# 4.5 GEOLOGY, MINERALS, SOILS, AND PALEONTOLOGICAL RESOURCES

This chapter identifies and evaluates the changes in conditions related to geology, minerals, soils, paleontological resources, and seismic conditions associated with implementation of the proposed project. The analysis addresses potentially significant geology and soil effects and impacts on paleontological resources, and recommends mitigation measures to reduce significant or potentially significant environmental impacts. This chapter is based on EDAW's review of local, State, and Federal websites and documents, as well as a Geotechnical Feasibility Study prepared for the project site by ENGEO in 2004.

## 4.5.1 ENVIRONMENTAL SETTING

### GEOLOGY

### Regional Geology

The project site is located in the Great Valley Geomorphic Province of California, a large northwest-trending valley bounded by the Sierra Nevada range to the east and south, the Coast Ranges to the west, and the Klamath Mountains to the north. The Great Valley is drained by the Sacramento and San Joaquin rivers, which join and flow out of the province through the San Francisco Bay. This geomorphic province is an asymmetric trough approximately 400 miles long and 50 miles wide, filled with a thick sequence of sediments ranging from Jurassic (180 million years ago) to Recent age.

The Central or Great Valley comprises the Sacramento Valley and the San Joaquin Valley. The Central Valley is a forearc basin comprising thousands of feet of sedimentary deposits, which has undergone alternating periods of subsidence and uplift over millions of years. The Central Valley basin began to form during the Jurassic period as the Pacific oceanic plate was subducted underneath the adjacent North American continental plate. During the Jurassic and Cretaceous periods of the Mesozoic era, the Central Valley existed in the form of an ancient ocean. By the end of the Mesozoic, the northern portion of the Central Valley began to fill with sediment as tectonic forces caused uplift of the basin. Geologic evidence surrounding the Stockton Arch suggests that the Sacramento Valley and San Joaquin Valley gradually separated into two separate waterbodies as uplift and sedimentation continued. By the time of the Miocene epoch (approximately 24 million years ago), sediments deposited in the Sacramento Valley were mostly of terrestrial origin. In contrast, the San Joaquin Valley continued to be inundated with water for another 20 million years, as indicated by marine sediments dated to the late Pliocene (approximately 5 million years ago). By the Pleistocene epoch, the San Joaquin Valley had emerged from the water and was enclosed by the Sierra Nevada Range to the east and the Coast Range to the west (Bartow 1991). Most of the surface of the San Joaquin Valley is covered with Pleistocene and recent (Holocene) alluvium. This alluvium comprises sediments from the Sierra Nevada Mountains to the east and the Coast Range Mountains to the west, which were carried by water and deposited on the valley floor. Siltstone, claystone, and sandstone are the primary types of sedimentary deposits.

### Project Site Geology

The project site is located within the U.S. Geological Survey Merced 7.5-Minute Quadrangle. Site topography is nearly flat, with elevations ranging from approximately 185 to 190 feet above mean sea level. The northern portion of the project site is located in Holocene-age (10,000 years Before Present [BP] to Present Day) alluvial deposits consisting of unconsolidated clay, silt, sand, and gravel from Bear Creek. The remainder of the project site is located in the Modesto Formation, which is discussed in greater detail below. (Wagner et al. 1991)

### *Modesto Formation*

Piper et al. (1939) were the first to publish detailed geologic maps in the southern Sacramento/northern San Joaquin Valley areas, and they designated the older alluvial Pleistocene deposits as the Victor Formation. However, in 1959, Davis and Hall proposed a subdivision of the Victor Formation into the Turlock Lake (oldest), Riverbank (middle), and Modesto (youngest) Formations. The type section of Modesto was designated along the south bluff of the Tuolumne River south of Modesto. Marchand and Allwardt (1981) proposed that the name Victor Formation be abandoned and that the Turlock Lake, Riverbank, and Modesto Formations be adopted as formal nomenclature for Quaternary deposits in the Sacramento and San Joaquin Valleys. Most later researchers have followed this recommendation.

In the San Joaquin Valley, the Modesto Formation forms ancient alluvial fans of the San Joaquin River and can be divided into upper and lower members. Researchers differ as to the age of this formation: Marchand and Allwardt (1981) placed the age between approximately 12,000 and 42,000 years BP, Atwater (1982) placed the age from 9,000 to 73,000 years BP. The upper member is composed primarily of unconsolidated, unweathered, coarse sand and sandy silt. This unit may range in age from 9,000 to 26,000 years BP. The lower member of the Modesto Formation is composed of consolidated, slightly weathered, well-sorted silt and fine sand, silty sand, and sandy silt. Age estimates for the lower member range from 29,000 to 73,000 year BP. The thickness of the Modesto at the project range may range from 50 to 700 feet below the ground surface (Page and Balding 1973).

## REGIONAL SEISMICITY AND FAULT ZONES

Potential seismic hazards resulting from a nearby moderate-to-major earthquake can generally be classified as primary and secondary. The primary effect is fault ground rupture, also called surface faulting. Common secondary seismic hazards include ground shaking, liquefaction, and subsidence. Each of these potential hazards is discussed below.

### Surface Rupture

Surface rupture is an actual cracking or breaking of the ground along a fault during an earthquake. Structures built over an active fault can be torn apart if the ground ruptures. Surface ground rupture along faults is generally limited to a linear zone a few meters wide. The Alquist-Priolo Act (see Section 4.5.2, "Regulatory Setting," below) was created to prohibit the location of structures designed for human occupancy across the traces of active faults, thereby reducing the loss of life and property from an earthquake.

No faults zoned under the Alquist-Priolo Act pass through or near the project site (California Geological Survey 2005a), nor is the project site underlain by any other known active faults (Jennings 1994).

### Seismic Ground Shaking

Ground shaking, motion that occurs as a result of energy released during faulting, could potentially result in the damage or collapse of buildings and other structures, depending on the magnitude of the earthquake, the location of the epicenter, and the character and duration of the ground motion. Other important factors to be considered are the characteristics of the underlying soil and rock, the building materials used, and the workmanship of the structure.

### *Active Fault Zones in the Project Vicinity*

The closest active/potentially active seismic sources to the project site are the San Joaquin Fault System, the Tesla-Ortigalita Fault Zone, and the Great Valley Fault Zone, discussed in more detail below.

### *San Joaquin Fault System*

The San Joaquin Fault System is located along the foothill-valley margin, and consists of a number of northeast-dipping faults that offset Quaternary rock formations. The zone parallels Interstate 5 from Tracy south to Panoche Creek. Although it is not considered "active" (i.e., a fault having surface displacement within the last 11,000 years, during the Holocene epoch) by the California Division of Mines and Geology (CDMG), geomorphic evidence indicates that fault movement has occurred as recently as the Pleistocene epoch (Lettis 1982, Bartow 1991, Jennings 1994), and therefore it can be considered potentially active.

### *Tesla-Ortigalita Fault Zone*

The Tesla-Ortigalita Fault Zone consists of a series of southwest-dipping strike-slip faults separated by pull-apart basins that extend from Orestimba Creek in the north to Panoche Creek in the south, along the eastern margin of the Coast Range. The zone has been divided into four segments, from north to south: Cottonwood Arm, Los Banos Valley, Piedra Azul, and Little Panoche (Bryant and Cluett 2000). The segments may represent different origins and histories (Bartow 1991), all of which show evidence of displacement during the late Pleistocene and Holocene epochs. The Tesla-Ortigalita Fault Zone marks the boundary between the Franciscan Complex and the Great Valley Sequence of rock formations. This fault zone is designated by CDMG as an active fault (i.e., a fault having surface displacement within the last 11,000 years), and it has been zoned under the Alquist-Priolo Earthquake Fault Zoning Act. It is aligned northwest-southeast and is located approximately 40 miles west of the project site.

The Tesla-Ortigalita Fault Zone is considered capable of generating a 6–7 Richter magnitude earthquake with a recurrence interval of 2,000 to 5,000 years (Anderson et al. 1982). The last major earthquake attributed to this fault occurred in 1981 and had a Richter magnitude of 3.7.

### *Great Valley Fault System*

A tectonic boundary is believed to exist along the western margin of the San Joaquin Valley of California, referred to as the Great Valley Fault System. The 6.7 Richter magnitude Coalinga earthquake in 1983 and a greater than 6.0 Richter magnitude earthquake in 1892 near Vacaville and Winters are believed to have occurred on segments of the Great Valley Fault System. These earthquakes were caused by blind thrust faults, which do not intersect the ground surface. This fault system is considered capable of generating a 6.7 Richter magnitude earthquake, although it has not been zoned under the Alquist-Priolo Earthquake Fault Zoning Act.

Table 4.5-1 identifies active faults (as designated by CDMG) that may pose a potential geologic hazard to the project site. Active faults are those that show evidence of displacement during Holocene time. In addition, Table 4.5-1 identifies the approximate distance from the project site, maximum moment magnitude, and fault type.

The California Geological Survey (formerly the California Department of Conservation, Division of Mines and Geology) identifies low, medium, and high earthquake severity zones within California. The eastern portion of Merced County, including the project site, lies in a moderate severity seismic hazard zone wherein some structural damage could occur (Merced County 1990).

Ground motions from seismic activity can be estimated by probabilistic method at specified hazard levels. The intensity of ground shaking depends on the distance from the earthquake epicenter to the site, the magnitude of the earthquake, site soil conditions, and the characteristic of the source. For purposes of this draft environmental impact report (DEIR), the California Geological Survey's Probabilistic Seismic Hazards Mapping Ground Motion Page (California Geological Survey 2005b) was consulted to estimate site-specific probabilistic ground acceleration for the project site. Peak horizontal ground acceleration (the level of ground shaking) with 10% probability of being exceeded in 50 years was calculated for firm rock, soft rock, and alluvium in percentage of gravity (or percentage of the earth's normal gravitational strength). These calculations found that there is a 1-in-

10 probability that an earthquake will occur within 50 years that would result in a peak horizontal ground acceleration exceeding 0.18 gravity.

**Table 4.5-1**
**Active Faults in the Project Vicinity**

| Fault | Approximate Distance (Miles) from the Project Site | Fault Type[1] | Maximum Moment Magnitude[2] |
|---|---|---|---|
| Great Valley Fault System | 33 | B | 6.7 |
| Ortigalita Fault Zone | 40 | B | 6.9 |
| Greenville | 60 | B | 6.9 |
| Calaveras Fault | 62 | B | 6.2–6.8 |
| Sargent Fault | 64 | B | 6.8 |
| San Andreas Fault | 68 | A | 7.8 |
| Hayward Fault | 72 | A | 7.1 |

Notes:

[1] Faults with an "A" classification are capable of producing large magnitude (M) events (M greater than 7.0), have a high rate of seismic activity (e.g., slip rates greater than 5 millimeters per year), and have well-constrained paleoseismic data (e.g., evidence of displacement within the last 700,000 years). Class "B" faults are those that lack paleoseismic data necessary to constrain the recurrence intervals of large-scale events. Faults with a "B" classification are capable of producing an event of M 6.5 or greater.

[2] The moment magnitude scale is used by seismologists to compare the energy released by earthquakes. Unlike other magnitude scales, it does not saturate at the upper end, meaning there is no particular value beyond which all earthquakes have about the same magnitude, which makes it a particularly valuable tool for assessing large earthquakes.

Sources: *Probabilistic Seismic Hazard Assessment for the State of California* (Petersen et al. 1996)

The California Building Standards Code (CBC) specifies more stringent design guidelines where a project would be located adjacent to a Class "A" or "B" fault as designated by the California Probabilistic Seismic Hazard Maps. As shown in Table 4.5-1, the nearest Class A or B fault is located 33 miles from the project site.

### Ground Failure/Liquefaction

Soil liquefaction occurs when ground shaking from an earthquake causes a sediment layer saturated with groundwater to lose strength and take on the characteristics of a fluid, thus becoming similar to quicksand. Factors determining the liquefaction potential are soil type, the level and duration of seismic ground motions, the type and consistency of soils, and the depth to groundwater. Loose sands and peat deposits are susceptible to liquefaction, while clayey silts, silty clays, and clays deposited in freshwater environments are generally stable under the influence of seismic ground shaking. Liquefaction poses a hazard to engineered structures. The loss of soil strength can result in bearing capacity insufficient to support foundation loads, increased lateral pressure on retaining or basement walls, and slope instability.

Most of the project site is underlain by the Modesto Formation, which consists of generally stable silty clays. Perched groundwater at the project site was observed between 34 and 40 feet below the existing surface (ENGEO 2004). According to historic topographic maps, two intermittent streams meandered through the property: one in the northern portion of the site and one in the southeast corner of the site. The stream channels have been filled at some time in the past and no longer exist at the project site. Liquefaction could be an issue in these areas of recent fill where loose soils and higher groundwater conditions may exist.

## SUBSIDENCE

Land surface subsidence can be induced by both natural and human phenomena. Natural phenomena include: subsidence resulting from tectonic deformations and seismically induced settlements; soil subsidence from consolidation, hydrocompaction, or rapid sedimentation; subsidence from oxidation or dewatering of organic-rich soils; and subsidence related to subsurface cavities. Subsidence related to human activity includes subsurface fluid or sediment withdrawal. Pumping of water for residential, commercial, and agricultural uses from subsurface water tables causes more than 80% of the identified subsidence in the United States. (Galloway et al. 1999). Lateral spreading is the horizontal movement or spreading of soil toward an open face, such as a streambank, the open side of fill embankments, or the sides of levees. The potential for failure from subsidence and lateral spreading is highest in areas where there is a high groundwater table, where there are relatively soft and recent alluvial deposits, and where creek banks are relatively high. Merced County is most affected by subsidence caused by groundwater withdrawal, hydrocompaction, and earthquakes.

The fill that was placed in the historic stream channels noted above may represent a potential for settlement or consolidation that could adversely affect building foundations.

## SLOPE STABILITY

A landslide is the downhill movement of masses of earth material under the force of gravity. The factors contributing to landslide potential are steep slopes, unstable terrain, and proximity to earthquake faults. This process typically involves the surface soil and an upper portion of the underlying bedrock. Expansive soil on slopes tends to shrink and swell in response to moisture content changes. During this shrinking and swelling process, gravity tends to work the soil downslope. Movement may be very rapid, or so slow that a change of position can be noted only over a period of weeks or years (creep). The size of a landslide can range from several square feet to several square miles.

Because the project site is flat, and is not located in close proximity to any steep hillslides where landslides would occur, slope stability should not be an issue at the project site.

## PALEONTOLOGY

### Paleontological Resource Inventory Methods

A stratigraphic inventory was completed to develop a baseline paleontological resource inventory of the project site and surrounding area by rock unit, and to assess the potential paleontological productivity of each rock unit. Research methods included a review of published and unpublished literature and a search for recorded fossil sites at the UC Berkeley Museum of Paleontology. These tasks complied with Society of Vertebrate Paleontology (SVP) (1995) guidelines.

#### *Stratigraphic Inventory*

Geologic maps and reports covering the geology of the project site and surrounding study area were reviewed to determine the exposed rock units and to delineate their respective aerial distributions in the project study area.

#### *Paleontological Resource Inventory*

Published and unpublished geological and paleontological literature were reviewed to document the number and locations and previously recorded fossil sites from rock units exposed in and near the project site and surrounding study area, as well as the types of fossil remains each rock unit has produced. The literature review was supplemented by a database search conducted at the University of California Museum of Paleontology in Berkeley, California on July 31, 2006.

### *Field Survey*

A field reconnaissance was conducted in July 2006 to document the presence of any previously unrecorded fossil sites and of strata that might contain fossil remains. However, the ground surface was completely covered with recently mown hay and a small orchard; therefore, the surface was not visible. The surface topography was nearly flat, and no exposed road cuts or other escarpments were noted where the Modesto Formation was exposed. No fossils were observed at the project site.

## Paleontological Resource Assessment Criteria

The potential paleontological importance of the project site can be assessed by identifying the paleontological importance of exposed rock units within the project area. Because the aerial distribution of a rock unit can be easily delineated on a topographic map, this method is conducive to delineating parts of the project site that are of higher and lower sensitivity for paleontological resources and to delineating parts of the project that may require monitoring during construction.

A paleontologically important rock unit is one that (1) has a high potential paleontological productivity rating and (2) is known to have produced unique, scientifically important fossils. The potential paleontological productivity rating of a rock unit exposed at the project site refers to the abundance/densities of fossil specimens and/or previously recorded fossil sites in exposures of the unit in and near the project site. Exposures of a specific rock unit at the project site are most likely to yield fossil remains representing particular species in quantities or densities similar to those previously recorded from the unit in and near the project site.

An individual vertebrate fossil specimen may be considered unique or significant if it is identifiable and well preserved, and it meets one of the following criteria:

- a type specimen (i.e., the individual from which a species or subspecies has been described);
- a member of a rare species;
- a species that is part of a diverse assemblage (i.e., a site where more than one fossil has been discovered) wherein other species are also identifiable, and important information regarding life history of individuals can be drawn;
- a skeletal element different from, or a specimen more complete than, those now available for its species; or
- a complete specimen (i.e., all or substantially all of the entire skeleton is present).

For example, identifiable vertebrate marine and terrestrial fossils are generally considered scientifically important because they are relatively rare. The value or importance of different fossil groups varies, depending on the age and depositional environment of the rock unit that contains the fossils, their rarity, the extent to which they have already been identified and documented, and the ability to recover similar materials under more controlled conditions, such as part of a research project. Marine invertebrates are generally common, well developed, and well documented. They would generally not be considered a unique paleontological resource.

The following tasks were completed to establish the paleontological importance of each rock unit exposed at or near the project site:

- The potential paleontological productivity of each rock unit was assessed, based on the density of fossil remains previously documented within the rock unit.
- The potential for a rock unit exposed at the project site to contain a unique paleontological resource was considered.

## Paleontologic Resource Inventory Results

### *Stratigraphic Inventory*

Regional and local surficial geologic mapping and correlation of the various geologic units in the vicinity of the project site has been provided at a scale of 1:24,000 by Lettis (1982); 1:125,000 by Marchand and Allwardt (1981); 1:250,000 by Wagner et al. (1991); and 1:500,000 by Bartow (1991).

### *Paleontological Resource Inventory and Assessment by Rock Unit*

#### *Holocene Alluvium*

By definition, to be considered a fossil, an object must be more than 10,000 years old; therefore, project-related activities in this rock formation would have no effect on paleontological resources.

#### *Modesto Formation*

Surveys of late Cenozoic land mammal fossils in northern California have been provided by Hay (1927), Lundelius et al. (1983), Jefferson (1991a, 1991b), Savage (1951), and Stirton (1939). On the basis of his survey of vertebrate fauna from the nonmarine late Cenozoic deposits of the San Francisco Bay region, Savage (1951) concluded that two major divisions of Pleistocene-age fossils could be recognized: the Irvingtonian (older Pleistocene fauna) and the Rancholabrean (younger Pleistocene and Holocene fauna). These two divisions of Quaternary Cenozoic vertebrate fossils are widely recognized today in the field of paleontology. The age of the later Pleistocene, Rancholabrean fauna was based on the presence of bison and on the presence of many mammalian species that are inhabitants of the same area today. In addition to bison, larger land mammals identified as part of the Rancholabrean fauna include mammoths, mastodons, camels, horses, and ground sloths.

Remains of land mammals have been found in the project region at various localities in alluvial deposits referable to the Modesto Formation. Jefferson (1991a, 1991b) compiled a database of California late Pleistocene vertebrate fossils from published records, technical reports, unpublished manuscripts, information from colleagues, and inspection of museum paleontological collections at more than 40 public and private institutions. He listed a number of sites in Merced County that have yielded Rancholabrean vertebrate fossils that could be referable to the Modesto Formation. For example, specimens of Rancholabrean-age horse, camel, and deer were recovered from Bear Creek, several miles north of the project site. Specimens of Rancholabrean-age mammoth and camel were recovered from Planada, approximately 7 miles east of the project site.

A records search of the University of California Museum of Paleontology (UCMP) Paleontology Collections database yielded the following information: Locality V-2049, approximately 8 miles northeast of the project site, yielded one specimen of a Rancholabrean-age elephant. Locality V-6806, approximately 23 miles northwest of the project site, yielded Rancholabrean-age specimens of horse, bison, camel, and Harlan's ground sloth. Locality V-69194, approximately 24 miles northwest of the project site, yielded an unidentified Rancholabrean-age vertebrate fossil specimen.

Specimens from sediments referable to the Modesto Formation have been reported at other locations throughout the San Joaquin Valley (UCMP 2006), including Stockton, Modesto, Tracy (along the Delta-Mendota Canal), and Manteca. The Tranquility site in Fresno County (UCMP V-4401), approximately 60 miles south of the project site, has yielded more than 130 Rancholabrean-age fossils of fish, turtles, snakes, birds, moles, gophers, mice, wood rats, voles, jack rabbits, coyote, red fox, grey fox, badger, horse, camel, pronghorn antelope, elk, deer, and bison from sediments referable to the Modesto Formation.

Results of the paleontological record search at UCMP indicated no fossil remains at the project site, and no fossils were observed during the reconnaissance field visit.

## SOILS

Subsurface investigations of the project site conducted by ENGEO (2004) indicate that the site is underlain by interbedded sandy silts and silty clays, as well as graded sands to a depth of approximately 40 feet. The sand layers are underlain by a consolidated silty clay layer at least 10 feet thick (50 feet was the maximum depth explored by ENGEO). Perched groundwater was encountered at depths of 34 to 40 feet.

Review of the March 1990 U.S. Department of Agriculture, Soil Conservation Service (now called the Natural Resources Conservation Services [NRCS]) *Soil Survey of the Merced Area* (NRCS 1962) indicates that soils types at the project site are as follows:

- Honcut silty clay loam, 0 to 1% slopes
- Landlow silty clay loam, 0 to 1% slopes
- Porterville clay, 0 to 3% slopes
- Wyman clay loam, 0 to 3% slopes
- Wyman clay loam, deep over hardpan, 0 to 1% slopes
- Wyman loam, 0 to 3% slopes
- Yokohl clay loam, 0 to 3% slopes

Exhibit 4.5-1 shows the location of the soils at the project site, and the characteristics of these soils are summarized in Table 4.5-2.

### Expansive Soils

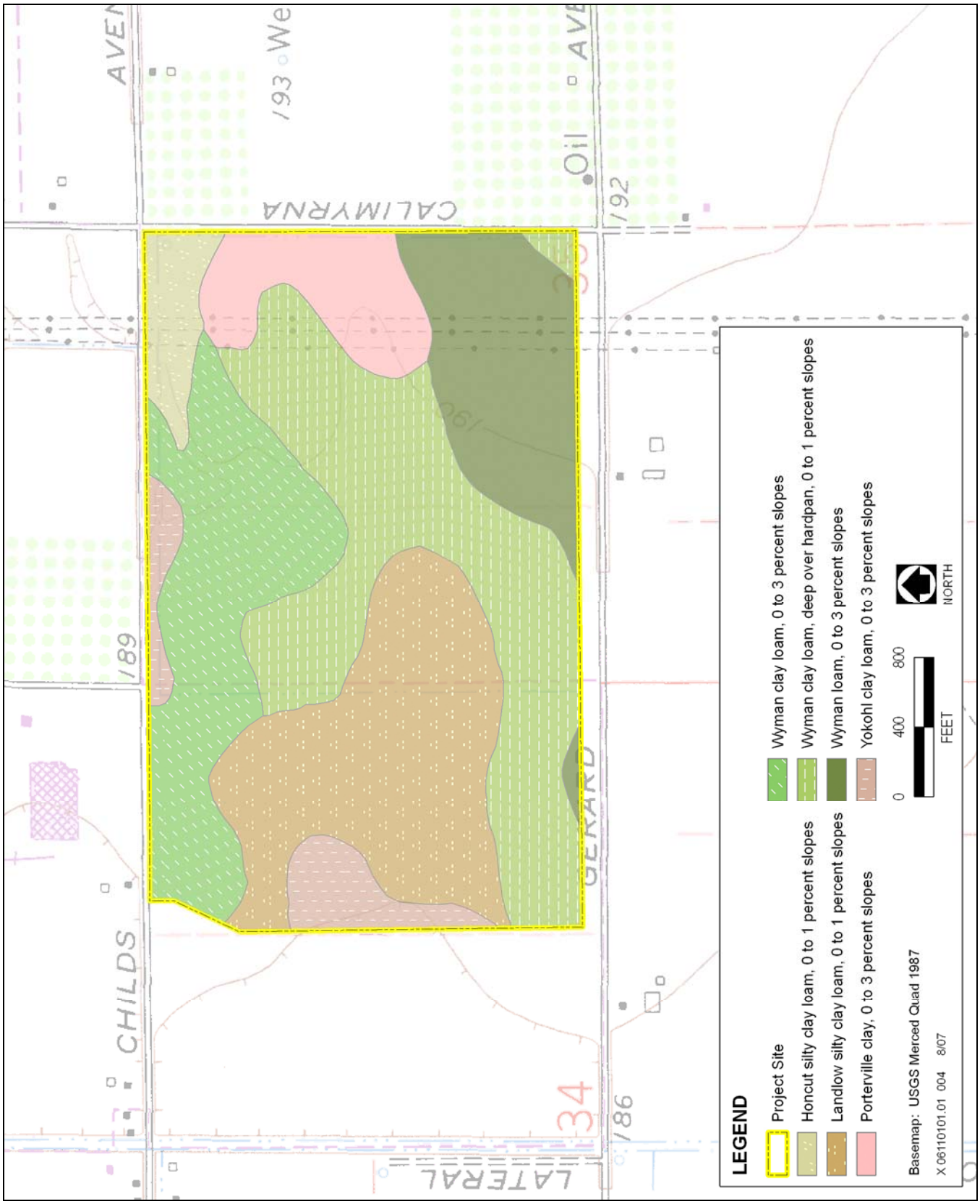
Expansive soils are composed largely of clays, which greatly increase in volume when saturated with water and shrink when dried. Because of this effect, building foundations may rise during the rainy season and fall during the dry season. If this expansive movement varies underneath different parts of a single building, foundations may creak, structural portions of the building may be distorted, and doors and windows may become warped so that they no longer function properly. The potential for soil to undergo shrink and swell is greatly enhanced by the presence of a fluctuating, shallow groundwater table. Volume changes of expansive soils can result in the consolidation of soft clays following the lowering of the water table or the placement of fill.

Soil borings collected by ENGEO (2004) had moderate-to-high plasticity indices (19–29) indicating that soils within the project site have a moderate-to-high shrink/swell potential.

## MINERAL RESOURCES

Mineral extraction in Merced County consists primarily of sand and gravel operations. Active mining is occurring in concentrated locations on both the east and west sides of the County in the alluvial floodplain deposits of the Los Banos Creek and the off-channel floodplain of the Merced River. Sand and gravel are created from years of mountain erosion and from seasonal storms that result in rapid stream movement. Approximately 1 million tons are mined from the County annually, primarily from streambeds and floodplain deposits. Other local mineral resources include gypsum and diatomite in southwestern Merced County, lode gold in the western portion of the County, and clay along the eastern margin of the County.

In compliance with the California Surface Mining and Reclamation Act (SMARA), the California Department of Conservation, Division of Mines and Geology has established a classification system to denote both the location and significance of key extractive resources. An explanation of the classification system for Merced County is presented in Table 4.5-3. Lands are included in one of four categories based on available information indicating their potential to contain mineral deposits.




Source: Data compiled by EDAW 2007

**Project Site Soil Types** **Exhibit 4.5-1**

**Table 4.5-2**
**Characteristics of Soils Found on the Project Site**

| Soil Series Name | Shrink-Swell Potential | Permeability | Drainage | Runoff Potential | T Erosion Factor[1] | pH | % Clay | Limitations |
|---|---|---|---|---|---|---|---|---|
| Honcut silty clay loam | Moderate | Moderately rapid | Well drained | Slow to moderate | 5 | 7.0–7.1 | 30 | Moderate limitation for small commercial buildings (shrink-swell potential)<br>Severe limitation for local roads and streets (low soil strength, shrink-swell potential)<br>Somewhat limited for shallow excavations (cutbank caving) |
| Landlow silty clay loam | High | Slow | Somewhat poorly drained | High | 5 | 7.5–8.0 | 36–46 | Severe limitation for small commercial buildings (flooding, wetness, shrink-swell potential)<br>Severe limitation for local roads and streets (low soil strength, wetness, shrink-well potential, and flooding)<br>Very limited use for shallow excavations (depth to saturated zone, too much clay, cutbanks cave) |
| Porterville clay | High | Slow | Well drained | High | 5 | 7.5 | 50 | Severe limitation for small commercial buildings (shrink-swell potential)<br>Severe limitation for shallow excavations (cutbanks cave, too much clay)<br>Sever limitation for local roads and streets (low soil strength, shrink-swell potential) |
| Wyman clay loam | Moderate | Moderately slow | Well drained | Moderate | 5 | 6.7–7.4 | 23–30 | Moderate limitation for small commercial buildings (shrink-swell potential)<br>Moderate limitation for shallow excavations (cutbanks cave)<br>Severe limitation for local roads and streets (low soil strength, shrink-swell potential) |
| Wyman clay loam over hardpan | Moderate | Moderately slow | Well drained | Moderate | 3 | 6.7–7.2 | 28–30 | Moderate limitation for small commercial buildings (shrink-swell potential)<br>Moderate limitation for shallow excavations (cutbanks caving)<br>Severe limitation for local roads and streets (low soil strength, shrink-well potential) |
| Wyman loam | Moderate | Moderately slow | Well drained | Moderate | 5 | 6.7–7.4 | 21–30 | Moderate limitation for small commercial buildings (shrink-swell potential)<br>Moderate limitation for shallow excavations (cutbanks caving)<br>Severe limitation for local roads and streets (low soil strength, shrink-well potential) |

**Table 4.5-2**
**Characteristics of Soils Found on the Project Site**

| Soil Series Name | Shrink-Swell Potential | Permeability | Drainage | Runoff Potential | T Erosion Factor[1] | pH | % Clay | Limitations |
|---|---|---|---|---|---|---|---|---|
| Yokohl clay loam | High | Slow | Well drained | Very high | 1 | 6.7–7.0 | 30–45 | Severe limitation for small commercial buildings (low depth to cemented hardpan, shrink-well potential)<br>Severe limitation for shallow excavations (low depth to cemented hardpan, cutbanks cave)<br>Severe limitation for local roads and streets (low soil strength, low depth to cemented hardpan, cutbanks cave) |

Source: NRCS 1962, 2006

Notes:

[1] T represents soil loss tolerance, which is defined as the maximum rate of soil erosion (wind and water) without reducing crop production or environmental quality. Values range from 1 to 5 tons of soil loss per acre per year, with 5 representing soils less sensitive to erosion.

**Table 4.5-3**
**California Division of Mines and Geology Mineral Land Classification System, Merced County**

| Classification | Description |
|---|---|
| MRZ-1 | Areas where available geologic information indicates that little likelihood exists for the presence of significant mineral resources |
| MRZ-2a | Areas underlain by mineral deposits where geologic data indicate that significant measured or indicated resources are present |
| MRZ-2b | Areas underlain by mineral deposits where geologic information indicates that significant inferred resources are present |
| MRZ-3a | Areas containing known mineral occurrences of undetermined mineral resource significance |
| MRZ-3b | Areas containing inferred mineral occurrences of undetermined mineral resources significance |
| MRZ-4 | Areas of no known mineral occurrences where geologic information does not rule out either the presence or absence of significant mineral resources.[1] |

Notes: MRZ = Mineral Resource Zone

[1] MRZ-4 classification does not imply that there is little likelihood for the presence of mineral resources, but rather there is a lack of knowledge regarding mineral occurrence. Further exploration work in MRZ-4 areas could result in the reclassification of land to MRZ-3 or MRZ-2 categories.

Source: Clinkenbeard 1999

The project site is located in an area designated by CDMG as MRZ-1: areas where available geologic information indicates that little likelihood exists for the presence of significant mineral resources. The site is underlain by interbedded sandy silts and silty clays (ENGEO 2004). There are no economically viable deposits of clean sand or gravel that would be useful to extract for riprap, aggregate, or other industrial uses.

## 4.5.2 REGULATORY SETTING

### FEDERAL PLANS, POLICIES, REGULATIONS, AND LAWS

#### Earthquake Hazards Reduction Act

In October 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act to reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program. To accomplish this, the act established the National Earthquake Hazards Reduction Program (NEHRP). This program was significantly amended in November 1990 by the National Earthquake Hazards Reduction Program Act (NEHRPA) by refining the description of agency responsibilities, program goals, and objectives.

The mission of NEHRP includes improved understanding, characterization, and prediction of hazards and vulnerabilities; improved building codes and land use practices; risk reduction through post-earthquake investigations and education; development and improvement of design and construction techniques; improved mitigation capacity; and accelerated application of research results. The NEHRPA designates the Federal Emergency Management Agency as the lead agency of the program and assigns several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, National Science Foundation, and U.S. Geological Survey.

### STATE PLANS, POLICIES, REGULATIONS, AND LAWS

#### Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Act (Public Resources Code Sections 2621–2630) was passed in 1972 to mitigate the hazard of surface faulting to structures designed for human occupancy. The main purpose of the law is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The law addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Alquist-Priolo Act requires the State Geologist to establish regulatory zones known as "Earthquake Fault Zones" around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning efforts. Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults.

#### Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 (Public Resources Code Sections 2690–2699.6), addresses earthquake hazards from nonsurface fault rupture, including liquefaction and seismically induced landslides. The act established a mapping program for areas that have the potential for liquefaction, landslide, strong ground shaking, or other earthquake and geologic hazards. The Act also specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

#### National Pollutant Discharge Elimination System Permit

In California, the State Water Resources Control Board (SWRCB) administers regulations promulgated by the U.S. Environmental Protection Agency (55 Code of Federal Regulations 47990) requiring the permitting of stormwater-generated pollution under the National Pollutant Discharge Elimination System (NPDES). In turn, the SWRCB's jurisdiction is administered through nine regional water quality control boards. Under these federal regulations, an operator must obtain a general permit through the NPDES Stormwater Program for all construction activities with ground disturbance of 1 acre or more. The general permit requires the implementation

of best management practices to reduce sedimentation into surface waters and control erosion. One element of compliance with the NPDES permit is preparation of a Storm Water Pollution Protection Plan (SWPPP) that addresses control of water pollution, including sediment, in runoff during construction. (See Section 4.6, "Hydrology and Water Quality," for more information about NPDES and SWPPPs.)

### California Building Standards Code

The State of California provides minimum standard for building design through the CBC (California Code of Regulations, Title 24). Where no other building codes apply, Chapter 29 regulates excavation, foundations, and retaining walls. The CBC applies to building design and construction in the state and is based on the federal Uniform Building Code (UBC) used widely throughout the country (generally adopted on a state-by-state or district-by-district basis). The CBC has been modified for California conditions with numerous more detailed and/or more stringent regulations.

The state earthquake protection law (California Health and Safety Code Section 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. Specific minimum seismic safety and structural design requirements are set forth in Chapter 16 of the CBC. The CBC identifies seismic factors that must be considered in structural design.

Chapter 18 of the CBC regulates the excavation of foundations and retaining walls, and Appendix Chapter A33 regulates grading activities, including drainage and erosion control, and construction on unstable soils, such as expansive soils and areas subject to liquefaction.

### California Surface Mining and Reclamation Act

SMARA (Public Resources Code Section 2710 et seq.) was enacted by the State Legislature in 1975 to regulate activities related to mineral resource extraction. The act requires the prevention of adverse environmental effects caused by mining, the reclamation of mined lands for alternative land uses, and the elimination of public health and safety hazards from the effects of mining activities. At the same time, SMARA encourages both the conservation and production of extractive mineral resources, requiring the State Geologist to identify and attach levels of significance to the state's varied extractive resource deposits. Under SMARA, the mining industry in California must adequately plan for the reclamation of mined sites for beneficial uses and provide financial assurances to guarantee that the approved reclamation will actually be implemented. The requirements of SMARA must be implemented by the local lead agency with permitting responsibility for the proposed mining project.

## LOCAL PLANS, POLICIES, REGULATIONS, AND ORDINANCES

### City of Merced General Plan

The following policies of the City of Merced 2015 General Plan are applicable to the proposed project:

#### *Safety Element*

**GOAL AREA 2:** Seismic Safety. Reasonable safety for City residents from the hazards of earthquake and other geologic activity.

- **Policy S-2.3:** Restrict urban development in all areas with potential ground failure characteristics

### Professional Paleontological Standards

SVP (1995, 1996), a national scientific organization of professional vertebrate paleontologists, has established standard guidelines that outline acceptable professional practices in the conduct of paleontological resource

assessments and surveys, monitoring and mitigation, data and fossil recovery, sampling procedures, specimen preparation, analysis, and curation. Most practicing professional paleontologists in the nation adhere to the SVP assessment, mitigation, and monitoring requirements, as specifically spelled out in its standard guidelines. The criteria for determining sensitivity of paleontological resources are described below under "Method of Analysis" and "Thresholds of Significance."

## 4.5.3 ENVIRONMENTAL IMPACTS

### METHOD OF ANALYSIS

Evaluation of potential geologic and soil impacts was based on a review of documents pertaining to the project site, including the County General Plan (Merced County 1990), the U.S. Department of Agriculture Soil Conservation Service (SCS) *Merced Area Soil Survey* (SCS 1991) geologic maps, and published and unpublished geologic literature. The information obtained from these sources was reviewed and summarized to establish existing conditions and to identify potential environmental effects, based on the standards of significance presented in this section.

In its standard guidelines for assessment and mitigation of adverse impacts on paleontological resources, SVP (1995) established three categories of sensitivity for paleontological resources: high, low, and undetermined. Areas where fossils have been previously found are considered to have a high sensitivity and a high potential to produce fossils. In areas of high sensitivity that are likely to yield unique paleontological resources, full-time monitoring is typically recommended during any project-related ground disturbance. Areas that are not sedimentary in origin and that have not been known to produce fossils in the past typically are considered to have low sensitivity and monitoring is usually not needed during project construction. Areas that have not had any previous paleontological resource surveys or fossil finds are considered to be of undetermined sensitivity until surveys and mapping are performed to determine their sensitivity. After reconnaissance surveys, observation of exposed cuts, and possibly subsurface testing, a qualified paleontologist can determine whether the area should be categorized as having high or low sensitivity. In keeping with the significance criteria of SVP (1995), all vertebrate fossils are generally categorized as being of potentially significant scientific value.

### THRESHOLDS OF SIGNIFICANCE

Based on Appendix G of the State CEQA Guidelines, a geology, soils, or mineral resources impact is considered significant if implementation of the proposed project would do any of the following:

- expose people or property to seismic hazards, including fault rupture, strong seismic ground shaking, or seismically induced ground failure, including liquefaction;

- expose persons or property to geologic hazards such as landslides, land subsidence, or expansive soils;

  Because the project site is located in an area of relatively flat topography, there would be no hazard related to landslides, and this impact is not evaluated further in this DEIR.

- result in substantial erosion or unstable soil conditions from excavation grading or fill; or

- result in the loss of availability of known mineral resources that would be of future value to the region or result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan.

  Because the project site is underlain by interbedded sandy silts and silty clays and does not contain any known mineral resources that would be of future value to the region, this impact is not evaluated further in this DEIR.

- Based on Appendix G of the State CEQA Guidelines, viewed in light of the professional paleontological standards described above, significant adverse environmental impacts on paleontological resources would result if the proposed project would directly or indirectly destroy a unique paleontological resource or site. For the purposes of this DEIR, an individual vertebrate fossil specimen may be considered unique or significant if it is identifiable and well preserved, and it meets one of the following criteria:

  - a type specimen (i.e., the individual from which a species or subspecies has been described);
  - a member of a rare species;
  - a species that is part of a diverse assemblage; (i.e., a site where more than one fossil has been discovered) wherein other species are also identifiable, and important information regarding life history of individuals can drawn;
  - a skeletal element different from, or a specimen more complete than, those now available for its species; or
  - a complete specimen (i.e., all or substantially all of the entire skeleton is present).

  The value or importance of different fossil groups varies depending on the age and depositional environment of the rock unit that contains the fossils, their rarity, the extent to which they have already been identified and documented, and the ability to recover similar materials under more controlled conditions (such as for a research project). Marine invertebrates are generally common; the fossil record is well developed and well documented, and they would generally not be considered a unique paleontological resource. Identifiable vertebrate marine and terrestrial fossils are generally considered scientifically important because they are relatively rare.

## IMPACT ANALYSIS

IMPACT 4.5-1 Disturbance of Paleontological Resources during Earth-Moving Activities. *Previously undiscovered paleontological resources could be present in sediments of the Modesto Formation that underlie the project site. Therefore, construction activities could potentially disturb unknown subsurface paleontological resources. Destruction of "significant" paleontological resources would be a* ***potentially significant*** *impact.*

Based on the record search conducted at UCMP, no previously recorded fossil sites are located at the project site. However, as detailed in the "Paleontological Resources Inventory and Assessment by Rock Unit" contained earlier in this section, the project site is located within sediments of the Modesto Formation, which is a paleontologically sensitive rock unit under the SVP guidelines (1995, 1996). Locality V-2049, approximately 8 miles northeast of the project site, yielded one specimen of a Rancholabrean-age elephant. Locality V-6806, approximately 23 miles northwest of the project site, yielded Rancholabrean-age specimens of horse, bison, camel, and Harlan's ground sloth. Locality V-69194, approximately 24 miles northwest of the project site, yielded an unidentified Rancholabrean-age vertebrate fossil specimen. Specimens from sediments referable to the Modesto Formation have been reported at other locations throughout the San Joaquin Valley (UCMP 2006), including Stockton, Modesto, Tracy (along the Delta-Mendota Canal), and Manteca.

The occurrence of numerous Pleistocene vertebrate fossil remains in sediments referable to the Modesto Formation throughout the San Joaquin Valley suggests that the potential exists for uncovering additional similar fossil remains during construction-related earth-moving activities at the project site. Because the potential exists for proposed earth-moving activities at the project site to uncover or disturb previously undiscovered paleontological resources, this would be a ***potentially significant*** impact.

Mitigation Measure 4.5-1: Implement Construction Personnel Training and Recover Paleontological Resources if Encountered. To minimize potential adverse impacts on unique, scientifically important paleontological resources, the project applicant shall do the following:

- Before the start of grading or excavation activities, construction personnel involved with earth-moving activities shall be informed of the possibility of encountering fossils, the appearance and types of fossils likely to be seen during construction activities, and proper notification procedures should fossils be encountered. This worker training shall be prepared and presented by a qualified paleontologist or archaeologist.

- If paleontological resources are discovered during earth-moving activities, the construction crew shall immediately cease work in the vicinity of the find and shall notify the City planning department. The project applicant shall retain a qualified paleontologist to evaluate the resource and prepare a proposed mitigation plan in accordance with SVP guidelines (1995). The proposed mitigation plan may include a field survey, construction monitoring, sampling and data recovery procedures, museum storage coordination for any specimen recovered, and a report of findings. Recommendations determined by the lead agency to be necessary and feasible shall be implemented before construction activities can resume at the site where the paleontological resources were discovered.

Implementation of Mitigation Measure 4.5-1 would result in avoidance of damage to, and further study of, any paleontological resources that were encountered by project-related activities, and would therefore reduce potentially significant impacts of the proposed project on unique, scientifically important paleontological resources to a ***less-than-significant*** level.

IMPACT 4.5-2 Risks to People and Structures from Surface Fault Rupture and Strong Seismic Ground Shaking. *The project site is located in an area of low seismic activity and structures at the site would be designed in accordance with CBC standards. Therefore, this impact is considered* ***less than significant****.*

The project site is not located in a known fault zone and no faults known to be active within Holocene time are located within 30 miles of the project site; therefore, the potential for surface fault rupture to cause damage to proposed structures is improbable. Although the project site could be subject to seismic ground shaking from faults 30 miles west of the project site in the Coast Range, compliance with the CBC would require the site's seismic-design response spectrum to be established and incorporated into the design of all new buildings. Roadways, utilities, and structures would be designed to withstand seismic forces per CBC requirements for Seismic Zone 3. Therefore, potential damage to structures from surface fault rupture and strong seismic ground shaking would be a ***less-than-significant*** impact.

Mitigation Measure

No mitigation is required.

IMPACT 4.5-3 Risks to People and Structures from Seismically-Induced Liquefaction and/or Subsidence. *While the project site is located in an area of low seismic activity, localized areas of the project site may pose a hazard related to liquefaction and/or subsidence if seismic activity were to occur. Therefore, this impact is considered* ***potentially significant****.*

The project site could be subject to seismic ground shaking from faults 30 miles west of the project site in the Coast Range. Most of the project site is underlain by the Modesto Formation, which consists of generally stable silty clays. Perched groundwater at the project site was observed between 34 and 40 feet below the existing surface (ENGEO 2004). According to historic topographic maps, two intermittent streams meandered through the property: one in the northern portion of the site and one in the southeast corner of the site. The stream channels have been filled at some time in the past and no longer exist at the project site. Because of the potentially unstable

nature of the fill materials and the perched groundwater located near the ground surface, the liquefaction and subsidence hazards in and around the historic streambeds are considered ***potentially significant***.

Mitigation Measure 4.5-3a: Prepare a Final Geotechnical Design Report and Implement All Applicable Recommendations. Before the approval of grading plans for all project phases, a final geotechnical subsurface investigation report shall be prepared by the project applicant(s) for the proposed development and shall be submitted to the City. The final geotechnical engineering report shall address and make recommendations on the following:

- site preparation;
- appropriate sources and types of fill;
- potential need for soil amendments;
- road, pavement, and parking areas;
- structural foundations, including retaining wall design;
- grading practices;
- erosion/winterization;
- expansive/unstable soils; and
- liquefaction.

The geotechnical investigation shall include subsurface testing of soil and groundwater conditions and determine appropriate foundation designs that are consistent with the CBC. Recommendations contained in the geotechnical engineering report shall be noted on the grading plans and implemented as appropriate before the issuance of building permits. Design and construction of all new development in all phases of the project shall be in accordance with the CBC. It is the responsibility of the project applicant(s) to provide for engineering inspection and certification that earthwork has been performed in conformity with recommendations contained in the report.

Mitigation Measure 4.5-3b: Provide On-Site Construction Monitoring by a Geotechnical Engineer. All earthwork shall be monitored by a geotechnical engineer retained by the project applicant(s). The geotechnical engineer shall provide oversight during all excavation, placement of fill, and disposal of materials removed from and deposited on the subject site and other sites. Before export/import of any soil to/from an off-site location, the project applicant(s) shall obtain a grading permit from the City Inspection Services Division.

With implementation of Mitigation Measures 4.5-3a and 4.5-3b, potentially significant impacts related to construction in areas susceptible to liquefaction and/or subsidence would be reduced to a ***less-than-significant*** level because buildings and structures would incorporate design recommendations of a geotechnical engineer and on-site monitoring by a geotechnical engineer would provide for appropriate correction in grading activities if unexpected pockets of loose or unstable soils were encountered.

IMPACT 4.5-4 Potential Temporary, Short-Term Construction-Related Erosion. *Construction activities during project implementation would involve grading and movement of earth, which could expose soils to erosion and result in the loss of topsoil. This impact is considered* ***potentially significant****.*

Project implementation would include construction activity that would result in the temporary disturbance of soil and would expose disturbed areas to winter storm events. Rain of sufficient intensity could dislodge soil particles from the soil surface. Once particles are dislodged and the storm is large enough to generate runoff, localized erosion could occur. In addition, soil disturbance during the summer months could result in loss of topsoil because of wind erosion. Therefore, a ***potentially significant*** impact from soil erosion could result from construction activities associated with the project.

Mitigation Measure 4.5-4: Prepare and Implement a Grading and Erosion Control Plan. A grading and erosion control plan shall be prepared by a California Registered Civil Engineer retained by the project applicant(s) for all project phases. The grading and erosion control plan shall be submitted to the City Inspection Services Division before

issuance of grading permits for all new development within the project site. The plan shall be consistent with Appendix Chapter A33 of the CBC as well as the City's National Pollutant Discharge Elimination System (NPDES) permit and shall include the site-specific grading associated with development for all project phases. The plan shall include the location, implementation schedule, and maintenance schedule of all erosion and sediment control measures, a description of measures designed to control dust and stabilize the construction-site road and entrance, and a description of the location and methods of storage and disposal of construction materials. Erosion and sediment control measures could include the use of detention basins, berms, swales, wattles, and silt fencing. Stabilization of construction entrances to minimize trackout (control dust) is commonly achieved by installing filter fabric and crushed rock to a depth of approximately 1 foot. The project applicant(s) shall ensure that the construction contractor is responsible for securing a source of transportation and deposition of excavated materials.

Implement Mitigation Measures 4.5-4 and 4.6-1a.

Implementation of Mitigation Measures 4.5-4 and 4.6-1a would reduce the potentially significant impacts associated with construction-related erosion hazards to a ***less-than-significant*** level because a grading and erosion control plan and a Storm Water Pollution Prevention Plan, which would contain specific Best Management Practices to reduce erosion, would be prepared and implemented.

IMPACT 4.5-5 Potential Damage to Structures from Construction on Expansive Soils. *Portions of the project site are underlain by soils that have a moderate to high potential for expansion when wet. Construction in these soils may result in foundation movements that could cause damage to overlying structures. This impact is considered* ***significant****.*

Expansive soils shrink and swell as a result of moisture change. These volume changes can result in damage over time to building foundations, underground utilities, and other subsurface facilities if they are not designed and constructed appropriately to resist the changing soil conditions. Volume changes of expansive soils also can result in the consolidation of soft clays following the lowering of the water table or the placement of fill.

Portions of the project site are underlain by clayey soils with a moderate to high expansion potential. Soil expansion could pose problems for foundation design of structures and roadways. Furthermore, these soils could be subjected to volume changes during seasonal fluctuations in moisture content, which could adversely affect interior slabs-on-grade and landscaping hardscapes. Therefore, the potential damage to structures from construction in areas of expansive soils is considered a ***significant*** impact.

Mitigation Measure 4.5-5: Implement Mitigation Measures 4.5-3a and 4.5-3b.

With implementation of Mitigation Measures 4.5-3a and 4.5-3b, significant impacts related to construction on expansive soils would be reduced to a ***less-than-significant*** level because buildings and structures would incorporate design recommendations of a geotechnical engineer and on-site monitoring by a geotechnical engineer would provide for appropriate correction in grading activities if unexpected pockets of expansive soils were encountered.