3.6 - Geology and Soils

3.6.1 - Introduction

This section describes existing conditions related to geology and soils in the region and project area as well as the relevant regulatory framework. This section also evaluates the possible impacts related to geology and soils that could result from implementation of the proposed project. Information included in this section is based, in part, on the project-specific geotechnical exploration[1] and Paleontological Records Search[2] included in Appendix F as well as the City of Antioch General Plan and General Plan Environmental Impact Report (EIR). No public comments were received during the EIR public scoping period related to geology and soils.

3.6.2 - Environmental Setting

Geologic Setting

Contra Costa County Area

Contra Costa County is situated in the Coast Ranges geomorphic province of California. The Coast Ranges have experienced a complex geological history characterized by Late Tertiary folding and faulting that has resulted in a series of northwest-trending mountain ranges and intervening valleys. Bedrock in the Coast Ranges consists of igneous, metamorphic, and sedimentary rocks that range in age from Jurassic to Pleistocene. The present physiography and geology of the Coast Ranges are the result of deformation and deposition along the tectonic boundary between the North American plate and the Pacific plate. Plate boundary fault movements are largely concentrated along the well-known fault zones, which in the area include the San Andreas Fault, Hayward Fault, and Calaveras Fault, as well as other lesser-order faults.

The geology of Contra Costa County is dominated by several northwest trending fault systems that divide the County into large blocks of rock. For example, the Briones Hills are bounded by the Hayward Fault on the west and elements of the Franklin-Calaveras Fault system on the east. Within a particular block the rock sequence consists of: (1) a basement complex of broken and jumbled pre-Tertiary sedimentary, igneous and metamorphic rocks; (2) a section of younger Tertiary sedimentary rocks and some volcanic rocks (flows and tuffs) that locally intertongue with and overlie the sedimentary section; and, (3) surficial deposits including stream alluvium, colluvium (slopewash deposits at the foot of steeper slopes), slides, alluvial fans, and Bay Plain deposits.[3]

City of Antioch

The Lowland Area of Antioch is underlain by alluvium younger than 2 million years old, consisting mainly of unconsolidated floodplain deposits with sand, silt, gravel, and clay irregularly interstratified.[4]

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1 ENGEO Inc. 2018. The Ranch at Antioch. Geotechnical Exploration. September.
2 Kenneth Finger, PhD. 2019. The Ranch Residential Project. Paleontological Records Search. June.
3 Contra Costa County General Plan 2025. Section 10.6, Seismic Hazards. Page 10-4, Local Geology.
4 City of Antioch. 2003. General Plan EIR. Section 4.5, Geologic and Seismic Hazards. Page 4.5-1.

The Upland Area consists of tilted sedimentary rocks ranging in age from Upper Cretaceous (65 million years old) to Holocene (11,000 years old). The following geologic units are present: Unit D sandstone, Deer Valley sandstone of Coburn, Lower Unit E siltstone, Upper Unit E siltstone, surficial deposits, Cierbo sandstone, Domingene Formation, Meganso Formation, Neroly sandstone, and Markley Formation.[5]

Black Diamond area coal deposits (within the Domingene Formation) are located in the southwestern portions of the Planning Area. Past mining activities followed two principal coal seams to a depth of more than 550 feet below ground surface (bgs). Records of the Black Diamond Coal Company indicate that, by 1890, more than 85 percent of the total reserve at the Black Diamond region had been mined.

Access tunnel and ventilation shafts constructed as part of the mining operation were generally located at the head of ravines, where erosion had naturally worn away portions of the hillside overlying the coal. Most access tunnels were well documented, and have been relocated and sealed over the years. Ventilation shafts, however, are more numerous and their locations are poorly documented. These shafts were typically sealed through construction of timber floors placed about 10 feet bgs and then backfilled to grade during closure of the mine. The timber floors deteriorate over time, and ventilation shafts can collapse creating soil slumps. The remaining mine openings provide a connection to a labyrinth of subsurface tunnels that can be subject to cave-ins and unexpected dropoffs.

Pockets of poisonous carbon monoxide or methane gas may also be present. These mines present a possible risk of collapse and surface subsidence that could compromise the integrity of buildings developed overlying the mine tunnels. Ultimately, the potential for mine collapse is dependent upon the type of mining that was conducted, the size and dimensions of the mined area, the bearing strength of the materials bounding the mined area, depth of mining, and the length of time since the mining was discontinued.[6]

Project Site

The project site is located in the Coast Ranges geomorphic province on the eastern side of Mount Diablo, where bedrock is mapped as Tertiary Eocene and Oligocene age marine sedimentary rock. The bedrock in the area generally consists of interbedded sandstone and claystone that vary from friable to strong. Bedrock structures in the area generally strike to the northwest and dip at an inclination of 15 to 30 degrees to the northeast.

Soils

Corrosive soils are a geologic hazard, because they react with concrete and ferrous metals, which can cause damage to foundations and buried pipelines. Expansive soils are a geologic hazard, because an increase in soil volume can exert forces on structures and, thus, damage building foundations, walls, and floors. In general, areas are susceptible to differential settlement if underlain by compressible

[5] City of Antioch. 2003. General Plan EIR. Section 4.5, Geologic and Seismic Hazards. Page 4.5-3.
[6] City of Antioch. 2003. General Plan EIR. Section 4.5, Geologic and Seismic Hazards. Page 4.5-4.

sediments, such as poorly engineered artificial fill or loose unconsolidated alluvial sediments. When these soils dry out and shrink, structural damage can occur.

Contra Costa County Area

The United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) has characterized the majority of native, undisturbed soils in the Contra Costa County area according to three soil associations: (1) nearly level to strongly sloping, somewhat excessively drained to very poorly drained soils on Valley fill, basin, low terraces, flood plains, and alluvial fans; (2) nearly level, poorly drained and very poorly drained souls on the Delta, flood plains, and saltwater marshes and tidal flats; and (3) nearly level to very steep, moderately well drained to excessively drained soils on terraces and mountainous uplands.[7]

The NRCS divides all soil types into four categories based on the potential to produce runoff. Type A soils have the lowest runoff potential and typically have high infiltration rates. Type D soils have the highest runoff potential and typically have low infiltration rates and/or are shallow.

City of Antioch

The City of Antioch consists of two general topographic areas: the Lowland Area and the Upland Area. The Lowland Area generally corresponds to the estuarine and flatland soils, and the Upland Area includes hillside soils.

The Lowland Area includes the generally level terrain and wetlands adjacent to the San Joaquin River and low-lying areas to the south. Elevations in the Lowland Area generally range from near sea level to approximately 100 feet above mean sea level and contain slopes that range from 0 to 15 percent. The Lowland Area of Antioch is underlain by alluvium that is less than 2 million years old, and consists mainly of unconsolidated floodplain deposits with sand, silt, gravel, and clay irregularly interstratified. The Upland Area comprises moderate to steeply sloping hills, and is generally located south of the Lowland Area. The Upland Area of the City consists primarily of tilted sedimentary rocks that range in age from Upper Cretaceous (65 million years old) to Holocene (11,000 years old).

Specifically, the City of Antioch is comprised of the Capay-Rincon soil association, which consists of nearly level to strong sloping, moderately well drained and well-drained clays and clay loams on valley fill.[8]

Project Site Vicinity

Remnants of a former mining town, known as Judsonville, are located near the western border of the project site along Empire Mine Road. Various debris piles were observed near the Judsonville site, including approximately 5 feet of artificial fills. Given that records pertaining to the placement of these artificial fills could not be found, the artificial fills are, therefore, considered to be non-engineered, which can be highly variable and potentially compressible. Previous mining operations associated with Judsonville occurred to the east of the project site and were used to mine coal. Two

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[7] United States Department of Agriculture (USDA), Natural Resources Conservation Service. General Soil Map of Contra Costa County, California. Website: https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/california/CA013/0/maps/gsm.pdf. Accessed February 14, 2019.

[8] Ibid.

additional historic coal mines, the Teutonia Mine and the Israel Mine, are located to the south of the project site; all were active during the mid-1860s.

Project Site

The majority of the project site contains soils composed of Capay clay (CaA), Rincon clay loam (RbA), Altamont clay (AbE), and Altamont-Fontana complex (AcF). These soils have a low soil permeability and have a very low potential for water to infiltrate the soil.

The Geotechnical Exploration Report (Appendix F) notes that potentially expansive lean clay soils were observed near the surface in all of the soil test pits. These soils have moderate to high shrink/swell potential with variations in moisture content. Expansive soils can shrink or swell and cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations. Successful performance of structures on expansive soils requires specific procedures for grading and for establishment of building foundations.

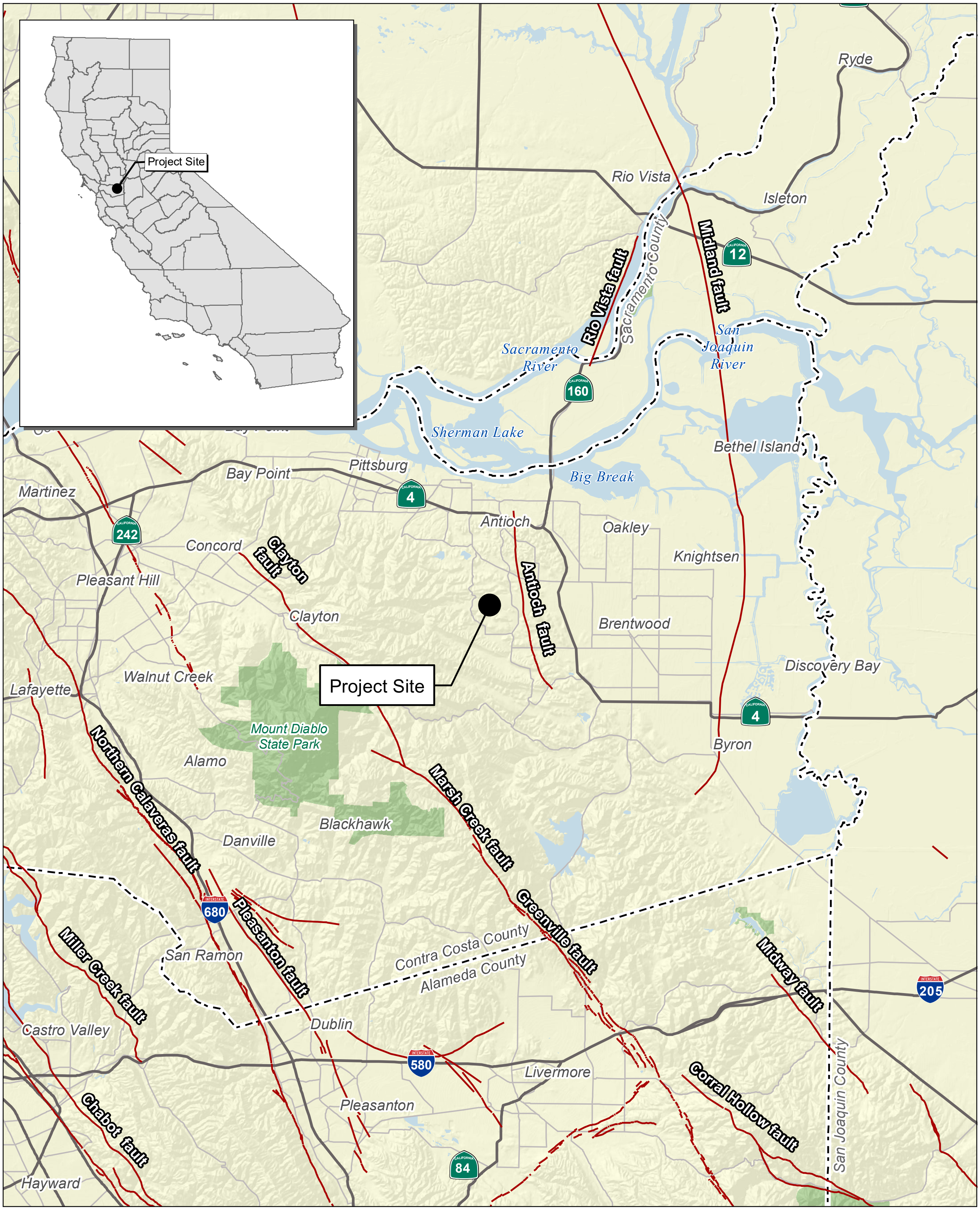
Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, fine-grained sands. Although some silty and clayey sand soils were encountered on-site, the Geotechnical Exploration Report concludes that site soils have a low potential for liquefaction, given the soil density and the high fine-grained material content that was observed in the test pits.

Seismicity

The term "seismicity" describes the effects of seismic waves that are radiated from an earthquake fault in motion. While most of the energy released during an earthquake results in the permanent displacement of the ground, as much as 10 percent of the energy may dissipate immediately in the form of seismic waves. Seismicity can result in seismic-related hazards such as fault rupture, ground shaking, and liquefaction faults formed in rocks when stresses overcome the internal strength of the rock. Fault rupture occurs when movement on a fault breaks through to the surface and can result in damage to infrastructure and persons. Ground movement during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. Strong ground shaking from an earthquake can result in damage, with buildings shifted off their foundations and underground pipes broken. Liquefaction occurs when an earthquake causes ground shaking that result in saturated soil to lose shear strength, deform, and act like a liquid. When liquefaction occurs, it can result in ground failure that can result in damage to roads, pipelines, and buildings.

Contra Costa County Area

Exhibit 3.6-1 depicts the location of fault lines in Contra Costa County. Seismic risk is assumed by every occupant and developer in Contra Costa County, because the County is within an area of high seismicity; the San Francisco Bay Area (Bay Area) has been impacted by more than 10 severe earthquakes during historic time.



Source: Census 2000 Data, The CaSIL. California Geological Survey.

FIRSTCARBON SOLUTIONS™

5 2.5 0 5 Miles

Exhibit 3.6-1
Regional Fault Map

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CITY OF ANTIOCH • THE RANCH PROJECT
ENVIRONMENTAL IMPACT REPORT

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Contra Costa County has been subjected to numerous seismic events, originating both on faults within the County and in other parts of the region. Six major Bay Area earthquakes have occurred since 1800 that affected the County, and at least two of the faults that produced them run through or into the County. These earthquakes and the originating faults include the 1836 and 1868 earthquakes on the Hayward Fault, and the 1861 earthquake on the Calaveras Fault. Two earthquakes, in 1838 and 1906, originated on the San Andreas Fault, west of the County near San Francisco or to the south. One earthquake, with two major shocks, occurred in 1872 that caused some damage in the County and was centered north of Contra Costa County in the Vacaville-Winters area of Solano County. These latter events likely occurred on a thrust fault and are not known to have been accompanied by surface fault rupture. A smaller earthquake, centered near Collinsville in Solano County on a fault of uncertain identity, occurred in 1889. Table 3.6-1 lists active faults located in the vicinity of the project site.

Table 3.6-1: Location and Approximate Magnitude of Potential Earthquakes on Bay Area Faults

Causative Fault	Distance and direction from project site	Magnitude
Greenville	5 miles to the SW	6.9
Green Valley	11 miles to the W	6.9
Concord	13 miles to the W	5.0–6.0
		6.0–7.0
Calaveras	15 miles to the SE	6.0–7.0
		7.0–7.5
Hayward	24 miles to the SW	6.0–7.0
		7.0–7.5
San Andreas	42 miles to the SW	7.0–8.0
		8.0–8.5

Notes:
SW = southwest
W = west
SE = southeast
Source: Contra Costa County Conservation and Development Department estimates.
Source: ENGEO Inc. 2018. The Ranch at Antioch. Geotechnical Exploration. September.

City of Antioch

The City of Antioch, located within eastern Contra Costa County, is located within one of the most seismically active regions in the United States. Areas in the vicinity of Antioch have experienced major earthquakes, which can be expected to occur again in the future. There are no active faults within the City of Antioch. However, there are several major faults located within a few miles. The San Andreas Fault, the largest fault of the region, is approximately 45.00 miles west of Antioch.

Project Site

There are no known active faults mapped across the project site,[9] and the project site is not located within an Alquist-Priolo Earthquake Fault Zone.[10] The nearest known active fault surface trace is the Greenville Fault, which is located 5.00 miles southwest from the proposed project site, and the Green Valley Fault located 11.00 miles west of the project site. Portions of the Green Valley Fault are considered seismically active thrust faults; however, since the Green Valley Fault segments are not known to extend to the ground surface, the State of California has not defined Earthquake Fault Hazard Zones around the postulated traces. Active faults within the San Francisco Bay Area capable of producing significant ground shaking at the project site include the Green Valley Fault located 11.00 miles to the west; the Calaveras Fault located 15.00 miles to the southeast; the Hayward Fault located 24.00 miles to the southwest, and the San Andreas Fault located 42.00 miles to the southwest. While the Antioch Fault is located directly east of the site, this fault is not considered active.[11]

Slope Disturbance

Slope disturbance from long-term geologic cycle of uplift, mass wasting, intense precipitation or wind, and gravity can result in slope failure in the form of mudslides and rock fall. The project area is seismically active with known faults; however, the project area does not contain active faults that would cause geologic uplifting. Mass wasting refers to a variety of erosional processes from gradual downhill soil creep to mudslides, debris flows, landslides, and rock fall—processes that are commonly triggered by intense precipitation or wind, which varies according to climactic shifts. Often, various forms of mass wasting are grouped together as landslides, which are generally used to describe the downhill movement of rock and soil. Soil creep is a long-term, gradual downhill migration of soil under the influence of gravity and is generally about a fraction of an inch per year. These soils can creep away downslope sides of foundations and reduce lateral support.

Contra Costa County Area

The major geologic hazards in Contra Costa County, aside from earthquake rupture and direct effects of ground shaking, are unstable hill slopes and reclaimed wetlands and marsh fill areas. Slopes may suffer landslides, slumping, soil slips, and rockslides. Reclaimed wetlands, whether filled or not, experience amplified lateral and vertical movements, which can be damaging to structures, utilities, and transportation routes and facilities.

The Contra Costa County General Plan 2025 recognizes that major slope areas in excess of 26 percent are “not readily developable” and “undevelopable,” recognizing the cost and engineering difficulties of grading steep slopes as well as their inherent unsuitability.[12] Figure 10-6 of the Contra Costa County General Plan 2025 shows Landslide Hazards in Contra Costa County.

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[9] An active fault is defined by the California Geologic Survey as one that has had surface displacement within Holocene time (about the last 11,000 years). The State of California has prepared maps designating zones for special studies that contain these active earthquake faults.

[10] ENGEO Inc. 2018. The Ranch at Antioch. Geotechnical Exploration. September.

[11] An active fault is defined by the California Geologic Survey as one that has had surface displacement within Holocene time (about the last 11,000 years). The State of California has prepared maps designating zones for special studies that contain these active earthquake faults.

[12] Contra Costa County General Plan 2025. Section 10.7, Ground Failure and Landslide Hazards. Page 10-22.

City of Antioch

According to the City of Antioch General Plan EIR, the majority of slopes in the southwest corner of the City are considered unstable or moderately unstable. The eastern portions of Lone Tree Valley across the site have stable to generally stable slopes, and the area north of Lone Tree Valley is generally to marginally stable. Most of the lowlands in the northern area of the City contain stable, generally stable, and marginally stable slopes. The northwest area of the City, including Dow Wetland Preserve, is unstable.[13]

Project Site

Project site elevations vary from approximately 200 feet above mean sea level along Deer Valley Road, to more than 400 feet above mean sea level in the southern hills. Sand Creek divides the site and flows from west to east. Slopes adjacent to the creek generally vary in height between 5 and 40 feet, and can be as steep as 1:1 (horizontal: vertical). Based on topographic and lithologic data, the risk of regional subsidence or uplift, lateral spreading, and landslides is considered to be low to negligible at the project site.[14] The California Department of Conservation's Earthquake Zones of Required Investigation Map identifies the project site as located within a liquefaction zone.[15] However, as noted above in the discussion of soils, the Geotechnical Exploration Report (Appendix F) found a low potential for liquefaction during seismic events, given the soil density and the high fine-grained material content that was observed in the test pits.

Paleontological Resources

Project Site Vicinity

University of California Museum of Paleontology (UCMP) locality V4719 (Heldorn) yielded late Pleistocene horse (*Equus)* cheek teeth 1.00-mile northwest of the project site. Additionally, 1.00 mile north of that site yielded a mastodon (*Mammut)* skull fragment of that age was collected at UCMP locality V6650 (Antioch Dam).[16]

Project Site

No known paleontological resources are located within the project site boundaries.[17]

3.6.3 - Regulatory Framework

Federal

National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) was established by the U.S. Congress when it passed the Earthquake Hazards Reduction Act of 1977, Public Law 95–124. In establishing the NEHRP, Congress recognized that earthquake-related losses could be reduced through improved design and construction methods and practices, land use controls and redevelopment, prediction

[13] City of Antioch. 2003. General Plan EIR. Section 4.5, Geologic and Seismic Hazards. Page 4.5-16.
[14] ENGEO Inc. 2018. The Ranch at Antioch. Geotechnical Exploration. September.
[15] California Department of Conservation. Seismic Hazards and Zones of Required Investigation. Website: https://www.conservation.ca.gov/cgs/Pages/Program-SHP/regulatory-hazard-zones.aspx. Accessed December 11, 2019.
[16] Kenneth Finger, PhD. 2019. The Ranch Residential Project. Paleontological Records Search. June.
[17] Ibid.

techniques and early warning systems, coordinated emergency preparedness plans, and public education and involvement programs. The four basic goals remain unchanged:

1. Develop effective practices and policies for earthquake loss reduction and accelerate their implementation.
2. Improve techniques for reducing earthquake vulnerabilities of facilities and systems.
3. Improve earthquake hazards identification and risk assessment methods, and their use.
4. Improve the understanding of earthquakes and their effects.

Several key federal agencies contribute to earthquake mitigation efforts. There are four primary NEHRP agencies:

- National Institute of Standards and Technology of the Department of Commerce
- National Science Foundation
- United States Geological Survey (USGS) of the Department of the Interior
- Federal Emergency Management Agency (FEMA) of the Department of Homeland Security

Implementation of NEHRP priorities is accomplished primarily through original research, publications, and recommendations to assist and guide State, regional, and local agencies in the development of plans and policies to promote safety and emergency planning.

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System (NPDES) permit program, authorized by Section 402(p) of the federal Clean Water Act, controls water pollution by regulating point sources, such as construction sites and industrial operations that discharge pollutants into waters of the United States. A Storm Water Pollution Prevention Plan (SWPPP) is required to control discharges from a project site, including soil erosion, to protect waterways. A SWPPP describes the measures or practices to control discharges during both the construction and operational phases of the project. A SWPPP identifies project design features and structural and nonstructural Best Management Practices (BMPs) that will be used to control, prevent, remove, or reduce stormwater pollution from the site, including sediment from erosion.

Society of Vertebrate Paleontology Guidelines

The Society of Vertebrate Paleontology, a national scientific organization of professional Vertebrate Paleontologists, has established standard guidelines that outline acceptable professional practices in the conduct of paleontological resource assessments and surveys, monitoring and mitigation, data and fossil recovery, sampling procedures, specimen preparation, analysis, and curation.[18] Most practicing professional Paleontologists in the nation adhere to the SVP assessment, mitigation, and monitoring requirements, as specifically spelled out in the SVP Standard Guidelines.

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[18] The Society of Vertebrate Paleontology (SVP). 2010. Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources. Website: http://vertpaleo.org/the-Society/Governance-Documents/SVP_Impact_ Mitigation_Guidelines.aspx. Accessed December 11, 2019.

State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code [PRC] §§ 2621–2630) was passed in 1972 to provide a Statewide mechanism for reducing the hazard of surface fault rupture to structures used for human occupancy. The main purpose of the Act is to prevent the siting of buildings used for human occupancy across the traces of active faults. It should be noted that the Act addresses the potential hazard of surface fault rupture and is not directed toward other earthquake hazards, such as seismically-induced ground shaking or landslides.

The law requires the State Geologist to identify regulatory zones (known as Earthquake Fault Zones or Alquist-Priolo Zones) around the surface traces of active faults, and to depict these zones on topographic base maps, typically at a scale of 1 inch to 2,000 feet. Earthquake Fault Zones vary in width, although they are often 0.75 mile wide. Once published, the maps are distributed to the affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. With the exception of single-family wood-frame and steel-frame dwellings that are not part of a larger development (i.e. four units or more), local agencies are required to regulate development within the mapped zones. In general, construction within 50 feet of an active fault zone is prohibited.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (PRC §§ 2690–2699.6), which was passed in 1990, addresses earthquake hazards other than surface fault rupture. These hazards include strong ground shaking, earthquake-induced landslides, liquefaction, or other ground failures. Much like the Alquist-Priolo Earthquake Fault Zoning Act discussed above, these seismic hazard zones are mapped by the State Geologist to assist local government in the land use planning process. The Act states, “It is necessary to identify and map seismic hazard zones in order for cities and counties to adequately prepare the safety element of their general plans and to encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety.” The Act also states, “Cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard.”

California Building Standards Code

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

The State earthquake protection law (California Health and Safety Code § 19100 *et seq*.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. The intent of the CBC is to enable structures to (i) resist minor earthquakes without damage, (ii) resist moderate earthquakes without structural damage but with some non-structural damage, and (iii) resist major earthquakes without collapse but with some structural as well as non-structural damage. Specific minimum seismic safety and structural design requirements are set forth in Chapter 16, Structural Design, of the CBC.[19] The CBC identifies seismic factors that must be considered in structural design.

Chapter 18, Soils and Foundations, of the CBC regulates the excavation of foundations and retaining walls, and Appendix Chapter A33 regulates grading activities, including drainage and erosion control and construction on unstable soils, such as expansive soils and areas subject to liquefaction. The CBC contains specific requirements for seismic safety, excavation, foundations, retaining walls, and site demolition. It also regulates grading activities, including drainage and erosion control (Appendix J). The CBC is updated every 3 years, and the current 2016 CBC took effect January 1, 2017.[20] The 2016 CBC has been adopted by the City of Antioch according to Title 8, Building Regulations, Section 8-1.01, Adoption of the 2016 California Building Code, of the City of Antioch Municipal Code.[21]

Local

City of Antioch General Plan

The City of Antioch General Plan, adopted in 2003, serves as the overall guiding policy document for the City of Antioch. The following is a list of applicable City of Antioch General Plan objectives and policies most pertinent to the proposed project with respect to geology and soils.

Land Use Element

- **Policy 4.4.6.7b.s:** Sand Creek, ridgelines, hilltops, stands of oak trees, and significant landforms shall be preserved in their natural condition. Overall, a minimum of 25 percent of the Sand Creek Focus Area shall be preserved in open space, exclusive of lands developed for gold course use.
- **Policy 4.4.6.7b.cc:** Mass grading within the steeper portions of the Focus Area (generally exceeding 25 percent slopes) is to be avoided.

Community Image and Design Element

- **Policy 5.4.14a:** Design hillside development to be sensitive to existing terrain, views, and significant natural landforms and features.
- **Policy 5.4.14b:** Projects within hillside areas shall be designed to protect important natural features and to minimize the amount of grading. To this end, grading plans shall conform to the following guidelines.
  - *Slopes less than 25%:* Redistribution of earth over large areas may be permitted.
  - *Slopes between 25% and 35%:* Some grading may occur, but landforms need to retain their natural character. Split-level designs and clustering are encouraged as a means of avoiding the need for large padded building areas.

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[19] California Building Standards Code (CBC). Chapter 16, Structural Design. Website: https://up.codes/viewer/california/ca-building-code-2016-v2/chapter/16/structural-design#16. Accessed December 11, 2019.

[20] California Building Standards Code (CBC). Website: https://up.codes/viewer/california/ibc-2018. Accessed May 20, 2019.

[21] City of Antioch Municipal Code. Title 8, Building Regulations, Chapter 1, Building Code, Section 8-1.01, Adoption of the 2016 California Building Code. Website: http://library.amlegal.com/nxt/gateway.dll/California/antioch/cityofantiochcaliforniacodeofordinances?f=templates$fn=default.htm$3.0$vid=amlegal:antioch_ca. Accessed May 20, 2019.

- *Slopes between 35% and 50%:* Development and limited grading can occur only if it can be clearly demonstrated that safety hazards, environmental degradation, and aesthetic impacts will be avoided. Structures shall blend with the natural environment through their shape, materials and colors. Impact of traffic and roadways is to be minimized by following natural contours or using grade separations. Encouraged is the use of larger lots, variable setbacks and variable building structural techniques such as stepped or post and beam foundations are required.
- *Slopes greater than 50%:* Except in small, isolated locations, development in areas with slopes greater than 50% should be avoided.

- **Policy 5.4.14c:** Manufactured slopes in excess of five vertical feet (5') shall be landform graded. "Landform grading" is a contour grading method which creates artificial slopes with curves and varying slope ratios in the horizontal and vertical planes designed to simulate the appearance of surrounding natural terrain. Grading plans shall identify which slopes are to be landform graded and which are to be conventionally graded.
- **Policy 5.4.14d:** The overall project design/layout of hillside development shall adapt to the natural hillside topography and maximize view opportunities to, as well as from the development.
- **Policy 5.4.14e:** Grading of ridgelines is to be avoided wherever feasible, siting structures sufficiently below ridgelines so as to preserve unobstructed views of a natural skyline. In cases where application of this performance standard would prevent construction of any structures on a lot of record, obstruction of views of a natural skyline shall be minimized through construction techniques and design, and landscaping shall be provided to soften the impact of the new structure.
- **Policy 5.4.14f:** Hillside site design should maintain an informal character with the prime determinant being the natural terrain. This can be accomplished by:
  - Utilizing variable setbacks and structure heights, innovative building techniques, and retaining walls to blend structures into the terrain, and
  - Allowing for different lot shapes and sizes.
- **Policy 5.4.14g:** Buildings should be located to preserve existing views and to allow new dwellings access to views similar to those enjoyed from existing dwellings.
- **Policy 5.4.14h:** Streets should follow the natural contours of the hillside to minimize cut and fill, permitting streets to be split into two one-way streets in steeper areas to minimize grading and blend with the terrain. Cul-de-sacs or loop roads are encouraged where necessary to fit the terrain. On street parking and sidewalks may be eliminated, subject to City approval, to reduce required grading.
- **Policy 5.4.14i:** Clustered development is encouraged as a means of preserving the natural appearance of the hillside and maximizing the amount of open space. Under this concept, dwelling units are grouped in the more level portions of the site, while steeper areas are preserved in a natural state.
- **Policy 5.4.14j:** Project design should maximize public access to canyons, overlooks, and open space areas by:
  - Providing open space easements between lots or near the end of streets or cul-de-sacs; and
  - Designating public pathways to scenic vistas.

- **Policy 5.4.14k:** Permit the use of small retaining structures when such structures can reduce grading, provided that these structures are located and limited in height so as not to be a dominant visual feature of the parcel.
  - Where retaining walls face public streets, they should be faced with materials that help blend the wall into the natural character of the terrain.
  - Large retaining walls in a uniform plane should be avoided. Break retaining walls into elements and terraces, and use landscaping to screen them from view.

Resource Management Element

- **Policy 10.9.2c:** When existing information indicates that a site proposed for development may contain paleontological resources, a Paleontologist shall monitor site grading activities with the authority to halt grading to collect uncovered paleontological resources, curate any resources collected with an appropriate reposition, and file a report with the Community Development Department documenting any paleontological resources found during site grading.

Environmental Hazards Element

- **Objective 11.3.2:** Minimize the potential for loss of life, physical injury, property damage, and social disruption from seismic ground shaking and other geologic events.
- **Policy 11.3.2a:** Require geologic soils reports to be prepared for proposed development sites, and incorporate the findings and recommendations of these studies into project development requirements. As determined by the City of Antioch Building Division, a site-specific assessment shall be prepared to ascertain potential ground shaking impacts on new development. The site-specific ground shaking assessment shall incorporate up-to-date data from government sources and may be included as part of any site-specific geotechnical investigation. The site-specific ground shaking assessment shall include specific measures to reduce the significance of potential ground shaking hazards. This site-specific ground shaking assessment shall be prepared by a licensed geologist and shall be submitted to the City of Antioch Building Division for review and approval prior to the issuance of building permits. For the purposes of this policy, "development" applies to new structures and existing structures or facilities that undergo expansion, remodeling, renovation, refurbishment or other modification. This policy does not apply to second units or accessory buildings.
- **Policy 11.3.2g:** Require that engineered slopes be designed to resist seismically-induced failure.
- **Policy 11.3.2h:** Require that parcels overlying both cut and fill areas within a grading operation be over-excavated to mitigate the potential for seismically-induced differential settlement.
- **Policy 11.3.2i:** Limit development in those areas, which, due to adverse geologic conditions, will be hazardous to the overall community and those who will inhabit the area.
- **Policy 11.3.2j:** Require evaluations of potential slope stability for developments proposed within hillside areas, and incorporate the recommendations of these studies into project development and requirements.
- **Policy 11.3.2k:** Require specialized soil reports in areas suspected of having problems with potential bearing strength, expansion, settlement, or subsidence, including implementation of the recommendations of these reports into the project development, such that structures

designed for human occupancy are not in danger of collapse or significant structural damage with corresponding hazards to human occupants. Where structural damage can be mitigated through structural design, ensure that potential soils hazards do not pose risk of human injury or loss of life in outdoor areas of a development site.

- **Policy 11.3.2l:** Where development is proposed within an identified or potential liquefaction hazard area (as determined by the City), adequate and appropriate measures such as (but not limited to) designing foundations in a matter that limits the effects of liquefaction, the placement of an engineered fill with low liquefaction potential, and the alternative siting of structures in areas with a lower liquefaction risk, shall be implemented to reduce potential liquefaction hazards. Any such measures shall be submitted to the City of Antioch Building Division for review prior to the approval of the building permits.
- **Policy 11.3.2m:** As appropriate and necessary to protect public health and safety, abandoned mines shall be placed in natural open space areas, with appropriate buffer areas to prevent unauthorized entry.
- **Policy 11.3.2n:** Within areas of known historic mining activities, site-specific investigations shall be undertaken prior to approval of development to determine the location of any remaining mine openings, the potential for subsidence or collapse, and necessary measures to protect public health and safety, and prevent the collapse or structural damage to structures intended for human occupancy due to mine-related ground failure or subsidence. Such measures shall be incorporated into project approvals.
- **Policy 11.3.2o:** All identified mine openings shall be effectively sealed.
- **Policy 11.3.2p:** Construction of structures for human occupancy shall be prohibited within areas found to have a high probability of surface collapse or subsidence, unless foundations are designed that would not be affected by such surface collapse or subsidence, as determined by site-specific investigations and engineered structural design.
- **Policy 11.3.2q:** The locations of all oil or gas wells on proposed development site shall be identified in development plans. Project sponsors of development containing existing or former oil or gas wells shall submit documentation demonstrating that all abandoned wells have been properly abandoned pursuant to the requirements of the California Department of Conservation Oil, Gas, and Geothermal Resources.

City of Antioch Municipal Code

Building and Construction

City of Antioch Municipal Code Section 8-1.01 adopts the 2016 CBC based on the 2015 International Building Code as the City's Building Code.[22] As such, all new development is required to adhere to its seismic safety standards.

[22] City of Antioch Municipal Code. Title 8, Building Regulations, Chapter 1, Building Code, Section 8-1.01, Adoption of the 2016 California Building Code. Website: http://library.amlegal.com/nxt/gateway.dll/California/antioch/cityofantiochcaliforniacodeofordinances?f=templates$fn=default.htm$3.0$vid=amlegal:antioch_ca. Accessed May 20, 2019.

Stormwater Control Plan Required

Because construction activity during land development has the potential to result in pollution of nearby waterways, City of Antioch Municipal Code Section 8-13.01 requires the implementation of stormwater pollution control measures during all construction phases.[23]

3.6.4 - Impacts and Mitigation Measures

Significance Criteria

According to the 2019 California Environmental Quality Act (CEQA) Guidelines, Appendix G Environmental Checklist, to determine whether impacts to geology and soils are significant environmental effects, the following questions are analyzed and evaluated. Would the proposed project:

a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving:
   i. 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? (Refer to Division of Mines and Geology Special Publication 42.)
   ii. Strong seismic ground shaking?
   iii. Seismic-related ground failure, including liquefaction?
   iv. Landslides?

b) Result in substantial soil erosion or the loss of topsoil?

c) 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?

d) 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?

e) 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?

f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

Approach to Analysis

Impacts related to geology and soils were determined by reviewing information contained in the geotechnical exploration prepared for the project site, which is included in Appendix F.

ENGEO, Inc. performed field explorations on August 29, 2019, as part of the Geotechnical Exploration Report. The field exploration included excavation of seven test pits within the historic

[23] City of Antioch Municipal Code. Title 8, Building Regulations, Chapter 13, Storm Water Pollution Control, Section 8-13.01. Website: http://library.amlegal.com/nxt/gateway.dll/California/antioch/%20cityofantiochcaliforniacodeofordinances?f=templates$fn=default.htm$3.0$vid=amlegal:antioch_ca. Accessed December 11, 2019.

orchard and homestead. Locations of the explorations were approximate and were estimated using handheld global positioning satellite (GPS) equipment.

An ENGEO, Inc. representative observed the test pit excavation and logged the subsurface conditions at each location. A backhoe was used to excavate the test pits using a 3-foot wide bucket. The type, location, and uniformity of the underlying soil/rock was logged. The maximum depth penetrated by the test pits was 4.25 feet.

The test pit logs present descriptions and graphically depict the subsurface conditions encountered. Field logs were used to develop the report logs found in Appendix A of the Geotechnical Exploration Report. Previous geotechnical reports and historical geologic maps were also reviewed.

Additional evaluations of potential geologic and soil impacts of the proposed project were based on review of available documentation, including the City of Antioch General Plan; USGS "Shake Map" webpage; the USDA NRCS Web Soil Survey; and Association of Bay Area Governments, California Geological Survey, and USGS data and publications.

Impacts to paleontological resources were determined by reviewing the Paleontological Records Search prepared for the project site by Consulting Paleontologist, Kenneth Finger, PhD. Dr. Finger performed a records search on the UCMP database for the project site.

Impact Evaluation

Earthquakes

Impact GEO-1: **The proposed project could directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving:**

i) 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? Refer to Division of Mines and Geology Special Publication 42.

ii) Strong seismic ground shaking.

iii) Seismic-related ground failure, including liquefaction.

iv) Landslides.

Construction/Operation

Ground Rupture

Based on the project-specific geotechnical exploration (Appendix F) prepared for the project site, the potential for ground rupture is considered unlikely. The California Division of Mines and Geology has not identified any active faults within the project site. Additionally, the site is not located within an Alquist-Priolo Earthquake Fault Zone, and surface evidence of faulting was not observed during site reconnaissance. Although portions of the Green Valley Fault were identified 11.00 miles west of the project site, the fault does not extend to the ground surface and therefore, is not considered to be active by the State of California. Ground rupture occurring at the site is considered to be unlikely.

Strong Seismic Ground Shaking

There is potential for considerable ground shaking at the project site resulting from an earthquake of moderate to high magnitude generated within the San Francisco Bay Region.[24] This represents a potentially significant impact related to future structures and residents.

Ground shaking effects can be mitigated through implementation of CBC requirements and sound engineering judgement as outlined in Mitigation Measure (MM) GEO-1a. In addition, the project-specific geotechnical exploration provides earthwork recommendations that would also reduce potential impacts to less than significant. MM GEO-1b requires that final grading and foundation plans be reviewed by a qualified Geotechnical Engineer to confirm that project-specific geotechnical exploration recommendations are incorporated. MM GEO-1b also requires monitoring during construction to check the validity of the assumptions made in the geotechnical exploration, to ensure that site preparation and selected fill materials are satisfactory, and that placement and compaction of the fill is performed in accordance with recommendations and the project specifications. As such, with implementation of identified mitigation, the proposed project would not expose people or structures to substantial adverse effects associated with seismic ground shaking. Therefore, operational impacts related to strong seismic ground shaking would be less than significant with mitigation.

Seismic-related Ground Failure

The project-specific geotechnical exploration indicated that the project site has low potential for seismic related liquefaction due to the densities and high fine-grained material content in the sand on-site. Therefore, operational impacts related to seismic related ground failure would be less than significant with incorporation of the Geotechnical recommendations as required by MM GEO-1a.

Landslides

The project-specific geotechnical exploration determined that the site has little to no potential for landslides based on the topographic and lithologic data observed at the test pits. Furthermore, the incorporation of CBC requirements as well as the specific grading and foundation design recommendations required by MM GEO-1a and MM GEO-1b, would reduce the potential for seismically induced landslides to less than significant.

Level of Significance Before Mitigation

Potentially Significant (ground shaking, landslides, and liquefaction)

Mitigation Measures

MM GEO-1a Implement Project-specific Geotechnical Report Recommendations

Prior to issuance of any grading permits, all recommendations and specifications set forth in the project-specific Geotechnical Exploration Report prepared for the proposed project shall be reflected on the project grading and foundation plans (inclusive of seismic design parameters), subject to review and approval by the City of Antioch Engineer.

[24] ENGEO Inc. 2018. The Ranch at Antioch. Geotechnical Exploration. September.

MM GEO-1b Grading and Foundation Plan Review and Construction Monitoring

Prior to issuance of any grading permits, the project Applicant shall retain the design geotechnical engineering firm to review the final grading and foundation plans and specifications to evaluate whether recommendations have been implemented from the project-specific Geotechnical Exploration Report, and to provide additional or modified recommendations, as needed.

Construction monitoring shall be performed by a California Registered Geologist and/or Engineer to check the validity of the assumptions made in the geotechnical investigation. Earthwork operations shall be performed under the observation of a California Registered Geologist and/or Engineer to check that the site is properly prepared, the selected fill materials are satisfactory, and that placement and compaction of the fills has been performed in accordance with recommendations and the project specifications.

Level of Significance After Mitigation

Less Than Significant

Soil Erosion or Topsoil Loss

Impact GEO-2: The proposed project could result in substantial soil erosion or the loss of topsoil.

Construction

Erosion is a natural and inevitable geologic process whereby earth materials are loosened, worn away, decomposed, or dissolved and transported from one place to another by wind, rain, etc. Erosion can cause damage to the environment by depositing silt, sand, or mud in waterways impacting biological resources. It can also damage infrastructure, including storm drains, roads, and tunnels, by clogging them. Erosion and the loss of topsoil can be accelerated during construction due to disturbance of vegetation cover and soil. As mentioned in Section 3.9, Hydrology and Water Quality, project construction would involve grading, earth-moving activity, and soil disturbance that would take place on 373.60 acres of the 551.50-acre project site and the off-site improvement area. Chapter 9 of the City's Municipal Code, Storm Water Management and Discharge Control, requires projects that propose to disturb more than 1.00 acre of land, such as the proposed project, must obtain coverage under the State's General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit), which pertains to erosion- and siltation-related pollution from grading and project construction. Compliance with the Permit requires the Applicant to file a Notice of Intent (NOI) with the California State Water Resources Control Board (State Water Board) and prepare a SWPPP prior to construction. The SWPPP would incorporate BMPs in order to prevent, or reduce to the greatest feasible extent, adverse impacts to water quality from erosion and sedimentation. Such BMPs would include hydro-seeding, the placement of erosion control measures within drainage ways and ahead of drop inlets, he temporary lining (during construction activities) of drop inlets with "filter fabric" (a specific type of geotextile fabric), the placement of straw wattles along slope contours, directing subcontractors to a single designation "wash-out" location (as opposed to allowing them to wash-out in any location they desire), the use of siltation fences, and the use of sediment basins and dust palliatives

Impacts related to soil erosion and the loss of topsoil would be reduced to a less than significant level with the implementation of MM GEO-2. Therefore, construction impacts related to substantial soil erosion or the loss of topsoil would be less than significant with mitigation.

Operation

Upon completion of the construction stage, previously disturbed areas would be ultimately protected through the placement of structures, roadways, landscaping, and other improvements, which would substantially minimize long-term erosion. Furthermore, the City implements the NPDES Phase II Municipal Separate Storm Sewer Systems (MS4) requirements through a stormwater management plan and its stormwater ordinance, which require implementation of post-construction stormwater quality improvements. Thus, the potential for erosion or loss of topsoil during project operation would be less than significant.

Level of Significance Before Mitigation

Potentially Significant

Mitigation Measures

MM GEO-2 a. Development of a Storm Water Pollution Prevention Plan

Prior to the issuance of grading permits, the project Applicant shall prepare and submit to the City Public Works Department and Central Valley Regional Water Quality Control Board (RWQCB), a Storm Water Pollution Prevention Plan (SWPPP) detailing measures to control soil erosion and waste discharges during construction. The SWPPP shall include an erosion control plan, a water quality monitoring plan, a hazardous materials management plan, and post-construction Best Management Practices (BMPs).

Level of Significance After Mitigation

Less Than Significant

Unstable Geologic Location

Impact GEO-3: The proposed project could be located on a geologic unit or soil that is unstable, or that could become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

Construction/Operation

The project-specific geotechnical exploration conducted by ENGEO, Inc. determined that the potential for lateral spreading, landslide, subsidence, and liquefaction is low to negligible based on topographic and lithologic data (see Appendix F). However, as mentioned above, the California Department of Conservation's Earthquake Zones of Required Investigation Map identifies the project site as located within a liquefaction zone.[25] Incorporation of standard building code requirements as well as the specific grading and foundation design recommendations required by MM GEO-1a and MM GEO-1b, would reduce the potential for impacts related to unstable soil or geologic units to a less than significant level.

Level of Significance Before Mitigation

Potentially Significant

Mitigation Measures

Implement MM GEO-1a and GEO-1b

Level of Significance After Mitigation

Less Than Significant

Expansive Soil

Impact GEO-4:	**The proposed project could 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.**

Construction/Operation

According to the project-specific geotechnical exploration, potentially expansive lean clay soils were observed near the surface in all of the soil test pits. These soils have moderate to high shrink/swell potential with variations in moisture content. Expansive soils can shrink or swell and cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations, which is considered a potentially significant impact. Successful performance of structures on expansive soils requires specific procedures for grading and for establishment of building foundations.

Implementation of geotechnical recommendations and MM GEO-1a and MM GEO-1b, which require the incorporation of all recommendations from the geotechnical exploration and monitoring during construction to ensure proper implementation, as well as replacing native soils with engineered fill or the addition of soil amendments are also effective means of mitigating expansive soils, and would reduce potential impacts related to expansive soil to less than significant.

Level of Significance Before Mitigation

Potentially Significant

Mitigation Measures

Implement MM GEO-1a and GEO-1b

Level of Significance After Mitigation

Less Than Significant

[25] California Department of Conservation. Seismic Hazards and Zones of Required Investigation. Website: https://www.conservation.ca.gov/cgs/Pages/Program-SHP/regulatory-hazard-zones.aspx. Accessed December 11, 2019.

Wastewater Disposal Systems

Impact GEO-5: The proposed project would not 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.

Construction/Operation

The proposed project would be connected to and served by the existing municipal sanitary sewer system, and would not use septic tanks or any alternative wastewater disposal system. Therefore, there would be no impacts related to soil capability of supporting the use of alternative wastewater disposal systems.

Level of Significance

No Impact

Destruction of Paleontological Resource or Unique Geologic Feature

Impact GEO-6: The proposed project could directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

Construction/Operation

The Paleontological Records Search on the UCMP revealed that the project site consists primarily of Holocene alluvium (QA), which is too young to be fossiliferous, and Eocene Markley Sandstone Member (Tkm) of the Kreyenhagen Formation, which is located in the southwestern portion of the site as well as along the northern boundary.

Within the 0.50 mile search perimeter, the records search identified Eocene rocks assigned to the other members of the Kreyenhagen Formation and older Eocene rocks of the Domengine (Tds) and Meganos Formation (Tmgd).

No known paleontological resources have been identified on the project site, although paleontological resources have been identified within a distance of 1.00 mile. The records search noted that the unmapped older alluvium and Markley sandstone would be of concern during project construction, and that the potential of finding late Pleistocene (Rancholabrean) vertebrates in Lone Tree Valley must also be taken into account. The terrain across the project site is relatively undisturbed and both of the mapped geologic units (Markley sandstone and Quaternary alluvium) have produced significant paleontological resources in the vicinity. This would represent potentially significant impact related to destruction of paleontological resources.

MM GEO-3 requires a pre-construction paleontological walkover survey, and the creation and implementation of a paleontological monitoring program, including training for the construction crew by a qualified professional Paleontologist. With the implementation of this mitigation, impacts related to destruction of paleontological resources or unique geologic features would be less than significant.

Level of Significance Before Mitigation

Potentially Significant

Mitigation Measures

MM GEO-3 Preconstruction Paleontological Survey

Prior to any grading or excavation activities, a professional Paleontologist shall conduct a worker awareness training to inform construction personnel of the possibility of encountering fossils, the appearance and types of fossils likely to be seen during construction activities, and the property notification procedures to follow should fossils be encountered.

If paleontological resources are discovered during earth-moving activities, the construction crew shall immediately stop work within 100 feet of the discovery and notify the Planning Department. A qualified Paleontologist shall be retained to evaluate the resource and prepare and implement a proposed mitigation plan, including curation, in accordance with the Society of Vertebrate Paleontology Guidelines.[26]

Level of Significance After Mitigation

Less Than Significant

3.6.5 - Cumulative Impacts

The geographic scope of the cumulative geology and soils analysis is the project vicinity. Adverse effects associated with geology and soils tend to be localized; therefore, the area near the project site would be the area most affected by project activities (generally within a 0.50-mile radius). None of the cumulative projects listed in Chapter 3, Environmental Impact Analysis, Table 3-1, Cumulative Projects, are within 0.50 mile of the proposed project; the closest one is the Aviano development, located approximately 0.75 mile to the east. Development in the project vicinity has not included any uses or activities that would result in geology or soils impacts. All construction phases of this project, and other foreseeable projects in the area, would be required to implement mitigation measures similar to those above and adhere to all federal, State, and local programs, requirements, and policies pertaining to building safety and construction permitting. All projects would be required to adhere to the City's Building Code and Grading Ordinance. Therefore, the potential for cumulative impacts related to geology and soils is less than significant.

Cumulative projects, including the project site, have the potential to experience strong to violent ground shaking from earthquakes. The other cumulative projects listed in Table 3-1 would be exposed to the same ground shaking hazards and likewise would be subject to the same requirements. Cumulative projects would adhere to the provisions of the CBC, and policies of the City of Antioch General Plan and Antioch Municipal Code reducing potential hazards associated with seismic ground shaking and ground failure. As such, the proposed project in conjunction with other cumulative projects would not result in a less than significant cumulative impact associated with seismic-related hazards.

[26] The Society of Vertebrate Paleontology (SVP). 1995. Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontological Resources—Standard Guidelines, Society of Vertebrate Paleontology News Bulletin, Vol. 163. Pages 22-27.

Soil-related Hazards

Soil conditions associated with the project site, such as expansive soils, are specific to the project site and generally do not contribute to a cumulative effect. Some or all other cumulative projects may have similar conditions but they also would not contribute to a general geologic or soil cumulative effect. The proposed project would be subject to all City of Antioch General Plan policies, City Municipal Code policies, and the CBC reducing soil-related hazard impacts. Other current and future development/redevelopment projects in the region would similarly be required to adhere to standards and practices that include stringent geologic and soil-related hazard mitigations. As such, the proposed project, in conjunction with other projects, would not have a cumulatively significant impact associated with soil-related hazards.

Unique Geologic Feature and Paleontological Resources

The geographic scope of the cumulative unique geologic features and paleontological resources analysis is the immediate project vicinity (within a 0.5-mile radius). Geologic resources and paleontological resource impacts tend to be localized, because the integrity of any given resource depends on what occurs only in the immediate vicinity around that resource, such as disruption of soils.

Construction activities associated with development cumulative projects in the project vicinity may have the potential to encounter undiscovered geologic resources and paleontological resources. These cumulative projects would be required to mitigate for impacts through compliance with applicable federal and State laws governing geologic resources and paleontological resources. The likelihood of presence of geologic resources and paleontological resources on the cumulative project sites is relatively low, given that the majority of soil disturbance associated with these projects will take place within Holocene soils too young to be fossiliferous. Although there is the possibility that previously undiscovered resources could be encountered by subsurface earthwork activities, the implementation of standard construction mitigation measures would ensure that undiscovered geologic and paleontological resources are not adversely affected by cumulative project-related construction activities, which would prevent the destruction or degradation of potentially significant cultural resources in the project vicinity. Given the low potential for disruption and the comprehensiveness of mitigation measures that would apply to the cumulative projects in the vicinity, the proposed project, in conjunction with other planned and approved projects, would result in a less than significant cumulative impact related to unique geologic and paleontological resources.

Level of Cumulative Significance

Less Than Significant