4.6 GEOLOGY, SOILS, MINERAL, AND PALEONTOLOGICAL RESOURCES

This section describes the federal and state regulations and local policies related to geologic hazards and seismic conditions; existing geologic and soil conditions in the region and at the project site; potential geologic hazards and soils impacts associated with project construction and implementation; mineral resources; and paleontological resources. Due to changes to the State CEQA Guidelines in December 2018, the threshold related to paleontological resources, which was often addressed (including within the August 2018 NOP for the project) as part of the cultural resources issue area of Appendix G, was moved to the CEQA issue area for geology and soils. As a result of the recent changes to the CEQA Guidelines, the analysis of potential impacts to paleontological resources is addressed as part of this section of the Draft Subsequent Environmental Impact Report (SEIR). Potential environmental effects related to water quality resulting from soil erosion and other stormwater issues are addressed in Section 4.9, "Hydrology and Water Quality."

No comments pertaining to geology, soils, mineral, or paleontological resources were received during public review of the Notice of Preparation for the proposed project.

4.6.1 Regulatory Setting

FEDERAL PLANS, POLICIES, AND REGULATIONS

National Earthquake Hazards Reduction Act

The National Earthquake Hazards Reduction Act was passed to reduce the risks to life and property resulting from earthquakes. To accomplish this, the act established the National Earthquake Hazards Reduction Program (NEHRP). 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. NEHRP designates the Federal Emergency Management Agency as the lead agency of the program and assigns several planning, coordinating, and reporting responsibilities. Other NEHRP agencies include the National Institute of Standards and Technology, National Science Foundation, and the U.S. Geological Survey.

STATE PLANS, POLICIES, AND REGULATIONS

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (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 primary purpose of the law is to prevent the construction of buildings used for human occupancy on the surface trace, the intersection of a fault with the ground surface, 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 other than surface 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.

Guidelines for Evaluation and Mitigation of Seismic Hazards in California

Originally adopted March 13, 1997 by the State Mining and Geology Board in accordance with the Seismic Hazards Mapping Act of 1990, and revised in 2008, Special Publication 117A constitutes the guidelines for evaluating seismic hazards other than surface fault-rupture, and for recommending mitigation measures.

California Building Standards Code

The State of California provides minimum standards for building design through the California Building Standards Code (CBC) (Title 24 of the California Code of Regulations [CCR]). 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 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 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 Chapter 33 regulates grading activities, including drainage and erosion control and construction on unstable soils, such as expansive soils and areas subject to liquefaction.

Title 27 of California Code of Regulations

Title 27 of the CCR, Division 2, Solid Waste provides criteria for all waste management units, facilities, and disposal sites. Article 4 of Chapter 3 addresses waste management unit construction standards and states that Class III landfills shall have containment structures which are capable of preventing degradation of waters of the state as a result of waste discharges to the landfills if site characteristics are inadequate. Liners shall be designed and constructed to contain the fluid, including landfill gas, waste, and leachate, as required by Article 3 of Subchapter 2 (Section 20240 et seq., and Section 20310). Leachate collection and removal systems (LCRS) are required for Class II landfills and surface impoundments, and for Class III landfills which have a liner or which accept sewage or water treatment sludge. The LCRS shall be installed directly above underlying containment features for landfills and waste piles, and installed between the liners for surface impoundments. Article 4 of Chapter 4 of Title 27 also states that a stability analysis, including a determination of expected peak acceleration, must be conducted) for Class III landfills (Section 21750(f)(5)).

REGIONAL AND LOCAL PLANS, POLICIES, REGULATIONS AND ORDINANCES

The County is responsible for implementation of state- and federally-mandated laws and regulations related to geology and soils before permitting projects. In addition, portions of the County General Plan and County Code relate to geology, soils, and other geologic hazards.

Solano County General Plan-Chapter 5, Public Health and Safety

The following policies of the County General Plan are considered applicable to the project, with respect to geology and soils.

- Policy HS.P-12: Require new development proposals in moderate or high seismic hazard areas to consider risks caused by seismic activity and to include project features that minimize these risks.

- Policy HS.P-14: Identify and minimize potential hazards to life and property caused by fault displacement and its impact on facilities that attract large numbers of people, are open to the general public, or provide essential community services and that are located within identified earthquake fault zones.
- Policy HS.P-15: Reduce risk of failure and reduce potential effects of failure during seismic events through standards for the construction and placement of utilities, pipelines, or other public facilities located on or crossing active fault zones.
- Policy HS.P-18: Make information about soils with a high shrink-swell potential readily available. Require proper foundation designs in these areas.

Solano County Code—Chapter 31, Grading and Erosion Control

Chapter 31 of the Solano County Code provides regulations related to grading and erosion control. In conjunction with Chapter 70 of the Uniform Building Code, this chapter sets forth the means for controlling soil erosion, sedimentation, increased rates of water runoff, and related environmental damage. It does so by establishing minimum standards and providing regulations for the construction and maintenance of fills, excavations, cuts and clearing of vegetation, revegetation of cleared areas, drainage control, and protection of exposed soil surfaces to protect downstream waterways and wetlands and promote the safety, public health, convenience, and general welfare of the community.

4.6.2 Environmental Setting

The primary sources of information for this section are the *Joint Technical Document, Recology Hay Road* report prepared by Golder Associates Inc. (Golder 2018), The Solano County General Plan (Solano County 2008a), and the *Solano County General Plan EIR* (Solano County 2008b).

GEOLOGY AND TOPOGRAPHY

Western Solano County consists of hilly to very steep mountainous uplands of the Coast Ranges that grade down to the low elevation, flatter areas of the Sacramento Valley in the eastern part of the county. These flatter areas are comprised of low alluvial plains and fans, as well as flooded basins. Low hills and dissected uplands lie north of Vacaville to Putah Creek with the Suisun Bay Tidal Flats and the San Pablo Bay to the south.

The project site is located in the southern portion of the Putah Plain, a relatively flat, broad area that stretches from the Coast Range, northwest of the City of Vacaville, to the Sacramento River Delta to the southeast. The Putah Plain is comprised of relatively flat Holocene alluvial fan deposits that consist of fine-grained silts and clays characteristic of floodplain deposits, inter-bedded with sand and gravel lenses attributed to stream channel deposition. Over time, the Putah Plain has been developed for farming and ranching. Drainages have been modified and controlled, minimizing flooding and new sediment deposition. The upper soils have been tilled and disturbed, breaking the clay-rich hardpan in some areas.

Topography within the permitted landfill boundary has been substantially altered and is dominated by the landfill mounds within the central and eastern portion of the permitted landfill. The Recology Hay Road (RHR) Property has little natural relief other than small drainage swales and small mounds and slight depressions. The ground surface was originally between 18 to 30 feet above mean sea level (Golder 2018).

Geologic maps published by U.S. Geological Survey within Williamson et al. (1989) show the geology of site and surrounding area as containing continental rocks and deposits (Pliocene to Holocene) that include younger alluvium, older alluvium and pre-Quaternary to Quaternary (<2.6 million years old) surficial deposits (Golder 2015: 2). A hydrogeological investigation of the site prepared by Einarson Geoscience, Inc. (1995; cited in Golder 2015: 2) identified three primary geologic units beneath the RHR Property (in order from youngest to oldest):

- Younger alluvium: Holocene; from ground surface to between 5 and 10 feet below ground surface (bgs) and located primarily within the northeastern portion of the Landfill and underlain by older alluvium;

- Older Alluvium: Pleistocene to Holocene; from 5 to 10 feet bgs to between 60 and 130 feet bgs (dominant geologic unit at the project site); and
- Tehama Formation: Pliocene to Pleistocene; below 60 to 130 feet bgs within the site.

These geologic units are relatively flat-lying alluvial sediments. They are often similar in lithology, and the subsurface contacts between the units are not well defined and may be gradational (Einarson 1995; cited in Golder 2018: 3-4). In general, the upper alluvial units are unconsolidated, but increase in density with depth. The Tehama Formation is similar in composition to the older alluvium at the site such that Einarson (1995; cited in Golder 2015) could not differentiate them in boring logs. The Tehama Formation, however, is typically more cemented by calcium carbonate than the overlying older alluvium and is characteristically more consolidated (Einarson 1995; cited in Golder 2015: 2-3), A detailed description of these units is provided below.

Younger Alluvium (Holocene, Recent–10,000 years old)

The younger alluvium is generally comprised of pale brown to gray-brown sandy silts typically ranging from 0 to 20 feet thick and uncomformably overlies the older alluvium. These deposits have been primarily mapped as fine-grained Holocene-age alluvium and occur at the ground surface over the northeastern portion of the site near Alamo Creek (Golder 2018: 3-4, 3-5).

Older Alluvium (Pleistocene: 10,000–1.8 million years old)

The older alluvium occurs at the ground surface over much of the Putah Plain. These sediments are typically orange-brown, loose to moderately compacted sandy silts and clays, with lenses and tongues of sand and gravel. The thickness of the older alluvium throughout the Putah Plain ranges from 60 to 130 feet. The older alluvium is distinguished from the younger alluvium by the presence of a mature soil profile containing a dense, clay-rich B-horizon (Golder 2018: 3-5).

Tehama Formation

The Tehama formation has no surface exposure at the RHR Property. The presence of the formation at depth is based on regional geologic relationships and the sediments encountered in the deepest site borings. The Tehama formation consists of alluvial sediments lithologically similar to older alluvial, with some calcium carbonate cementation and greater compaction. The Tehama Formation generally consists of moderately compacted silt, clay and silty fine sand with lenses of sand and gravel. The formation exhibits some degree of calcium carbonate cementation and greater compaction than the overlying older alluvium. The formation varies significantly in thickness, ranging from a thickness of 2,500 feet east of the site to 98 feet west of the site. However, the considerable thinning of the formation is likely due to tectonic faulting by the Vaca fault, which has been mapped approximately 6 miles west of the site (Golder 2018: 3-5).

SOILS

Soil conditions for the portion of Solano County where the project site is located are provided in Thomasson et al. (1960; cited in Golder 2015: 10), which indicates that, in general, the western two-thirds of the RHR Property is underlain by older alluvial deposits consisting of loose to moderately compacted silt, silty clay, sand and gravel. The eastern one-third of the RHR Property was constructed in an area containing young alluvial deposits (up to 20 feet thick) composed mostly of loose silt and fine sand with clay and gravel (Golder 2015: 10).

Erosion Potential and Hazard Rating

Erosion is the process by which surface soils are detached and transported by water and/or wind. Erosion has a detrimental effect on soil productivity because erosion begins with the upper horizons of a soil profile, which contain organic matter and microbial communities vital to supporting plant growth. Factors that influence the erosion potential of a soil include: vegetative cover; soil properties such as soil texture, structure, rock fragments and depth; steepness and slope length; and climatic factors such as the amount and intensity of precipitation.

The Natural Resources Conservation Service (NRCS) rates erosion hazards of disturbed soil into one of the following four categories:

- 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; or
- Very Severe – significant erosion is expected, loss of soil productivity and offsite damage are likely and erosion control measures may be costly and generally impractical. (Solano County 2008b:4.7-34)

Per the 2008 Solano County General Plan, the project site is located in an area with slight erosion potential (Solano County 2008b: 4.7-20,-25,-34).

Expansive Soils

Expansive soils contain shrink-swell clays that are capable of absorbing water. As water is absorbed the clays increase in volume. This change in volume is capable of exerting enough force on buildings and other structures to damage foundations and walls. Damage can also occur as these soils dry out and contract. The Solano County General Plan indicates that the RHR Property is located within an area of high shrink-swell potential area (Solano County 2015: Figure HS-10, HS-39).

SEISMICITY AND FAULT ZONES

An earthquake is classified by the amount of energy released, which traditionally has been quantified using the Richter scale. Recently, seismologists have begun using a moment magnitude (M) scale because it provides a more accurate measurement of the size of large earthquakes. For earthquakes of less than M 7.0, the moment and Richter magnitude scales are nearly identical. For earthquakes greater than M 7.0, readings on the moment magnitude scale are slightly higher than the corresponding Richter magnitude.

The intensity of seismic shaking, or strong ground motion, during an earthquake is dependent on the distance and direction from the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions of the surrounding area. Ground shaking could potentially result in the damage or collapse of buildings and other structures. Most earthquakes occur along faults, which are fractures or geological areas of weakness, along which rocks on one side have been displaced with respect to those on the other side. Most faults are the result of repeated displacement that may have taken place suddenly and/or by slow creep.

A seismic hazard assessment for the RHR Property was prepared by Golder Associates in March 2015 (Golder 2015). According to the report, there are 22 active faults located within 100 kilometers (62 miles) of the project site. Major earthquake events within 62 miles of the site that produced a M 4 or greater, are shown in Table 4.6-1. The closest recorded earthquake to the site greater than M 4.0 was the M 6.4 earthquake that occurred on April 19, 1892 (Golder 2015: 4-6).

Table 4.6-1 Recorded earthquakes within 100 km (62 mi) of the RHR Landfill, Solano County, California

Date	Latitude (°N)	Longitude (°W)	Distance From RHR Site (miles)	Reported Moment Magnitude (M)
April 18, 1906	37.750	122.550	55	7.7
October 21, 1868	37.700	122.100	45	6.8
April 19, 1892	38.414	121.961	10	6.4
January 24, 1980	37.743	121.825	39	5.8
October 2, 1969	38.296	122.755	50	5.7
March 31, 1986	37.512	121.649	56	5.6
October 31, 2007	37.426	121.810	61	5.6

Date	Latitude (°N)	Longitude (°W)	Distance From RHR Site (miles)	Reported Moment Magnitude (M)
Sept. 3, 2000	38.379	122.413	32	5.0
May 8, 2005	38.378	122.166	30	4.1
Source: Golder 2015:4-5				

Figure 4.6-1 shows major fault zones and historic earthquake epicenters within about 62 miles (100 km) of the project site. The northern segment of Midland Fault is located about 4.3 miles northeast of the E Property and is considered the most significant fault that can control the maximum peak ground acceleration (PGA) value at the RHR Property (Golder 2015: 8). The results of Golder's assessment indicate that a PGA value of 0.58 g can be expected at the site from a maximum credible earthquake (MCE) generated by movement along the northern segment of the Midland Fault (Golder 2015: 15).

Liquefaction and Ground Failure

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. 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, and silty clays are generally stable under the influence of seismic ground shaking (California Geological Survey 2008:35-37). 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. Sites underlain by relatively loose sandy soils and saturated deposits of fill combined with a shallow groundwater table, which typically are located in alluvial river valleys/basins and floodplains, are susceptible to liquefaction.

The site is not located within a liquefaction hazard zone, as mapped by the California Geological Survey (CGS) (CGS 2019). The Solano County General Plan (Chapter 5, Public Health and Safety), identifies the majority of the RHR Property as containing low liquefaction potential and an area along the western boundary of the RHR Property as having high liquefaction potential (Solano County 2015: HS-37).

Loose saturated sandy soils are typically associated with liquefaction hazards (Golder 2018: 3-10). As described in the Recology Hay Road Permit Revision Initial Study (Douglas Environmental 2012: 2-28, 2-29), the soils underlying the landfill site consist of silty clay and clayey sand that typically are not susceptible to liquefaction.

SUBSIDENCE AND EXPANSION

Land surface subsidence can be induced by both natural and human phenomena. Natural phenomena include: tectonic deformations and seismically induced settlements; consolidation, hydrocompaction, or rapid sedimentation; oxidation or dewatering of organic rich soils; 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 percent of the identified subsidence in the United States (Galloway et al. 1999:1). Lateral spreading is the horizontal movement or spreading of soil toward an open face, such as a stream bank, 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.

The native materials underlying the RHR Property consist of silty clay and clayey sand that typically are not susceptible to landsliding, lateral spreading, subsidence, liquefaction, or collapse (Douglas Environmental 2012: 2-29).

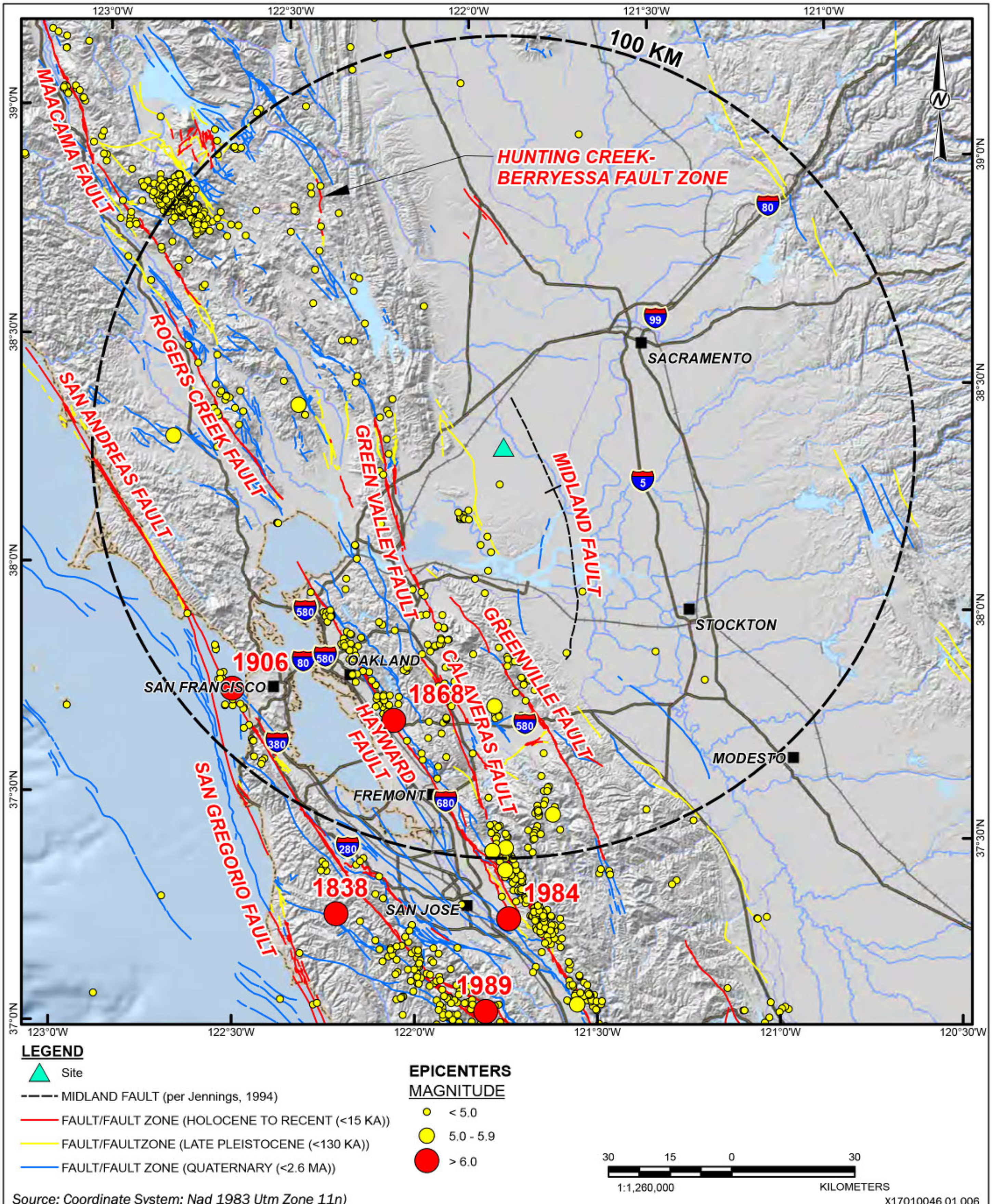

Figure 4.6-1 Major Quaternary Faults and Historical Earthquake Events

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.

Although the project site is located in an area where natural topography is generally flat, slope stability of engineered landfill slopes must be evaluated for compliance with Title 27 of the CCR. Article 4 of Chapter 4 of Title 27 also states that a stability analysis, including a determination of expected peak acceleration, must be conducted) for Class III landfills (Section 21750(f)(5)).

MINERAL RESOURCES

Mineral resources mined or produced within Solano County include mercury, sand and gravel, clay, stone products, calcium, and sulfur. Known mineral resource zones in Solano County consist of an area located northeast of Vallejo, south and southeast of Green Valley, areas south and east of Travis Air Force Base, and pockets located within both Vacaville and Fairfield (Solano County 2008b). Solano County falls within Mineral Resources Zones described in California Surface Mining and Reclamation Act (SMARA) Mineral Land Classification Reports SR 146 Parts I and III, and SR 156 (DOC 2013). Based on a review of these maps, there are no known mineral resources zones associated with the project site (Stinson, Manson, and Plappert 1983 Plate 3.2, Dupras 1988).

PALEONTOLOGICAL RESOURCES

Known Paleontological Resources within Solano County

To identify known fossil locations in the county, an online fossil locality search was conducted on June 20, 2018, using the Berkeley Natural History Museums' online database; specifically, data from the University of California Museum of Paleontology, Berkeley (UCMP 2018). Relevant paleontological and geological literature for Solano County and its vicinity was reviewed for a characterization of the county's geology and paleontological sensitivity. The locality search identified 297 known fossil sites within the county. Of this total, 69 sites consist of vertebrate specimens and 169 contain invertebrate specimens. The localities occur in 12 distinguishable geologic formations, all of which are known to contain fossils. Within the county, most sedimentary geological units and some of the igneous geological units of Solano County are paleontologically sensitive (Solano County 2008b:4.10-22).

Solano County's diverse geological setting spans 144 million years, from the early Jurassic Period through today. Geologically, the western portion of the county is made up of the north-south trending Sacramento and San Joaquin Valleys, as well as a small portion of the Northern California Coast Ranges. The Northern California Coast Range in Solano County, known as the Vaca Mountains, consists of Cretaceous and Tertiary strata that has been uplifted and tilted eastward. A large predominantly Quaternary plain lies to the east of the Vaca Mountains. In the southwestern portion of the county, Pliocene and late Miocene volcanic deposits are commonly found. The Pleistocene Montezuma Hills lie just north of the confluence of the Sacramento and San Joaquin Rivers, where they drain to Suisun Bay. Suisun and Montezuma Sloughs mark a large tidal wetland that enters Grizzly Bay along the southern border of the county.

Onsite Potential

A review of the geologic map for Solano County indicates that the project site is comprised of younger (Holocene) alluvium, older (Pleistocene) alluvium, and Tehama Formation. These geologic units are described as follows.

Younger Alluvium (Holocene: Recent–10,000 years old)

These Late Holocene alluvial deposits overlie older Pleistocene alluvium and/or the upper Tertiary bedrock formations in the. This alluvium consists of sand, silt, and gravel deposited in fan, valley fill, terrace, or basin environments. This unit is typically in smooth, flat valley bottoms, in medium-sized drainages and other areas where terrain allows a thin veneer of this alluvium to deposit, generally in shallowly sloping or flat environments (Graymer et al. 2002; cited in Solano County 2008b: 4.7-1). These alluvial deposits contain vertebrate and invertebrate fossils of extant, modern taxa (Helley et al. 1979; cited in Solano County 2008b: 4.7-1), which are generally not considered paleontologically significant (Solano County 2008b:4.10-19).

Older Alluvium (Pleistocene: 10,000–1.8 million years old)

The majority of alluvium in the central and eastern portion of the county consists of sedimentary deposits that are Plio-Pleistocene in age. These less permeable sediments are basin, landslide intertidal, terrace, or riverbank deposit. Vertebrate fossils found in Late Pleistocene alluvium are representative of the Rancholabrean land mammal age from which many taxa are now extinct (Bell et al. 2004; cited in Solano County 2008b: 4.7-1) and include but are not limited to bison, mammoth, ground sloths, saber-toothed cats, dire wolves, cave bears, rodents, birds, reptiles and amphibians (Bell et al. 2004, Helley et al. 1979, Hertlein 1951, Savage 1951, Stirton 1951; cited in Solano County 2008b: 4.7-1). These alluvial deposits are highly sensitive for paleontological resources (Solano County 2008b:4.10-19).

The Tehama Formation (Pliocene: 1.8–5.3 million years old)

The Tehama Formation occurs at the ground surface in the low hills lying west of the site and underlies most of the remainder of the Putah Plain (Golder 2018:3-5). The Tehama Formation generally consists of moderately compacted silt, clay and silty fine sand with lenses of sand and gravel. The formation exhibits some degree of calcium carbonate cementation and greater compaction than the overlying older alluvium. The formation varies significantly in thickness, ranging from a thickness of 2,500 feet east of the site to 98 feet west of the site. However, the considerable thinning of the formation is likely due to tectonic faulting by the Vaca fault, which has been mapped approximately 6 miles west of the site (Einarson Geoscience 1995; cited in Golder 2018:3-5). This series of fluvial deposits is 2,000 feet thick on average and contains fragmentary vertebrate bones (Russell 1927; cited in Solano County 2008b:4.10-19). Although only one vertebrate fossil locality is recorded from this formation within the county, the Tehama Formation contains significant fossils (Graymer, Jones, and Brabb 2002; cited in Solano County 2008b:4.10-19) and has high paleontological sensitivity (Solano County 2008b:4.10-19).

4.6.3 Environmental Impacts and Mitigation Measures

SIGNIFICANCE CRITERIA

Based on Appendix G of the State CEQA Guidelines, the project could have a significant adverse effect related to geology and soils resources if it would:

- directly or indirectly cause 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;
  - seismic-related ground failure, including liquefaction; or
  - landslides;
- 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 offsite 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 direct or indirect 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 the 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; and
- Directly or indirectly destroy a unique paleontological site or unique geological feature.

METHODOLOGY

Information describing regional and site-specific geologic and soil conditions was reviewed and the potential risks associated with development of the proposed project were assessed in the context of potential risks and constraints. This analysis relies on review of the JTD prepared for the project site as well as published geologic maps and literature.

It is assumed that structural design and construction techniques must comply with applicable CBC requirements and that recommendations contained in site specific geotechnical investigations will be implemented.

ISSUES NOT DISCUSSED FURTHER

Mineral Resources

A review of the Solano County General Plan (2008a: RS-33) and applicable SMARA mineral land classification reports (Stinson, Manson, and Plappert 1983 Plate 3.2, Dupras 1988) indicate that there are no known mineral resources zones associated with the RHR Property. Thus, the project would not affect the availability of a known mineral resources and there would be no impacts. This issue is not discussed further in this SEIR.

Septic Tank

The potential for onsite soils to be incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems was identified as a potentially significant impact requiring mitigation in the RHR Landfill Draft SEIR (EDAW 2005: 4-57). The 2005 SEIR also identified the potential for significant groundwater and surface water contamination if the onsite sewage disposal system was not properly installed. Mitigation Measure GEO-1 required the facility operator to implement all necessary design measures to prevent impacts to surface or groundwater to reduce the impact to less than significant (EDAW 2005: 4-57). A new septic system is not proposed as part of this project. Existing wastewater supplies are collected via an onsite septic system and because no expansion of administrative or other use that would require septic service would occur under the project, no expansion of septic is proposed. Therefore, the issue is not discussed further in this SEIR.

Liquefaction

The site does not lie in a State of California Liquefaction Hazard Zone, as mapped by the California Geological Survey (CGS). The Solano County General Plan (Chapter 5, Public Health and Safety) identifies the majority of the RHR Property as containing low liquefaction potential and an area along the western boundary of the RHR Property as having high liquefaction potential (Solano County 2015: HS-37). However, loose saturated sandy soils are typically associated with liquefaction hazards and the native materials underlying the RHR Property consist of silty clay and clayey sand (Douglas Environmental 2012: 2-29). Thus, no impacts related to liquefaction are anticipated. This issue is not discussed further in this SEIR.

Subsidence

As noted above, subsidence occurs when large amounts of groundwater have been withdrawn from certain types of soils, such as fine-grained sediments, and the soil loses support and collapses upon itself. The native materials underlying the RHR Property consist of silty clay and clayey sand that typically are not susceptible to landsliding, lateral spreading, subsidence, or collapse (Douglas Environmental 2012: 2-29). Because unstable soil conditions were not identified at the project site, this issue is not discussed further in this SEIR.

PROJECT IMPACTS AND MITIGATION MEASURES

Impact 4.6-1: Exposure of people or structures to potential increases in seismic hazards

Project facilities would be constructed on a site that may be subject to strong seismic ground shaking from active earthquake faults and the site is located within an area of high shrink-swell potential area. Seismic ground shaking, though infrequent, could cause structural failure of proposed facilities. Because the project would be designed, engineered, and constructed in conformance with applicable codes and standard engineering practices, which consider the characteristics of materials and forces, and are designed to result in adequate strength and safety requirements, the potential for structural damage and associated hazards to people during a seismic event would be substantially reduced, and this impact would be **less than significant**.

Solano County is an area of relatively high seismicity and will be subject to earthquake shaking in the future. Earthquake triggered landslides are a potential major problem that can be induced by moderate ground shaking. In addition, ground failure in the form of liquefaction, lurching, and settlement could also result from shaking. The RHR facility and the project site is not located within an Alquist-Priolo Special Studies Zone. The RHR facility is located approximately 4 miles from the Midland Fault north segment, but there is insufficient data to confirm that the north segment is an active seismogenic source. However, this absence of data is predominately due to the lack of detailed studies on the north segment. In addition, The active Concord-Green Valley Fault is located approximately 20 miles from the project site. A characteristic earthquake (maximum moment magnitude of 6.9) on this fault would cause strong to moderate ground shaking. Because of the potential for major earthquake activity in the region, ground shaking would be a potential hazard associated with the proposed project. Ground shaking intensity would depend on the magnitude of the earthquake, the distance from the epicenter, and the duration of shaking.

The shrinking and swelling of expansive soils as a result of moisture changes can damage building foundations, underground utilities, and other subsurface facilities if these facilities are not designed and constructed to resist the changing soil conditions. As discussed above, The Solano County General Plan indicates that the RHR Property is located within an area of high shrink-swell potential (Solano County 2015: Figure HS-10, HS-39).

The RHR Property is located in an area with natural slopes of 4 percent or less (Solano County 2015: HS-33).The proposed project would involve a lateral expansion of the landfill disposal area by approximately 24-acres and deepening and widening of the borrow pit. State regulations require that landfills comply with specific slope stability criteria that include both seismic and static conditions. CCR Title 27, Section 21090 specifies maximum final slopes and minimum design requirements. A slope or foundation stability report is required for final slopes that exceed a horizontal to vertical ratio of 3:1 or for slopes in areas subject to liquefaction or unstable areas with poor foundation conditions. The slopes of the landfill would be consistent with state requirements and would be required to remain stable under both static and seismic loading conditions. All proposed improvements would be designed, engineered, and constructed in conformance with applicable codes and standard engineering practices to minimize potential damage from seismic hazards and expansive soils.

Upon completion of disposal activities associated with the proposed project, a final cover would be installed over the waste disposal area that would meet or exceed appropriate regulatory standards and would be planted with native and non-native grasses to reduce runoff velocities and prevent erosion. In addition, the final cover would be designed to accommodate anticipated settlement and subsidence and to withstand the effects of seismic events throughout the minimum 30-year post-closure maintenance period and beyond. Final cover would be placed in accordance with a closure schedule to be included in a final closure and post-closure maintenance plan, which would be subject to approval by the Central Valley Regional Water Quality Control Board (RWQCB), California's Department of Resources Recycling and Recovery (CalRecycle), and the Local Enforcement Agency.

The proposed project includes deepening and widening of the existing borrow pit. Excavation and reclamation activities at the borrow pit would occur concurrently. This includes cultivation, gradation, and revegetation of bare sides, as necessary to minimize erosion potential and provide interim slope stabilization. These activities would comply with Chapter 33 of the CBC, which regulates grading activities, including drainage and erosion control and construction on unstable soils, such as expansive soils and areas subject to liquefaction. Grading and erosion control would also be consistent with applicable regulations related to grading and erosion control in Chapter 31 of the Solano County Code. Reclamation activities and compliance with required regulations would minimize the potential for landsliding and other potentially adverse seismic related impacts.

The Triangle area would be developed consistent with CCR Title 27 requirements. The borrow pit would be expanded consistent with applicable regulations and would continue to be managed to minimize the potential for landsliding and other potentially adverse seismic-related impacts. Thus, because the proposed project would be designed, engineered, and constructed in conformance with standard engineering practices to minimize potential structural damage during a seismic event, this impact would be **less than significant**.

Mitigation Measures

No mitigation measures are necessary.

Impact 4.6-2: Destruction of a unique paleontological resource

Portions of the Recology Hay Road (RHR) Property are underlain by older(Pleistocene) alluvium and the Tehama Formation, two geologic units known to be highly sensitive for paleontological resources. Thus, the project could have a **potentially significant** impact on paleontological resources.

According to the UC Berkeley Museum of Paleontology database, there are 297 localities in which fossil remains have been found in Solano County (UCMP 2018). The geological formations identified do not include formations at the site, younger (Holocene) alluvium, older (Pleistocene) alluvium, or the Tehama Formation. However, portions of the project site underlain by older (Pleistocene) alluvium and the Tehama Formation are considered highly sensitive for paleontological resources. Therefore, ground-disturbing construction activities could uncover previously unknown paleontological resources. This impact would be potentially significant.

Mitigation Measures

Mitigation Measure 4.6-1: Paleontological Resources

Before initiation of earthmoving activities associated with the Triangle or deepening of the borrow pit, Recology shall retain a qualified paleontologist to alert all construction personnel involved with earthmoving activities, including the site superintendent, about the possibility of encountering fossils. The appearance and types of fossils likely to be seen during construction will be described. Construction personnel will be trained about the proper notification procedures should fossils be encountered.

If paleontological resources are discovered during earthmoving activities, the construction crew will be directed to immediately cease work in the vicinity of the find and notify the County. Recology will retain a qualified paleontologist that will be readily available for quick identification and salvage of fossils so that construction delays can be minimized. If large specimens are discovered, the paleontologist will have the authority to halt or divert grading and construction equipment while the finds are removed. The paleontologist will be responsible for implementing the following measures.

- In the event of discovery, salvage of unearthed fossil remains, typically involving simple excavation of the exposed specimen but possibly also plaster-jacketing of large and/or fragile specimens, or more elaborate quarry excavations of richly fossiliferous deposits
- Recovery of stratigraphic and geologic data to provide a context for the recovered fossil remains, typically including description of lithologies of fossil-bearing strata, measurement and description of the overall stratigraphic section, and photographic documentation of the geologic setting
- Laboratory preparation (cleaning and repair) of collected fossil remains to a point of curation, generally involving removal of enclosing rock material, stabilization of fragile specimens (using glues and other hardeners), and repair of broken specimens

- Cataloging and identification of prepared fossil remains, typically involving scientific identification of specimens, inventory of specimens, assignment of catalog numbers, and entry of data into an inventory database
- Transferal, for storage, of cataloged fossil remains to an appropriate repository
- Preparation of a final report summarizing the field and laboratory methods used, the stratigraphic units inspected, the types of fossils recovered, and the significance of the curated collection.

Significance after Mitigation

Implementation of Mitigation Measure 4.6-1 would reduce significant impacts on previously-unknown paleontological resources to a **less-than-significant** level because construction workers would be alerted to the possibility of encountering paleontological resources and, if resources were encountered, fossil specimens would be appropriately recorded and treated, including potential curation.

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FILE CONTENTS

APPENDICES

FIGURES

TABLES

Acronyms/Abbreviations

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Citations

Green = matched
Aqua = missing
Pink = no citation in text

Bell et al. 2004
California Geological Survey 2008
CGS 2019
DOC 2013
Douglas Environmental 2012
Dupras 1988
EDAW 2005
Einarson 1995; cited in Golder 2018
Galloway et al. 1999
Golder 2015
Golder 2018
Graymer et al. 2002; cited in Solano County 2008b
Helley et al. 1979
Hertlein 1951
Russell 1927; cited in Solano County 2008b
Savage 1951
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Stinson, Manson, and Plappert 1983
Stirton 1951; cited in Solano County 2008b

UCMP 2018
Williamson et al. (198

References

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