 and 2 may extend onto the area of this scarp.

Examination of vegetation on the aerial photographs suggests that the slopes and possible slide mass(es) on the property have been largely stable for at least sixty years, with the possible exception of the shallow, bowl-shaped slopes at the head of the ravine on proposed Lot 3. In the 1990 aerial photographs, these slopes did not appear vegetated, even though they appeared vegetated in aerial photographs taken in 1982 and 1997. The geomorphic appearance of the slopes did not appear to have changed significantly in the years between these photographs, so it may be that a small fire or some surficial grading accounts for the apparent absence of vegetation in the 1990 photographs. When the area in question was vegetated, the vegetation appeared to consist of grasses and some brush. The boundary of the wooded areas on the edge of the area in question did not appear to change significantly from 1982 to 1997.

None of the possible slope failures observed in aerial photographs of the property are extensive, and none appear to have occurred within the last sixty years. But the exact ages of the different possible landslide features on the subject property are unknown, and it is therefore not possible to determine the recency or frequency with which slopes on the property have failed. It is therefore prudent to assume that any of the steep slopes on the subject property are potentially capable of failing, and any development projects on the subject property should be located well back from any steep slopes. A setback of 50 feet from all steep breaks-in-slope is recommended.

Field Investigation of the Subject Property

Our field investigation of the subject property supported the observations made during the aerial photograph investigation. In addition, we observed some features on proposed Lot 4 that suggest possible past earth movements on this lot.

In general, the terrain on Lot 4 is hummocky in nature, which is generally interpreted as indicating shallow, surficial downslope movement of earth materials on the slope. Hummocky terrain does not necessarily indicate past sudden, catastrophic failure of a slope, but it does indicate a general condition of instability. In addition, we observed the presence of a large number of ferns on the proposed Lot 4. Ferns are known to prefer soil where water is plentiful, which suggests that the slopes on the proposed Lot 4 may frequently experience an elevated water table compared with the surrounding slopes. An elevated water table on a hummocky slope in an area in which landslides have occurred in the past is cause for concern, as saturation of earth materials is a condition which helps create conditions in which a slope might fail.

As the slopes on proposed Lot 4 do not exhibit a distinct break-in-slope, a recommendation of a 50 foot setback from any break-in-slope is not appropriate. However, as the hummocky nature of the slopes indicates potential instability of those slopes, it is critical that a qualified geotechnical engineer perform a detailed site investigation on the proposed Lot 4. It is also critical that any structures built on the proposed Lot 4 be designed to survive any potential downslope movement of the earth materials on the proposed Lot 4, i.e. foundations should be founded on bedrock. Any setbacks or restrictions recommended by the geotechnical engineer should be rigidly adhered to. Although slopes on the proposed Lot 4 are not as steep as some of the slopes on the other proposed lots, they may actually be less stable than those steeper slopes.

In summation, all of the proposed lots contain slopes that have the potential to fail under the right conditions. For all of the lots, it is critical that nothing be done to destabilize these slopes. In particular, care should be taken not to undercut any of the slopes. During our field investigation, we noted that active grading was occurring downslope of the subject property. A road was being constructed, which had resulted in cutslopes alongside the road, in some cases over ten feet high. Unless properly engineered, these cutslopes could potentially destabilize the slopes above. Destabilization of these slopes could have dire consequences for any developments on the upper reaches of the slopes.

Settlement and Differential Compaction

Settlement and differential compaction are the result of a loss of volume resulting from seismic ground shaking. Compaction is more likely in water saturated, low density alluvial material. The most likely areas are paleo-swamps and/or marsh, or strata of fine grained silts and sands. Generally, for this phenomena to occur, the site soils must be of low relative density and be dilatant. The soils at the subject property are unlikely to meet these criteria. It is unlikely that any significant settlement or compaction of the subsurface material would occur on the subject property.

DRAINAGE AND EROSION HAZARDS

Erosion is the removal of surface soil, sediment, and rock by wind, water and ice. Rainfall erosion is the most common type of erosion. Rainfall and runoff can initiate slopewash, gullying, siltation, and sedimentation. Rainfall erosion is a function of climatic conditions, topography, soil erodability, and vegetation type and coverage. Wind erosion is controlled by the same basic factors as rainfall erosion.

It is possible that extended heavy rainfall at the subject property could result in some erosion. If the rainfall was severe enough, some of the sediment and fractured bedrock could wash downslope. Maintaining good vegetative ground cover will substantially reduce the risk of erosion at the property.

The presence of hydrophilic plants on the slopes of the proposed Lot 4 suggests that there may be a perched water table. Because of potential instabilities associated with such a perched water table, it is critical that any development on the property include a well-engineered drainage system to keep runoff from any paving or structures from either eroding the slope or contributing to the possible perched water table.

FLOODING

Inspection of the FEMA (Federal Emergency Management Agency) Flood Maps for the Monterey County Flood Control and Water Conservation District indicate the subject property is located outside the 100 year flood zone. There are no significant waterways upstream of the ephemeral creek in the bottom of Coyote Gulch, which lies at the bottom of the slopes on which the subjecct property is situated. Therefore, flooding is not a critical geohazard to the current project site. The likelihood of such a failure occurring is not deemed great enough to be considered a significant risk.

Tsunamis and Seiche

Tsunamis and seiche are inundations by oceanic or fresh water waves generated by seismic events. According to the Geotechnical Study for the Seismic Safety Element in Monterey County prepared by Burkland and Associates (1975), there is no record of any tsunamis more than nine feet high occurring in the state of California. Since the subject property is located approximately eight miles from the seacoast and over 1050 feet above sea level, a tsunami is not a relevant hazard.

According to the Geotechnical Study for the Seismic Safety Element, Monterey County, seiches (fresh water tsunami) characteristically do not raise the water level in an inland body of water more than a few feet. As the subject property is hundreds of feet in elevation above the nearest inland body of water, a seiche is not a relevant hazard.

CONCLUSIONS

It is critical that a detailed, thorough, geotechnical investigation be performed prior to the design or construction of any buildings. An adequate setback (50 feet) should be maintained from the breaks in slope above and below any building sites. On proposed Lot 4, it is critical that the recommendations of the geotechnical investigation be followed scrupulously, as there is not a distinct break-in-slope, but the slopes in general have the potential to be unstable. Any building must have a well-designed, site specific, engineered foundation. Such a foundation is also crucial to surviving the strong shaking that could be generated at the subject property during a large-magnitude earthquake.

LIMITATIONS

In performing our professional services, we have applied present engineering and scientific judgement and used a level of effort consistent with the standard of practice on the date of this report and the locale of the subject property for similar type studies. CapRock makes no warranty, expressed or implied, in fact or by law, whether of merchantability, fitness for any particular purpose, or otherwise, concerning any of the materials or "services" furnished by CapRock to the client.

This report does not make any attempt to evaluate appropriate foundation design, and is not a Geotechnical Report or a Slope Stability Investigation. Subsurface soil conditions can vary both vertically and horizontally.

We appreciate the opportunity to provide engineering geology services for this project. Should you have any questions or comments concerning this Geological Investigation report, please contact us at (831) 484-5053.

Sincerely
CapRock

Robert Barminski, R.G., C.E.G.
Principal Geologist

AERIAL PHOTOGRAPH REFERENCES

Year:	1949
Agency:	USDA Agriculture Adjustment Administration
Flown By:	Park Aerial Survey, Inc
Scale:	1:20,000
Index:	1949C; ABG 17F-137, 138

1956
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Aero Service Corp., Philadelphia, PA
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1956C; ABG 5R-41,42

1966
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1971
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1981-82
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1990
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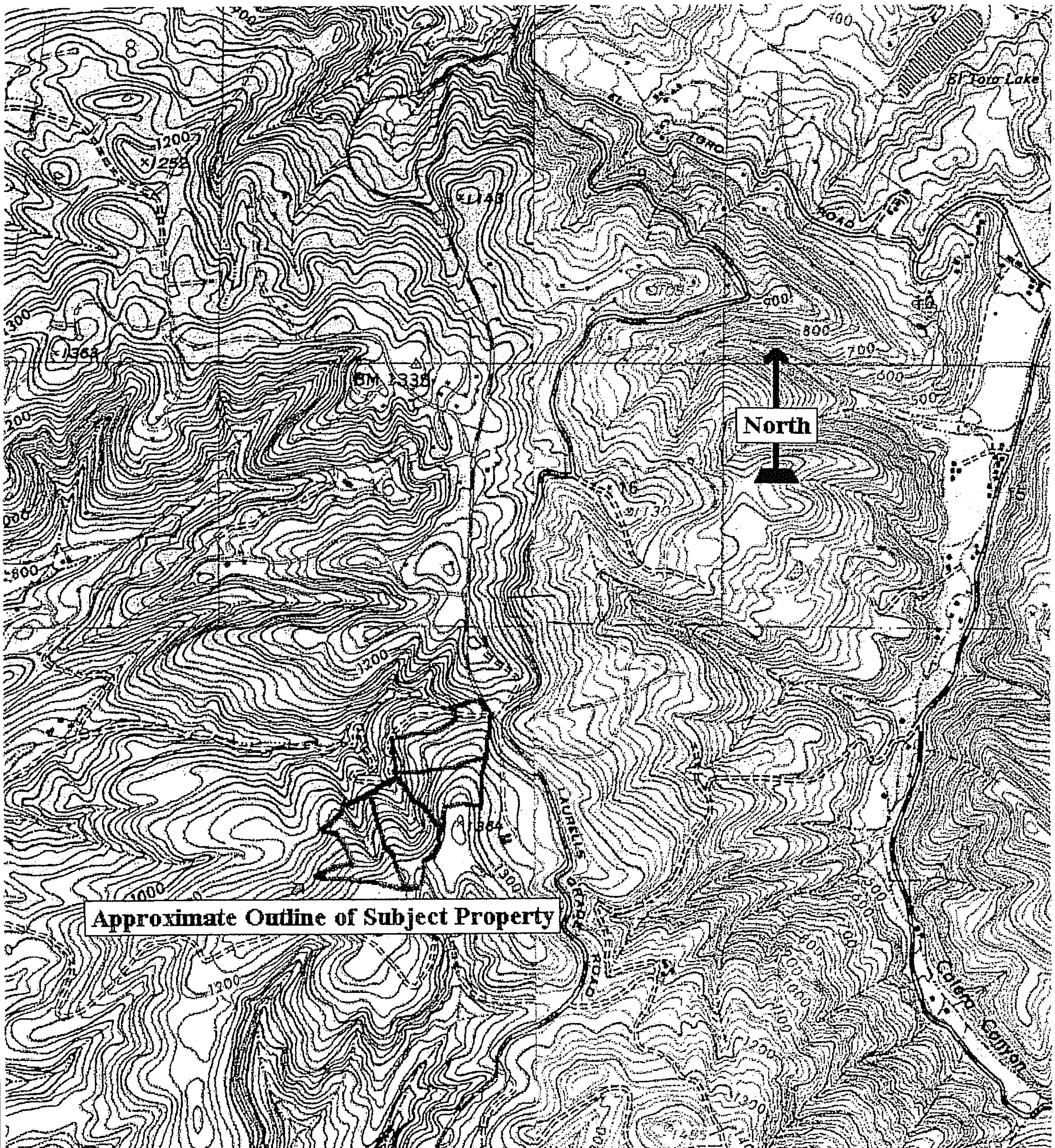

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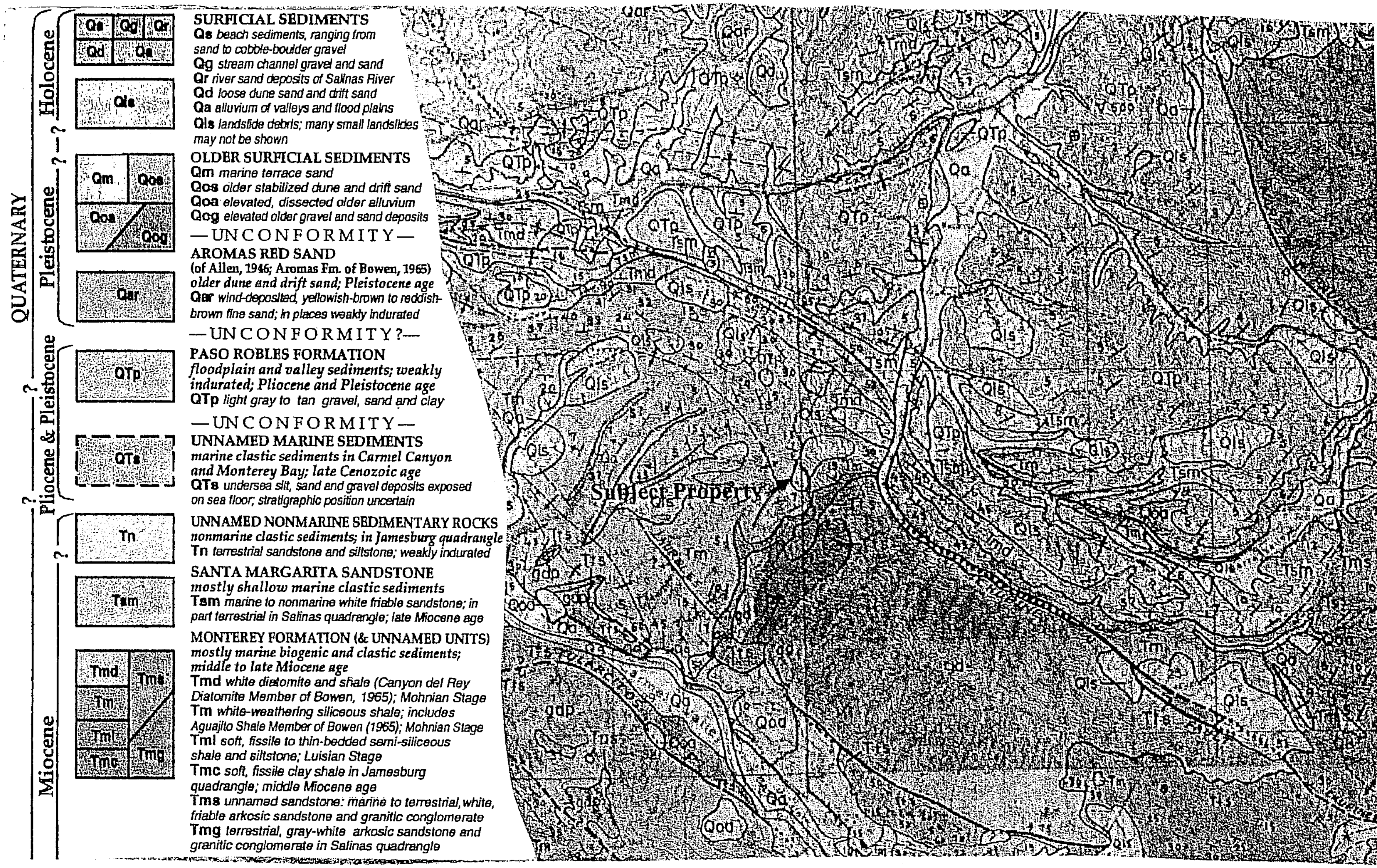
Scale: 1"=12,000'

CapRock Environmental and Engineering Geology	**Site Location Map**	**FIGURE 1**
	APN# 416-082-027, Monterey County, California **Ref. No.: 4112-01**	



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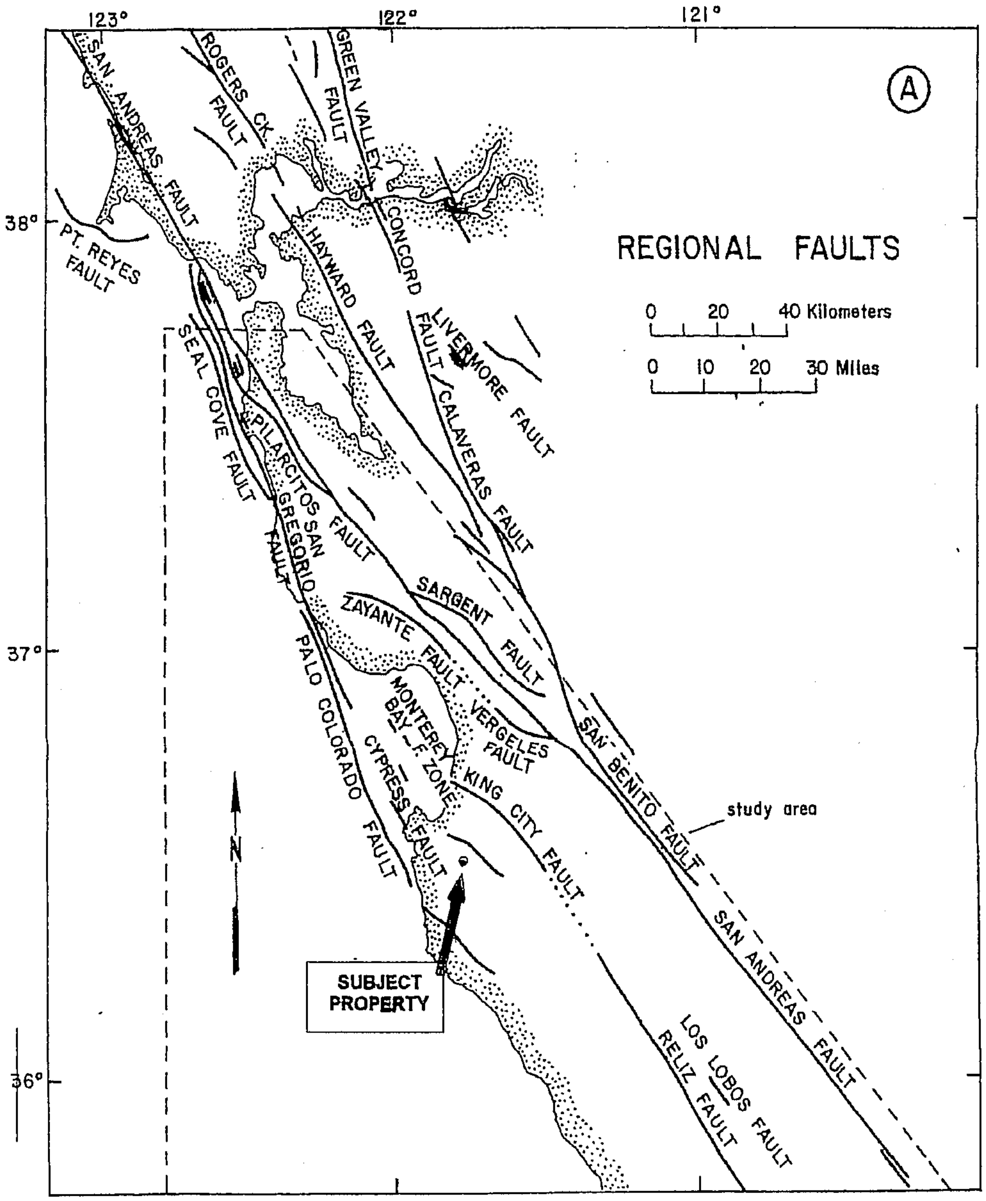
Environmental and Engineering Geology

GEOLOGY MAP
from Dibblee, 1999

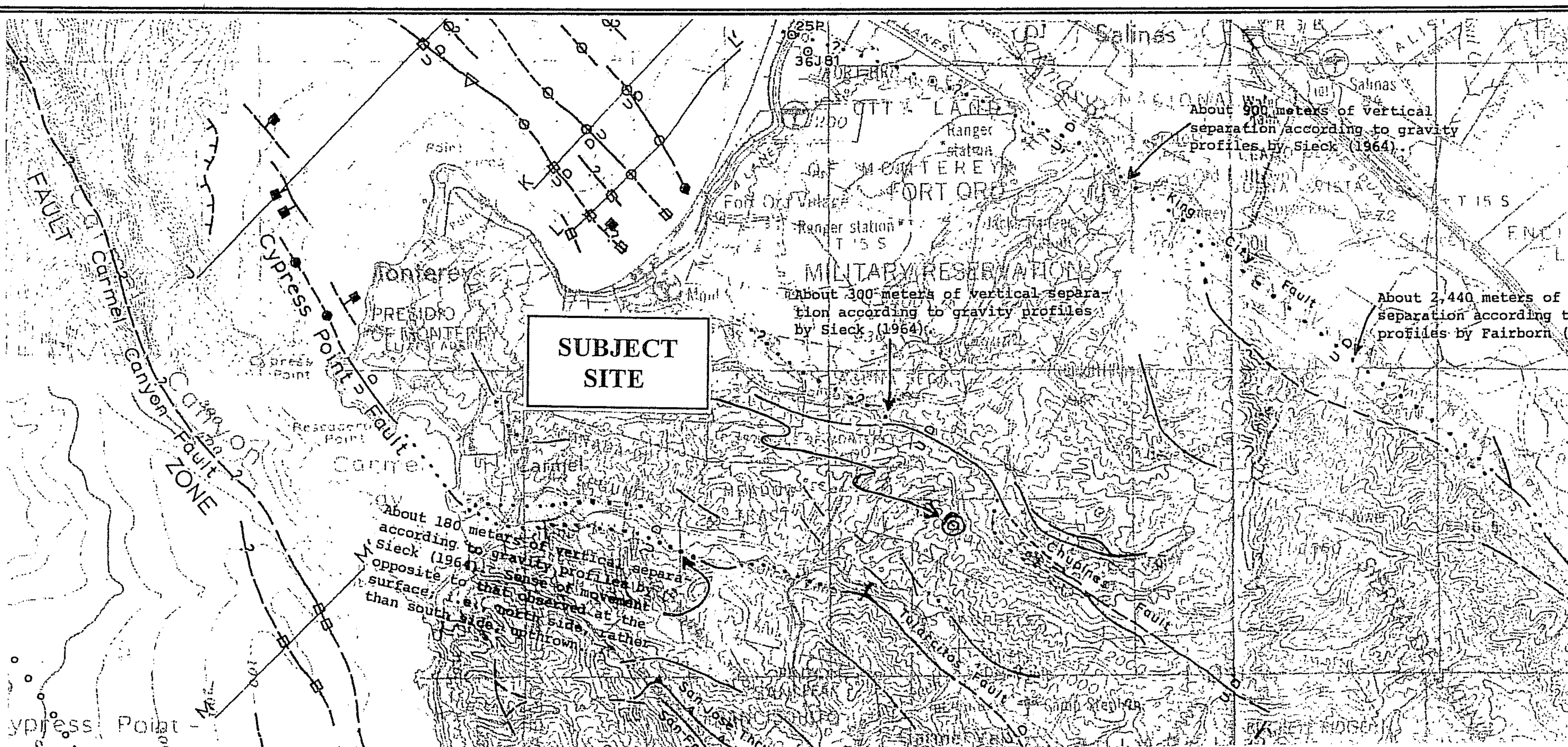
APN # 416-082-027, Carmel Valley, California

Ref. No.: 4112-01

FIGURE 2



CapRock Environmental and Engineering Geology	**REGIONAL FAULT MAP** **from McCrory et al., 1977**	**FIGURE** **3**
	APN # 416-082-027, Carmel Valley, California **Ref. No.: 4112-01**	



SCALE 1:200,000

0 2 4 NAUTICAL MILES

0 2 4 6 KILOMETERS

Onland contour interval - 200 feet (60 meters)
Offshore contour interval - 100 fathoms (600 feet or 183 meters)
Contour interval of the detailed Monterey Bay area - 10 meters to a depth of 100 meters - 50 meters at depths greater than 100 meters

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1990

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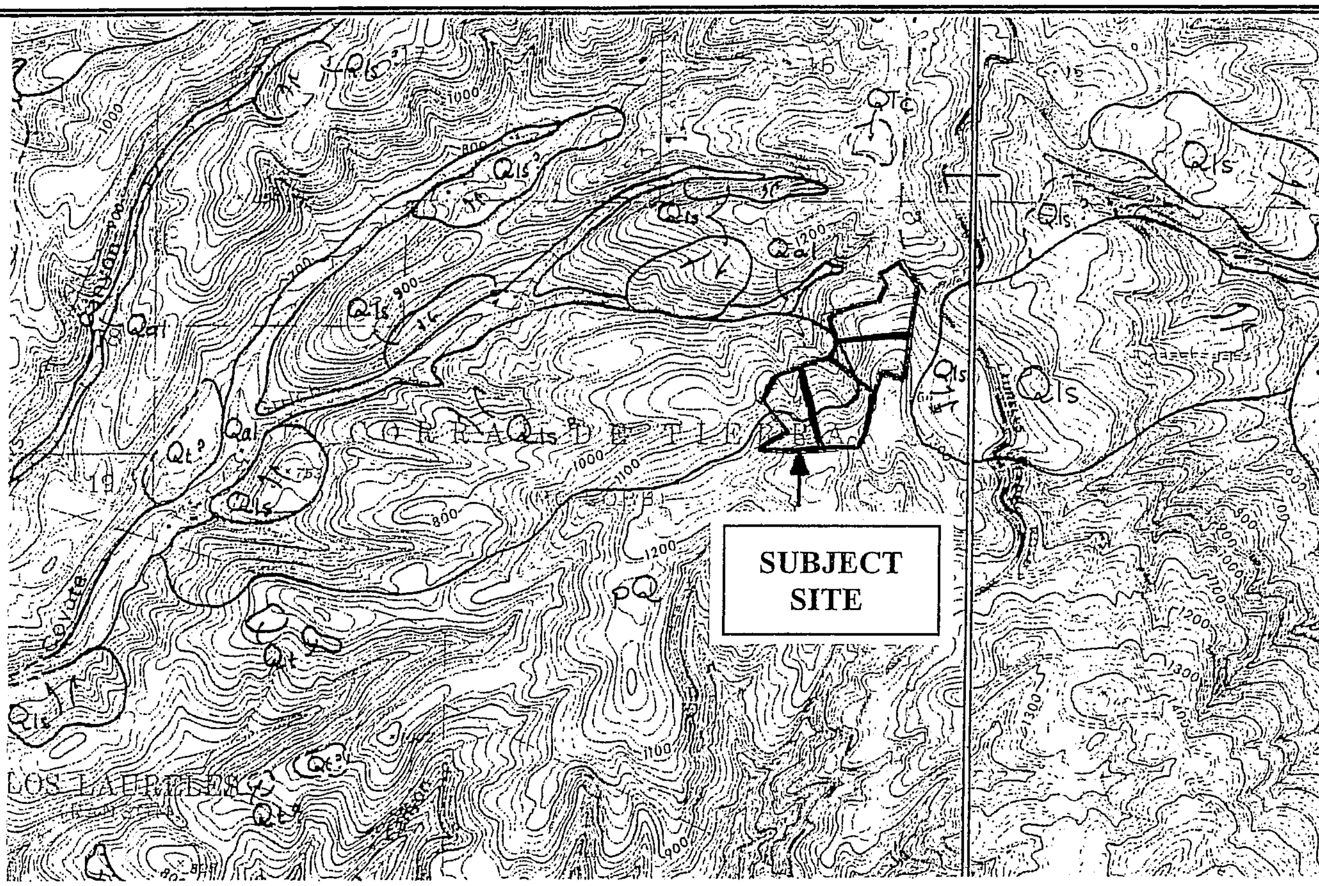
LOCAL FAULT MAP
from Greene et al., 1973

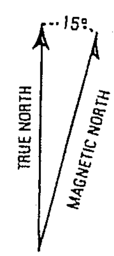
APN # 416-082-027, Carmel Valley, California

Ref. No.: 4112-01

FIGURE 4



Qls Landslide deposits (Quaternary)--Heterogeneous mixture of deposits ranging from large block slides in indurated bedrock to debris flows in semiconsolidated sand and shale; only locally delineated. Younger landslides have a relatively high probability of failure during or after an earthquake, but the susceptibility for liquefaction is relatively low



Qal Alluvial deposits, undivided (Holocene)--Unconsolidated, heterogeneous, moderately sorted silt and sand with discontinuous lenses of clay and silty clay. Locally includes large amounts of gravel. May include deposits equivalent to both the younger and older flood-plain deposits (Qyf and Qof, respectively) in areas where these were not differentiated. Thickness highly variable; may be more than 30 m thick near the coast. Variable permeability and porosity. Depth to water table highly variable. High susceptibility to flooding in areas where not incised by present stream. Liquefaction susceptibility moderate to high where water table is close to surface

pQ Sedimentary, igneous, and metamorphic rocks, undivided (pre-Quaternary)--Characterized by very low susceptibility for liquefaction

Landslide deposit–Arrows show general direction of movement

SCALE 1:24 000

1 ½ 0 1 MILE

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LOCAL LANDSLIDES MAP
from Dupré , 1990

APN # 416-082-027, Carmel Valley, California

Ref. No.: 4112-01

FIGURE 5