4.7 GEOLOGY, SOILS, AND MINERAL RESOURCES

This section includes a description of the existing geology, soils, and mineral resources in the planning area and an evaluation of how adoption and implementation of the Draft General Plan and GGRP would affect these resources.

4.7.1 REGULATORY SETTING

FEDERAL PLANS, POLICIES, REGULATIONS, AND LAWS

The U. S. Department of Agriculture Natural Resources Conservation Service (NRCS) produces soil surveys that assist planners in determining which land uses are suitable for specific soil types and locations.

STATE PLANS, POLICIES, REGULATIONS, AND LAWS

California Geologic Survey

The California Geological Survey (CGS) provides regulatory information pertaining to soils, geology, mineral resources, and geologic hazards. CGS maintains and provides information about California's nonfuel mineral resources. California ranks second in the United States in nonfuel mineral production. In 2007, more than 30 nonfuel commodities were produced from 660 California mines (CGS 2008).

Surface Mining and Reclamation Act of 1975

SMARA requires all jurisdictions to incorporate mapped mineral resources designations approved by the California Mining and Geology Board within their general plans. SMARA was enacted to limit new development in areas with significant mineral deposits. The California Department of Conservation's Office of Mine Reclamation and the California Mining and Geology Board are jointly charged with ensuring proper administration of the act's requirements. The California Mining and Geology Board promulgates regulations to clarify and interpret the act's provisions and also serves as a policy and appeals board. The Office of Mine Reclamation provides an ongoing technical assistance program for lead agencies and operators, maintains a database of mine locations and operational information statewide, and is responsible for compliance-related matters (OMR 2008). No mineral resources are currently being mined or produced in the Citrus Heights planning area.

Alquist-Priolo Earthquake Fault Zoning Act of 1972

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. There are no Alquist-Priolo Earthquake Fault Zones in the planning area (CGS 2007).

California Seismic Hazards Mapping Act of 1990

The Seismic Hazards Mapping Act of 1990 directs CGS to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides, and amplified ground shaking. The purpose of the act is to reduce threats to public safety and to minimize loss of life and property by identifying and mitigating these seismic hazards. The Seismic Hazards Mapping Act was passed by the California Legislature after the 1989 Loma Prieta earthquake. There are no Zones of Required Investigation in the planning area (CGS 2009).

California Building Standards Code

The State of California provides minimum standards for building design through the California Building Standards Code (CBC, California Code of Regulations [CCR] Title 24). Information on current code requirements can be found on the California Building Standard Commission's website (http://www.bsc.ca.gov/). The CBC applies to all occupancies throughout the state unless local amendments have been adopted, and includes regulations for seismic safety, excavation of foundations and retaining walls, and grading activities (including drainage and erosion control and construction on unstable soils).

The 2010 CBC became effective on January 1, 2011, and updated all the subsequent codes under CCR Title 24. The 2010 CBC uses Seismic Design Categories A through F (where F requires the most earthquake-resistant design) for structures designed for a project site. These Seismic Design Categories provide protection through "collapse prevention," meaning that structures are designed to prevent collapse from the maximum level of ground shaking that could occur. Chapter 16 of the CBC specifies exactly how each seismic design category is to be determined on a site-specific basis depending on soil characteristics and proximity to potential seismic hazards.

Chapter 18 of the CBC regulates the excavation of foundations and retaining walls. This chapter describes the preparation of a preliminary soil report, engineering geologic report, geotechnical report, and supplemental ground-response report. Chapter 18 also describes analysis of expansive soils and the determination of the depth to groundwater table. For Seismic Design Category C, Chapter 18 requires analysis of slope instability, liquefaction, and surface rupture attributable to faulting or lateral spreading. For Seismic Design Categories D, E, and F, Chapter 18 requires these same analyses, plus an evaluation of lateral pressures on basement and retaining walls, liquefaction and soil strength loss, and lateral movement or reduction in foundation soil-bearing capacity. It also addresses mitigation measures to be considered in structural design, which may include ground stabilization, selecting appropriate foundation type and depths, selecting appropriate structural systems to accommodate anticipated displacements, or any combination of these measures. The potential for liquefaction and soil strength loss must be evaluated for site-specific peak ground acceleration magnitudes and source characteristics consistent with the design earthquake ground motions.

REGIONAL AND LOCAL PLANS, POLICIES, REGULATIONS, AND LAWS

The City of Citrus Heights is responsible for implementation of state and federally mandated laws and regulations related to geology and soils before permitting projects. In addition, several portions of the Municipal Code relate to geology, soils, and other geologic hazards.

Citrus Heights Municipal Code

Chapter 18 of the Municipal Code provides regulations for buildings and construction. Article 4 of the City's building code adopts by reference the California Building Code Part 2, 2007 Edition, which is based on the 2006 International Building Code. Article 12 includes land grading and erosion control requirements to minimize the degradation of water quality and water courses; disruption of drainage flows from land preparation and development activities; and sediment and pollutant runoff from construction activities.

4.7.2 ENVIRONMENTAL SETTING

This section presents the geologic and seismic hazards, as well as the soil and mineral resources in the planning area.

TOPOGRAPHY AND REGIONAL GEOLOGY

The planning area is located in the Sacramento Valley, which forms the northern portion of the Great Valley geomorphic province of California. The Great Valley is an alluvial plain approximately 50 miles wide and 400 miles long that lies between the mountains and foothills of the Sierra Nevada to the east and the Coast Ranges to the west. It was once an arm of the ocean that became isolated by mountain ranges as they formed and eventually rose above sea level. As a result, the valley is underlain by an asymmetrical depression (formed by intersecting, downward sloping folds of bedrock) in which marine sediments from the receding ocean were followed more recently by river deposits (alluvial deposits) washing down from the Sierra Nevada and the Klamath, Cascade, and Coast Ranges.

The Great Valley covers more than 6,500 square miles and fills a northwest-trending structural depression bounded on the west by the Great Valley fault zone and the Coast Ranges and on the east by the Sierra Nevada and the Foothills fault zone. Relatively few faults in the Great Valley have been active during the last 10,000 years. Most of the surface of the Great Valley is covered with Holocene and Pleistocene-age alluvium, composed primarily of sediments from the Sierra Nevada and the Coast Ranges that were carried by water and deposited on the valley floor. Siltstone, claystone, and sandstone are the primary types of sedimentary deposits. Older Tertiary deposits underlie the Quaternary alluvium (Hackel 1966, Cherven and Graham 1983).

The Great Valley is divided into various geomorphic subunits characterized by Holocene deposits, including the low-lying Delta lands that extend along Sacramento County’s western boundary. This region was previously covered with tidal marshes and sloughs. Currently, this area has been drained and numerous islands have been created by the construction of the levee system. Citrus Heights is located within the Delta geomorphic subunit, a Holocene floodplain containing peat deposits (Jennings 1985).

Riverbank Formation

Sediments in the Riverbank Formation consist of weathered reddish gravel, sand, and silt that form alluvial terraces and fans. In the Sacramento Valley, this formation contains more mafic rock fragments than the San Joaquin Valley and thus tends toward stronger soil-profile developments that are more easily distinguishable from the Modesto Formation (Helley and Harwood 1985). Estimates place the age of the Riverbank Formation between 130,000 and 450,000 years BP (Helley and Harwood 1985). The Riverbank Formation is located in the southwestern portion of the planning area along Cripple Creek and Arcade Creek.

Turlock Lake Formation

The Turlock Lake Formation was named by Davis and Hall (1959) as the oldest subdivision of the Victor Formation. Sediments of the Turlock Lake Formation consist of weathered arkosic gravels with small amounts of metamorphic rock fragments and quartz pebbles. The Turlock Lake Formation is Pleistocene in age and is oldest of the sediments exposed in the project area. Estimates place the age of the Turlock Lake between 450,000 and 600,000 years BP (Helley and Harwood 1985). This formation represents eroded alluvial fans derived primarily from the plutonic rocks of the Sierra Nevada to the east.

The Turlock Lake Formation is from the early to middle Pleistocene period and is older than the Riverbank Formation. Sediments in the Turlock Lake Formation consist of brown to tan sandstone and siltstone. The Turlock Lake Formation is found throughout the planning area.

VOLCANIC ACTIVITY

The planning area is within the Northern Coast Range region of the Pacific Mountain System. The Pacific Mountain System region is one of the most geologically young and tectonically active regions in North America (USGS 2006). The generally rugged, mountainous landscape of this province provides evidence of ongoing mountain building. The Pacific Mountain System straddles the boundaries between several of Earth's moving plates—the source of the monumental forces required to build the sweeping arc of mountains that extends from Alaska to the southern reaches of South America. This province includes the active and sometimes deadly volcanoes of the Cascade Range and the young, steep mountains of the Pacific Border and the Sierra Nevada.

Nearby volcanoes and volcanic areas include Mount Lassen (potentially active, approximately 120 miles north of Citrus Heights), the Sutter Buttes (not active, approximately 45 miles northwest of the planning area), and the Clear Lake volcanic field (potentially active, located approximately 80 miles west/northwest of Citrus Heights) (Jennings 1994, USGS 2003).

The Sutter Buttes, although formed by volcanic activity, are not considered active or potentially active. The most recent known eruptive activity at the Sutter Buttes took place approximately 1.4 million years ago (Jennings 1994). The most recent eruptive activity reported in the Clear Lake field occurred approximately 10,000 years ago (Wood and Kienle 1990). Volcanism in the Clear Lake volcanic field is considered to be largely nonexplosive. One major airfall tuff and no ash flows have occurred in this field. Eruptive activity at Mount Lassen has occurred more recently (as recently as 1917).

The planning area is not located within any of the identified volcanic fields, nor is the planning area located within an Area Subject to Potential Hazards from Future Eruptions (Miller 1989). There are no known risks associated with volcanic activity in the planning area.

SEISMICITY

Seismic activity may result in geologic and seismic hazards: seismically induced fault displacement and rupture, ground shaking, liquefaction, lateral spreading, landslides and avalanches, and structural hazards.

Earthquakes are measured based on either energy released (Richter Magnitude scale) or the intensity of ground shaking at a particular location (Modified Mercalli scale). The Richter Magnitude scale measures the magnitude of an earthquake based on the logarithm of the amplitude of waves recorded by seismographs, with adjustments made for the variation in the distance between the various seismographs and the epicenter of the earthquake. The Richter scale starts with 1.0 and has no maximum limit. The scale is logarithmic—an earthquake with a magnitude of 2.0 is 10 times the magnitude (30 times the energy) of an earthquake with a magnitude of 1.0. The Modified Mercalli scale is an arbitrary measure of earthquake intensity; it does not have a mathematical basis. This scale is composed of 12 increasing levels of intensity that range from imperceptible shaking (Scale I) to catastrophic destruction (Scale XII). Table 4.7-1 provides a description of the Modified Mercalli Intensity scale.

Faults

The planning area is located within an area of California with relatively low seismic activity and is not located within a highly active fault zone. Seismic activity may result in geologic and seismic hazards, including seismically induced fault displacement and rupture, ground shaking, liquefaction, lateral spreading, landslides and avalanches, and structural hazards. Nearby fault systems and associated seismic hazards are described below.

Major faults located within 60 miles of Citrus Heights are listed in Table 4.7-2. The closest known active fault mapped by the California Division of Mines and Geology is the Foothills Fault Zone which is located approximately 15 miles northeast of Citrus Heights. Other active or potentially active faults that may be a hazard to the area include Green Valley-Concord, Hayward, San Andreas, and Calaveras. Known fault traces in the vicinity of the City are shown on Exhibit 4.7-1.

Ground Shaking

According to the Probabilistic Seismic Hazard Assessment for the State of California (CDMG 1996, p. 22), the planning area is not believed to have experienced earthquake-induced ground shaking of MMI VII or greater (the level at which damage to unreinforced masonry buildings would be expected) between 1800 and 1996.

Table 4.7-1
Modified Mercalli Index

Intensity	Effect
I	Not felt. Marginal and long period effects of large earthquakes.
II	Felt by persons at rest, on upper floors, or favorably placed.
III	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
IV	Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frame creak.
V	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
VI	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).
VII	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
VIII	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
IX	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
X	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
XI	Rails bent greatly. Underground pipelines completely out of service.
XII	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Notes:

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

Source: ABAG 2003

Table 4.7-2 Active & Potentially Active Regional Faults				
Fault	Location Relative to Planning Area	Earthquake Year / Location	Historic Activity[a]	MCE[b]
Midland Fault[c]	32 miles W	Pre-Quaternary (older than 1.6 m.y.)	--	7.0
Dunnigan Hills[c]	35 miles W	Holocene (200–10,000 y.)	--	6.5
Unnamed Fault (Coast Range-Sierran Block)	45 miles W	1892, Vacaville-Winters	6.5-7.0	7.0
Green Valley-Concord	60 miles SW	Holocene (200–10,000 y.)	Creep[e]	7.0
Foothills Fault System[d]	15 miles NE	1975 Oroville	5.7	6.5
Coast Range-Sierra Block Boundary	35 miles SW	1892 Vacaville-Winters	--	7.0
Hayward	60 miles SW	1836, 1868	6.8	6.5-7.0
Calaveras	50 miles SW	1861	6.1	6.5-7.0
San Andreas	80 miles SW	1906, 1989 Loma Prieta	7.1	8.3

Notes:

[a] Historic activity refers to the magnitude of past events that have been recorded in the historical record.

[b] MCE is the Maximum Credible Earthquake, defined as the strongest earthquake that is likely to be generated along an active fault zone, based on the geologic character of the fault and the earthquake history

[c*] Evidence of Quaternary (i.e. less than 1.6 million years old) faulting is not definitive for this fault zone.

[d] Evidence of Late Quaternary (i.e. less than 100,000 years) faulting is not definitive for this entire fault zone.

[e] Creep refers to slow, more or less continuous movement occurring on faults due to ongoing tectonic deformation.

Sources: Placer County, 1997; El Dorado County, 1997; USGS, 2009

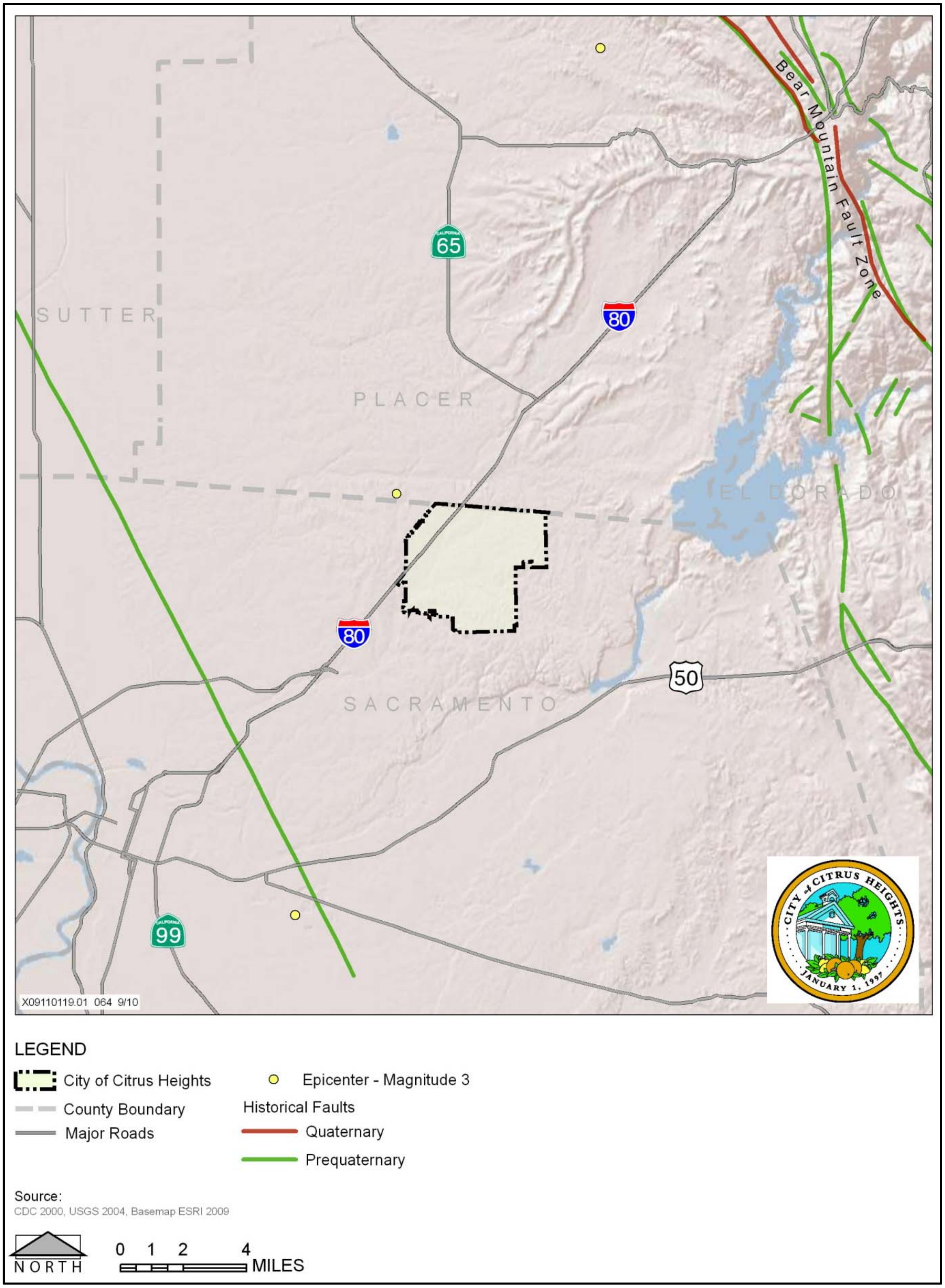
Liquefaction

Liquefaction, which may occur under strong ground shaking during earthquakes, is the transformation of granular sediment or fill material from a solid state to a temporarily liquid state. Liquefaction is a serious hazard because buildings on ground which undergoes liquefaction may sink or suffer major structural damage. Evidence of liquefaction may be observed in “sand boils,” which are expulsions of sand and water from below the surface due to increased pore-water pressure below the surface. Liquefaction during an earthquake requires strong shaking continuing for a long time period and loose, clean granular materials (particularly sands) that may settle and compact because of the shaking.

There are two areas within Sacramento County with liquefaction potential based on depth to water and soil characteristics: the Sacramento-San Joaquin River Delta and the downtown area of the City of Sacramento (Sacramento County 2010, 13-7). The Citrus Heights planning area was not identified as having liquefaction potential. The depth to the water table and the underlying geologic materials within the planning area do not support high liquefaction potential.

Tsunamis and Seiches

Tsunamis are long-period waves commonly caused by vertical faulting of the ocean floor. Such earthquake-associated waves (often erroneously called tidal waves) can cause considerable damage when they reach shallow coastal areas. A seiche is a stationary wave produced in reservoirs, lakes, and other closed or restricted bodies of water by ground shaking. The phenomenon is similar to the oscillations which result when a bowl of water is shaken. When they occur in large reservoirs, such waves can cause overtopping of dams, posing a serious threat to adjacent areas.



Source: California Department of Conservation, 2000; USGS, 2004

Faults and Epicenters **Exhibit 4.7-1**

SLOPE STABILITY AND LANDSLIDING

The topography of the Citrus Heights area is characterized by flat terrain with small hills in some locations. Slopes within the planning area range from zero to 15% with the majority of the steeper slopes located in the southeastern portion of Citrus Heights. No landslides or landslide deposits have been mapped within the planning area. No evidence of slope instability such as landslide scars or mudflow features are observed in the planning area. Overall potential for slope instability in the planning area is considered low.

SOILS

The Soil Survey of Sacramento County, prepared by the United States Department of Agriculture (USDA), Natural Resource Conservation Service (formerly Soil Conservation Service) maps soil types in most of Sacramento County, including Citrus Heights (see Exhibit 4.7-2). The planning area is underlain by numerous soil types that have various properties (see Table 4.7-3); however, the predominant soil types are urban soils including the Urban land-Xerarents-Fiddyment complex and the Fiddyment-Orangevale-Urban land complex.

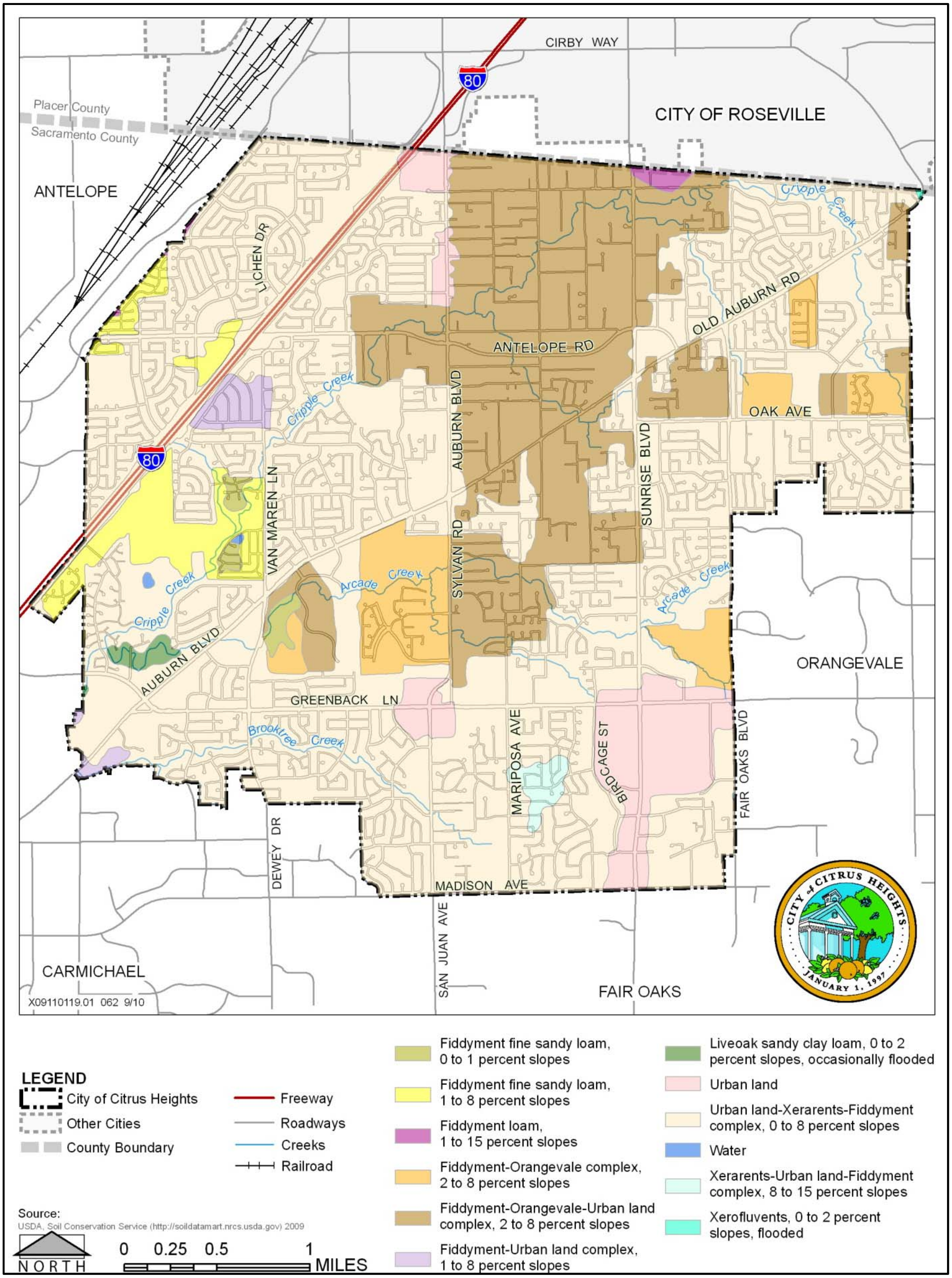
Table 4.7-3
Soil Types in Citrus Heights

Soil Type	Soil Slope[a]	Erosion Hazard	Shrink/Swell Potential[b]
229 Urban Land-Xerarents-Fiddyment complex	0–8%	slight to moderate	low to high
145 Fiddyment fine sandy loam	1–8%	slight	low to moderate
146 Fiddyment loam	1–15%	slight to moderate	high
227 Urban Land (large areas covered by impervious surfaces)[c]	n/a	n/a	n/a
241 Xerarents-Urban Land-Fiddyment Complex	8–15%	moderate	low to high
242 Xerofluvents	0–2%	slight	low
149 Fiddyment-Urban Land complex	1–8%	slight to moderate	moderate
148 Fiddyment-Orangevale-Urban land complex	2–8%	moderate	moderate
147 Fiddyment-Orangevale complex	2–8%	slight to moderate	moderate
144 Fiddyment Fine Sandy Loam	0–1%	slight	moderate
172 Liveoak Sandy Clay Loam	0–2%	slight	Low

Notes:
[a] Soil types are known to occur within this slope range.
[b] The shrink-swell potential of soils could be a restrictive factor when it comes to site development. Site restrictions are identified when the type of use and site-specific characteristics are known (usually when a geotechnical study is developed for a project).
[c]. Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.
Source: USDA, Soil Conservation Service (http://soildatamart.nrcs.usda.gov) 2009; Soil Science Society of America, 2010.

Soil properties influence the development of building sites, including the site selection, structure design, construction, performance after construction, and site and structure maintenance. The NRCS soil database for Sacramento County indicates the limitations of soils within the county with respect to dwellings, dwellings with basements, and small commercial buildings.

Soils limitations are rated as slight, moderate, and severe. The rating system indicates the extent to which the soils are limited by all of the soil features that affect building site development. Slight limitations indicate soil properties and site features generally are favorable for the indicated use and limitations are minor and easily



Source: Soil Conservation Service 2009

Soils in the Planning Area **Exhibit 4.7-2**

overcome. Moderate limitations occur if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations. Severe limitations describe soil properties or site features that are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required (USDA 1987, 144).

Two soils within the planning area have severe limitations with respect to dwellings, dwellings without basements, and small commercial buildings: Fiddyment loam and Liveoak Sandy Clay Loam. The Xerarents-Urban land-Fiddyment Complex has severe limitations with respect to small commercial buildings (USDA 1987, 303-312).

Soil limitation ratings listed in the NRCS database for Sacramento County are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (which is inferred from the Unified classification).[1] The properties that affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

The reported limitations are related to flooding, shrink-swell potential, slope, depth to rock, and cemented pan. These limitations can affect the load-supporting capacity of a soil. Shrink-swell potential is the relative change in volume to be expected with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes damage to building foundations, roads, and other structures. A high shrink/swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Soil Hazards

Shrink-Swell Potential

Soils in the planning area generally have a low to high shrink-swell potential. Construction activities alter the soil profile, and the previously developed condition in much of the planning area causes this range in shrink-swell potential. High rated shrink/swell soil (Fiddyment loam on Table 4.7-3) areas are located along the northern City boundary and southeast of the Union Pacific Railroad tracks. Shrink-swell potential is likely to vary from site to site within the planning area. Expansive or shrink-swell soils contain substantial amounts of clay minerals that swell when wet and shrink when dry. These clays tend to swell despite the heavy loads imposed by large structures. Damage (such as cracking of foundations) results from differential movement and from the repetition of the shrink-swell cycle. Shrinking and swelling of soil can damage roads, dams, building foundations, and other structures. In some cases, this problem may be avoided by removing the top soil layer before placing a foundation. Although these soils can be an expensive nuisance, awareness of their existence before construction often means that the problem can be eliminated through foundation design.

Erosion

Highly erosive soils can damage roads, bridges, buildings, and other structures and result in damage to sensitive ecosystems such as riparian areas and waterbodies. NRCS soil erosivity is based on slope and on soil erodibility

[1] The Unified Classification System is used to classify soils for engineering purposes. This specifically refers to the American Society for Testing and Materials (ASTM) Standard: D2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). All soil surveys related to soil engineering properties must be conducted in accordance with the ASTM Standard. NRCS references the Unified Classification System and ASTM Standards in all soil survey manuals and survey documents related to soils. Soil compressibility is defined as the resistance against volume decrease when soil is subjected to a mechanical load. Soil compression behavior can be influenced by organic matter in soil, soil moisture content, and bulk density. The Unified Classification System provides a standardized means to determining the soil properties that contribute to compressibility.

factors. Soil loss is caused by sheet or rill erosion in areas where 50–75% of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance (USDA 2004). Erosion hazards of disturbed soil are described as slight, moderate, severe, or very severe:

- Slight: Erosion is unlikely under ordinary climatic conditions.
- Moderate: Some erosion is likely and erosion control measures may be needed.
- Severe: Erosion is very likely and erosion control measures such as revegetation of bare areas may be needed.
- Very Severe: Significant erosion is expected, loss of soil productivity and off-site damage are likely and erosion control measures are costly and generally impractical.

Soils in the planning area have a slight, slight to moderate, or moderate erosion risk.

MINERAL RESOURCES

No mineral resources are currently being mined or produced in the planning area. The planning area has been evaluated for California Surface Mining and Reclamation Act (SMARA) Mineral Land Classification. SMARA classification projects assist the board in adopting and designating lands needed for their mineral content. The classification system is intended to ensure consideration of statewide or regionally significant mineral deposits in planning and development administration. These mineral designations are intended to prevent incompatible land use development on areas determined to have significant mineral resource deposits. Permitted uses within a mineral resource zone include mining, uses that support mining such as smelting and storage of materials, or uses that will not hinder future mining such as grazing, agriculture, large-lot rural development, recreation, and open space.

The most important zone with respect to the presence of resources is MRZ-2, which is defined as “areas where adequate information indicates that significant mineral (aggregate) deposits are present or where it is judged that there is a high likelihood for their presence.” This zone is applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high. MRZ-3 zones suggest the potential for aggregate deposits. This zone is less definitive than MRZ-2 and is defined as “areas containing mineral deposits the significance of which cannot be evaluated from available data.”

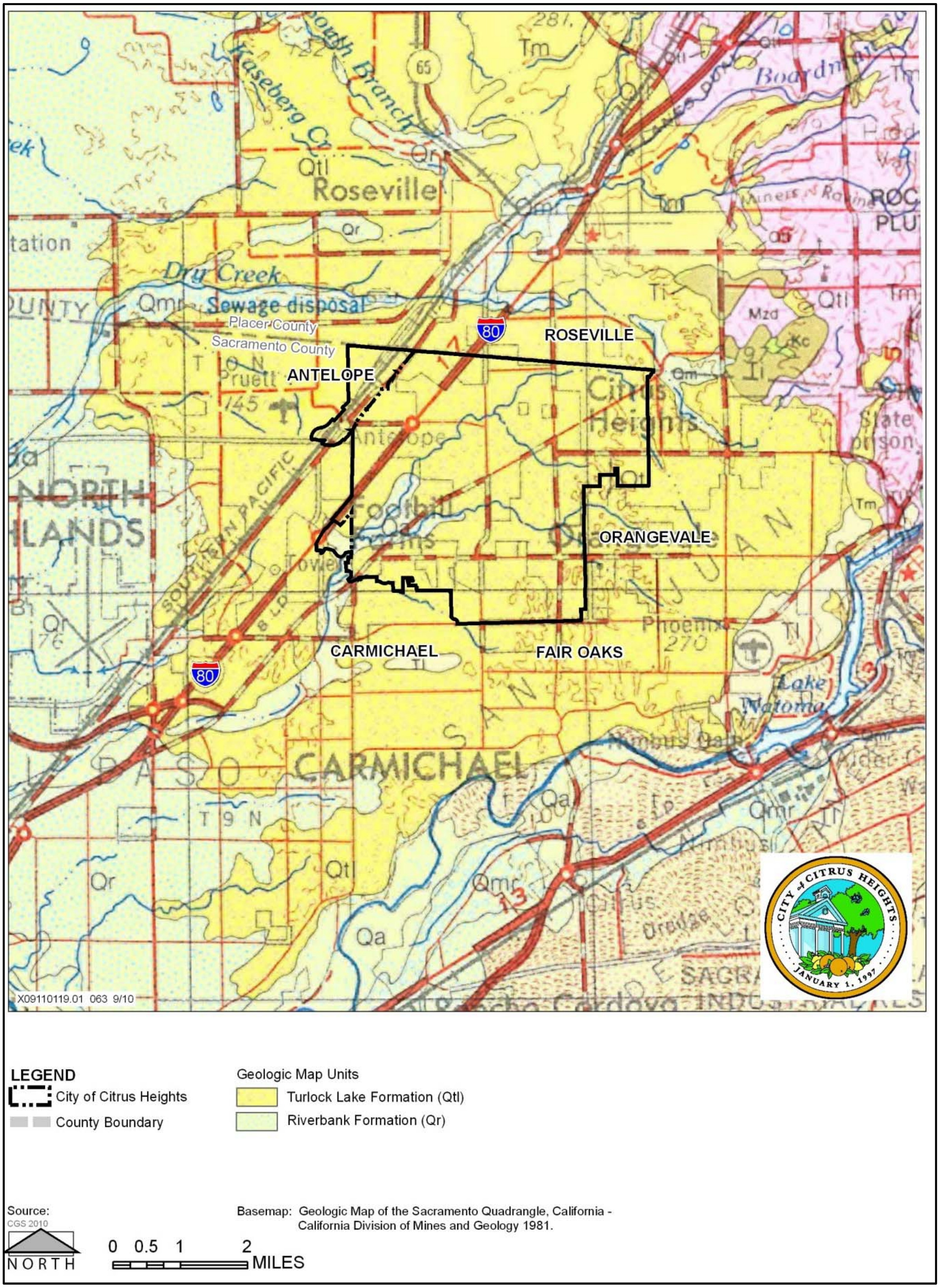
The planning area is primarily designated as MRZ-1, which is defined as “ areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.” A portion of the southwestern planning area is designated as MRZ-3 (CDMG 1999).

Asbestos

Ultramafic rock complexes which would be expected to contain asbestos are not exposed in the planning area (Jennings 1994).

PALEONTOLOGICAL RESOURCES

The planning area includes geologic units (the Riverbank and Turlock Lake formations) which have been found to contain fossils (including fossils of vertebrate animals ranging from rodents and lizards to mammoths) in other areas of the Central Valley (see Exhibit 4.7-3).



Source: California Geological Survey, 2010

Turlock Lake and Riverbank Rock Formations **Exhibit 4.7-3**

Paleontological Resource Inventory and Assessment by Rock Unit

Turlock Lake Formation

Vertebrate fossils have been recovered from the Turlock Lake Formation in the Central Valley. The Fairmead Landfill site, near Chowchilla, which is located within sediments of both the Turlock Lake Formation and the Riverbank Formation, has yielded thousands of Pleistocene-age specimens from 35 species, including mammoth, ground sloth, bear, sabertooth cat, wolf, deer, camel, horse, antelope, rodents, birds, reptiles, and plants. Excavations for the California Department of Transportation's Fresno SR 180 West Freeway project uncovered fossil specimens from a Pleistocene-age camel in sediments of the Turlock Lake Formation in Fresno County (Hansen 2008). Fossilized fish specimens, plant fragments, petrified wood, and ichnofossils were reported in the sediments of the Turlock Lake Formation near Roseville (Fisk and Butler 2005, cited in URS 2006).

The widespread occurrence of Pleistocene vertebrate fossil remains in sediments referable to the Riverbank and Turlock Lake Formations throughout the Central Valley suggests potential for uncovering additional similar fossil remains during construction-related earth-moving activities within the planning area.

Riverbank 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 region at various localities in alluvial deposits referable to the Riverbank 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 two sites in Sutter County that have yielded Rancholabrean vertebrate fossils near Yuba City (approximately 42 miles north of the planning area). These sites yielded a Pleistocene-age bison in sediments referable to the Modesto Formation and a Pleistocene-age horse in sediments referable to the Riverbank Formation.

A records search of the UCMP paleontology collections database yielded information regarding a number of vertebrate fossil localities referable to the Riverbank Formation. UCMP Localities V-91247, V-91204, and V-3402 west of Woodland (approximately 30 miles from the planning area) yielded Rancholabrean-age horse and mammoth specimens from mixed sediments containing both the Modesto and Riverbank Formations. UCMP Localities V-5430, V-6911, and V-76199 west of Davis (approximately 30 miles from the planning area) yielded Rancholabrean-age Harlan's ground sloth and saber-toothed cat specimens also from mixed sediments containing both the Modesto and the Riverbank Formations. UCMP Localities V-6846, V-68141, V-74086, V-69129, V-6747, V-69129, and V-75126, all in Sacramento (approximately 16 miles from the planning area), yielded specimens of bison, camel, coyote, horse, Harlan's ground sloth, mammoth, packrat or woodrat, Sacramento blackfish, mole, garter snake, and gopher from sediments of the Riverbank Formation. In addition, fossil specimens recovered from excavation activities at ARCO Arena north of Sacramento in the Riverbank Formation (approximately 17 miles from the planning area) included specimens of Harlan's ground sloth, bison, coyote, horse, camel, squirrel, antelope or deer, mammoth, and several types of plants (Hilton, Dailey, and McDonald 2000).

Marchand and Allwardt (1981) reported fossil specimens from the Riverbank Formation near its type locality in the City of Riverbank (approximately 87 miles south of the planning area). The Fairmead Landfill near Chowchilla (approximately 145 miles south of the planning area) is an active paleontological dig site in sediments of the Riverbank Formation. To date, thousands of fossil specimens have been uncovered at the site, including 35 different species of mammals.

4.7.3 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

THRESHOLDS OF SIGNIFICANCE

Geology, Soils, and Mineral Resources

Based on Appendix G of the State CEQA Guidelines, an impact on geologic resources, soils, or mineral resources is considered significant if the proposed project would:

- expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
    - rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;
    - strong seismic ground shaking; or
    - seismic-related ground failure, including liquefaction, or landslides.
- result in substantial soil erosion or the loss of topsoil;
- be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
- be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property;
- have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater;
- result in the loss of availability of a known mineral resource that would be of value to the region and residents of the state; 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.

Although there are active faults within 30 miles of the planning area, there are no identified active or potentially active faults within the planning area itself. Therefore, no impact due to exposure of people or structures to rupture of a known earthquake fault would result from implementation of the Draft General Plan. This topic is not evaluated further in this EIR.

The potential for seiches in the planning area is low as a predicted effect of an earthquake since ground shaking in the planning area is low to moderate and no reservoirs are located in the planning area. This topic is not evaluated further in this EIR.

Landslide susceptibility is a function of various combinations of factors including rainfall, rock and soil types, slope, aspect, vegetation, seismic conditions, and human construction. Generally, landslides are expected to occur most often on slopes steeper than 15%, in areas with a history of landslides, and in areas underlain by certain geologic units. Based on the flat topography of the planning area (with the exception of small, localized areas along streambanks), the California Division of Mines and Geology (now known as the California Geological Survey) estimated no risk of landslide in the planning area (1973). Therefore, no impact due to exposure of people or structures to landsliding would result from implementation of the Draft General Plan. This topic is not evaluated further in this EIR.

The majority of the planning area is designated as MRZ-1, where no significant mineral deposits are present. A small portion of the planning area is defined as MRZ-3, which has unknown mineral resources. However, because the planning area is an urbanized area and because the Draft General Plan does not propose to change existing planned land uses, extraction of any potential mineral resources is unlikely. Therefore, this topic is not evaluated further in this EIR.

Paleontological Resources

For the purpose of the analysis of impacts to paleontological resources (Impact 4.7-5), the following thresholds of significance have been used to determine whether implementing the Draft General Plan would result in a significant impact. These thresholds of significance are based on the State CEQA Guidelines, which state that a paleontological resources impact is considered significant if implementation of the proposed project would directly or indirectly destroy a unique paleontological resource or site.

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 a 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. 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).

IMPACT ANALYSIS

IMPACT 4.7-1 **Potential for Exposure to Seismic Ground Shaking.** *Future land uses consistent with the Draft General Plan would not result in development of areas prone to strong seismic ground shaking. Implementation of policies in the Draft General Plan and existing regulations would implement best practices to reduce the potential for substantial adverse effects due to exposure to seismic ground shaking. This impact would be* ***less than significant.***

Different types of structures are subject to different levels of ground shaking damage from seismic activity. Conventional one- and two-story wood-frame residential structures generally have performed very well during strong seismic ground shaking. Collapse or total destruction of wood-frame homes is rare, even during strong earthquakes, except in cases where these structures are affected by ground rupturing or landsliding, or are affected by extremely high ground acceleration. Unreinforced masonry buildings and other buildings constructed before 1930 that have not been seismically retrofitted would be most likely to suffer structural failure or collapse as a result of seismic ground shaking.

The planning area is located in an area of low seismic activity that has not experienced an earthquake of MMI VII or greater (the intensity at which damage to buildings would be expected) between 1800 and 1996 (CGS 1996, p. 22). The nearest active fault, the Foothills Fault System, is located approximately 15 miles northeast of the planning area. No significant seismic event has been recorded in the area since 1908, when an earthquake estimated at greater than 4.0 on the Richter Scale occurred on an unnamed fault in southwestern Placer County.

Draft General Plan Policies

The Draft General Plan includes the following policies related to risk from seismic ground shaking:

Policies

- **50.1:** Implement the California Building Code to comply with federal and State earthquake protection and slope stability standards for new development.

- **50.2:** Require soils reports for new development to identify the potential for liquefaction, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

Conclusion

Although potential damage to people or structures from seismic ground shaking could occur, the low likelihood of a seismic event with a MMI of VII or greater, and the Draft General Plan's policies, combined with compliance with the CBC regulations described in the regulatory setting of this chapter, would require seismic safety requirements to be established and incorporated into the design of all new residences and buildings on a site-specific basis. Roadways, utilities, and structures would be designed to withstand seismic forces based on CBC requirements for the appropriate site-specific Seismic Design Category. Therefore, potential damage to structures from seismic activity and related geologic hazards would be **less than significant**.

No mitigation beyond compliance with existing regulations and Draft General Plan policies is required.

IMPACT 4.7-2	Potential for Seismic Ground Failure. *Future land uses consistent with the Draft General Plan would result in development of areas with moderate potential for seismic-related ground failure, including liquefaction. Implementation of policies in the Draft General Plan and compliance with existing regulations would implement best practices to reduce the potential for substantial adverse effects due to exposure to seismic ground failure. This impact would be* less than significant*.*

Seismic ground failure refers to conditions such as soil liquefaction, associated lateral spreading, landslides, and collapse resulting from loss of strength during earthquake shaking. The liquefaction of soils can cause them to move laterally outward from under buildings, roads, pipelines, transmission towers, railroad tracks, and other structures such as bridges. Damage is usually greatest to large or heavy structures on shallow foundations and takes the form of cracking, tilting, and differential settlement. Where gentle slopes exist, such as on stream or slough banks, liquefaction may cause lateral-spreading landslides. Whole buildings can be moved downslope by this type of ground failure. Where the condition is known to exist, structural and foundation design can usually minimize or eliminate liquefaction hazard to new construction. As mentioned above under "Environmental

Setting," the planning area does not contain any soil types or geologic characteristics that make the area susceptible to the potential for liquefaction.

Draft General Plan Policies

The Draft General Plan includes the following policies related to risk from seismic ground failure:

Policies

- **50.1:** Implement the California Building Code to comply with federal and State earthquake protection and slope stability standards for new development.

- **50.2:** Require soils reports for new development to identify the potential for liquefaction, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

Conclusion

Implementation of policies in the Draft General Plan and compliance with existing regulations (including compliance with the CBC regulations described in the regulatory setting of this chapter) would reduce the potential for substantial adverse effects due to exposure to seismic-related ground failure. This impact would be **less than significant**.

No mitigation beyond compliance with existing regulations and the Draft General Plan policies is required.

IMPACT 4.7-3 Soil Erosion or Loss of Topsoil. *Future land uses consistent with the Draft General Plan would be constructed on soils with slight to moderate erosion potential, and earth-disturbing and construction activities could result in some soil erosion or loss of topsoil. Compliance with existing regulations would result in use of best management practices to prevent substantial soil erosion and topsoil loss. This impact would be* ***less than significant****.*

Soils within the planning area are considered to have slight to moderate erosion potential. Highly erosive soils can damage roads, bridges, buildings, and other structures and result in damage to sensitive biological habitats such as riparian areas and waterbodies (water quality impacts of soil erosion are discussed in Impact 4.5-3 in Section 4.5, "Hydrology and Water Quality.") Soil loss can be caused by sheet or rill erosion in areas where 50–75% of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.

Erosion is a large-scale impact caused by human activity and disturbance of surface soil, wind, and water. Erosion cannot be eliminated altogether, although existing regulations such as Chapter 18, Article IV Building Code and Article XII Land Grading and Erosion Control of the City of Citrus Heights Municipal Code (which includes erosion control measures and best management practices) can reduce the potential impacts of erosion.

Conclusion

Implementation of existing regulations (including the California Building Code regulations described in the regulatory setting of this chapter and Chapter 18, Article 4 Building Code and Article 12 Land Grading and Erosion Control of the City of Citrus Heights Municipal Code), would reduce the potential for substantial erosion associated with future land uses through application of best management practices and engineering controls. This impact would be **less than significant**. No mitigation beyond compliance with existing regulations is required.

IMPACT 4.7-4 **Potential for Unstable Soils.** *Future land uses consistent with the Draft General Plan would result in construction of occupied structures in areas located on a geologic unit or soil that is unstable or that would become unstable, potentially resulting in on- or off-site lateral spreading, subsidence, liquefaction, or collapse. Implementation of policies in the Draft General Plan and compliance with existing regulations would prevent damage from unstable soils. This impact would be* ***less than significant****.*

Unstable soils include soils subject to landsliding, lateral spreading, liquefaction, or collapse. This kind of hazard can be caused by earthquake shaking (i.e., liquefaction, lateral spreading, landslides, collapse), caused by seasonal saturation of soils and rock materials (subsidence), or caused by grading and construction activities.

Soil liquefaction (and associated lateral spreading, landslides, and collapse) results from loss of strength during earthquake shaking. The liquefaction of soils can cause them to move laterally outward from under buildings, roads, pipelines, transmission towers, railroad tracks, and other structures such as bridges. Damage is usually greatest to large or heavy structures on shallow foundations, and takes the form of cracking, tilting, and differential settlement. Where gentle slopes exist such as on stream or slough banks, liquefaction may cause lateral-spreading landslides. Whole buildings can be moved downslope by this type of ground failure. Where the condition is known to exist, structural and foundation design can usually minimize or eliminate liquefaction hazard to new construction.

Subsidence and settlement are localized hazards, commonly caused by the withdrawal of fluids (such as groundwater) from subsurface reservoirs or from the collapse of surface soils over subterranean caves or mines. Settlement results when weak or porous soils (such as fill soils) are compressed as a result of construction activities.

Due to the flat topography of the planning area, damage from lateral spreading, collapse, and landsliding is not expected. As mentioned under Impact 4.7-2, there is limited liquefaction potential within the planning area.

Draft General Plan Policies

The Draft General Plan includes the following policies related to risk from unstable soils:

Policies

- **50.1:** Implement the California Building Code to comply with federal and State earthquake protection and slope stability standards for new development.

- **50.2:** Require soils reports for new development to identify the potential for liquefaction, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

Conclusion

Implementation of existing regulations (including the CBC regulations described in the regulatory setting of this chapter), as well as the policies of the Draft General Plan, would reduce the impacts that unstable soils could have on future development consistent with the Draft General Plan through application of best management practices and engineering controls. This impact would be **less than significant**.

No mitigation beyond existing regulations and the Draft General Plan policies is required.

IMPACT 4.7-5 **Construction in Areas with Expansive Soils.** *Future land uses consistent with the Draft General Plan would result in construction of occupied structures in areas with expansive soils. This impact would be* ***less than significant****.*

Expansive or shrink-swell soils contain significant amounts of clay minerals that swell when wet and shrink when dry. These clays tend to swell despite the heavy loads imposed by large structures. Damage (such as cracking of foundations) results from differential movement and from the repetition of the shrink-swell cycle. Urban soils comprise the majority of soils in the planning area, and have a shrink-swell potential that ranges from low to high. Shrink-swell potential is likely to vary from site to site within the urban soils as the soil profiles have been previously disturbed by past construction activity. Awareness of the presence of expansive soils before construction often means that the problem can be eliminated through foundation design.

Draft General Plan Policies

The Draft General Plan includes the following policy that would control development in areas of expansive soils:

Policy

- **50.2:** Require soils reports for new development to identify the potential for liquefaction, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

Conclusion

Implementation of existing regulations (including the CBC regulations described in the regulatory setting of this chapter), as well as Policy 50.2 of the Draft General Plan, would reduce the impacts of expansive soils through application of best management practices and engineering controls. This impact would be **less than significant**.

No mitigation beyond compliance with existing regulations and the Draft General Plan policies is required.

IMPACT 4.7-6 **Construction of Septic Systems on Poor Soils.** *Future land uses consistent with the Draft General Plan could result in construction of new septic systems on incompatible soils. This impact would be* ***less than significant****.*

Certain soil units are unsuitable for installation of septic systems to dispose of sewage based on the percolation characteristics of the underlying soil. Soils must be permeable enough to allow percolation, while transmitting wastewater slowly enough to filter bacteria and viruses. Sand and gravel transmit wastewater relatively quickly, before filtering can be completed. Silt and clay can effectively filter wastewater, but have low wastewater flow rates.

Conclusion

Construction of new septic systems within the planning area would have to comply with Title 6, Chapter 6.32 of the Sacramento County Code regarding septic system standards. This would reduce the impacts of septic systems on planning area soils through application of best management practices and engineering controls. This impact would be **less than significant**.

IMPACT 4.7-7 **Possible Damage to Unknown, Potentially Unique Paleontological Resources during Earthmoving Activities.** *Construction activities associated with future development of land uses consistent with the Draft General Plan could disturb previously unknown paleontological resources within the planning area. This impact would be* ***significant****.*

The planning area is underlain by Pleistocene-age sediments of the Turlock Lake and Riverbank Formations, which are considered paleontologically sensitive rock units under SVP guidelines (1995). The potential that unique paleontological resources could be discovered varies on a project-by-project basis, and increases with larger projects that disturb larger areas. Numerous vertebrate fossil specimens have been recorded from the Turlock Lake Formation in Roseville, Chowchilla, and Fresno, and from the Riverside Formation in Yuba City, Woodland, Davis, Sacramento, and Chowchilla. The fact that vertebrate fossils have been recovered near the planning area and other recorded vertebrate fossil localities have been recorded throughout the Sacramento and San Joaquin Valleys, and that all have been in sediments referable to the Turlock Lake and Riverbank Formations, suggests that there is a potential for uncovering similar fossil remains during construction-related earthmoving activities in the planning area. However, since the majority of the planning area is already developed and most areas have been disturbed by previous earthmoving activities, the chances of uncovering previously undiscovered paleontological remains is remote. Nonetheless, because all areas that could be developed as a part of future projects consistent with the Draft General Plan, the potential for damage to unique paleontological resources during earth-moving activities at the project site would be considered a **significant** impact requiring mitigation.

The following mitigation is required for projects with earth disturbing components.

Mitigation Measure 4.7-7: Discovery of Potential Paleontological Resources

If potential paleontological resources are detected by construction workers or City staff during construction of future land uses, work shall stop immediately, and consultation is required to avoid further impacts. Actions after work stoppage will be designed to avoid significant impacts to the greatest extent feasible. These measures could include, but are not limited to, construction worker personnel education, consultation with a qualified paleontologist, coordination with experts on resource recovery and curation of specimens, and/or other measures considered appropriate after further consultation.

Significance after Mitigation

The City is not currently aware of any significant paleontological resources in the planning area. However, the City recognizes the possibility that previously undiscovered resources could be uncovered. Implementation of Mitigation Measure 4.7-7 would reduce impacts related to potential damage to unique paleontological resources to a **less-than-significant** level by ensuring that earth disturbing activities cease if any possible resources are uncovered, minimizing potential adverse impacts on unique, scientifically important paleontological resources.