3.8 Geology, Soils, and Paleontological Resources

3.8.1 Introduction

This section describes the regulatory setting and affected environment related to geology, soils, seismicity, and paleontological resources. This section addresses the geology, soils, seismicity, and paleontological resources that are known to occur or have the potential to occur in the geology, soils, seismicity, and paleontological resources RSA and describes the potential impacts on those resources during construction and operation of the proposed Project. This section also identifies the cumulative impacts of the proposed Project on geology, soils, seismicity, and paleontological resources when considered in combination with other relevant projects.

3.8.2 Regulatory Setting

This section identifies the applicable federal, state, regional, and local laws, regulations, and orders that are relevant to the analysis of geology, soils, seismicity, and paleontological resources. This section also addresses the proposed Project's consistency with the regulations described herein.

3.8.2.1 Federal

National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) was established by the United States (U.S.) Congress when it passed the Earthquake Hazards Reduction Act of 1977. In establishing NEHRP, Congress recognized that earthquake-related losses could be reduced through improved design and construction methods and practices, land use and redevelopment controls, prediction techniques and early-warning systems, coordinated emergency preparedness plans, and public education and involvement programs.

The four basic NEHRP goals are:

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

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

- National Institute of Standards and Technology;
- National Science Foundation;
- U.S. Geological Survey (USGS); and
- Federal Emergency Management Agency (FEMA).

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 Engineering Handbook

The National Engineering Handbook was prepared by the United States Department of Agriculture (USDA) in 1983. Chapter 3 (Erosion) of Section 3 (Sedimentation) states that in planning programs, to reduce erosion and sediment yield, it is most important that the various types of erosion be thoroughly investigated as sources of sediment. Proper conservation practices and land stabilization measures can then be planned and applied.

Federal Soil Protection Act

The purpose of the Federal Soil Protection Act is to protect or restore the functions of the soil on a permanent and sustainable basis. Protection and restoration activities include prevention of harmful soil changes, rehabilitation of the soil of contaminated sites and of water contaminated by such sites, and precautions against negative soil impacts. If impacts are made on the soil, disruptions of its natural functions and of its function as an archive of natural and cultural history should be avoided, as far as practicable.

United States Geological Survey (USGS) Landslide Hazard Program

The USGS created the Landslide Hazard Program in the mid-1970s. According to the USGS, the primary objective of the Landslide Hazards Program is to reduce long-term losses from landslide hazards by improving understanding of the causes of ground failure and suggesting mitigation strategies. The federal government takes the lead role in funding and conducting this research, whereas the reduction of losses due to geologic hazards is primarily a state and local responsibility.

Clean Water Act

According to the Environmental Protection Agency (EPA), the Clean Water Act (CWA 1972) establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. “Clean Water Act” became the Act’s common name with amendments in 1972. Under the CWA, the EPA has implemented pollution control programs such as setting wastewater standards for industry. EPA has also developed national water quality criteria recommendations for pollutants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters unless a permit was obtained. EPA’s National Pollution Discharge Elimination System (NPDES) permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. In addition, the requirements of the NPDES permit provide guidance for protection of geologic and soil resources by requiring site operators to have proper stormwater controls in place which help reduce sedimentation and erosion at construction sites.

Preservation of American Antiques (43 Code of Federal Regulations [CFR] 3)

CFR Title 43, Part 3 originally contained the regulations to implement the Antiquities Act of 1906. The Antiquities Act was recodified in 2014 by the National Park Service (NPS) and Related Programs (54 United States Code [USC] 320301 – 320303. CFR Title 43, Part 3 has been revised to contain the regulations that implement 54 USC 320301 – 320303. CFR Title 43, Part 3 requires the Secretary of Agriculture, Secretary of the Army, or the Secretary of Interior over lands within their jurisdiction to grant a permit for the examination of ruins, excavation of archeological sites and removal of objects of antiquity to reputable museums, universities, colleges, or other recognized scientific or educational institutions, or to their duly authorized agents. CFR Title 43, Part 3 "objects of antiquity" has been interpreted to include fossils by the Bureau of Land Management (BLM), the NPS, the United States Forest Service (USFS), and other federal agencies.

3.8.2.2 State

Paleontological resources must be considered under CEQA. Appendix G of the CEQA Guidelines provides guidance relative to significant impacts on paleontological resources, indicating that a project would have a significant impact on paleontological resources if it disturbs or destroys a unique paleontological resource or site or unique geologic feature.

General Permit for Construction Activities

The CGP (NPDES No. CAS000002, SWRCB Order No. 2022-0057-DWQ) was adopted on September 8, 2022, and went into effect on September 1, 2023. The CGP regulates construction site stormwater management. Dischargers whose projects disturb 1 or more acres of land area, or whose projects disturb less than 1 acre but are part of a larger common plan of development that in total disturbs 1 or more acres, are required to obtain coverage under the general permit for discharges of stormwater associated with construction activity. Permit applicants are required to submit a Notice of Intent to the SWRCB and to prepare a SWPPP. The SWPPP identifies BMPs that must be implemented to reduce construction effects on receiving water quality based on pollutants. The BMPs identified are directed at implementing both sediment and erosion control measures and other measures to control chemical contaminants.

California Building Standards Code

According to the Department of General Services, the California Building Standards Code is a compilation of three types of building standards from three different origins: 1) Building standards that have been adopted by state agencies without change from building standards contained in national model codes; 2) Building standards that have been adopted and adapted from national model codes to address California's ever-changing conditions; and 3) Building standards, authorized by the California legislature, that constitute amendments not covered by national model codes, that have been created and adopted to address particular California concerns. All occupancies in California are subject to national model codes adopted into Title 24, and occupancies are further subject to amendments adopted by state agencies and ordinances implemented by local jurisdictions' governing bodies. The 2019 California Building Code (CBC), California Code of Regulations, Title 24 was published July 1, 2019, with an effective date of January 1, 2020.

California Public Resources Code

State requirements for paleontological resource management are included in Public Resources Code (PRC) Section 5097.5 and Section 30244. These statutes prohibit the removal of any paleontological site or feature from public lands without permission of the jurisdictional agency, define the removal of paleontological sites or features as a misdemeanor, and require reasonable mitigation of adverse impacts to paleontological resources from developments on public (state, county, city, district) lands.

Section 5097.5 of the California Public Resources Code specifies that any unauthorized removal of paleontological remains is a misdemeanor. Further, California Penal Code Section 622.5 sets the penalties for damage or removal of paleontological resources.

California Stormwater Best Management Practices Handbook and Stormwater Multiple Application and Report Tracking System

The California Stormwater Quality Association develops four Best Management Practices Handbooks, construction, industrial and commercial, municipal, and new development and redevelopments. These are generally matched to the three National Pollutant Discharge Elimination System (NPDES) permit types, municipal separate storm sewer systems, construction activities, and industrial activities, and offer stormwater runoff management support. The California State Water Resources Control Board Stormwater Multiple Application and Report Tracking System is compliant with NPDES and provides a platform where dischargers, regulators, and the public can enter, manage, and view storm water data including permit registration documents, compliance, and monitoring data associated with California's Storm Water General Permits.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (SHMA 1990) directs the Department of Conservation, California Geologic Survey (CGS) to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides and amplified ground shaking. The purpose of the SHMA is to reduce the threat to public safety and to minimize the loss of life and property by identifying and mitigating these seismic hazards. The SHMA was passed by the legislature following the 1989 Loma Prieta earthquake.

The SHMA requires the State Geologist to establish regulatory zones (Zones of Required Investigation) and to issue appropriate maps (Seismic Hazard Zone maps). These maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling construction and development. Single-family frame dwellings up to two stories which are also not part of a development of four or more units are exempt from the state requirements. However, local agencies can be more restrictive than state law requires.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted as the Special Studies Zones Act in 1971 to prevent land development and construction of structures for human occupancy directly across the trace of active faults.

The law requires the State Geologist to delineate approximately one quarter mile-wide zones (earthquake fault zones) along surface traces of active faults. The act defines an active fault as one that has ruptured the ground surface within the past 11,000 years. Prior to approving construction of structures for human occupancy within an earthquake fault zone, permit authorities must require a project's applicant to submit a fault investigation report for review and approval by the local jurisdiction. Although the Alquist-Priolo Act does not regulate transit or transportation projects, it provides relevant information about areas that would be susceptible to ground rupture from an earthquake.

Natural Hazard Disclosure Act

The Natural Hazards Disclosure Act came into effect on June 1, 1998, and requires sellers and their listing agents to provide prospective buyers with a Natural Hazards Disclosure statement that designates whether the home they are selling is located in a hazard area. Hazard areas include flood, fire, earthquake fault, and seismic hazard zones.

3.8.2.3 Local

General Plans required by California Government Code

The California Government Code (Section 65300-65303.4) requires the planning agencies of all cities and counties to prepare comprehensive, long-term general plans for the physical development, including projects, within their jurisdictions that provide objectives and policies addressing public health and safety, including protection against the impacts of seismic ground motions, fault ruptures, and other geologic and soils hazards. The legislative bodies of all California cities and counties must adopt General Plans that include, among other elements, a Conservation Element and Safety Element.

The Conservation Element is required to address at least:

- Reclamation of land and waters,
- Prevention, control, and correction of the erosion of soils, and
- Location, quantity and quality of rock, sand, and gravel resources.

The Safety Element must address the protection of the community from any unreasonable risks associated with the effects of:

- Seismically induced surface rupture (fault displacements),
- Ground shaking,
- Ground failure,
- Slope instability leading to mudslides and landslides,
- Subsidence (due to fluid or gas withdrawal),
- Liquefaction,
- Other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of Division 2 of the PRC, and
- Other geologic hazards known to the legislative body.

The Safety Element is required to include mapping of known seismic and other geologic hazards.

The proposed Project would be built within Alameda County and the following cities:

- Fremont,
- Newark,
- Union City,
- Hayward,
- Castro Valley,
- San Leandro, and
- Oakland.

Unincorporated portions of Alameda County that the proposed Project would encompass includes San Lorenzo.

The general plans for these jurisdictions were reviewed for policies relevant to paleontological resources.

Oakland: The Open Space, Conservation, and Recreation Element of the Oakland General Plan addresses paleontological resources with the following text: "Some of Oakland's most important natural assets are 'earth resources' including soils and minerals, archaeologic and fossil remains, and the geologic formations that define the city's topography" (City of Oakland 1996, page 3.2). But the General Plan does not explicitly address paleontological resources in any policies, goals, or objectives.

San Leandro: The San Leandro General Plan contains no requirements, policies, goals, or objectives relevant to the paleontological resources (City of San Leandro 2016).

Hayward: The Natural Resource Element of the Hayward General Plan has the following policies regarding paleontological resources (City of Hayward 2014):

Natural Resources (NR)-7: Identify, honor, and protect historically significant paleontological resources so they can be scientifically studied and preserved for current and future generations.

- NR-7.1: Paleontological Resource Protection: The City shall prohibit any new public or private development that damages or destroys a historically - or prehistorically - significant fossil, ruin, or monument, or any object of antiquity.
- NR-7.2: Paleontological Resource Mitigation: The City shall develop or ensure compliance with protocols that protect or mitigate impacts to paleontological resources, including requiring grading and construction projects to cease activity when a paleontological resource is discovered so it can be safely removed.

Union City: Union City General Plan has the following provision for the protection of paleontological resources (Union City 2019):

Resource Conservation (RC)-4.8. Protection of Paleontological Resources: The City shall require avoidance and/or mitigation for potential impacts to paleontological resources for any development in Union City that occurs within high sensitivity geologic units, whether they are mapped at the surface or occur at the subsurface. High sensitivity geology units include Great Valley Sequence (Panoche and Knoxville Formations), Monterey Group (Claremont Shale and Hambre Sandstone), Briones Formation, Orinda Formation, and Pleistocene age alluvial fan and fluvial deposits. When paleontological resources are uncovered during site excavation, grading, or construction activities, work on the site will be suspended until the significance of the fossils can be determined by a qualified paleontologist. If significant resources are determined to exist, the paleontologist shall make recommendations for protection or recovery of the resource.

The City shall require the following specific requirements for projects that could disturb geologic units with high paleontological sensitivity:

Retain a Qualified Paleontologist to Prepare a Paleontological Mitigation and Monitoring Program (PMMP). Prior to initial ground disturbance in previously undisturbed strata of geologic units with high sensitivity, the project applicant shall retain a Qualified Paleontologist, as defined by the SVP (2010), to direct all mitigation measures related to paleontological resources and design a PMMP for the project. The PMMP should include measures for a preconstruction survey, a training program for construction personnel, paleontological monitoring, fossil salvage, curation, and final reporting, as applicable.

Fremont: The Fremont General Plan contains no requirements, policies, goals, or objectives relevant to the paleontological resources (City of Fremont 2011).

Newark: The Newark General Plan contains no requirements, policies, goals, or objectives relevant to the paleontological resources (City of Newark 2013).

Alameda County: Castro Valley and San Lorenzo are unincorporated communities in Alameda County. The Alameda County plans listed below were reviewed. No provisions were found pertaining to paleontological resources:

- Countywide plan (Alameda County 1994)
- Castro Valley General Plan (Alameda County 2012)
- San Lorenzo Specific Plan (Alameda County 2004)

3.8.2.4 Other Guidance- Industry Design Standards and Guidelines

The design and construction of the proposed Project would conform to industry-wide engineering design guidelines and standards. These guidelines and standards define the parameters for the design and construction of facilities that protect the users of the facilities and others that may be affected by public use of the facility. Each improvement associated with the proposed Project would be designed to handle normal operating loads from the weight of the structure or train, as well as loads from environmental conditions, such as seismic shaking and wind forces. At locations where geologic conditions present a hazard, the guidelines and standards identify minimum requirements for characterizing the geologic conditions and then addressing the design issue, such as the stability of slopes, the corrosion of materials, and BMPs for water and wind erosion, stream sedimentation, or dust control. These guidelines and standards provide requirements for evaluating soil conditions, defining seismic loads, and evaluating the response of the foundation systems. Minimum performance requirements are also provided. The guidelines and standards also provide direction when minimum performance requirements are not met. Engineering geologists and geotechnical engineers who assist in the design of the proposed Project are obligated to use these guidelines and standards. To meet professional licensing requirements, contract design documents would have to be signed and stamped by engineering geologists, civil engineers, and geotechnical engineers registered in California, certifying that the designs have been completed in a manner that meets minimum standards and is protective of the public. Primary guidelines and standards that would be incorporated as part of the proposed Project to reduce risks associated with geology, soils, and seismicity are highlighted in this section.

2012 American Association of State Highway and Transportation Officials Load and Resistance Factor Design Bridge Design Specifications (6th Edition) and the 2011 American Association of State Highway and Transportation Officials Guide Specifications for Load and Resistance Factor Seismic Bridge Design

These American Association of State Highway and Transportation Officials (AASHTO) documents provide guidance for characterization of soils, as well as methods to be used in the design of bridge foundations and structures, retained cuts and retained fills, at-grade segments, and buried structures. These design specifications would provide minimum specifications for evaluating the seismic response of soil and structures.

American Railroad Engineering and Maintenance-of-Way Association Manual

The American Railroad Engineering and Maintenance-of-Way Association (AREMA) guidelines deal with rail systems. Although these guidelines cover many of the same general topics as the AASHTO, they are more focused on best practices for rail systems. The manual includes principles, data, specifications, plans, and economics pertaining to the engineering, design, and construction of railways.

Union Pacific Railroad Design and Construction Standards

These guidelines are specific to any work that will take place within or affect facilities owned and operated by Union Pacific Railroad (UPRR). In general, UPRR relies on the current guidance provided by the most recent version of AREMA, while applying its own criteria to its assets as it deems necessary. Where a conflict between the current UPRR criteria and the AREMA guidelines arises, the UPRR criteria will govern for facilities or resources within its right-of-way (ROW).

California Department of Transportation Design Standards

The California Department of Transportation (Caltrans) has specific minimum design and construction standards for all aspects of transportation system design, ranging from geotechnical explorations to construction practices. Caltrans design standards include state-specific amendments to the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications and Guide Specifications for LRFD Seismic Bridge Design. These amendments provide specific guidance for the design of deep foundations used to support elevated structures, for design of mechanically stabilized earth walls used for retained fills, and for design of various types of cantilever (e.g., soldier pile, secant pile, and tangent pile) and tie-back walls used for retained cuts. Caltrans standards would only apply within Caltrans ROW.

American Society for Testing and Materials International

American Society for Testing and Materials (ASTM) International has developed standards and guidelines for all types of material testing, from soil classifications to pile load testing or compaction testing through to concrete strength testing. The ASTM standards also include minimum performance requirements for materials. Most of the guidelines and standards cited in the preceding sections use ASTM or a corresponding series of standards from AASHTO to achieve the required and intended quality in the constructed project.

Society of Vertebrate Paleontology

The Society of Vertebrate Paleontologists (SVP) is a professional and academic organization that establishes guidelines for paleontological resource assessments, monitoring and mitigation, fossil recovery, sampling procedures, specimen preparation, and museum curation (SVP 1995, 1996, 2010). SVP guidelines are the standard against which many paleontological mitigation programs are judged. Most professional paleontologists in California adhere closely to the SVP guidelines for assessment, mitigation, and monitoring. Many regulatory agencies have formally or informally adopted the SVP guidelines.

3.8.2.5 Consistency with Plans, Policies, and Regulations

The proposed Project is consistent plans, policies, and regulations listed above. The proposed Project complies with the measures listed above for resources with high geology, soils, seismicity and paleontological potential.

3.8.3 Methods for Evaluating Environmental Impacts

3.8.3.1 Resource Study Area

As defined in Section 3.1, Introduction, RSAs are the geographic boundaries within which the environmental investigations specific to each resource topic were conducted.

For geology, soils, and seismicity, the RSA extends beyond the Project footprint and includes the subsurface below the footprint. The RSA for geology, soils, and seismicity is defined as the Project footprint plus a buffer of 0.25 miles. The seismic RSA includes active faults within 60 miles of the Project.

For paleontology, the RSA also extends beyond the Project footprint by 0.25 miles in each direction. It also includes the subsurface beneath the Project footprint.

3.8.3.2 Data Sources

The methodology used to evaluate the potential impacts upon the geology, soils, and seismicity of the proposed Project included a review of published maps, professional publications, reports, and databases pertaining to the geology, soils, and seismicity of the Project vicinity, including:

- USGS topographic maps;
- USGS elevation data;
- USGS and CGS geologic maps and geographic information systems (GIS) data;
- USDA and Natural Resources Conservation Service (NRCS) soil maps and GIS data; and
- CGS Earthquake Zones of Required Investigation maps, Seismic Hazard Zone reports, and associated GIS data.

The geology, soils, and seismicity analysis focuses on the potential of the proposed Project to increase the risk of personal injury, loss of life, and damage to property as a result of Project effects on existing geologic conditions in the RSA.

This Project uses SVP standards and Caltrans Standard Environmental Reference (SER) methodology for paleontology (Caltrans 2014). Caltrans SER criteria are commonly used in transportation projects and are in accordance with SVP standards.

The paleontological analysis included the following steps:

- A geological inventory of the RSA was performed.
- Fossil locality searches were conducted within a minimum one-mile radius of the RSA. The following online databases were queried: Paleobiology Database (PBDB) and the University of California at Berkeley Museum of Paleontology (UCMP) (PBDB 2023; UCMP 2023). Print fossil catalogs were also queried (Hay 1927; Jefferson 1991a, 1991b; Parkman 2006; Savage 1951).
- A literature review was conducted to search for fossils not recorded in the databases or for more detailed descriptions of particular localities, geologic units, or for land use history. The following sources were consulted: peer-reviewed journals, scientific reports, dissertations, historical topographic maps, agency fact sheets, and news sources.
- An assessment of paleontological potential following Caltrans and SVP guidelines was performed. SVP and Caltrans guidelines are listed in Table 3.8-1.

Table 3.8-1: Evaluation of Paleontological Sensitivity/Paleontological Potential

SVP Resource Potential	Caltrans Tripartite Scale	Geologic Unit Description
None	None	Geologic units of intrusive igneous origin, most extrusive igneous rocks, and medium- to high-grade metamorphic rocks are classified as having no potential for containing significant paleontological resources.
Low	Low	Geologic units that are potentially fossiliferous, based upon review of available literature and museum collections records, but have yielded few, if any, significant fossils in the past; or, have not yielded fossils, but possess a potential for containing fossil remains; or contain common and/or widespread invertebrate fossils (if the taxonomy, phylogeny, and ecology of the species are well understood). Geologic units of low potential also include those that yield fossils only on rare occasions or under unusual circumstances, eolian deposits, geologic units younger than 10,000 years, and deposits that exhibit a high degree of diagenetic alteration.
Undetermined	N/A	In some cases, available literature on a particular geologic unit is scarce and a determination of whether it is fossiliferous or potentially fossiliferous is difficult to make. Under these circumstances, the sensitivity is unknown and further study is needed to determine the unit's paleontological resource potential.

SVP Resource Potential	Caltrans Tripartite Scale	Geologic Unit Description
High	High	Geologic units with high potential for paleontological resources are those that, based on previous studies, have proven to yield vertebrate or significant invertebrate, plant, or trace fossils or are likely to contain new vertebrate materials, traces, or trackways. Geologic units with high potential also may include those that contain datable organic remains older than the late Holocene (e.g., animal nests or middens). These units include but are not limited to, sedimentary formations that contain significant nonrenewable paleontological resources anywhere within their geographical extent and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. These units may also include some volcanic and low-grade metamorphic rock units. Fossiliferous deposits with very limited geographic extent or an uncommon origin (e.g., tar pits and caves) are given special consideration and ranked as highly sensitive. A unit with high sensitivity is susceptible to surface-disturbing activities and includes fossiliferous sedimentary deposits that are well exposed with little vegetative cover as well as those shallowly covered by soil, alluvium, or vegetation.

Source: SVP, 2010; Caltrans, 2014.

3.8.3.3 CEQA Thresholds

To satisfy CEQA requirements, geology and soils impacts were analyzed in accordance with Appendix G of the CEQA Guidelines. According to the CEQA Guidelines, CCR, Title 14, Section 15002(g), "a significant effect on the environment is defined as a substantial adverse change in the physical conditions which exist in the area affected by the proposed project." As stated in CEQA Guidelines Section 15064(b)(1), the significance of an activity may vary with the setting. The impact analysis identifies and analyzes construction (short-term) and operation (long-term) impacts, as well as direct and indirect impacts (see PRC Section 21065).

The proposed Project would have significant geology and soils impacts under CEQA if it would:

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. 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; or
e. Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

3.8.4 Affected Environment

This section describes the physical environmental conditions for geology, soils, seismicity, and paleontological resources within the RSA and provides the baseline physical conditions by which a determination can be made whether an impact of the proposed Project is significant.

3.8.4.1 Environmental Setting

Topography and Drainage

The Project is located on the plain between the East Bay Hills and San Francisco Bay. The plain is generally flat to undulating with a general south-west aspect. The landscape has been greatly modified through development originally for agriculture, then urbanization, industrialization, and transportation infrastructure.

Drainages originate from the East Bay Hills flowing out onto the bay plain forming alluvial fans and washes. Natural drainages of the plain have been greatly modified through urbanization and infrastructure development where storm sewer systems flow into lined and unlined channels that are often bordered by artificial levees. Large areas of marshland bordering east San Francisco Bay have been converted to salt ponds or filled to create land for urban, industrial, or infrastructure purposes.

Regional Geologic Setting

The Project lies in the seismically active Coastal Ranges Geomorphic Province which consists of sub-parallel north-west trending faults, mountain ranges, and valleys in west-central California at the eastern margin of the San Francisco Bay that characterize the province's topography (California Geological Survey 2002). The Coastal Ranges Geomorphic province is bounded to the west by the Pacific coast and to the east by the San Joaquin valley. Regional basement rocks (rocks below a cover of sedimentary rocks) consist of marine deposited Jurassic-Cretaceous (period from 206 million years ago to 66 million years ago) Franciscan Complex and granitic rocks. Younger volcanic and sedimentary rocks were deposited throughout the province during the development of the San Andreas Fault system. Characteristic components of the Franciscan Complex are mostly detrital sedimentary rocks (composed of rock fragments that have been weathered from pre-existing rocks) with basaltic volcanic rocks, metamorphic, and chert with minor limestone.

Extensive late Cretaceous period (99 million years ago to 66 million years ago) through early Tertiary period (66 million years ago to 38 million years ago) folding and thrust faulting created complex geologic structural conditions that underlie the highly varied topography of today. Furthermore, transform faulting (horizontal sliding) during the last 12 million years associated with the San Andreas fault system overprinted and offset (displacement between points on either side of the fault) crustal fault structures and geologic units to create the modern distinctive north-west trending topography of today. Overprinting is a geological process that leaves marks altering the marks of an earlier process.

The San Francisco Bay occupies a depression in the Coast Ranges between the San Andreas Fault to the west and the Hayward Fault to the east. This depression is a structural trough in Franciscan Complex bedrock covered by a thick layer of sediment from the Pleistocene (2.6 million years ago to about 11,700 years ago) and Holocene (11,700 years ago to present) epochs (combined, these two epochs comprise the quaternary period).

Over the last few million years, sediment eroded from surrounding hills accumulated on the Bay coastal plain. As sea level has risen and fallen during glacial/interglacial cycles, parts of the Bay shoreline have been periodically submerged. These alternating wet and dry periods have resulted in alternating deposition of alluvium and mud. The last sea-level low stand was about 11,700 years ago at the Pleistocene/Holocene transition (Atwater, Hedel, and Helley 1977).

Valley bedrock is covered by Quaternary alluvium (sediments transported by creeks and rivers from local and more distant sources) and soils, varying in thickness from a few feet to several hundred feet where they have filled in previously eroded valleys. Bay Mud was deposited in the broad valley that formed the San Francisco Bay which has been submerged by a rising sea level during the past 5,000 years. Bay Mud thickness varies from several feet at the current bay margins to over 100 feet in central portions of the bay.

Local Setting

The Project area cross gently sloping plains and alluvial flatlands of the East Bay coastal plain. The East Bay Hills rise steeply east of the coastal plain, reaching more than 1000 feet above sea level. The Coast Subdivision crosses lower-lying shoreline regions close to the bay, mainly 10 to 25 feet above sea level. Niles Subdivision crosses gently undulating lands closer to the hills, mainly 30 to 80 feet above sea level. The RSA crosses the following streams as well as smaller tributaries: San Leandro Creek, San Lorenzo Creek, Zeile Creek, Dry Creek, and Alameda Creek. The RSA is characterized by artificial fill, mud, and alluvial material, as is discussed below in more detail.

Most of the RSA is highly developed for residential, commercial, transportation, and industrial uses.

Geologic Conditions

Geologic unit extents and descriptions for the RSA have been derived from Witter et al. (2006) and Graymer, et al. (1996). The great majority of the RSA is underlain by Quaternary sediments with only a very small section mapped to be underlain by Tertiary bedrock. Figure 3.8-1 through Figure 3.8-7 show the distribution of surface geologic units within the RSA. Table 3.8-2 lists the geologic units and the coverage of units in acres and percent located in the RSA.

Table 3.8-2: Summary of Geologic Units and Coverage within the RSA

Unit	Name	Age	Area (acres) / Unit Percent within the RSA
af	artificial fill	historic	115 / 1.5
afem	artificial over estuarine mud	historic	472 / 6.0
alf	artificial levee fill	historic	131 / 1.7
ac	artificial channel	historic	55 / 0.7
Qhc	Stream channel deposits	historic	3 / < 0.1
Qhfy	Alluvial fans	Latest Holocene	1505 / 19.2
Qhly	Alluvial fan levees	Latest Holocene	358 / 4.6
Qhbm	San Francisco Bay mud	Holocene	519 / 6.6
Qhf	Alluvial fans	Holocene	1590 / 20.3
Qhf1	Younger alluvial fans	Holocene	89 / 1.1
Qhf3	Older alluvial fans	Holocene	344 / 4.4
Qhff	Alluvial fans, fine facies	Holocene	1187 / 15.2
Qhl	Alluvial fan levees	Holocene	894 / 11.4
Qhl1	Younger alluvial fan levees	Holocene	278 / 3.6
Qhl3	Older alluvial fans	Holocene	289 / 3.7

Following is a description and brief discussion of the surface geologic units that are relevant to the proposed Project:

af - Artificial fill, Historic

Artificial fill can be engineered or non-engineered material and often underlies highway and railway embankments, and other developed areas.

afem - Artificial over estuarine mud, Historic

Unit afem is composed of artificial fill deposited over sediments along the margins of San Francisco Bay. Fill may be engineered and/or non-engineered material and each may occur within the same area. This artificial fill overlies estuarine sediment and was placed to form new land. The thickness of the fill overlying estuarine sediment is typically five to twenty feet.

This unit is present in a large part of the North Section of the RSA in the vicinity of Grant Avenue and Estudillo Canal. Groundwater is typically close to the surface. Liquefaction susceptibility of this unit is classed as very high based on the numerous past occurrences of liquefaction in this unit. Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading.

alf - Artificial levee fill, Historic

Historic artificial fill is composed of constructed levees bordering rivers, streams, salt ponds, sloughs, and delta islands for the purpose of containing flood or tidal waters. More recently constructed levees are compacted and quite firm, but levees built before 1965 (enactment of the Uniform Building Code) are likely to be uncompacted and made of poor-quality fill.

This unit intersects the RSA in several locations such as bordering Estudillo Canal, San Lorenzo Creek, and Ward Creek, and Alameda Creek. Liquefaction susceptibility is estimated to be very high to moderate for all artificial levees, based on the abundance of older non-engineered levees, the nature of the fill materials, the susceptibility of the underlying deposit, the possible proximity of channel free faces (unsupported steep banks and earthen cuts) vulnerable to lateral spreading (movement of ground laterally after the loss of support due to liquefaction), and their likelihood of saturation. Additionally, levees often are placed in areas where the underlying substrate itself is highly susceptible to liquefaction.

ac - Artificial channel, Historic

Historic artificial channels are modified stream channels and include straightened or realigned channels, flood control channels, and concrete canals. Deposits within artificial channels can range from almost none in some concrete canals, to significant thicknesses of loose, unconsolidated sand, gravel and cobbles, similar to deposits of modern stream channel deposits (Qhc).

This unit is present in discreet parts of the RSA such as San Leandro, San Lorenzo, Sulphur, Alameda, and Ward Creeks. Liquefaction susceptibility is considered to be very high to low, varying with channel design and the bank material. Channels that contain loose, sandy sediments such as Alameda Creek, are highly susceptible to Liquefaction. Adjacent levees or banks may be subject to lateral spreading if not well engineered.

Qhc - Stream channel deposits, Historic

Stream channel deposits are fluvial deposits within active, natural stream channels. Materials consist of loose, unconsolidated, poorly to well sorted sand, gravel and cobbles, with minor silt and clay. These deposits are reworked by frequent flooding and exhibit no soil development.

The only occurrence of this unit within the RSA is located within the Alameda Creek channel. Liquefaction susceptibility is considered to be very high.

Qhfy - Alluvial fans, Latest Holocene

Sediments of Latest Holocene alluvial fans are moderately to poorly sorted (sediment of various sizes is mixed together) and poorly bedded (not deposited in layers), and may be composed of gravel, sand, silt and clay, with minimally developed soils. This unit comprises about half of the South Section of the Coast Subdivision. Liquefaction susceptibility is high due to the deposits being relatively young, loose, and generally lacking cohesion. Lateral spread has been reported from this unit within the RSA in the vicinity the Ardenwood Park-and-Ride facility and south of Alameda Creek (CGS, 2003, Newark Quadrangle).

Qhly - Alluvial fan levees, Latest Holocene

Sediments of Latest Holocene alluvial fan levees may be composed of gravel, sand, silt, and clay. Within the RSA the unit is located adjacent to San Lorenzo Creek and the southern part of the Central Section of the Coast Subdivision.

Liquefaction susceptibility is considered very high because of the presence of very young, loose, likely saturated deposits.

Qhbm - San Francisco Bay Mud, Holocene

Holocene San Francisco Bay Mud was deposited at or near sea level in the San Francisco Bay estuary that is presently, or was historically tidal marsh, mud flat or bay bottom. Bay mud sediment typically has low bulk density (dry weight of soil divided by its volume) and includes silt, clay, peat, and fine sand. This unit was deposited when sea levels were rising relative to land and generally occupies the area between the modern shoreline and the historical limits of tidal marsh. The unit located parts of the North and South Sections of the Coast Subdivision within the vicinity of Ward Creek, and the general area of Grant Avenue.

Liquefaction susceptibility is considered moderate due to high groundwater levels (often tidally influenced) and the possible presence of sand lenses (areas of sand that in profile are thick in the middle and thin at the edges) within the mud and peat. The mud itself is unlikely to liquefy due to the abundance of clay. Estuarine sediment near the mouths of major streams, such as Alameda Creek, is probably the most susceptible to liquefaction because of large volumes of sand and silt. The presence of small marsh channels within the unit that likely contain sandy substrates is relevant to liquefaction potential.

Qhf - Alluvial fans, Holocene

Holocene alluvial fan sediments include sand, gravel, silt, and clay, and is moderately to poorly sorted, and moderately to poorly bedded to poorly sorted, and moderately to poorly bedded. The unit occupies large parts of the RSA except for the South Section of the Coast Subdivision.

Liquefaction susceptibility is moderate where groundwater is within fifteen feet of the surface. Deposits may be less susceptible where groundwater levels are considerably lower such as near alluvial fan apices and near the range front along the East Bay Hills. Susceptibility may be greater where small active channels pass through the unit.

Qhf1 - Younger alluvial fans, Holocene

This unit has the same description as Qhf except that it is considered the youngest sub-unit and possibly has a higher liquefaction susceptibility. The unit borders a small section between Thornton Avenue and the Ardenwood Park and Ride.

Qhf3 - Older alluvial fans, Holocene

This unit has the same description as Qhf except that it is considered the oldest sub-unit and possibly has a lower liquefaction susceptibility. The unit is located in the southern part of the South Section of the Coast Subdivision in the vicinity of Thornton Avenue and Central Avenue.

Qhff - Alluvial fans, fine facies, Holocene

The fine facies of Holocene alluvia fans are flood plain over-bank deposits (sediment deposited by waters that have broken through or overtopped the banks) laid down in very gently sloping portions of alluvial fans or valley floors. Slopes in these distant alluvial fan areas are generally less than or equal to 0.5 degrees, soils are clay rich, and ground water is within 3 meters of the surface. Deposits are dominated by clay and silt, with interbedded lobes of coarser alluvium (sand and occasional gravel). Deposits of coarse material within these fine-grained materials are elongated in the down fan or down valley direction. These lobes are potential conduits for ground water flow.

The unit occupies each section of the Coast Subdivision within the RSA. Liquefaction susceptibility is moderate based on shallow ground water and the presence of lenses of fine sand and silt.

Qhl - Alluvial fan levees, Holocene

Holocene alluvial fan levee deposits are loose, moderately to well sorted sand, silt, and clay. The unit occupies moderately large areas of the North and Central sections of the Coast Subdivision, . Liquefaction susceptibility is moderate because of the presence of unconsolidated, sandy materials adjacent to an active or formerly active stream channel. Where streams are incised and form a free face along the channel margin, these deposits may be susceptible to lateral spreading.

Qhl1 - Younger alluvial fan levees, Holocene

Younger alluvial fan levees have the same description as Qhl except that the unit may have a slightly higher liquefaction susceptibility due to the younger age and less consolidated sediments. The unit occupies an area between Thornton Avenue and SR 84 in the South Section of the Coast Subdivision.

Qhl3 - Older alluvial fans, Holocene

Older alluvial fan levees have the same description as Qhl except that the unit may have a slightly lower liquefaction susceptibility due to the older age and more consolidated sediments. The unit occupies an area between Thornton Avenue and Central Avenue in the South Section of the Coast Subdivision.

Figure 3.8-1. Geology of the Project Area Map Extent 1.

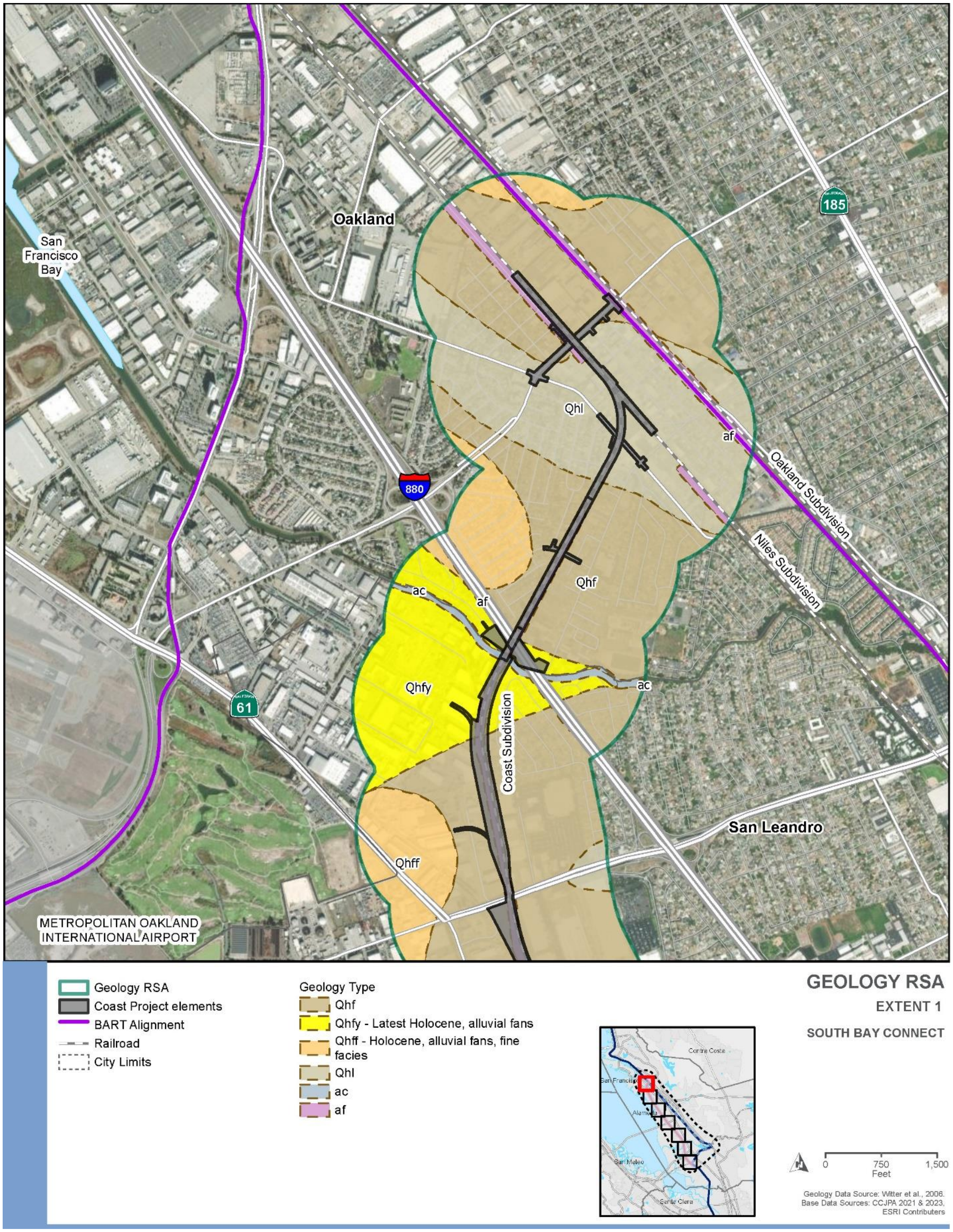


Figure 3.8-2. Geology of the Project Area Map Extent 2.

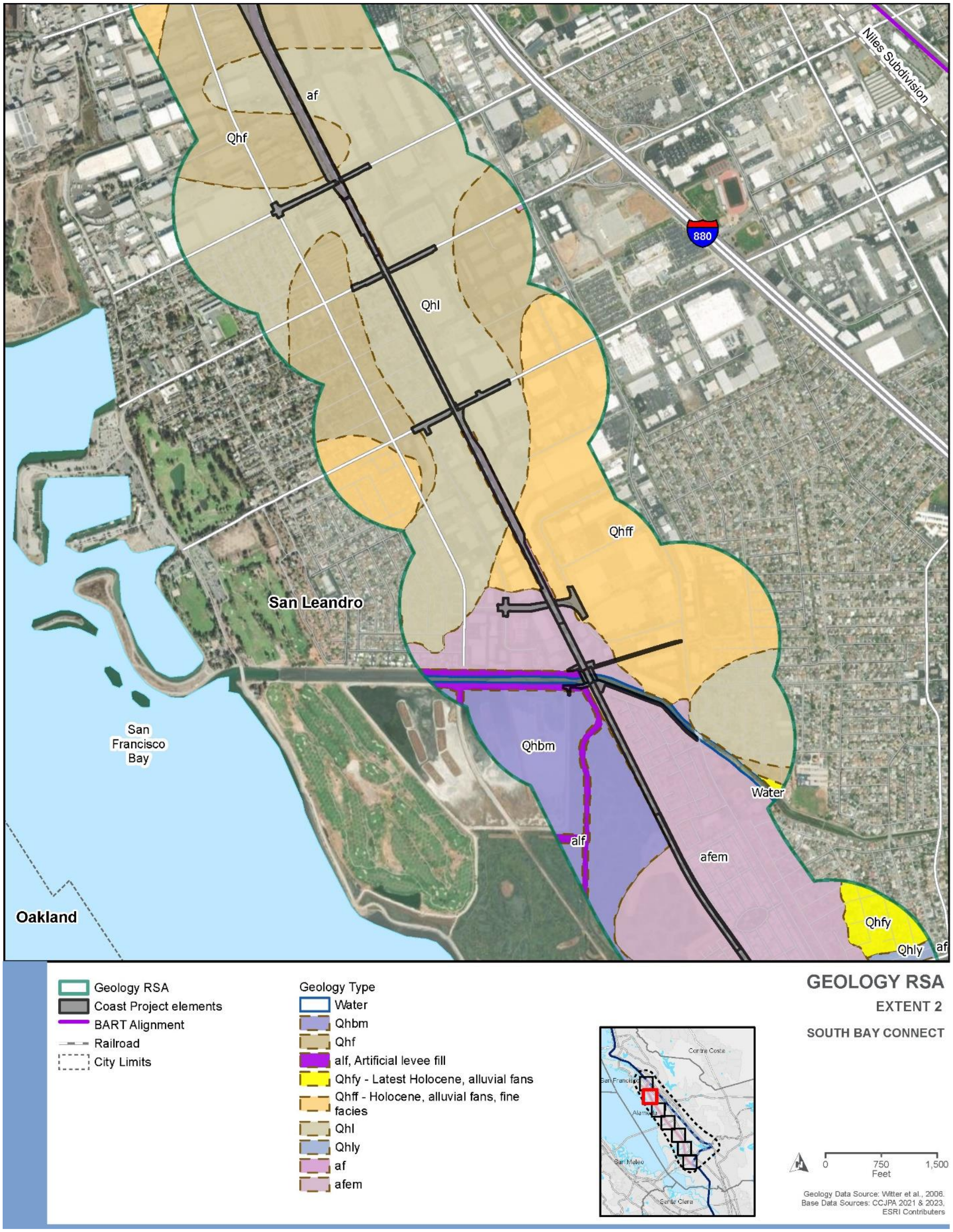


Figure 3.8-3. Geology of the Project Area Map Extent 3.

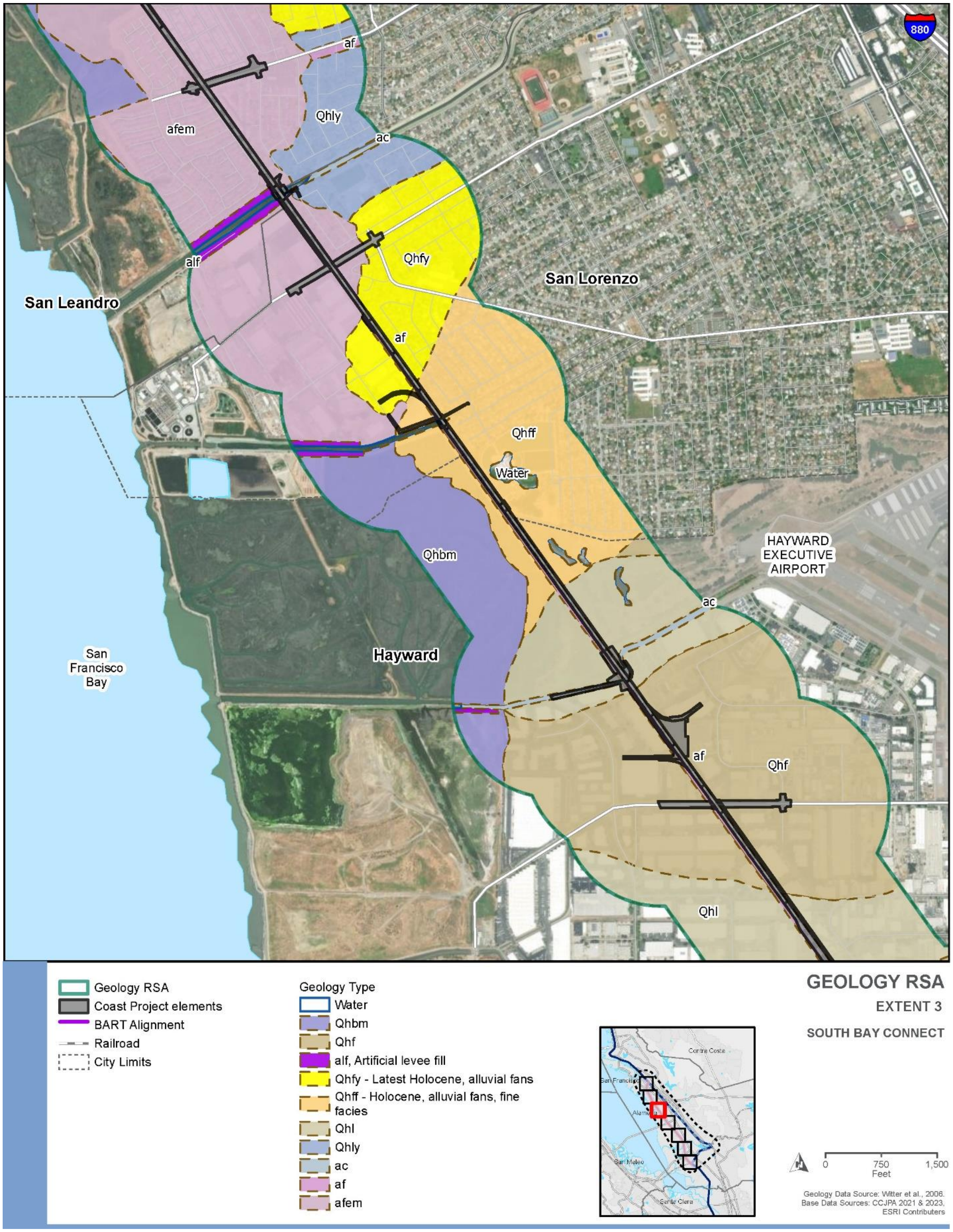


Figure 3.8-4. Geology of the Project Area Map Extent 4.

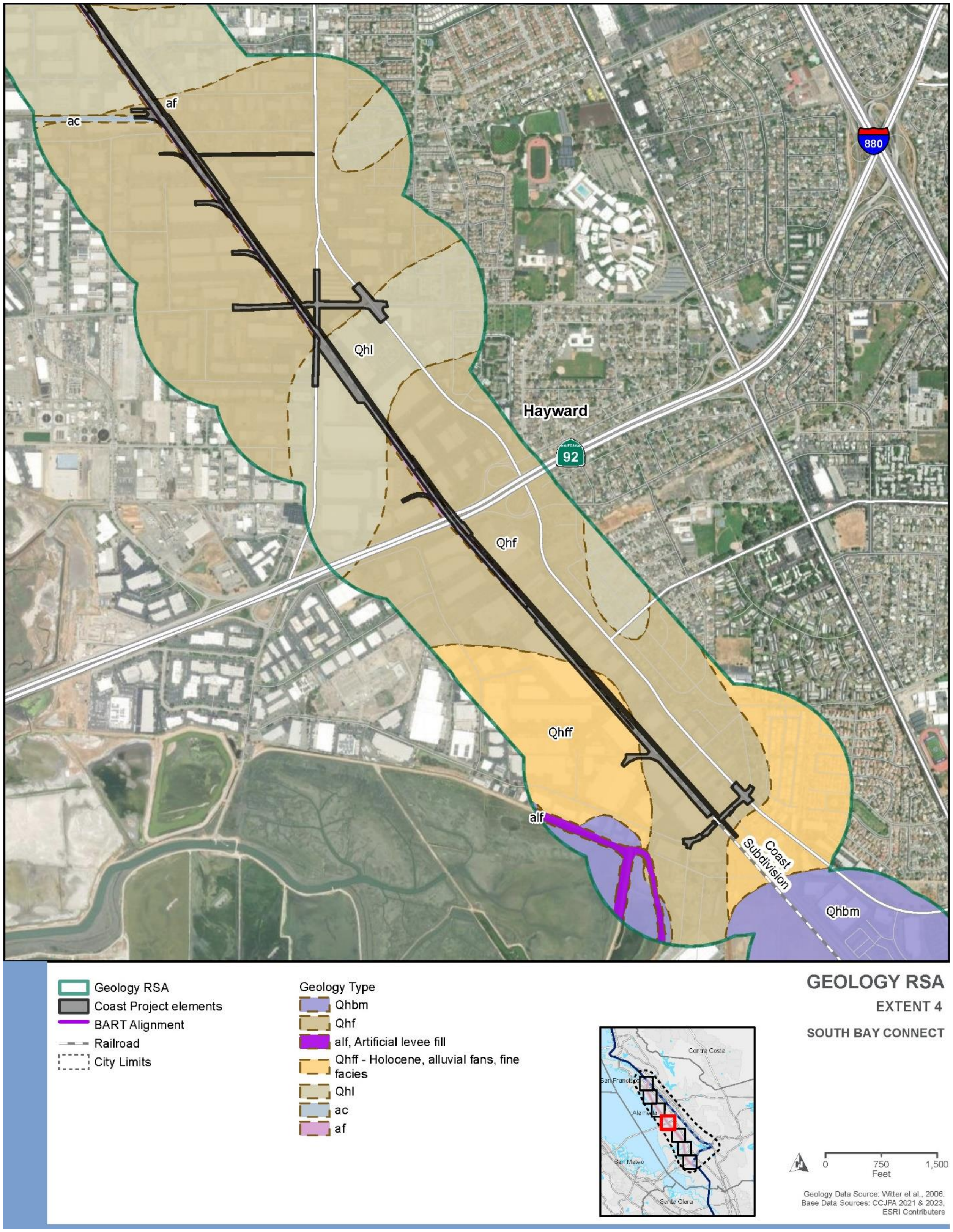


Figure 3.8-5. Geology of the Project Area Map Extent 5.

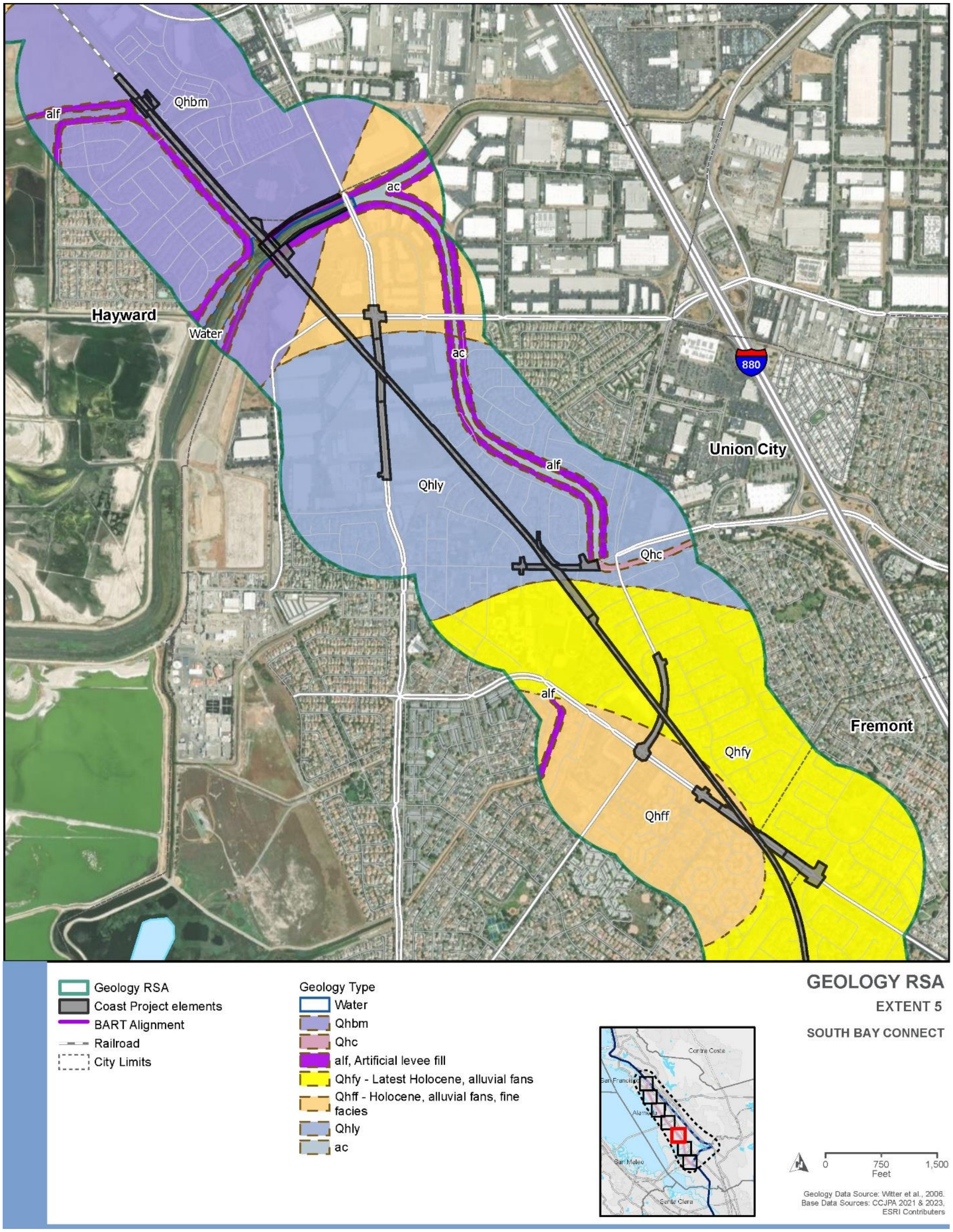


Figure 3.8-6. Geology of the Project Area Map Extent 6.

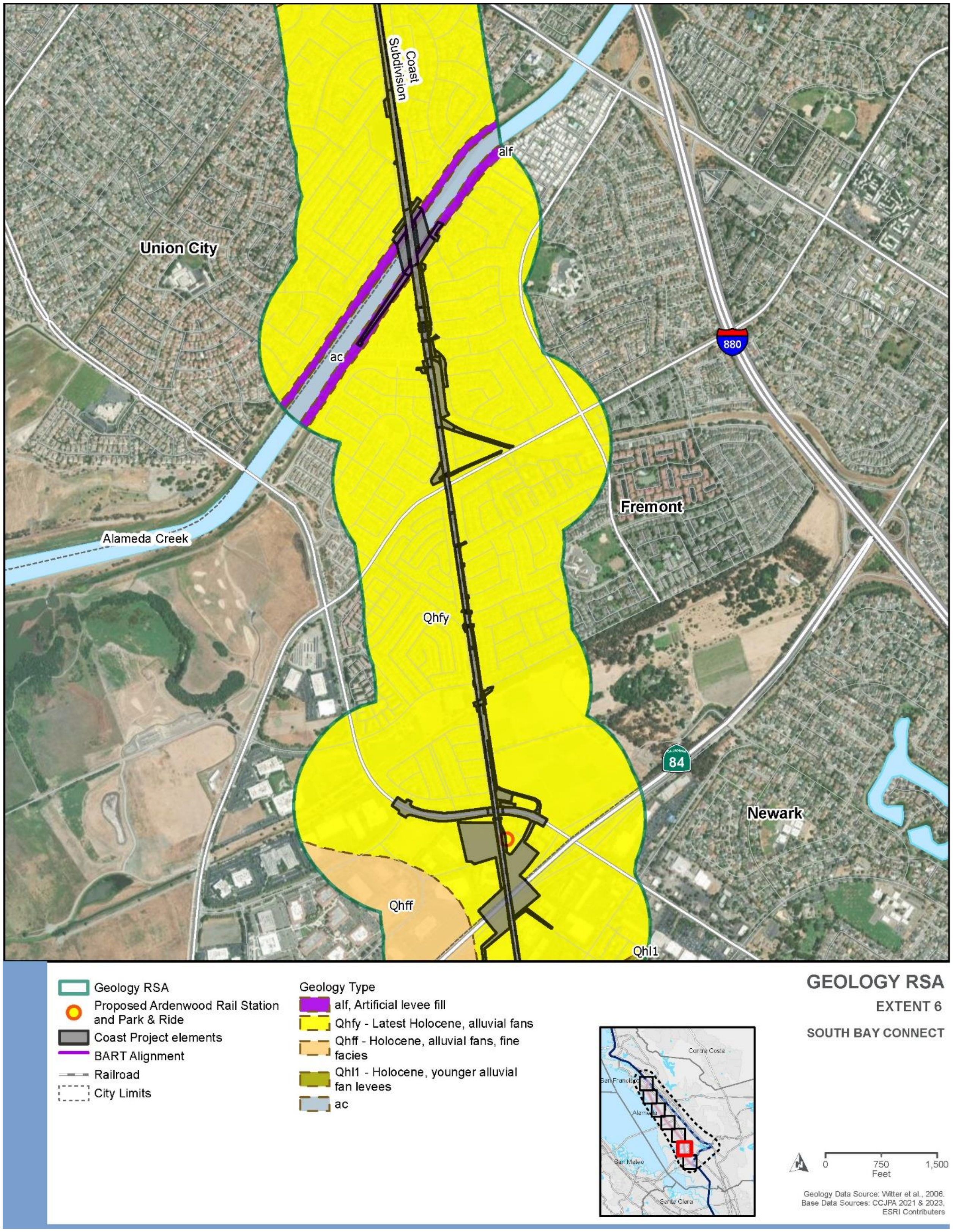
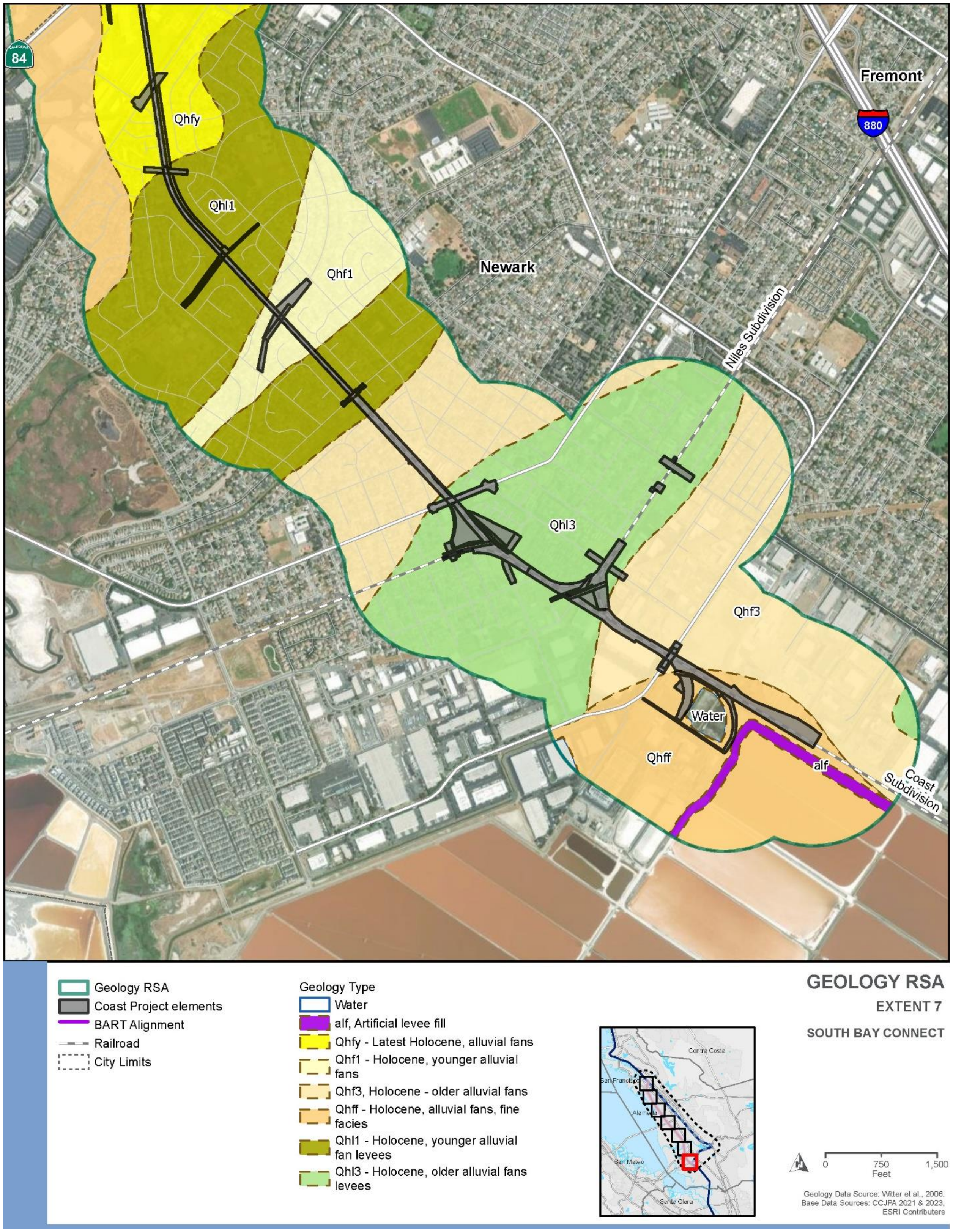


Figure 3.8-7. Geology of the Project Area Map Extent 7.



Faulting and Seismicity

The seismic RSA is susceptible to strong ground shaking generated during earthquakes on nearby faults. The major fault zones of the San Andreas Fault System (including the Hayward, Concord, and Calaveras faults) have been earthquake sources and are expected to be sources of future earthquakes within the seismic RSA. The California Code of Regulations (Title 14, Division 2, Section 3601(a)) defines an "active fault" as a fault that has had surface displacement within Holocene time (about the last 11,000 years). Active faults within this Memo are defined as those that have shown displacement within the latest Quaternary (< 15,000 years). The difference in definitions is due to the USGS Fault and Fold Database not distinguishing between Holocene and latest Quaternary active faults. Figure 3.8-8 shows active faults within the seismic RSA and the period of the last surface displacement. Table 3.8-3 provides further details.

The closest active fault to the Project footprint is the Hayward fault which borders the western margin of the East Bay Hills and trends northwest approximately 72 miles from San Pablo Bay in the north to Shingle Valley in the south. The Hayward fault is part of the San Andreas fault system and is the primary fault in the eastern San Francisco Bay Area. The Hayward fault dips 90 degrees with right-lateral strike-slip motion and striking approximately at 325 degrees.

The Hayward fault has produced large earthquakes over the last two hundred years, including in 1868, when an estimated 7.0 magnitude (M) earthquake occurred on the southern segment of the fault near Ashland, located about 2.5 miles northeast of the Coast Subdivision. Other earthquakes of note on the Hayward fault occurred in 1870 (5.8 M), 1889 (5.6 M), and 1955 (5.5 M). According to the Uniform California Earthquake Rupture Forecast (UCERF3) Appendix H (Field et al., 2013), the estimated recurrence intervals for the Northern and Southern Hayward fault are 318 and 168 years, respectively.

The Working Group on California Earthquake Probabilities (Field et al., 2013) updated the 30-year earthquake forecast for California and concluded that there is a 72 percent probability (or likelihood) of at least one earthquake of magnitude 6.7 or greater striking somewhere in the San Francisco Bay region before 2043.

Ground Shaking

Strong ground shaking occurs as energy is released during an earthquake. The intensity of ground shaking depends on the distance to the fault rupture, earthquake magnitude, and geologic conditions underlying and surrounding the site through which the seismic waves pass. Ground shaking induced by a seismic event is typically characterized by a value of horizontal peak ground acceleration (PGA) that is expressed as a percentage of the acceleration of gravity. Either deterministic or probabilistic methods are typically used to estimate the level of shaking that can be expected at a specific location. Given the proximity to active faults within the seismic RSA, including the Hayward fault, the PGA within the RSA is expected to be high.

The expected maximum credible earthquake on the Hayward fault would cause severe to violent ground shaking throughout the seismic RSA. The response of structures and physical elements of the Project to strong ground shaking would be dependent on foundation materials, structural design, and strength during shaking. The susceptibility of earth materials underlying the Project elements to failure is variable and would be determined during site specific geotechnical investigations.

Figure 3.8-8. Regional Active Faults in the Seismic RSA.

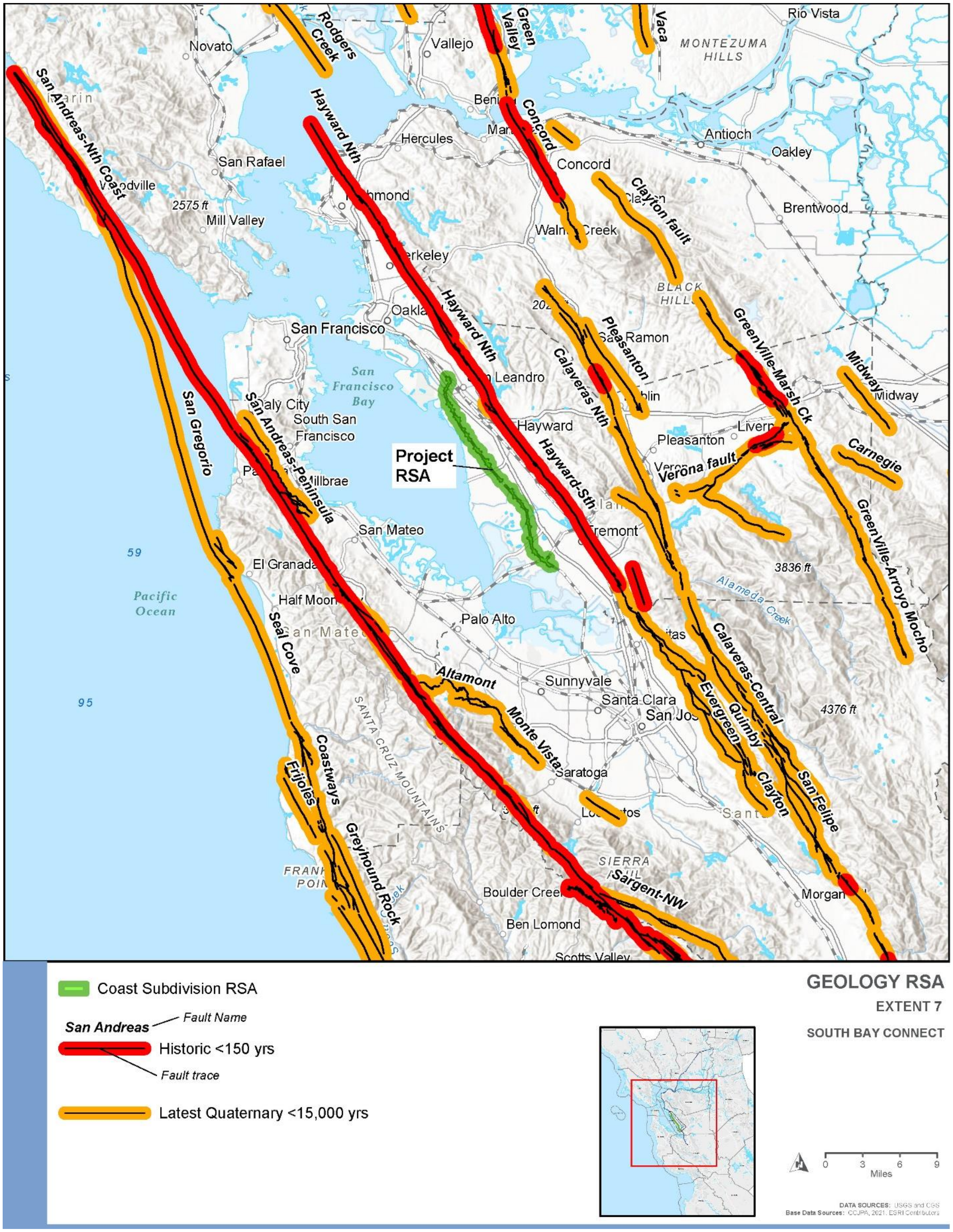


Table 3.8-3: Active Faults in the Seismic RSA

Fault and Section	Fault Type	Max Magnitude, MMax(1)	Approx. Distance Rx(2)(miles)
Hayward, Southern	strike-slip	7.3	0
Hayward, Northern	strike-slip	7.3	1.6
Calaveras, Northern	strike-slip	6.9	4.6
Hayward, Southeast Extension	strike-slip	6.7	7.6
Pleasanton	strike-slip	6.6	9.2
Calaveras, Central	strike-slip	6.9	9.5
Monte Vista-Shannon	reverse	6.4	11.6
San Andreas, Peninsula	strike-slip	8	13.5
Concord, Ignacio Valley	strike-slip	6.6	15
Greenville, Marsh Creek	strike-slip	6.9	16.7
Concord	strike-slip	6.6	17
San Andreas, Santa Cruz Mountains	strike-slip	8	17.3
Concord, Avon	strike-slip	6.6	18.5
Greenville, Arroyo Mocho	strike-slip	6.9	18.9
Greenville, Clayton	strike-slip	6.9	19
San Gregorio	strike-slip	7.4	21.1
Green Valley	strike-slip	6.8	23
Sargent, Northwest	strike-slip	7	26.4
West Napa	strike-slip	6.6	28.4
San Andreas, North Coast	strike-slip	8	28.9
Rodgers Creek	strike-slip	7.3	31

Notes:

(1) Magnitudes are derived from UCERF 3 (Field et al. 2013).

(2) Approximate fault distances were derived from the USGS Fault and Fold Database (2006). RX = Horizontal distance to the fault trace or surface projection of the rupture plane.

Fault Creep

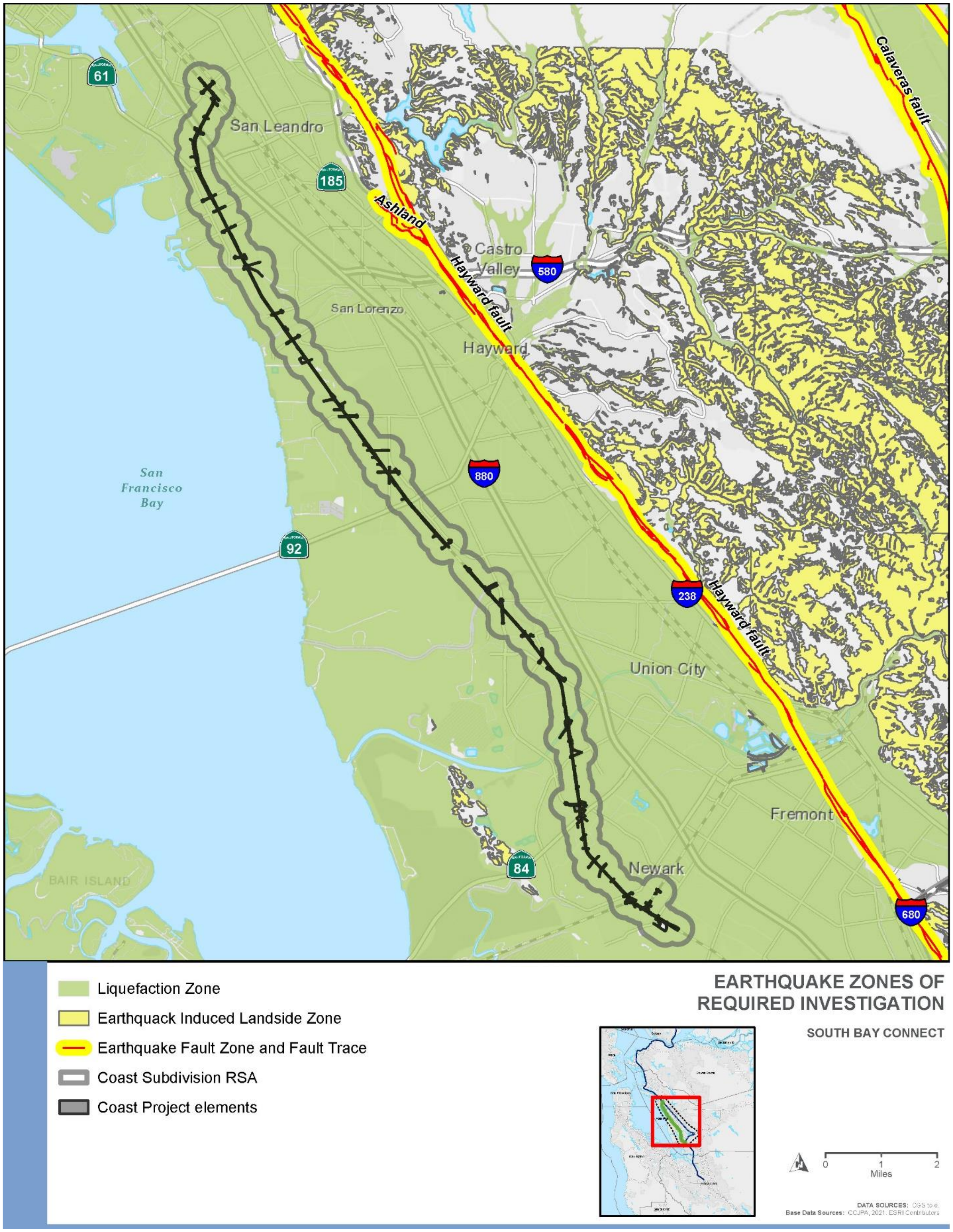
Evidence of fault creep has been observed along most of the Northern and Southern Hayward fault, including where the fault crosses the South Section of the Oakland Subdivision. Data from two fault creep meters located on either side of where the Hayward fault crosses Appian Way (approximately 4 miles north of the Coast Subdivision) and Gilbert Avenue (approximately 2.5 miles southwest of the Coast Subdivision) have average fault creep rates of 5.8 mm per year (Lienkaemper and USGS, 2006). Figure 3.8-8 shows the location of Hayward fault creep rates in the vicinity of the Coast Subdivision.

Alquist-Priolo Earthquake Fault Zones

The Niles Earthquake Zones of Required Investigation map shows that parts of the South Section of the Oakland Subdivision are located in an Alquist-Priolo Earthquake Fault Zone. Figure 3.8-9 shows the location of Alquist-Priolo Earthquake Fault Zones and Seismic Hazard Zones in relation to the geologic RSA. Seismic Hazard Zones include Liquefaction Zones and Earthquake Induced Landslide Zones.

Alquist-Priolo Earthquake Fault Zones encompass active faults that constitute potential hazard to structures from surface faulting or fault creep such that avoidance as described in Public Resources Code Section 2621.5(a) would be required. Alquist-Priolo Earthquake Fault Zones and Seismic Hazard Zones are collectively referred to as Earthquake Zones of Required Investigation.

Figure 3.8-9: Earthquake Zones of Required Investigation for the RSA.



Soils

Typical engineering properties of soils considered for design and construction include expansive potential, density, moisture content, shear strength, compressibility, erosion potential, cementation, and corrosion potential. Figure 3.8-10 through Figure 3.8-12 show the distribution of topsoils within the geologic RSA. Topsoils located within the geologic RSA were evaluated based on the USDA/NRCS Soil Survey Geographic Database (SSURGO). The SSURGO database contains information about soil as collected by the National Cooperative Soil Survey over the course of a century and is based on soil conditions within about five feet of the ground surface. Typical information contained in the database includes available water capacity, soil reaction, electrical conductivity, and frequency of flooding; yields for cropland, woodland, rangeland, and pastureland; and limitations affecting recreational development, building site development, and other engineering uses. The SSURGO data is generalized by area and should not be relied upon for site specific investigations.

The geologic RSA extends along parts of the eastern San Francisco Bay plain and consists alluvial fans, artificial and natural levees, tidal flats and estuaries that have been artificially filled.

Table 3.8-4 summarizes soil units and soil attributes that occur within the geologic RSA. The expansive potential, and corrosion potential of steel and concrete for each soil unit are discussed and shown in the Geologic Hazards discussion below.

Table 3.8-4: Summary of Soil Units and Soil Attributes that Occur Within the Geologic RSA

Map Symbol	Soil Unit Name*	Area (acres) / Unit Percent within the RSA	Erosion Factor Kw	Corrosion Steel	Corrosion Concrete	Shrink-swell
106	Botella loam, 0 to 2%	24 / 0.3	0.24	low	moderate	low
107	Clear Lake clay, drained, 0 to 2%	1622 / 20.8	0.17	very high	moderate	very high
111	Danville silty clay loam, 0 to 2%	1023 / 13.1	0.24	high	low	high
112	Danville silty clay loam, 2 to 9%	68/1.8	0.24	high	low	high
117	Laugenour loam, drained	337 / 4.3	0.43	moderate	low	moderate
125	Marvin silt loam, saline-alkali	662 / 8.5	0.49	high	moderate	high
131	Omni silty clay loam, drained	1070 / 13.7	0.24	high	low	high

Map Symbol	Soil Unit Name*	Area (acres) / Unit Percent within the RSA	Erosion Factor Kw	Corrosion Steel	Corrosion Concrete	Shrink-swell
132	Omni silty clay loam, strongly saline	132 / 2.1	0.24	high	moderate	high
133	Pescadero clay, drained	239 / 3.1	0.32	moderate	high	moderate
134	Pescadero clay, ponded	116 / 1.5	0.28	moderate	high	moderate
137	Novato clay, tidally flooded	—	0.2	high	high	high
138	Novato clay, ponded	30 / 0.4	0.24	high	high	high
139	Reyes clay, 0 to 2%	425 / 5.4	0.2	moderate	high	moderate
143	Sycamore silt loam, drained, 0 to 2%	1175 / 15.1	0.37	low	low	low
144	Sycamore silt loam, clay substratum	141 / 1.8	0.49	moderate	low	moderate
146	Urban land	—	—	—	—	—
148	Urban land-Clear Lake complex	77 / 1.0	—	high	—	high
154	Willows clay, drained	628/ 8.1	0.24	high	moderate	high
155	Xerorthents, clayey	64 / 0.8	0.15	high	low	high
161	Yolo silt loam, 0 to 3%, dry	—	0.43	low	low	low

Figure 3.8-10: Topsoils Within the Geologic RSA for Map Extent 1.

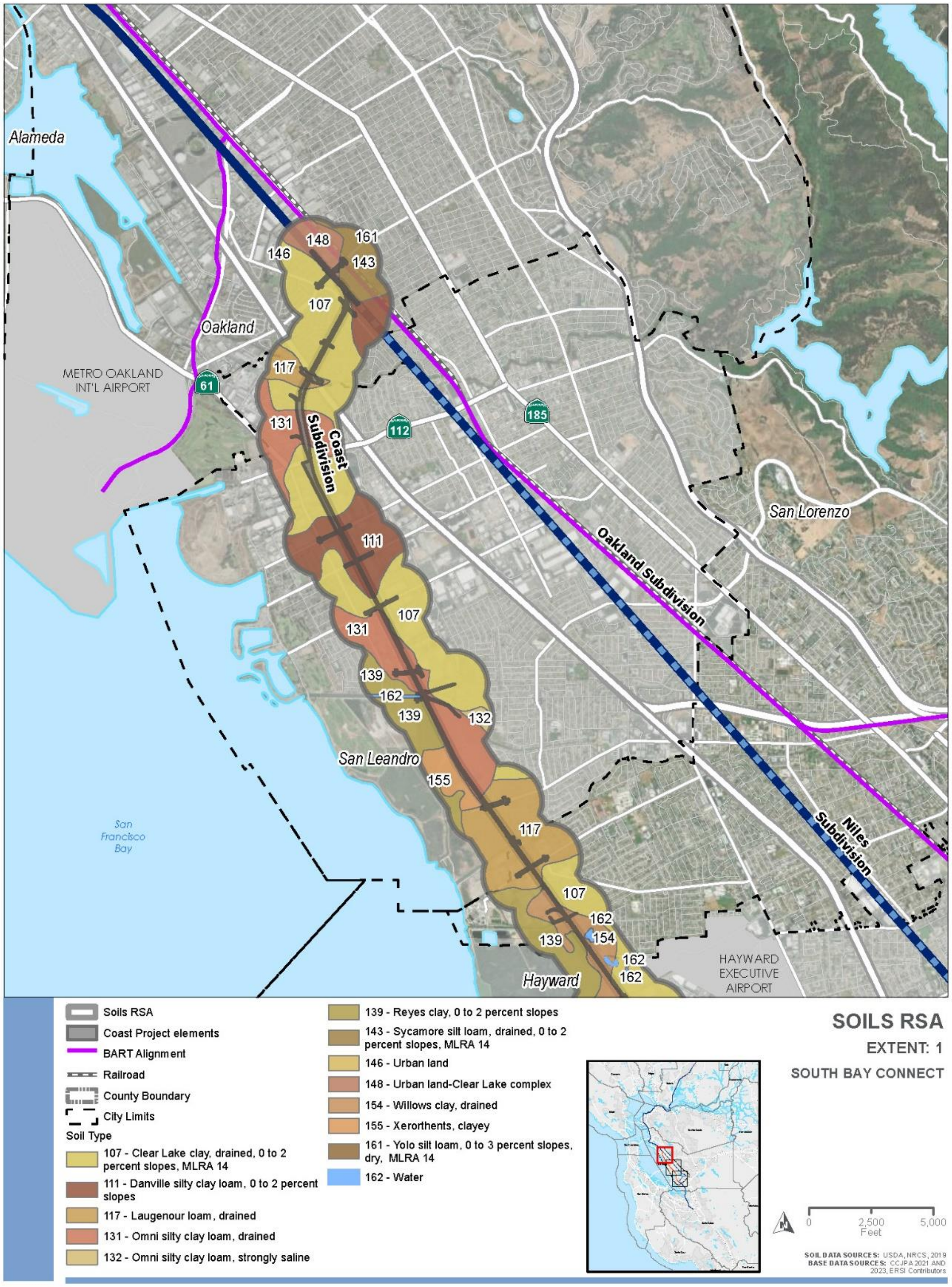


Figure 3.8-11: Topsoils Within the Geologic RSA for Map Extent 2.

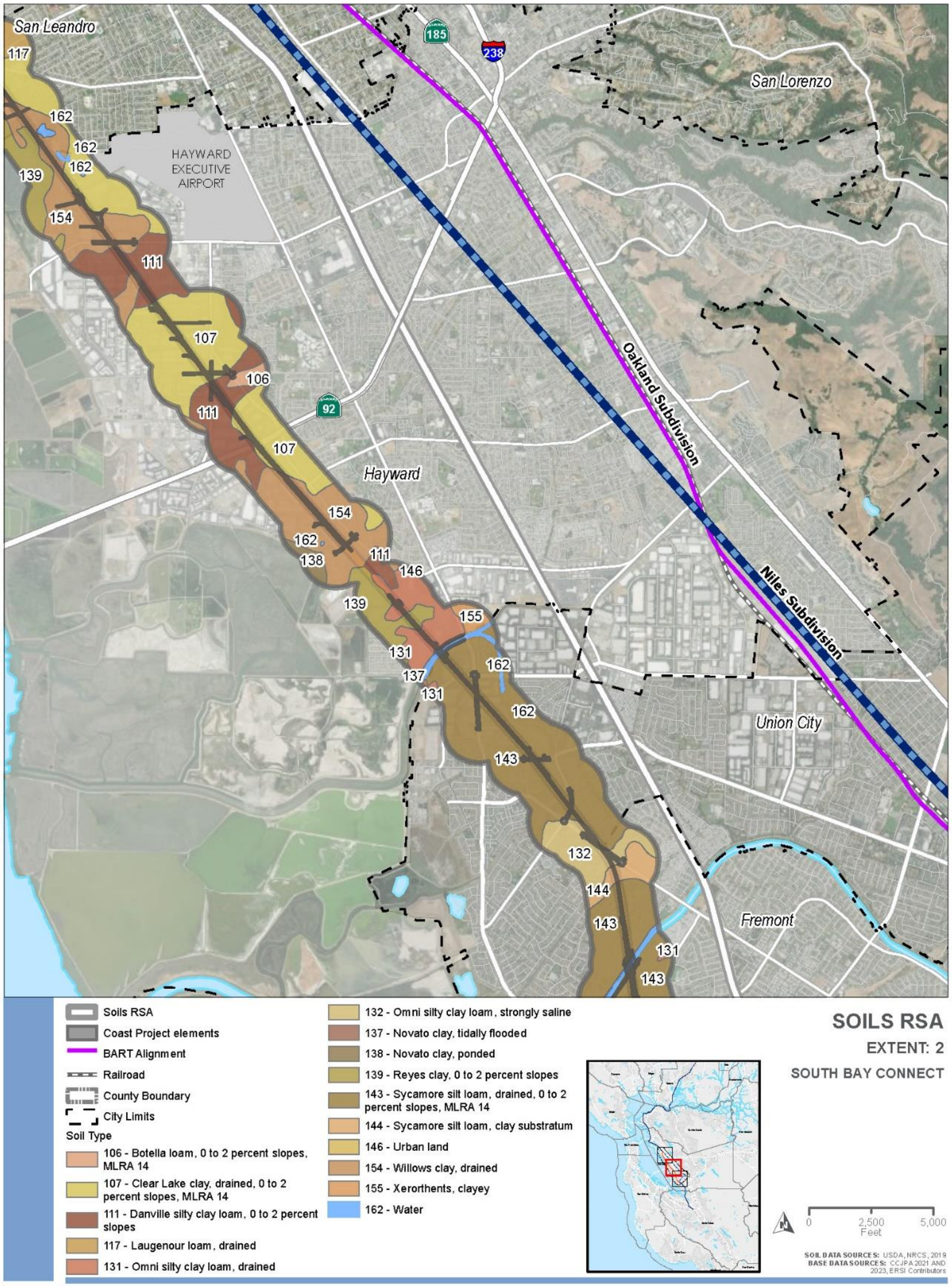
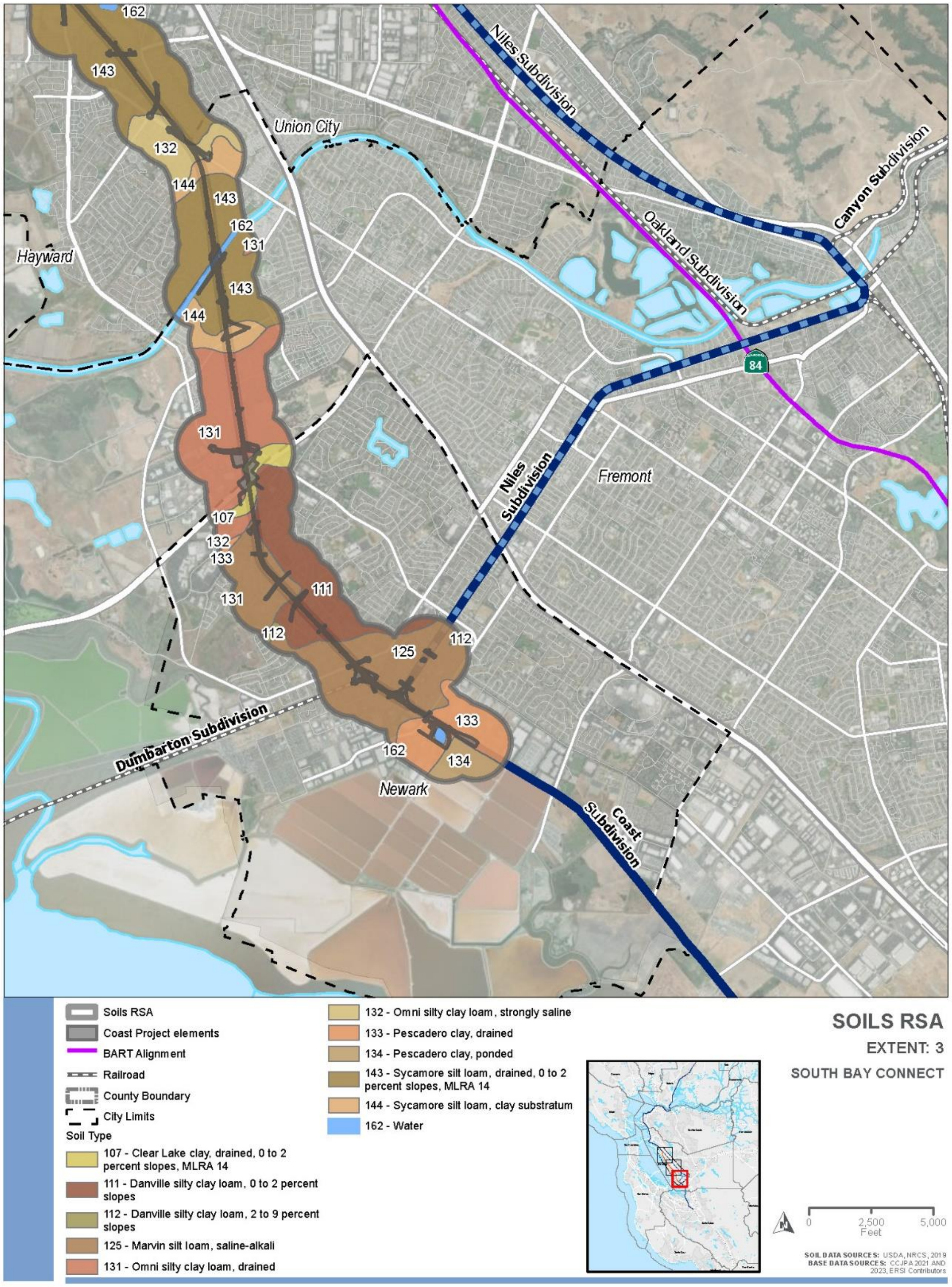


Figure 3.8-12: Topsoils Within the Geologic RSA for Map Extent 3.



Geologic Hazards

Landslides

Landslides and slope failure can occur when the force of gravity overcomes the strength of the soil or rock within a hillside or built embankment. The primary factors influencing the stability of a slope are the nature of the underlying soil or bedrock, slope geometry (height and steepness), rainfall, and groundwater. Excavation or erosion of material at the toe of a slope can destabilize the slope above. Slope failure can be initiated or exacerbated by seismic movements. Earthquake-induced ground-shaking can cause activation of new or previously existing landslides and other slope instabilities, especially during periods of high groundwater and rainfall.

Figure 3.8-9 shows Earthquake Induced Landslide Zones as shown on Earthquake Zones of Required Investigation maps (Niles, Newark, Redwood Point, Hayward, and San Leandro Quadrangles). These landslide zones represent areas where previous occurrence of landslide movement, or local topographic, geologic, geotechnical, and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in PRC Section 2693(c) would be required. Only relatively small areas within the geologic RSA are shown as being susceptible to earthquake induced landslides such as in the South Section of the Oakland Subdivision along Alameda Creek and the adjacent lakes, as shown in Figure 3.8-9.

Land Subsidence

Land subsidence is often attributed to over-extraction of groundwater, extraction of oil and gas, and seismic events. The State of California Department of Water Resources (2014), Summary of Recent, Historical, and Estimated Potential for Future Land Subsidence in California, indicates the geologic RSA is not subsiding as of 2014, and has a low potential for future land subsidence. Within the RSA, subsidence has not occurred due to oil and gas removal.

Ground Subsidence

Ground subsidence is a form of ground settlement that usually results from change in fluid content within soil or rock. The volume change can result from localized dewatering of peat, organic soils, or soft silts and clay. This type of ground settlement is often associated with construction activities when groundwater is lowered to allow construction below the groundwater table. The other form of land subsidence is from a regional withdrawal of groundwater, petroleum, or geothermal resources. Regional subsidence can also result from vertical fault movement. Although the mechanism is different, another cause of land subsidence is the ongoing decomposition of organic-rich soils.

Ground subsidence contours created by Poland and Ireland (1988) suggest the southern-most section of the Coast Subdivision (South Section) has subsided about 1 foot and is likely due to groundwater extraction.

According to State of California Department of Water Resources (2014) Summary of Recent, Historical, and Estimated Potential for Future Land Subsidence in California, the area of the RSA has a low estimated potential for future land subsidence. There is, however, a moderate susceptibility of small, localized areas of subsidence, or settlement, from construction-related dewatering of excavations.

Soil Erosion

Soil erosion is the action of surface processes, such as water flow and wind, that transport soil and rock particles from one location to another. Factors that affect soil erosion potential include soil type, soil moisture, rainfall, ground cover, slope, surface water flow, wind speed, and topography.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation and the Revised Universal Soil Loss Equation to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. Estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity. As a general measure of erosion, values of K can range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion. The majority of soil units within the RSA have low to moderate K values with the highest being the Marvin silt loam and the Sycamore silt loam which have a K factor of 0.49. Together these units cover about 9.4 percent of the RSA area.

Table 3.8-4 lists erosion factor Kw for surface soil units within the RSA. Erosion factor Kw indicates the erodibility of the whole soil and is modified by the presence of rock fragments.

Liquefaction

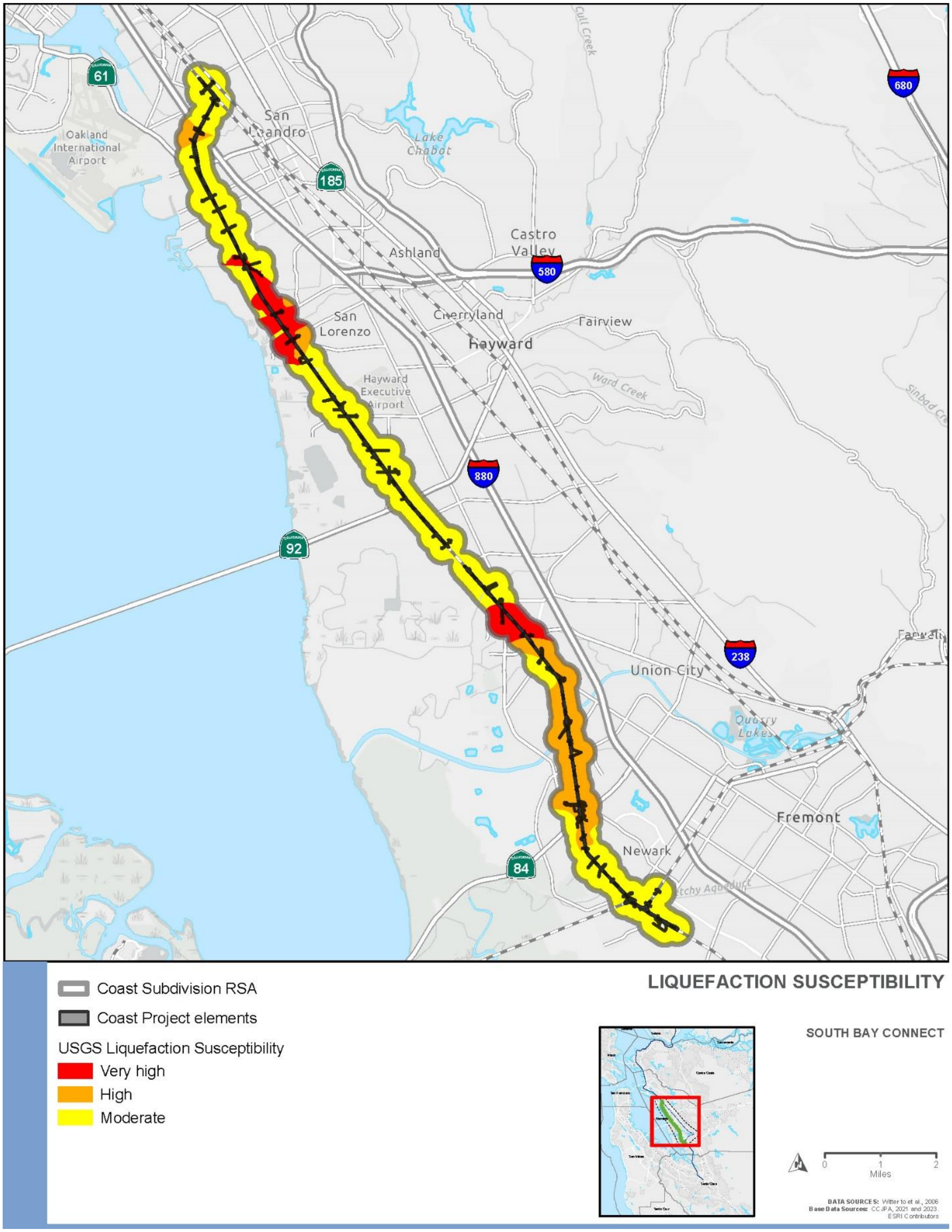
Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Submerged cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction. Clays are generally not susceptible to liquefaction as clay soil particles adhere more strongly than for example, sandy soils.

Figure 3.8-13 shows the liquefaction susceptibility within the geologic RSA. Liquefaction data was derived from Witter et al. (2006). For a comprehensive description of the methodology for determining liquefaction susceptibility see Witter et al. (2006).

The majority of the geologic RSA has a moderate liquefaction susceptibility with smaller areas of high and very high susceptibility. Within the North Section and the northern part of the Central Section of the Coast Subdivision, very high liquefaction susceptibility appears to be mostly associated with the following geologic units - artificial fill over estuarine mud and smaller areas of the latest Holocene alluvial fans. Areas with a high liquefaction susceptibility within the Coast Subdivision correlate to the latest Holocene alluvial fans geologic unit (see Table 3.8 2: Summary of Geologic Units and Coverage within the RSA).

Figure 3.8-13 shows Liquefaction Seismic Hazard Zones as shown on Earthquake Zones of Required Investigation maps and GIS data (CGS 1980a; 1980b; 1980c; 1980d; 1980e; 2003a; 2003b; 2003c; 2004a; and 2018). These liquefaction zones represent areas where historical occurrence of liquefaction, or local geologic, geotechnical, and ground water conditions indicate a potential for permanent ground displacements such that mitigation as defined in PRC Section 2693(c) could be required.

Figure 3.8-13: Liquefaction Susceptibility Within the Geologic RSA.



Lateral Spreading

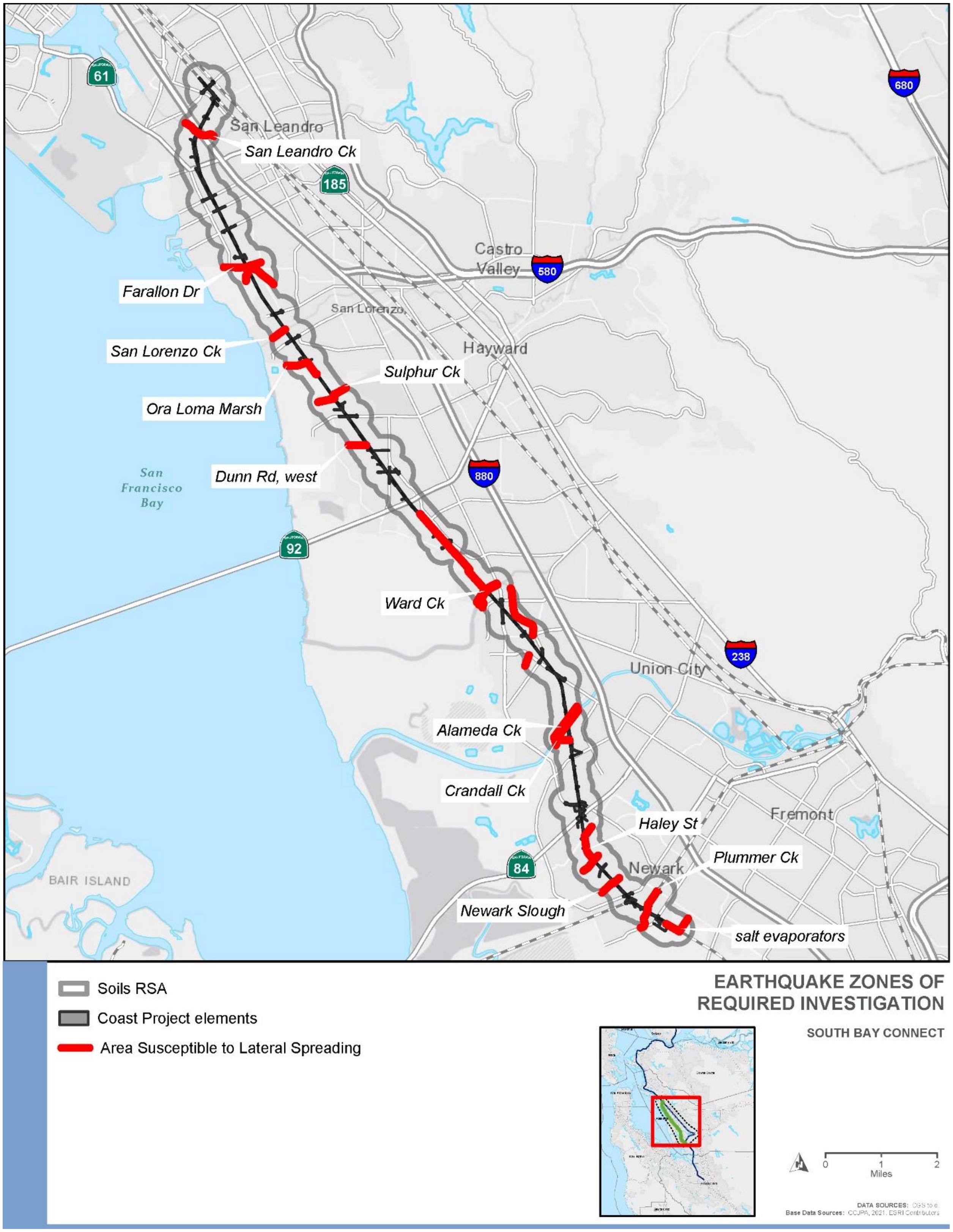
A consequence of seismic liquefaction in sloping ground areas is lateral spreading, which refers to the movement of ground laterally after the loss of support due to liquefaction. For this to occur, the liquefied area must be relatively close to a free face (e.g., an unsupported vertical, or sloping face) such as a road cut or stream/riverbank. Locations within the geologic RSA and are adjacent to the Project footprint that contain free faces are listed in Table 3.8-5. Locations were selected based on the slope, the presence of a free face, and/or a high or very high liquefaction susceptibility. Figure 3.8-14 shows the locations of these areas. Site specific investigations will determine the specific properties of soils at these locations. USGS elevation data was used to identify areas with moderate slopes and compared with Google Earth imagery to determine if the slopes were lined or unlined. The liquefaction susceptibility shown in Table 3.8-5 corresponds to Figure 3.8-14. The identified locations that are considered to have a higher risk of lateral spread are generally discreet moderately sloping areas bordering creeks, canals, lakes, and ponds.

Table 3.8-5: Locations Within the Geologic RSA That Have a Higher Risk of Lateral Spreading

Name	Section	Description	Geologic Units	Liquefaction Susceptibility
San Leandro Creek	North	un-lined creek banks	ac, af, Qhfy	high
Farallon Drive, south	North	un-lined creek banks	alf, afem, Qhbm	very high
San Lorenzo Creek	North	un-lined creek banks	alf & afem	very high
Ora Loma Marsh	Central	un-lined canal banks and levees	af, Qhbm, Qhff	moderate
Sulphur Creek	Central	un-lined creek banks	ac, af, Qhl	moderate
Dunn Rd, west	Central	un-lined canal banks	ac, Qhf	moderate
Ward Creek	Central	un-lined creek banks	alf, Qhbm	moderate
Alameda Creek	South	un-lined creek banks	ac, alf	high
Crandall Creek	South	un-lined creek banks	Qhfy	high
Haley St	South	un-lined canal banks	Qhfy, Qhl1	high
Newark Slough	South	un-lined creek banks	Qhl1, Qhf3	moderate
Plummer Creek	South	un-lined creek banks	Qhf3, Qhl3	moderate
salt evaporators	South	un-lined canal banks and levees	alf, Qhff	moderate

Source: Witter, et al., 2006.

Figure 3.8-14: Locations Within the Geologic RSA With a Potential for Seismically Induced Lateral Spreading.



Tsunami

Tsunamis are large ocean waves which are generated by major seismic events. Several areas of the North and Central Sections of the Coast Subdivision are located in the Tsunami Hazard Area for Alameda County and are shown in Figure 3.8-15 through Figure 3.8-17. The tsunami area shown on these figures represents the only areas that intersect with either the geologic RSA or Project footprint.

The Tsunami Hazard Area represents an area that could be exposed to tsunami hazards during a tsunami event. It is primarily based on inundation limits corresponding to a 975-year average return period tsunami event model. These limits have been extended to reflect potential local tsunami sources not considered in probabilistic analysis and are also modified to reflect the practical need to define limits that coincide with geographic features or city streets.

Groundwater

Groundwater data for the Project Study Area was derived from CGS Seismic Hazard Zone Reports (CGS 2003d; 2003e; 2003f; and 2004b) and is shown in Figure 3.8-18 through Figure 3.8-20. Depth to groundwater below surface for the Coast Subdivision varies between about five to ten feet. The relatively shallow groundwater of the Coast Subdivision is probably due to the low elevation and proximity to San Francisco Bay.

Note that groundwater levels shown here should not be used for design purposes; groundwater depths may vary seasonally due to anthropogenic and natural influences. Site specific groundwater investigations should be conducted during the design phases of the Project as groundwater directly influences geologic, soils, and seismic hazards such as shallow landslides and debris flow, slope stability, expansion and collapse potentials, and liquefaction.

Figure 3.8-15: Tsunami Hazard Area.

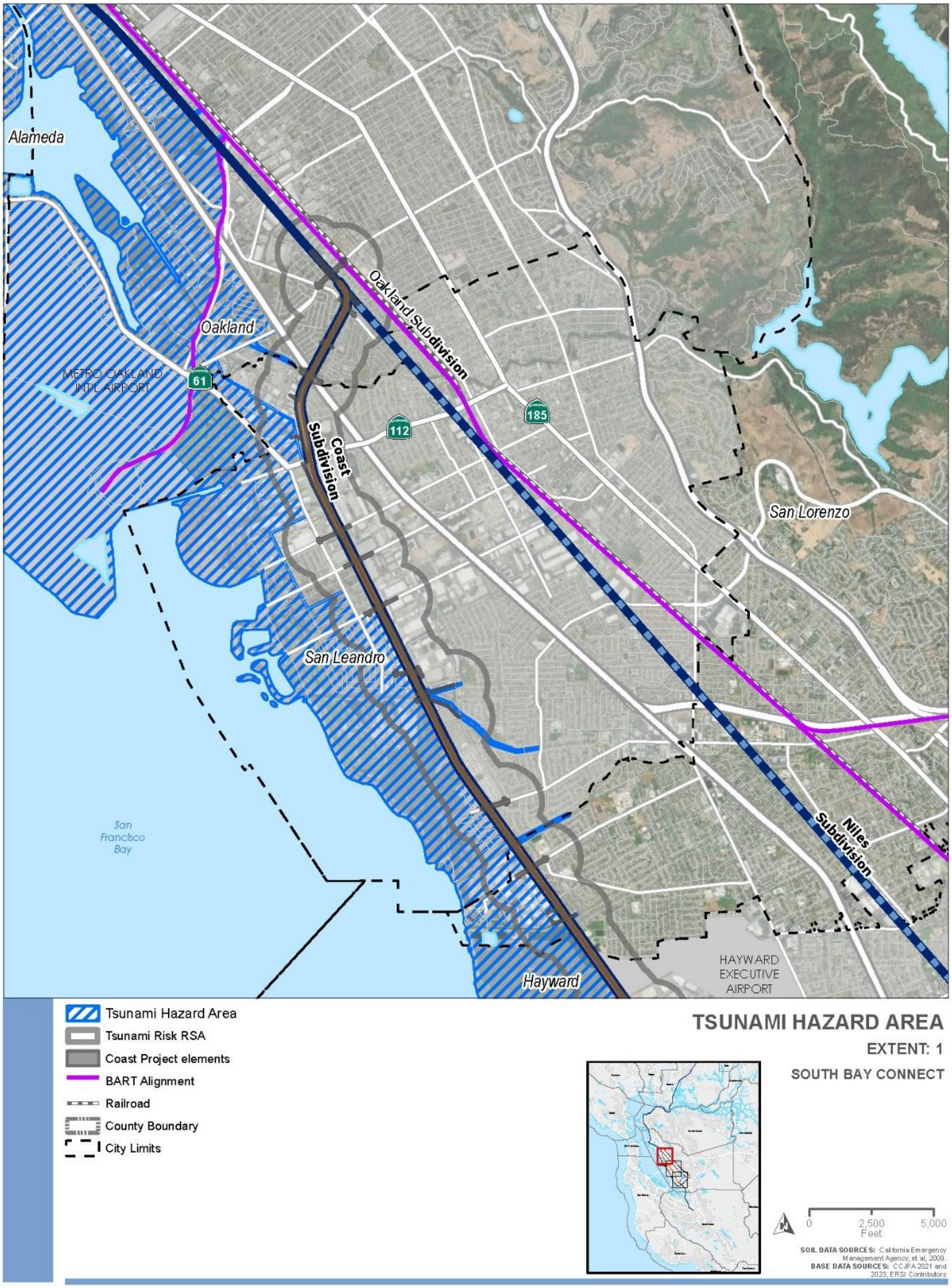


Figure 3.8-16: Tsunami Hazard Area.

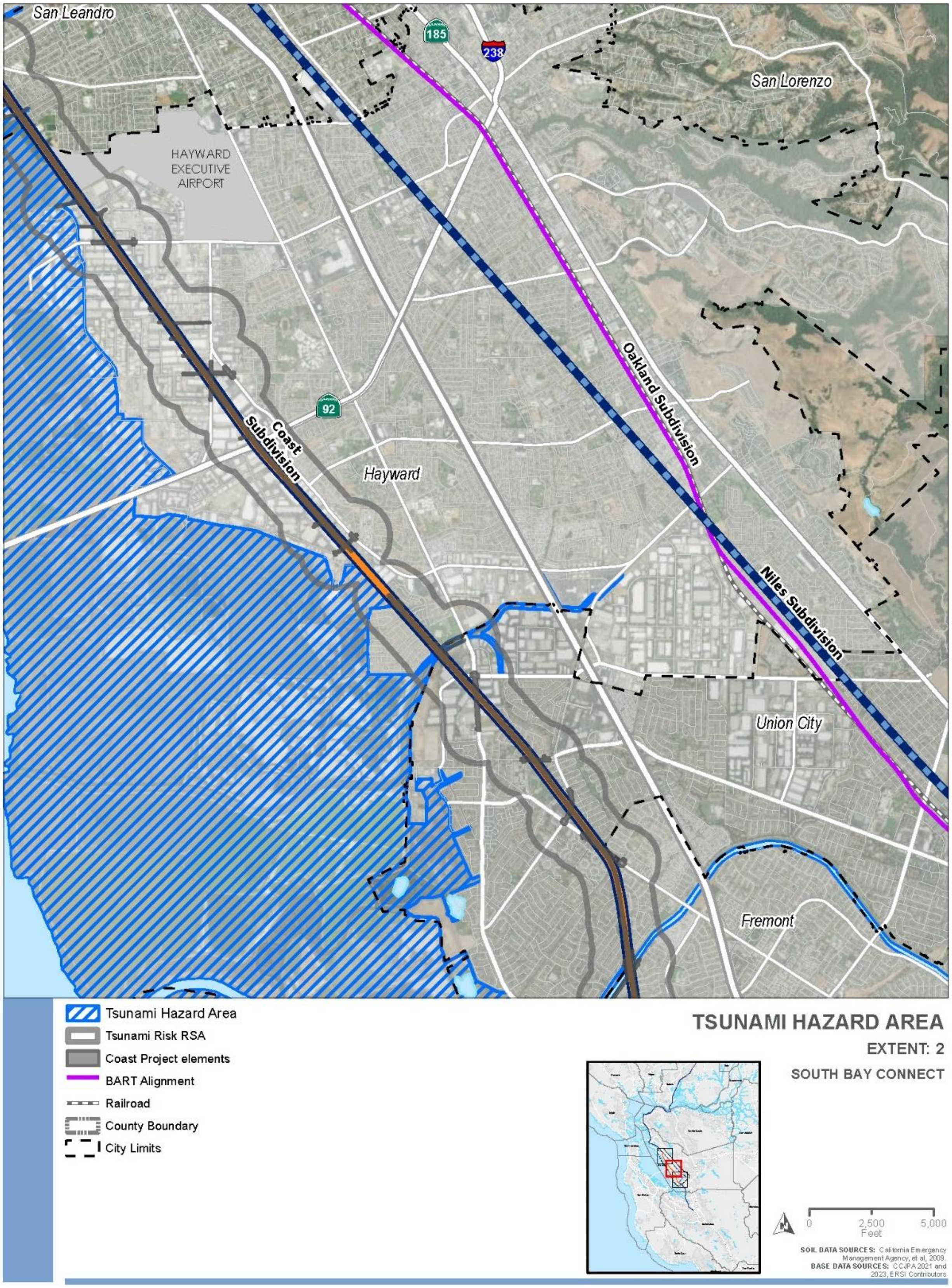


Figure 3.8-17: Tsunami Hazard Area.

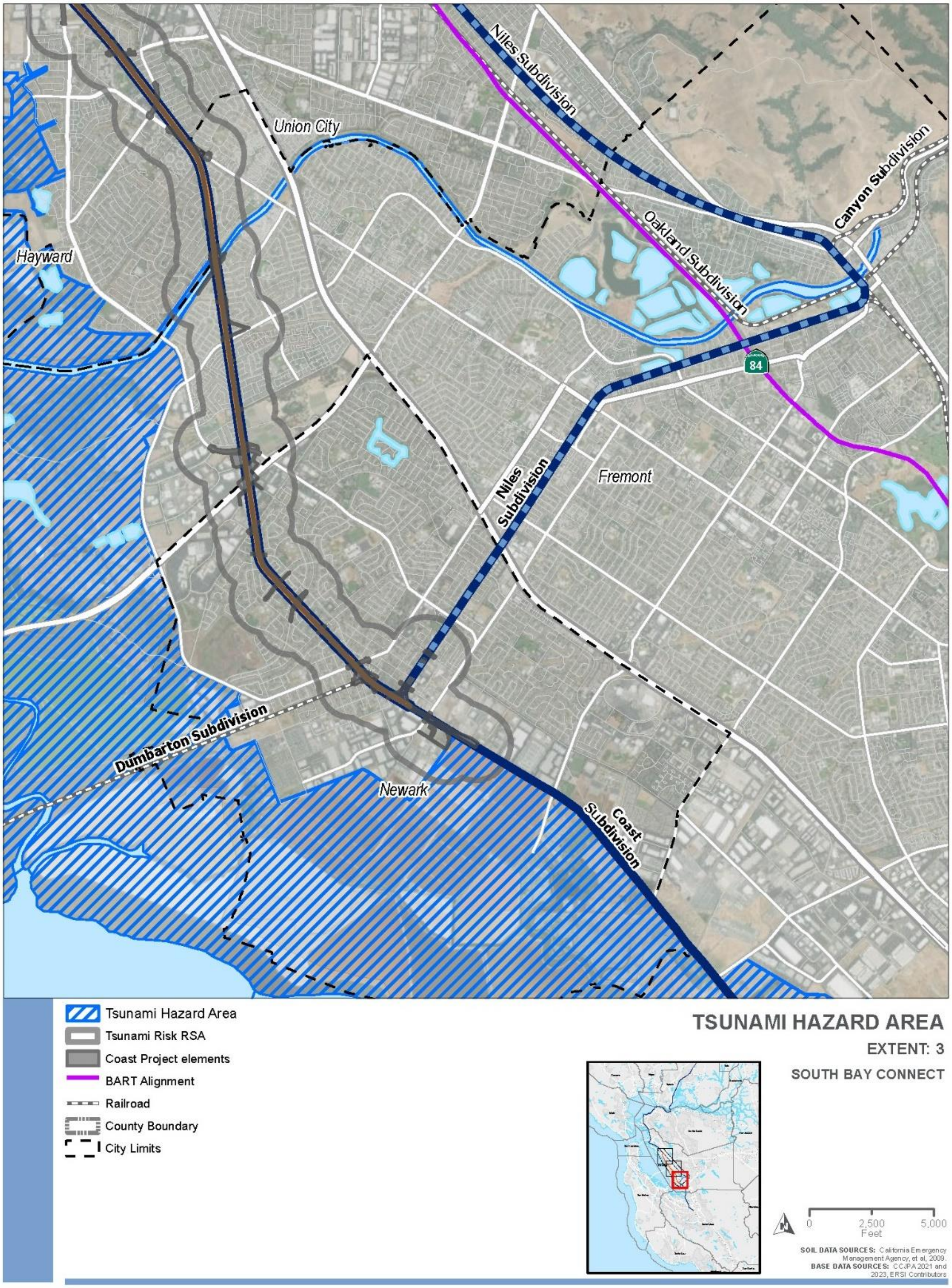


Figure 3.8-18: Groundwater Levels Below Surface for Map Extent 1.

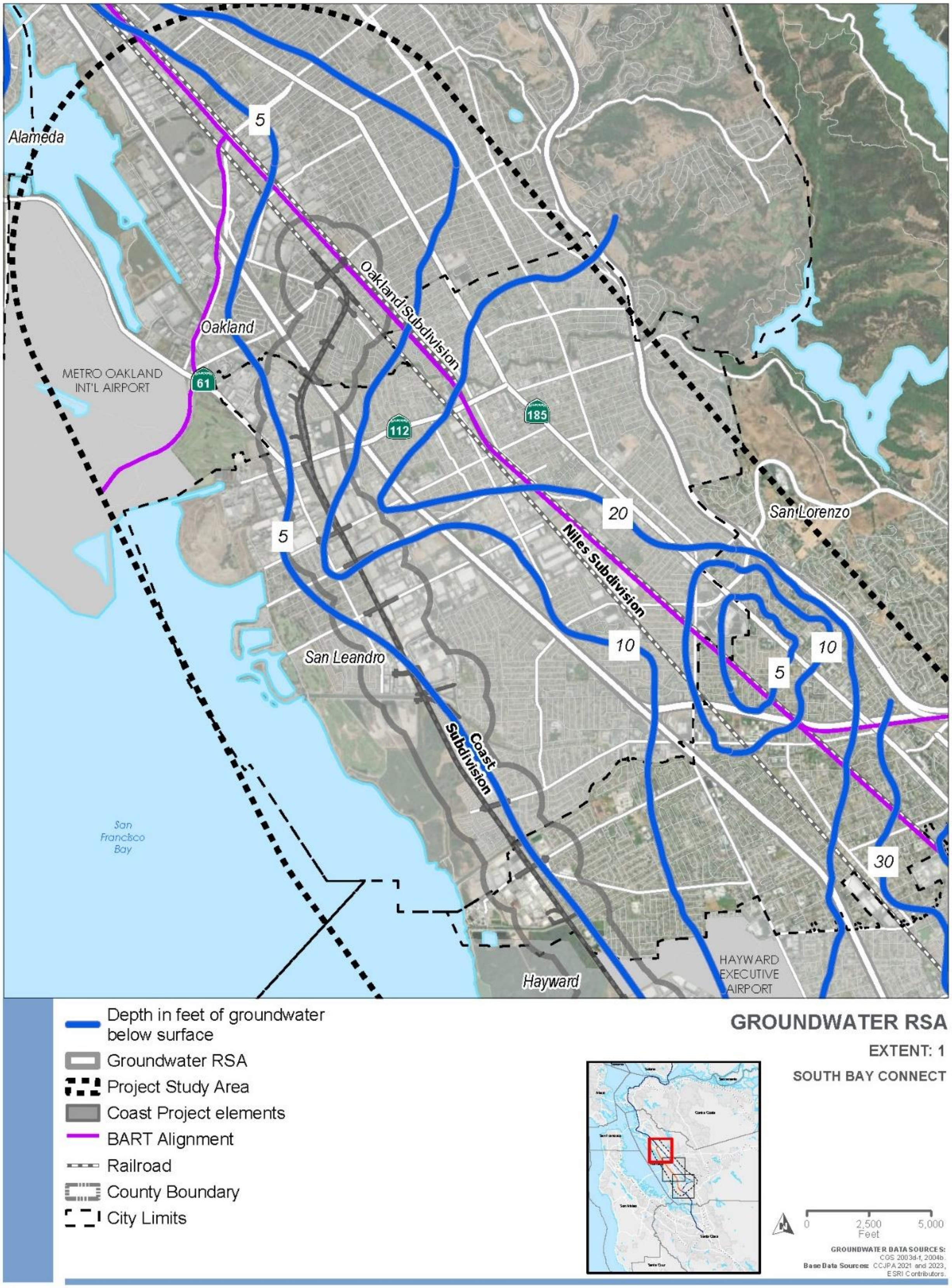


Figure 3.8-19: Groundwater Levels Below Surface for Map Extent 2.

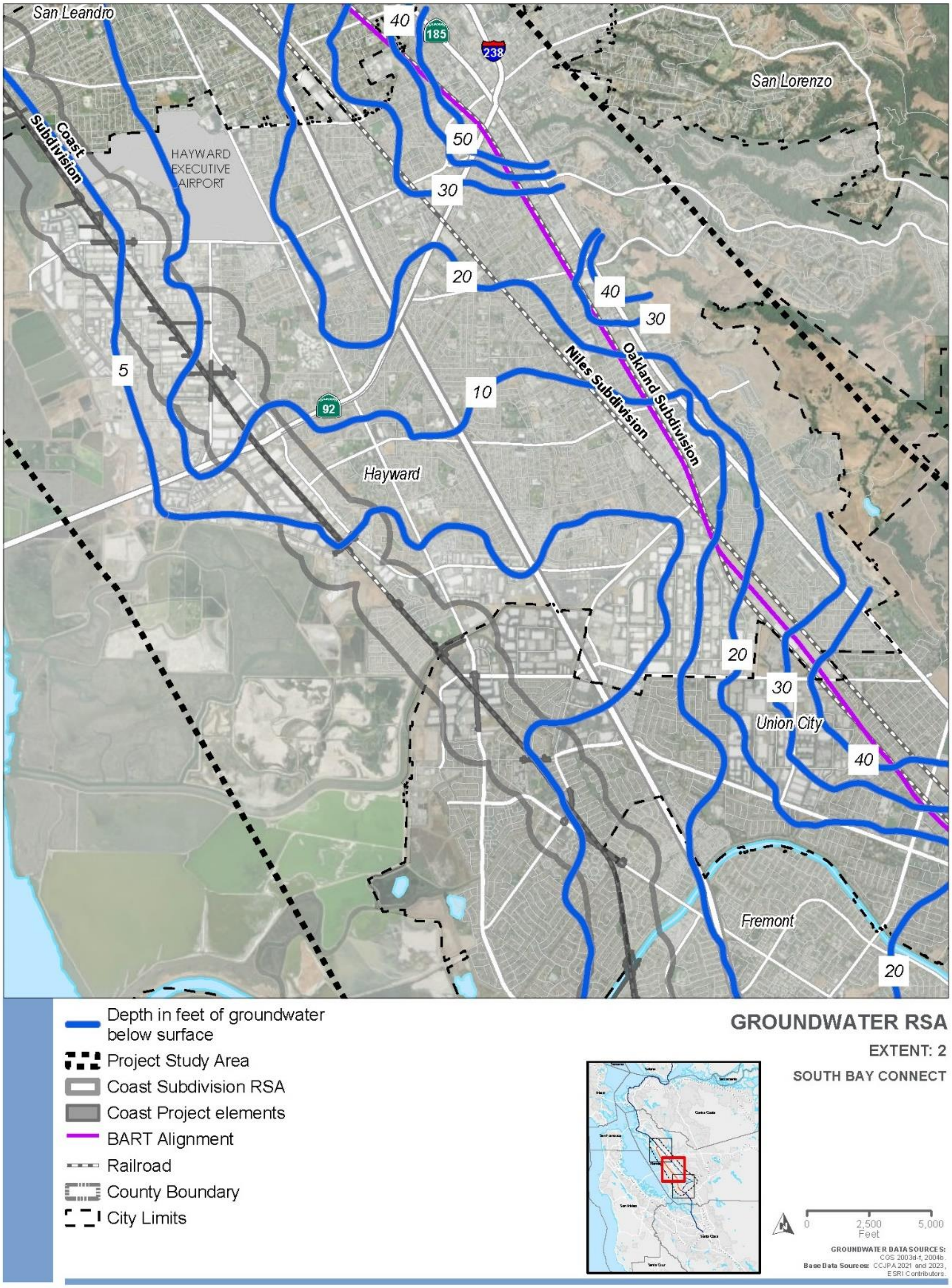
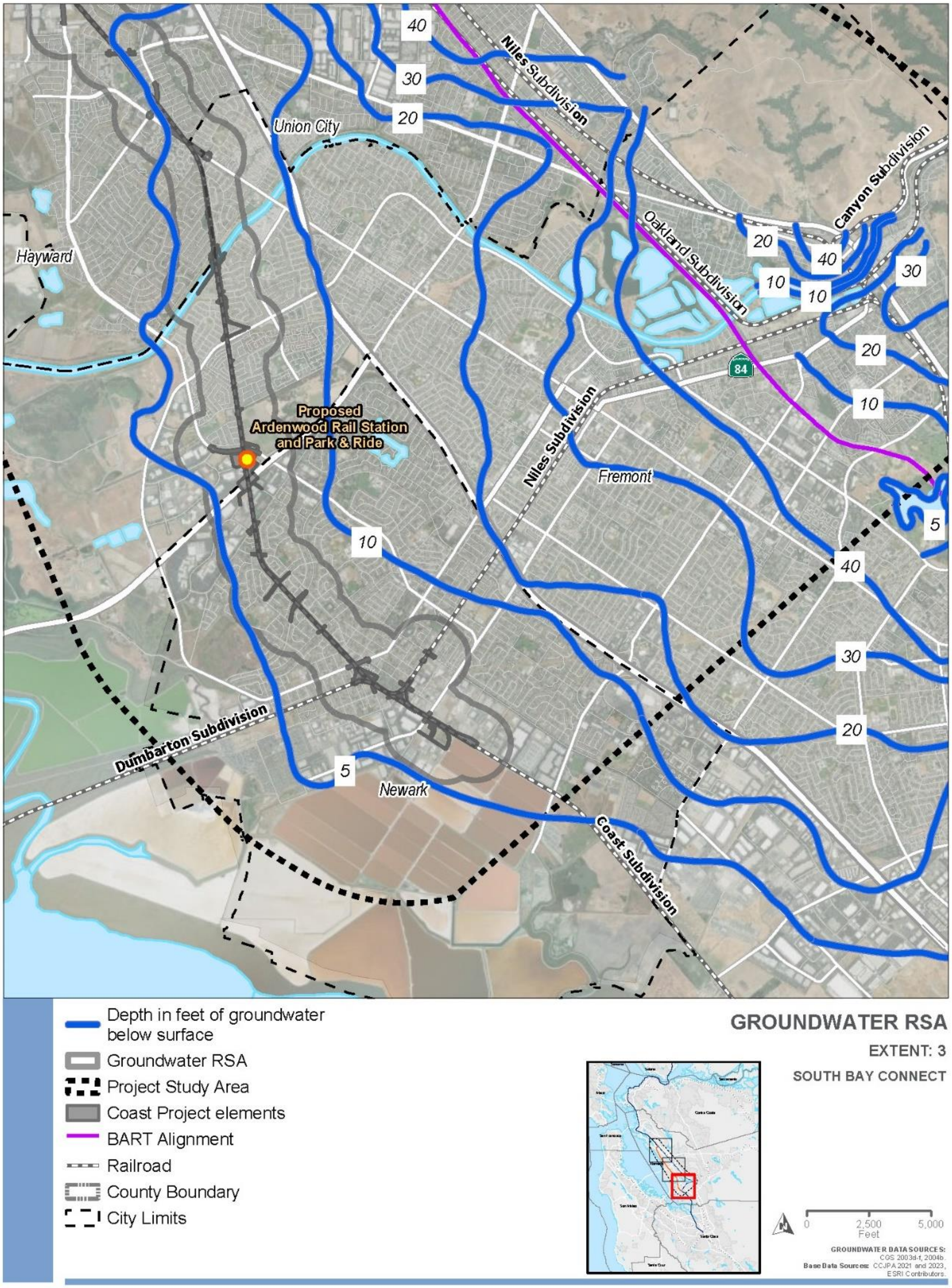


Figure 3.8-20: Groundwater Levels Below Surface for Map Extent 3.



Collapsible Soil

Collapsible soils are soils that undergo volume reduction or settlement upon the addition of water, which weakens or destroys soil particle bonds of loosely packed structure, reducing the bearing capacity of the soil. Other mechanisms for soil collapse include the sudden closure of voids (air pockets) in a soil, whereby the sudden decrease in volume results in loss of the soil's internal structure, causing the soil to collapse. Collapsible soils are typically associated with arid and semi-arid regions. Specific soil types, such as loess and other fine-grained aeolian soils, are most susceptible to collapse, although certain coarser-grained, rapidly deposited alluvial soils can also be susceptible.

Some soils within the geologic RSA may fit criteria such as coarse grained rapidly deposited soils, however soil collapse potential is considered low within the geologic RSA. Isolated cases may occur at localized areas within the geologic RSA for example if pipe ruptures occur.

Note that laboratory testing during Project field investigations would be required to support Project design to definitively identify soils and characterize susceptible to collapse potential.

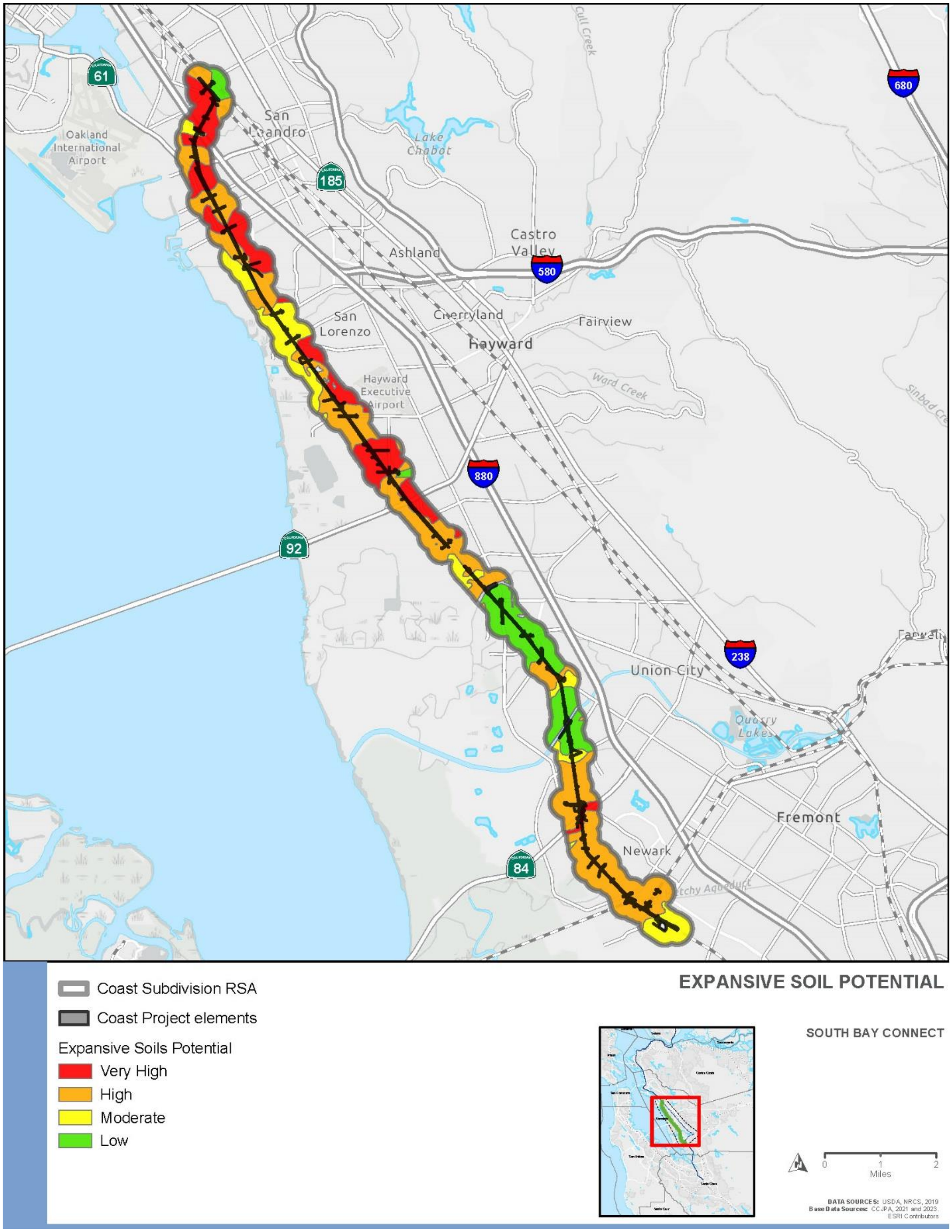
Expansive Soil

Expansive soil potential is the ability of some soils with high clay content to change volume with moisture content. Expansive soils pose a less significant hazard where soil moisture is relatively constant (either always wet or always dry). Expansive soils pose a significant hazard to sites, which undergo seasonal variation in soil moisture content, such as on hillsides or flatlands with a seasonally fluctuating water table.

Figure 3.8-21 shows the expansive potential of soils within the geologic RSA and is derived from the USDA SSURGO database (2020). The expansive soil potential varies significantly within the RSA and along the Project footprint from low to very high.

Note that laboratory testing during Project field investigations would be required to positively identify and characterize expansive soils to support Project design.

Figure 3.8-21: Expansive Soil Potential within the RSA.



Corrosive Soil

Soil corrosivity involves the measure of the potential of corrosion for steel and concrete caused by contact with some types of soil. Knowledge of potential soil corrosivity is often critical for the effective design of buried steel and concrete. Several factors (including soil composition, soil and pore water chemistry, moisture content, and pH) affect the response of steel and concrete to soil corrosion. Soils with high moisture content, high electrical conductivity, high acidity, and high dissolved salts content are most corrosive. In general, sandy soils have high resistivity and are the least corrosive. Clayey soils, including those that contain salt water, can be highly corrosive(see Table 3.8 4: Summary of Soil Units and Soil Attributes that Occur Within the Geologic RSA).

Figure 3.8-22 shows the risk of corrosion to uncoated steel for soils within the geologic RSA and was derived from the USDA SSURGO database (2020). The majority of the Coast and Niles Subdivisions appear to contain soils that have a high risk of corrosion to uncoated steel with smaller areas of low to moderate risk.

Figure 3.8-23 shows the risk of corrosion to concrete for soils within the RSA and was derived from the USDA Soil Survey Geographic (SSURGO) Database. The majority of the areas within the RSA are classed as having either a low or moderate risk of corrosion to concrete. Within the Coast Subdivision, the smaller areas of high corrosion risk appear to show a general correlation to geologic units San Francisco Bay Mud (Qhbm) and artificial fill over estuarine mud (afem). The very southern part of the Coast Subdivision with a high risk is associated with alluvial fans (Qhf3 and Qhff) and older alluvial fan levees (Qhl3).

Figure 3.8-22: Risk of Corrosion to Uncoated Steel for Soils Within the Geologic RSA.

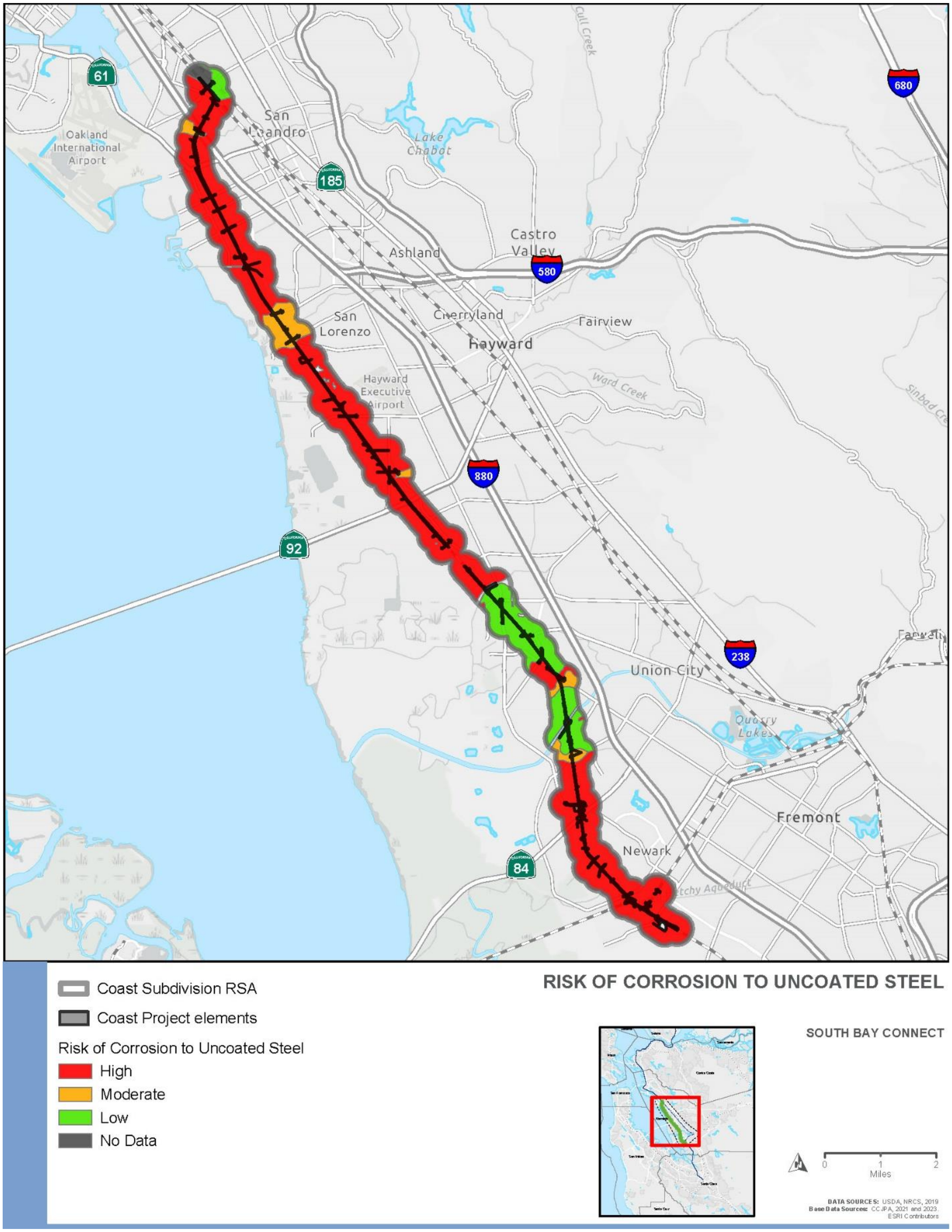
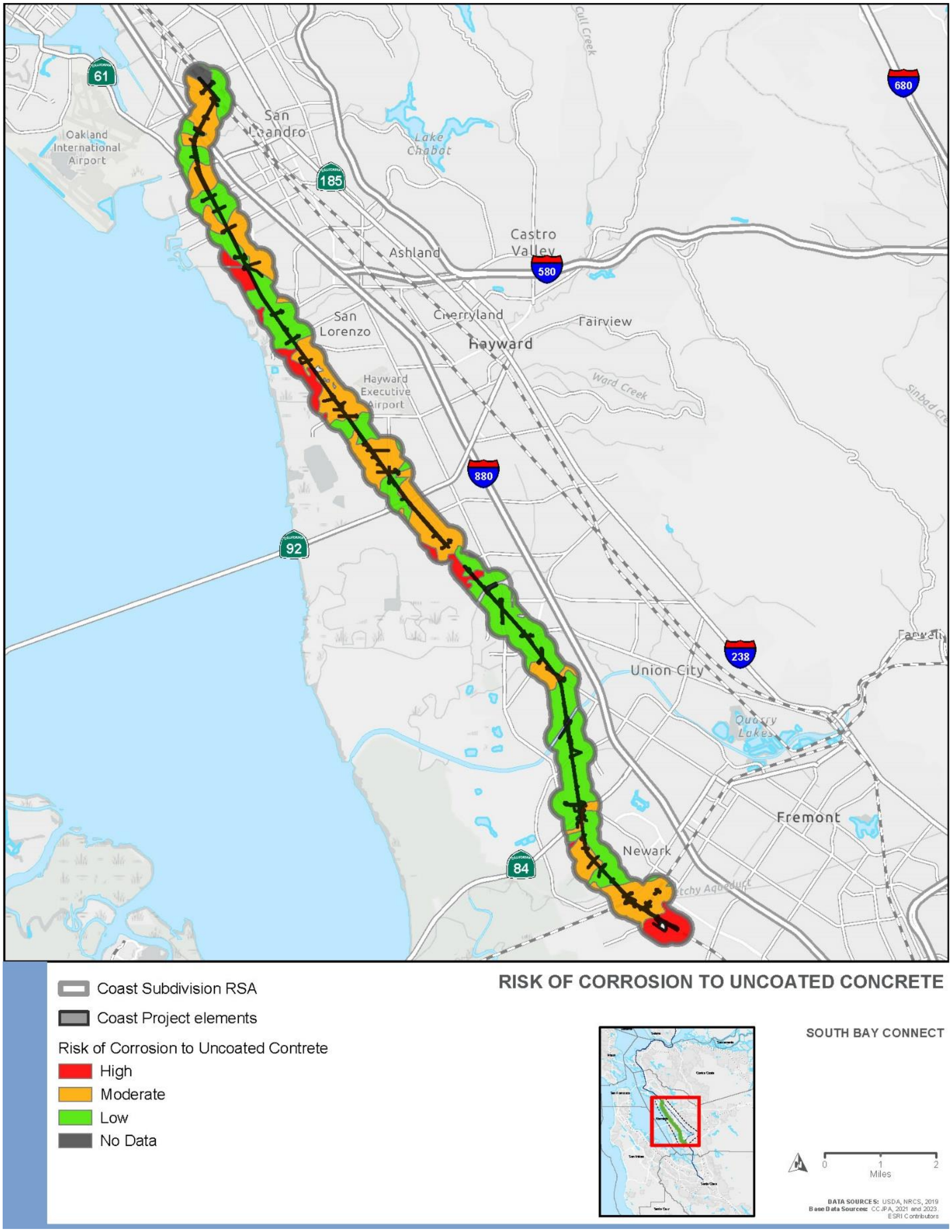


Figure 3.8-23: Risk of Corrosion to Concrete for Soils Within the Geologic RSA.



Paleontological Context

Fossil localities across the East Bay coastal plain were evaluated for this analysis and listed in Table 3.8-6 by distance from the RSA.

The RSA is generally within a mile or two of the wetlands at the edge of the bay. Three fossil localities are within a mile and a half of the Project footprint: 81st Street in Oakland, the Coliseum, and Newark. At these localities, mammoth and sloth specimens were identified. The next closest fossil localities to the RSA are within 2 to 3 miles of the Project footprint.

Table 3.8-6: East Bay Coastal Plain Fossil Localities Closest to the RSA

Locality Name	Location	ID	Miles from RSA	Taxon	Common Name	Other Information
81st Avenue	Oakland	V4045	<1	Mammuthus	mammoth	Excavation at Sunshine Bisquit Co.
Oakland Coliseum	Oakland	V6420	<1.5	Mammuthus, Glossotherium	mammoth, sloth	Construction of sports arena
Newark	Newark	V69195	<1.5	unidentified mammal	unidentified mammal	N/A
Hayward Freeway	Hayward	V5258	~2.5	Bison	bison	I-238 construction
San Lorenzo Creek	Hayward	unknown	~2.5	Equidae	horse	N/A
Hayward Gravel Pit	Hayward	V5928	~3	Equidae	horse	gravel pit
Centerville Gravel Pit	Centerville	V5370	~3	Mammuthus, Bison, Camelops, Odocoileus	mammoth, bison, camel, deer relative	N/A
Centerville	Centerville	unknown	~3	Equidae	horse	N/A
Niles Community	Niles	V59033	~3	Mammuthus and Bison	mammoth, bison	N/A
Hayward Motel	Hayward	V6304	~3	Equidae	horse	N/A
Alameda	Alameda Island	unknown	~3	Megalonyx	sloth	found on east end
Alameda Canal	Alameda	V69168	>3	Glossotherium	sloth	N/A

Locality Name	Location	ID	Miles from RSA	Taxon	Common Name	Other Information
Prune Avenue	Fremont	V5301	~4.5	63 small animal and invertebrate specimens	various	N/A
Mission San Jose	Fremont	unknown	~5.5	Proboscidea, Mastodon, Camelops	elephant relative, mastodon, camel	N/A
Harrison St Tunnel	Posey Tube	V2841	~6	Mammuthus	mammoth	Alameda tube construction
Alameda Tube Excavation	Webster St Tube	V6227	~6	26 specimens of various genera	various	Alameda tube construction
Webster St.	Alameda County	V69170	~6	Proboscidea	elephant relative	BART construction
San Francisco Public Utilities Commission water improvement program	Warm Springs	unknown	~6	50+ Rancholabrean and Irvingtonian specimens		N/A

Sources: Savage 1951; UCMP 2023; Jefferson 1991b; Parkman 2006; Hay 1927; Hutchison 1987; McGuire and Davis 2013; UCMP 2023; Hay 1927; Parr 2015

3.8.5 Best Management Practices

As noted in Chapter 2, Project Alternatives, CCJPA would incorporate a range of BMPs to avoid and minimize adverse effects on the environment that could result from implementation of the proposed Project. BMPs are included in the proposed Project description, and the impact analyses were conducted assuming application of these practices. The BMPs relevant to geology and soils are listed below. Full descriptions of the BMPs are provided in Chapter 2, Project Alternatives.

BMP GEO-1: Geotechnical Investigations

BMP GEO-2: Expansive Soil

3.8.6 Environmental Impacts

This section describes the potential environmental impacts on geology and soils as a result of implementation of the proposed Project. Lettering shown within title for each environmental factor below correlates with CEQA Statute and Guidelines, Appendix G table lettering and numbering.

3.8.6.1 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?

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative would not result in impacts or changes directly or indirectly that would cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault to within the RSA.

Proposed Project

Construction and Operations.

No Impact. As shown on Figure 3.8-9, the proposed Project is not located within an Earth Fault Zone. In addition, no active earthquake faults cross the RSA. Because there are no active earthquake faults located within the RSA, and because the proposed Project is not located within an Earthquake Fault Zone, the rupture of a known earthquake fault during construction or operation of the proposed project would not occur. Therefore, construction and operation of the proposed Project would not result in adverse effects involving fault ruptures, resulting in no impact.

3.8.6.2 Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving: Strong seismic ground shaking?

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative would not result in impacts or changes directly or indirectly that would cause potential substantial adverse effects, including the risk of loss, injury, or death strong seismic ground shaking within the RSA.

Proposed Project

Construction.

Less-than-Significant Impact. The proposed Project is in a region with active faults (Figure 3.8-8) that can cause strong ground shaking, which could contribute to loss, injury, or death during construction. Construction activities would be conducted for a limited period when considered in the timeframe of earthquake recurrence intervals of faults within the RSA. However, there is a chance that strong earthquakes could occur during construction. The proposed Project includes implementation of BMP GEO-1: Geotechnical Investigations. BMP GEO-1 requires CCJPA to conduct geotechnical investigations to inform Project design. In accordance with BMP GEO-1, the proposed Project would be designed to minimize risk of slope failure, settlement, and erosion as a result of strong seismic ground shaking, using recommended construction techniques and BMPs. With the implementation of BMP GEO-1, impacts related to seismic ground shaking during construction, and associated risk of loss, injury, or death, would be less than significant.

Operation.

Less-than-Significant Impact. The proposed Project is in a region with active faults (Figure 3.8-8) that can cause strong ground shaking, which could contribute to loss, injury, or death during Project operation. Risks would apply to mobile (i.e., trains) and static Project components. The proposed Project will implement all standards listed in Section 3.8.2.4, above and includes implementation of BMP GEO-1: Geotechnical Investigations. BMP GEO-1 requires that the proposed Project be designed to minimize risk of slope failure, settlement, and erosion as a result of strong seismic ground shaking, using recommended construction techniques and BMPs. With the implementation of BMP GEO-1, impacts related to seismic ground shaking during operations, and associated risk of loss, injury, or death, would be less than significant.

3.8.6.3 Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving: Seismic-related ground failure, including liquefaction?

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative would not result in impacts or changes directly or indirectly that would cause potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction within the RSA.

Proposed Project

Construction.

Less-than-Significant Impact. Risks associated with secondary seismic hazards such as liquefaction and lateral spreading, could affect construction and increase the risk of loss, injury, or death during construction of the proposed Project.

The risk of seismically induced liquefaction during construction would be greatest in areas of high and very high liquefaction susceptibility combined with shallow depth to groundwater. As shown on Figure 3.8-13, areas of high and very high liquefaction susceptibility are present within the RSA. However, the proposed Project includes implementation of BMP GEO-1: Geotechnical Investigations, which requires the Project to be designed to minimize slope failure, settlement, and erosion using recommended construction techniques and BMPs. With the implementation of BMP GEO-1, impacts related to liquefaction during construction would be less than significant.

The risk of seismically induced lateral spreading for the proposed Project is less than significant due to the limited construction timeframe and limited extent of areas susceptible to lateral spreading as shown in Figure 3.8-13. Further, the proposed Project includes implementation of BMP GEO-1: Geotechnical Investigations, which requires the Project to be designed to minimize slope failure, settlement, and erosion using recommended construction techniques and BMPs. Therefore, impacts related to lateral spreading during construction would be less than significant with implementation of BMP GEO-1.

The risk of seismically induced landslides to proposed Project construction would be no impact as the RSA is not located in areas with a distinct landslide susceptibility.

Operation.

Less-than-Significant Impact. Risks associated with secondary seismic hazards such as liquefaction and lateral spreading could affect operations and increase the risk of loss, injury, or death during operation of the proposed Project.

The risk of seismically induced liquefaction during operations would be greatest in areas of high and very high liquefaction susceptibility combined with shallow depth to groundwater. As shown on Figure 3.8-13, areas of high and very high liquefaction susceptibility are present within the RSA.

However, the proposed Project will implement all standards listed in Section 3.8.2.4, above and includes implementation of BMP GEO-1: Geotechnical Investigations, which requires the Project to be designed to minimize slope failure, settlement, and erosion using recommended construction techniques and BMPs. With the implementation of BMP GEO-1, impacts related to liquefaction during operations would be less than significant.

The risk of seismically induced lateral spreading for the proposed Project during operations is less than significant due to the limited extent of areas susceptible to lateral spreading as shown in Figure 3.8-13. Further, the proposed Project will implement all standards listed in Section 3.8.2.4, above and includes implementation of BMP GEO-1: Geotechnical Investigations, which requires the Project to be designed to minimize slope failure, settlement, and erosion using recommended construction techniques and BMPs. Therefore, impacts related to lateral spreading during operations would be less than significant with implementation of BMP GEO-1.

The risk of seismically induced landslides to proposed Project operations would be no impact as the RSA is not located in areas with distinct landslide susceptibility, such as areas with steep slopes and unstable geological units.

3.8.6.4 Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving: Landslides?

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative would not result in impacts or changes directly or indirectly that would cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides within the RSA.

Proposed Project

Construction and Operations.

No Impact. As shown in Figure3.8-9, the RSA is not located with a landslide zone. The impact of landslides to construction and operation of the proposed Project would be no impact due to the topography of the RSA being relatively flat and not located adjacent to significant steep slopes or hills.

3.8.6.5 Result in substantial soil erosion or the loss of topsoil?

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative would not result in impacts or changes to the existing geology and soils within the RSA.

Proposed Project

Construction.

Less-than-Significant Impact. Project earthwork activities would be conducted based on local and state regulations and would comply with appropriate permits such as the California Construction NPDES permit, which would reduce erosion and sedimentation though the implementation of BMP HYD-1: Construction Stormwater Management during construction. Therefore, construction of the proposed Project would result in a less than significant impact on erosion and loss of topsoil.

Operation.

Less-than-Significant Impact. The Project would be operated in areas that are either paved, have previously stabilized soils, or where slopes are either flat or close to horizontal. Such areas would be returned to pavement or stabilized after construction. The proposed Project would also adhere to NPDES construction permitting requirements for post-construction stabilization to reduce the risk of soil erosion or loss of topsoil (BMP HYD-4: Permanent Erosion Control). However, potential exists for soil erosion if proposed Project elements are not adequately designed and constructed to protect soils. Implementation of BMPs and compliance with industry standards and permit requirements would result in a less than significant impact.

3.8.6.6 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?

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative would not be located on a geologic unit or soil that is unstable, or that would become unstable, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.

Proposed Project

Construction.

Less-than-Significant Impact. Non-seismically induced landslides are generally associated with areas of moderate slopes, unstable geological units, and/or saturated soils. Project construction would have no impact with respect to on-or off-site landslides due to the topography of the geologic RSA being relatively flat and not located on unstable geologic units.

Non-seismically induced liquefaction would have a no impact level due to the limited duration and extent of construction activities. Seismically induced liquefaction during construction is addressed in Section 3.8.6.3 above.

As discussed in the Section 3.8.4, Affected Environment, some soils within the Project Footprint may fit the collapsible soil criteria such as coarse grained rapidly deposited soils, however soil collapse potential is considered low due to collapsible soils predominantly being associated with arid or semi-arid environments. The Project Footprint is not considered arid or semi-arid. Therefore, the impact of soil becoming collapsible during construction activities would be less than significant.

Land subsidence could occur where dewatering is required (such as for excavation and construction of foundations), however such dewatering would be limited in duration and depth. Dewatering for short-term construction would not cause deep seated land subsidence, such as has occurred in the San Joaquin Valley due to over-extraction of groundwater. Project impacts due to land subsidence during construction activities would be less than significant.

Lateral spreading is generally associated with seismic induced liquefaction in proximity to a free face. Due to the limited duration and extent of construction activities, and stabilization of free faces during construction, impacts related to lateral spreading are potentially significant. With the implementation of BMP GEO-1: Geotechnical Investigations, impacts related to lateral spreading during construction of the proposed Project would be less than significant.

Operation.

Less-than-Significant Impact. Where the design of the proposed Project includes new embankments and slopes such as the proposed Alameda Creek the risk of on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse of a geologic unit or soil could be affected. Geologic units at risk of these effects include those with a high or very high liquefaction susceptibility and shallow groundwater. As shown on Figure 3.8-13, areas with high or very high liquefaction susceptibility are present within the RSA. With the implementation of BMP GEO-1: Geotechnical Investigations, impacts related to on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse of a geologic unit or soil during operations of the proposed Project would be less than significant.

3.8.6.7 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?

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative would not be located on expansive soil, creating substantial direct or indirect risks to life or property.

Proposed Project

Construction.

Less-than-Significant Impact. The proposed Project contains areas that have varying potential for expansive soils, the locations of which are shown in Figure 3.8-21. For construction purposes, temporary shallow foundations may only be required for certain specific purposes and would be constructed within a short period of time. The proposed Project would have a less than significant impact with respect to expansive soils during construction due to the limited extent and duration of construction.

Operation.

Less-than-Significant Impact. As shown on Figure 3.8-21, areas of the RSA are located on soils classified as having a very high or high expansive soil potential. The effect of the high expansive soil potential on the proposed Project would be the development of high soil pressures when these soils are wetted and consequently swell. The resulting high soil pressures can cause damage to structures such as foundations, pavements, and retaining walls. However, the proposed Project includes implementation of BMP GEO-2: Expansive Soil. BMP GEO-2 requires that the Project structures be designed and constructed to withstand the earth pressure exerted by the expansive clays and to specifications determined by the geotechnical investigation prepared during final design. As necessary, BMP GEO-2 also requires expansive clays to be treated with lime to reduce shrink-swell potential or removed and replaced with a non-expansive material. With the implementation of BMP GEO-2, impacts related to expansive soils would be less than significant.

3.8.6.8 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?

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative 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.

Proposed Project

Construction and Operations.

No Impact. Activities associated with the construction of rail infrastructure improvements and station facilities are not anticipated to result in new substantial discharges of wastewater. During construction activities, the construction contractor would provide portable toilets on site, which would then be removed from the site on a regular basis for servicing off site at an approved wastewater handling facility. Similarly, new rail infrastructure improvements are not anticipated to generate substantial amounts of wastewater during operation or maintenance activities. However, new station or maintenance facilities could result in a minor new source of wastewater that would need to be treated by the local wastewater treatment facility. Therefore, construction and operation of the proposed Project would not require the use of septic tanks or alternative wastewater disposal systems because existing municipal sanitary systems would be utilized. Therefore, no impact would occur.

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

No Build Alternative

No Impact. Under the No Build Alternative, the Capitol Corridor passenger rail service between Oakland and San Jose would not be relocated from the Niles Subdivision to the Coast Subdivision. Improvements associated with the proposed Project would not occur. Capitol Corridor passenger trains would continue to operate based on current routes with no changes to rail connectivity or operational efficiency. Therefore, the No Build Alternative would not directly or indirectly destroy a unique paleontological resources or site or unique geologic features.

Proposed Project

Construction.

Less-than-Significant Impact with Mitigation Incorporated. Paleontological resources have the potential to be affected during earthmoving activity of undisturbed sediment within the RSA. Though the sediment within the RSA is mostly of Holocene age, older sediment that may be paleontologically sensitive underlies it at an unknown depth. The greater the excavation depth, the greater the likelihood of encountering paleontological resources. The estimated maximum depths of major Project features are listed in Table 3.8-7. The potential to encounter fossils is considered to be increased near known fossil localities. As discussed in Section 3.8.4, Affected Environment, several fossil localities are located along the East Bay Coastal Plain. In the Project vicinity, many but not all of the fossil localities are located closer to the hills.

Table 3.8-7: Maximum Estimated Depth of Proposed Project Features

Project Feature	Open Excavation (feet)*	Drilling/ Pile Driving (feet)	Potential to Affect Significant Paleontological Resources
New signals	n/a	10	Low – narrow gauge drill
Track improvement and construction	4	n/a	Low - shallow
Roadway work	2	n/a	Low - shallow
Fence foundation	n/a	5	Low - shallow
Ardenwood station platform	5	n/a	Low - shallow
Ardenwood pedestrian overcrossing	TBD	35	Potentially high
Ardenwood garage (potential)	TBD	100	Potentially high

Project Feature	Open Excavation (feet)*	Drilling/ Pile Driving (feet)	Potential to Affect Significant Paleontological Resources
SR-92 pier protection walls	n/a	35	Potentially high
San Leandro Creek bridge (PM 14.29)	TBD	180	Potentially high
San Lorenzo/Estudillo bridge (PM 16.93)	TBD	180	Potentially high
San Lorenzo Creek bridge (PM 18.24)	TBD	180	Potentially high
Bridge PM 18.97	TBD	180	Potentially high
Bridge PM 19.23	TBD	180	Potentially high
Sulphur Creek Bridge (PM 19.77)	TBD	180	Potentially high
Bridge PM 23.68	TBD	180	Potentially high
Alameda Creek Bridge PM 27.01	TBD	180	Potentially high
Crandall Creek Bridge PM 27.37	TBD	180	Potentially high
Alameda Creek Bridge PM 27.01	TBD	180	Potentially high

Note: * any excavation not done with a drill/auger, TBD = to be determined.

Open excavation deeper than 10 feet below the surface in previously undisturbed ground is considered to have the potential to encounter sensitive paleontological resources. Drilling and augering have the potential to recover scientifically significant resources depending on drill diameter. Narrow gauge drilling such as that for signal installation is unlikely to recover significant paleontological resources. However, bridge work would require larger gauge drilling and very deep excavation, increasing the chance of encountering sensitive resources.

This is considered a potentially significant impact. To reduce impacts on paleontological resources, mitigation measure MM GEO-1: Paleontological Resources Mitigation Plan (PRMP) would be implemented. The PRM will include provisions for construction workers to attend a paleontological resource awareness training session. It will determine the extent to which paleontological mitigation is necessary and establishes the ground rules for the program. The PRM shall discuss fossil discovery, recovery, and subsequent handling. With the implementation of MM GEO-1, impacts on paleontological resources would be reduced to a less-than-significant level.

Operations.

Operation and maintenance activities would occur in previously disturbed areas (within paved roads and rail corridors), resulting in no potential to impact paleontological resources. Therefore, impacts on paleontological resources during operation and maintenance of the proposed Project would be no impact.

3.8.7 Mitigation Measures

The following mitigation measure associated with geology, soils, seismicity, and paleontological resources would be implemented for the proposed Project.

MM GEO-1: Paleontological Resources Mitigation Plan

A PRMP will be prepared by a qualified paleontologist following SVP guidelines and implemented during the construction phase of the Project (SVP 2010).

The PRM will include provisions for construction workers to attend a paleontological resource awareness training session and establish the ground rules for the program. The PRMP will discuss fossil discovery, recovery, and subsequent handling protocols and monitoring requirements.

The extent of monitoring required would be dictated by the design of the selected alternative and would be determined during design by a qualified principal paleontologist (who holds a Master of Science or Doctorate degree in paleontology or geology and is familiar with paleontological procedures and techniques) to reduce the potential for impacts to previously undiscovered resources. The principal paleontologist would review the construction plans with proposed excavation sites to determine which, if any, Project components would involve earthmoving activities at depths sufficient to require monitoring. The principal paleontologist would review the construction schedule to develop the required monitoring schedule. Paleontological resources will also be discussed at the pre-bid meeting.

A qualified principal paleontologist will be made aware of the excavation schedule and remain on call during the period of construction specified in the PRMP. If fossils are discovered during construction, the construction crew will immediately notify the resident engineer, who will stop work within 60 feet of the finding. The resident engineer will notify the qualified principal paleontologist who will evaluate the find as soon as possible. If the resource is determined to be potentially significant, CCJPA will be notified, and a recovery program will be initiated.

3.8.8 Cumulative Impact Analysis

Cumulative impacts are two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts. CEQA requires discussion of the cumulative impacts of the proposed Project to determine if the proposed Project's incremental effect is cumulatively considerable. Cumulatively considerable means that the incremental effects of the proposed Project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects. A project would have a significant impact if the project has a considerable contribution to a significant cumulative impact.

Impacts related to geology, soils, seismicity, and paleontological resources are typically site-specific and depend on the local geologic and soil conditions. The geographic context for the analysis of potential cumulative impacts on geology, soils, and paleontological resources includes areas within and adjacent to the proposed Project. The RSA for geology, soils, and paleontological resources includes the geologic units affected by the proposed Project as listed in Figure 3.8-1 through Figure 3.8-7. Cumulative projects within this geographic context include the projects listed in Table 3.1-1 and identified on Figure 3.1-1.

Each of the projects listed in Table 3.1-1 was evaluated and considered for cumulative impacts. Although either being located substantially outside the RSA or having a relatively small footprint compared to the proposed Project, construction of any of cumulative projects listed in Table 3.1-1 could result in cumulatively significant erosion impacts unless construction activities are controlled. All new projects that disturb one or more acres, which includes most of the cumulative projects listed in Table 3.1-1 as well as the proposed Project, must comply with the NPDES Construction General Permit, which requires substantive controls to prevent erosion during project construction, including preparation of a SWPPP, as well as municipal and industrial NPDES permits. As a result, no significant cumulative erosion impact would occur.

Individual cumulative projects could increase exposure of people or structures to geologic, seismic and soil hazards that could result in a project-level impact. All individual projects would be subject to applicable state codes, particularly the California Building Standards Code and the requirements of the Alquist-Priolo Act, along with local codes and design standards, all of which are specifically designed to reduce site-specific geologic, seismic, and soils hazards. Portions of the proposed Project would be sited in areas with known geologic hazards, including liquefaction and expansive soils and strong ground shaking. However, the proposed Project would be designed and constructed in accordance with industry design standards, guidelines, and regulations, which would ensure that geologic and soil hazards do not compromise the structural integrity of the facilities that are proposed. Therefore, there would be no cumulative geologic and soil hazard impacts.

In theory, any project within the RSA that requires excavation in sediment that has not been previously disturbed could encounter scientifically significant paleontological resources. However, the majority of these projects would not involve deeper excavation than grading and utility relocation and are not likely to affect paleontological resources. Projects that utilize drilling are likely to damage fossils if encountered, making them nonrecoverable. Projects with deep, open excavation could result in paleontological impacts. If construction activities are not mitigated, the paleontological impacts could create an incremental contribution to paleontological resources that is cumulatively considerable. The proposed project would mitigate impacts to paleontological resources and would not contribute considerably to a cumulative impact.

Of the projects listed in Table 3.1-1, the most likely to have the potential to impact paleontological resources are the transportation projects such as the Quarry Lakes Parkway project (T-4), which is located in a paleontologically sensitive area in the Alameda Creek watershed. The I-880 Interchange Improvements (T-6) and State Route (SR) 262 Cross Connector (T-9) projects also have potential to affect paleontological resources. However, if individually mitigated, these and other potentially significant projects collectively, would not make a contribution to effects on paleontological resources that is cumulatively significant.

Implementation of MM GEO-1: Paleontological Resource Mitigation Plan identified in Section 3.8.7 would ensure that the proposed Project would not contribute to a cumulative impact on geologic, soil, mineral, or paleontological resources particularly related to seismicity, liquefaction and expansive soils and would consequently not be considered cumulatively considerable. Based on these factors, the proposed Project would not result in cumulative impacts on geology, soils, seismicity, and paleontological resources when considered with other planned projects. The impacts of the proposed Project therefore would not be cumulatively considerable and therefore the proposed Project would not have a significant cumulative impact.

3.8.9 CEQA Significance Findings Summary Table

Table 3.8-8 summarizes the geology, soils, and paleontological resources impacts of the proposed Project.

Table 3.8-8. Geology, Soils, and Paleontological Resources Impact Summary Table

Impact	Level of Significance Before Mitigation	Incremental Project Contribution to Cumulative Impacts	Mitigation	Level of Significance with Mitigation Incorporated	Incremental Project Cumulative Impact after Mitigation
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.	NI	NCC	N/A	NI	NCC
ii) Strong seismic ground shaking?	LTS	NCC	N/A	LTS	NCC
iii) Seismic-related ground failure, including liquefaction?	LTS	NCC	N/A	LTS	NCC
iv) Landslides?	NI	NCC	N/A	NI	NCC
b) Result in substantial soil erosion or the loss of topsoil?	LTS	NCC	N/A	LTS	NCC
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?	LTS	NCC	N/A	LTS	NCC

Impact	Level of Significance Before Mitigation	Incremental Project Contribution to Cumulative Impacts	Mitigation	Level of Significance with Mitigation Incorporated	Incremental Project Cumulative Impact after Mitigation
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?	LTS	NCC	N/A	LTS	NCC
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 waste water?	NI	NCC	N/A	NI	NCC
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	S/M	CC	MM GEO-1	LTS	NCC

Notes: LTS = Less-than-Significant Impact, NI = No Impact, N/A = Not Applicable, SI = Significant Impact, S/M = Significant Impact but Mitigable to a Less-than-Significant Level, CC = Cumulatively Considerable, NCC = Not Cumulatively Considerable.

3.8.10 References

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