4.7 GEOLOGY AND SOILS

This chapter describes the potential impacts associated with the adoption and implementation of the proposed project that are related to geology, soils, and seismicity. A summary of the relevant regulatory framework and existing conditions is followed by a discussion of project impacts and cumulative impacts.

4.7.1 ENVIRONMENTAL SETTING

4.7.1.1 REGULATORY FRAMEWORK

Federal Regulations

Paleontological Resources Preservation Act

The federal Paleontological Resources Preservation Act of 2002 limits the collection of vertebrate fossils and other rare and scientifically significant fossils to qualified researchers who have obtained a permit from the appropriate state or federal agency. Additionally, it specifies these researchers must agree to donate any materials recovered to recognized public institutions, where they will remain accessible to the public and to other researchers. This act incorporates key findings of a report, *Fossils on Federal Land and Indian Lands*, issued by the Secretary of the Interior in 2000, that establishes that most vertebrate fossils and some invertebrate and plant fossils are considered rare resources.[1]

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface fault rupture to structures used for human occupancy.[2] The main purpose of the act is to prevent the construction of buildings used for human occupancy on top of active faults. This act only addresses the hazard of surface fault rupture—not other earthquake hazards such as earthquake-induced liquefaction or landslides.[3] The act requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones or Alquist-Priolo Zones) around surface traces of active faults and to issue appropriate maps.[4] The maps, which are developed using existing United States Geological Survey's (USGS) 7.5-minute quadrangle map bases, are then distributed to all affected cities, counties, and State agencies for their use in planning

[1] U.S. Department of the Interior, May 2000, *Fossils on Federal & Indian Lands, Report of the Secretary of the Interior*, May 2000. https://www.blm.gov/sites/blm.gov/files/programs_paleontology_quick%20links_Assessment%20of%20Fossil%20Management%20on%20Federal%20%26%20Indian%20Lands%2C%20May%202000.pdf, accessed on May 3, 2019.

[2] California Geological Survey, Alquist-Priolo Earthquake Fault Zoning Act, https://www.conservation.ca.gov/cgs/alquist-priolo, accessed on May 3, 2019.

[3] California Geological Survey, Alquist-Priolo Earthquake Fault Zoning Act, https://www.conservation.ca.gov/cgs/alquist-priolo, accessed on May 3, 2019.

[4] California Geological Survey, Alquist-Priolo Earthquake Fault Zoning Act, https://www.conservation.ca.gov/cgs/alquist-priolo, accessed on May 3, 2019.

and controlling new or renewed construction. Generally, construction within 50 feet of an active fault zone is prohibited.

California Building Code

The State of California provides a minimum standard for building design through Title 24, Part 2, of the California Code of Regulations (CCR), commonly referred to as the "California Building Code" (CBC). The CBC is updated every three years. It is generally adopted on a jurisdiction-by-jurisdiction basis, subject to further modification based on local conditions. The City of San Rafael regularly adopts each new CBC update under the San Rafael Municipal Code (SRMC) Chapter 12.100, Adopted Codes. These codes provide minimum standards to protect property and public safety by regulating the design and construction of excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions. They also regulate grading activities, including drainage and erosion control.

California Environmental Quality Act

Paleontological resources are afforded protection under the California Environmental Quality Act (CEQA). The Society of Vertebrate Paleontology has set significance criteria for paleontological resources.[5] Most practicing professional vertebrate paleontologists adhere closely to the Society of Vertebrate Paleontology's assessment, mitigation, and monitoring requirements as specifically provided in its standard guidelines. Most State regulatory agencies with paleontological laws, ordinances, regulations, and standards accept and use the professional standards set forth by the Society of Vertebrate Paleontology.

California Public Resources Code Section 5097

California Public Resources Code (PRC) Section 5097.5 prohibits the destruction or removal of any paleontological site or feature from public lands without the permission of the jurisdictional agency.

California Penal Code Section 622.5

The California Penal Code Section 622.5 details the penalties for damage or removal of paleontological resources, whether from private or public lands.

Regional Regulations

Marin County Emergency Operations Plan

The County of Marin adopted an *Emergency Operations Plan* in October 2014[6] to better prepare for responses to "extraordinary" emergency situations that could result from natural disasters and

[5] Society of Vertebrate Paleontology, 2010, Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources. Society of Vertebrate Paleontology. Impact Mitigation Guidelines Revision Committee.

[6] County of Marin, 2014, Marin Operational Area Emergency Operations Plan. https://www.marinsheriff.org/assets/downloads/EOP-Final-Draft-10.14.2014.pdf.

technological incidents. To prepare for these emergencies, the County assessed the potential risks associated with earthquakes, flooding, wildland fire, and other disasters. Based on this evaluation, various response strategies were developed to address each of the threats. Emergency operations are split into four phases: 1) Preparedness Phase, 2) Response Phase, 3) Recovery Phase, and 4) Prevention/Mitigation Phase. The City of San Rafael coordinates with the Marin County Office of Emergency Services (Marin OES) to ensure emergency management functions meet the expectations of the City.

Marin County Operational Area Emergency Recovery Plan

The Marin County *Operational Area Emergency Recovery Plan* (*Emergency Recovery Plan*) adopted November 2012, establishes procedures, and assigns responsibility to ensure the effective management of emergency recovery operations in the Marin County Operational Area, which includes the Environmental Impact Report (EIR) Study Area. The *Emergency Recovery Plan* describes operational concepts relating to the recovery, identifies components of recovery organization, and describes general responsibilities of the Marin OES. Recovery operations in a multi-jurisdictional incident are coordinated and managed by the Marin OES in accordance with the California Emergency Services Act.

Marin County Multi-jurisdictional Local Hazard Mitigation Plan

The Marin County Multi-Jurisdictional Local Hazard Mitigation Plan (MCLHMP) was adopted in 2018 to assess risk of natural hazards and to develop a mitigation strategy for reducing the risks for all Marin County municipalities and special districts. The MCLHMP was jointly prepared by several jurisdictions in Marin County, including the City of San Rafael. Jurisdictions benefit in several ways when participating in a multijurisdictional planning process, including comprehensive approaches to mitigation of hazards that affect multiple jurisdictions while leveraging individual jurisdiction capabilities, sharing costs and resources, avoiding duplication of efforts, and adopting an external review and discipline process to ensure progress. The MCLHMP incorporates the existing plans, studies, and reports from county jurisdictions and agencies to inform uniform analyses and mitigation actions that all municipalities and special jurisdictions can use. In July 2019, the City adopted the MCLHMP, which complements the City's local hazard mitigation plan (LHMP) with additional programs covering a broader geographic area and wider range of hazards.

Local Regulations

San Rafael General Plan 2020

The City of San Rafael 2020 General Plan goals, policies, and programs relevant to geology and soils are primarily in the Safety and Resilience Element. Appendix F of the 2020 General Plan includes the Geotechnical Review Matrix that contains the requirements for site specific geotechnical review of proposed developments. As part of the proposed project, many existing General Plan policies would be amended or substantially changed, and new policies would be added. The changes are mostly in response to the LHMP, which was adopted by the City in November 2017. A comprehensive list of policy changes is provided in Appendix B, Proposed General Plan Goals, Policies, and Programs, of this Draft EIR. Applicable goals, policies, and programs are identified and assessed for their effectiveness and potential to result in an adverse physical impact under Section 4.7.3, Impact Discussion.

San Rafael Municipal Code

The SRMC includes various directives to minimize adverse impacts to geology, soil, and seismicity-related issues in San Rafael. The SRMC is organized by title, chapter, and section. Most provisions related to erosion, grading, drainage, and soil stability are in Title 9, Urban Runoff Pollution Prevention, Title 12, California Existing Building Code, Title 14, Zoning, and Title 15, Subdivisions.

- Chapter 9.30.150, Erosion and Sediment Control Plan Requirements. The purpose of this section is to ensure that projects required by Phase II Stormwater Permits or by the agency have Erosion and Sediment Control Plans with specific control measures. Erosion and Sediment Control Plans are required for any project within the City boundaries that:
  - Is subject to a grading permit under Chapter 12.12;
  - Is subject to a building permit or other permit that has the potential for significant erosion and/or significant non-stormwater discharges of sediment and/or construction site waste; and
  - As required by the City considering factors such as whether the project involves hillside soil disturbance, rainy season construction, construction near a creek or an intermittent or ephemeral drainageway, or any other condition or construction site activity that could lead to a non-stormwater discharge to a storm drain if not managed by effective implementation of an Erosion and Sediment Control Plan.
- Chapter 12.100, Adopted Codes. The City of San Rafael has adopted the CBC with certain modifications as Section 12.12.101 et seq.
- Chapter 12.340, Unreinforced Masonry Building Mitigation Program. The purpose of this chapter is to promote public health and safety by reducing the potential for injury or loss of life in an earthquake due to unreinforced masonry buildings. This chapter provides minimum standards for structural seismic resistance and systematic procedures for identification and classification of unreinforced masonry buildings, and requires qualified Historical Buildings to comply with the State Historical Building Code.
- Chapter 14.12, Hillside Development Overlay District. The purpose of the Hillside Development Overlay District is to minimize hazards associated with seismic events, landslides, soil erosion, fire danger, and development on steep or unstable slopes. This chapter also encourages preservation of natural hillside features, ensures adequate emergency access and on-site parking, and implements site design policies of the General Plan. This overlay applies to parcels with an average slope of 25 percent or greater or located in the Hillside Resource Residential or Hillside Residential land use designation.
- Section 14.16.170, Geotechnical Review. This section requires that geotechnical reports consistent with the geotechnical matrix in the General Plan appendices to assess such hazards as potential seismic hazards, liquefaction, landsliding, mudsliding, erosion, sedimentation, and settlement and hazardous soils conditions to determine the optimum location for structures, to advise of special structural requirements, and to evaluate the feasibility and desirability of a proposed facility in a specific location.
- Chapter 15.06, Grading and Drainage. This chapter states that no subdivision of land into two or more lots or parcels for the purpose of development shall be approved by the City unless it is determined that wastewater and sewage disposal for all new lots or parcels shall be provided by either the San

Rafael Sanitation District or the Las Gallinas Valley Sanitary District, depending upon the property location. The creation of an individual on-site septic system intended to serve a new lot or parcel is prohibited.

San Rafael Local Hazard Mitigation Plan

The LHMP, adopted in November 2017, is a guide to hazard mitigation in the EIR Study Area and serves as a tool to help decision-makers direct hazard mitigation activities and resources. In the context of the LHMP, mitigation is an action that reduces or eliminates long-term risk to people and property from hazards, including seismically induced hazards and expansive soils. The LHMP contains hazard mitigation actions to help reduce the risk of damage or injury from geologic and soil hazards, as shown in Table 4.7-1.

TABLE 4.7-1 LOCAL HAZARD MITIGATION PLAN ACTIONS RELEVANT TO GEOLOGY AND SOILS

Number	Actions
Geology and Soil Mitigation Actions	
Action 27	Retrofit/Upgrade Four Remaining Unreinforced Masonry Buildings.
Action 28	Earthquake Hazard Study.
Action 29	Public Facility Vulnerability Assessment and Improvements.
Action 30	Structural Soft Story Identification and Mitigation Plan.
Action 39	70-96 Bret Harte Sewer Easement Repair (seismic reinforcement).
Action 40	Landslide Identification and Management Program.
Action 41	Fairhills Slide Repair.

Source: San Rafael LHMP, 2017

4.7.1.2 EXISTING CONDITIONS

Geology

The EIR Study Area is in the USGS's San Rafael, Novato, San Quentin, and Petaluma Point Quadrangle 7.5-minute topographic map areas.[7,8,9,10] The area is typified by northwest-southwest-trending mountain ridges and intervening valleys.[11] Elevations range from sea level to approximately 1,800 feet along Big Rock Ridge. Regional mapping completed by the USGS indicates that there are 16 geologic units in the EIR Study Area. These units are broadly categorized by the California Geologic Survey (CGS) as Franciscan Complex, Colluvium/Landslide Deposits, Alluvium, Artificial Fill/Bay Mud, and Serpentinite. Figure 4.7-1 shows the location of each geologic category in the EIR Study Area.[12]

[7] United States Geological Survey, 1981, Petaluma Point Quadrangle California 7.5-Minute Topographic Map, scale 1:24,000.
[8] United States Geological Survey, 1980, Novato Quadrangle California 7.5-Minute Topographic Map, scale 1:24,000.
[9] United States Geological Survey, 1995, San Rafael Quadrangle California 7.5-Minute Topographic Map, scale 1:24,000.
[10] United States Geological Survey, 1995, San Quentin Quadrangle California 7.5-Minute Topographic Map, scale 1:24,000.
[11] City of San Rafael, 2004, General Plan 2020 Background Report: Geology, Soils, and Seismicity, page 1.
[12] City of San Rafael, 2017, Local Hazard Mitigation Plan. Page 4-51.

- **Franciscan Complex:** The bedrock in the EIR Study Area consists of Franciscan Melange, which is a weak matrix of sheared and altered shale and sandstone that contains serpentine, greenstone, chert, limestone, and schist. Franciscan Melange is susceptible to landslides, whereas Franciscan sandstone and shale are more stable. This geologic unit is found primarily in the hillsides of the EIR Study Area.
- **Colluvium/Landslide Deposits:** The colluvium geologic unit contains deposits of unconsolidated solid material and weathered rock fragments that gather at the base of slopes by gravitational or slope wash processes (i.e., landslides). Colluvium may be susceptible to flow failures.
- **Alluvium:** The alluvium geologic units consists of sedimentary rock that has been transported and deposited by streams. Alluvium is vulnerable to seismically induced instability.
- **Artificial Fill/Bay Mud:** The bay mud geologic unit is located in the marshes, mudflats, and valley floors and is approximately 130 feet deep in portions of the bay and 90 feet deep in diked and filled areas in the EIR Study Area. Bay mud consists of soft, unconsolidated, water-saturated materials and is susceptible to both subsidence and liquefaction.
- **Serpentinite:** Serpentinite is a metamorphic rock which forms at tectonic plate boundaries. Serpentinite is often formed in Franciscan Complexes when ocean water is heated and moved through upper mantle and ocean crust rocks, which hydrates the magnesium and iron-rich materials in the rocks.

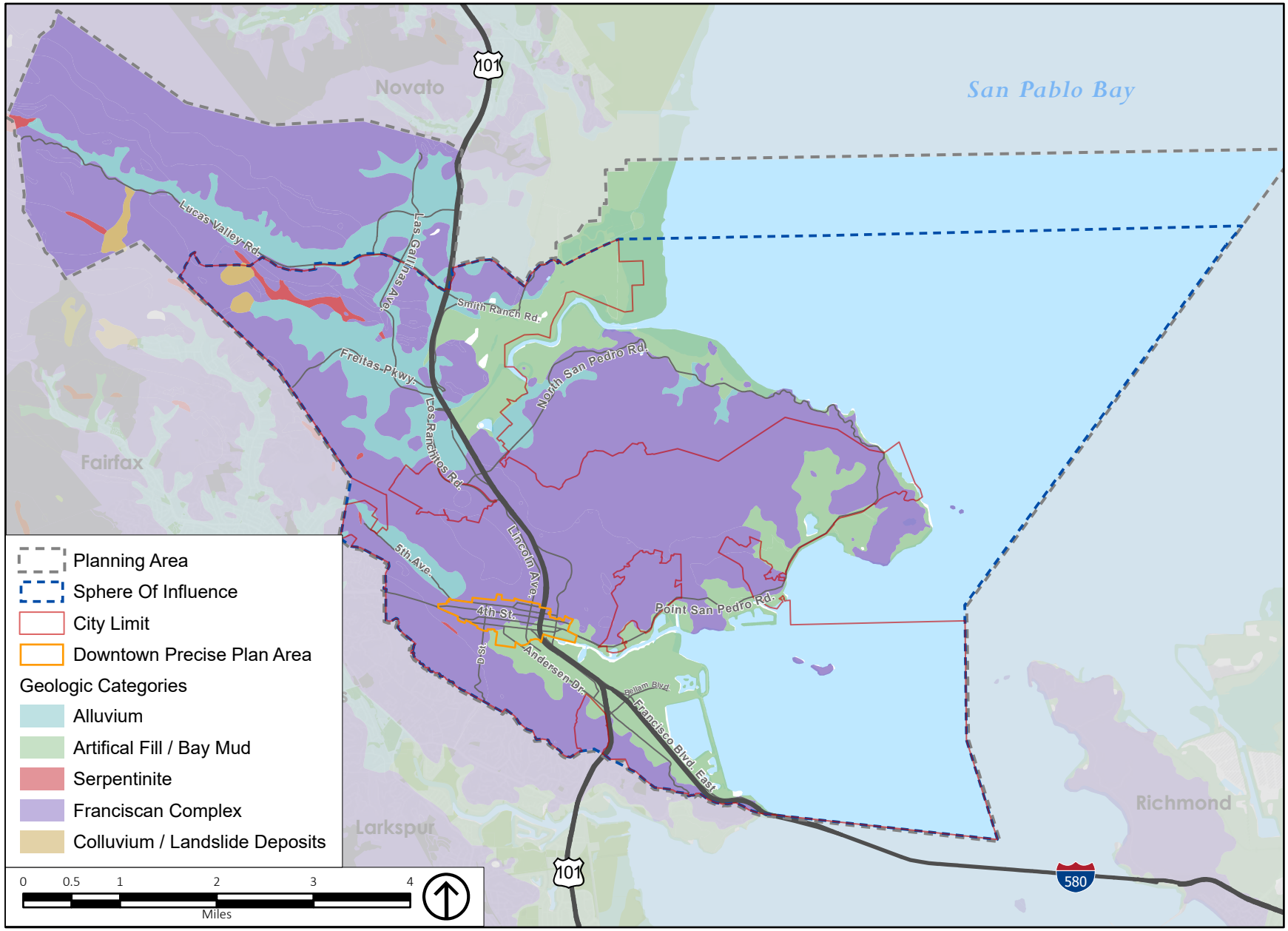
Unique geologic features are those that are unique to the field of geology. Each rock unit tells a story of the natural processes operating at the time it was formed. The rocks and geologic formations exposed at the earth's surface or revealed by drilling and excavation are our only record of that geologic history. What makes a geologic unit or feature unique can vary considerably. For example, a geologic feature may be considered unique if it is the best example of its kind and has distinctive characteristics of a geologic principle that is exclusive locally or regionally, is a key piece of geologic information important to geologic history, contains a mineral that is not known to occur elsewhere in the area, or is used as a teaching tool. Unique geological features are not common in San Rafael or the EIR Study Area. The geologic processes are generally the same as those in other parts of the state, country, and even the world. The geology and soils in the EIR Study Area are common throughout the city and region and are not considered to be unique.

Soils

The soils in the EIR Study Area have been mapped by the United States Department of Agriculture (USDA) Natural Resource Conservation Services. In general, the soils beneath the EIR Study Area are dominated by well-drained, shallow to moderately deep, fine-loamy soils such as loam and clay loam in the uplands, with additional areas of poorly drained clay and silty soils in the tidal flats and salt marshes.[13] Xerorthents soils consist of tidal flats, valley floors, and salt marshes. According to the USDA, the most prevalent soil types are the Tocaloma, McMillin, Xerorthents, urban land, water, Saurin, and Bonnydoon, as shown on Figure 4.7-2.[14]

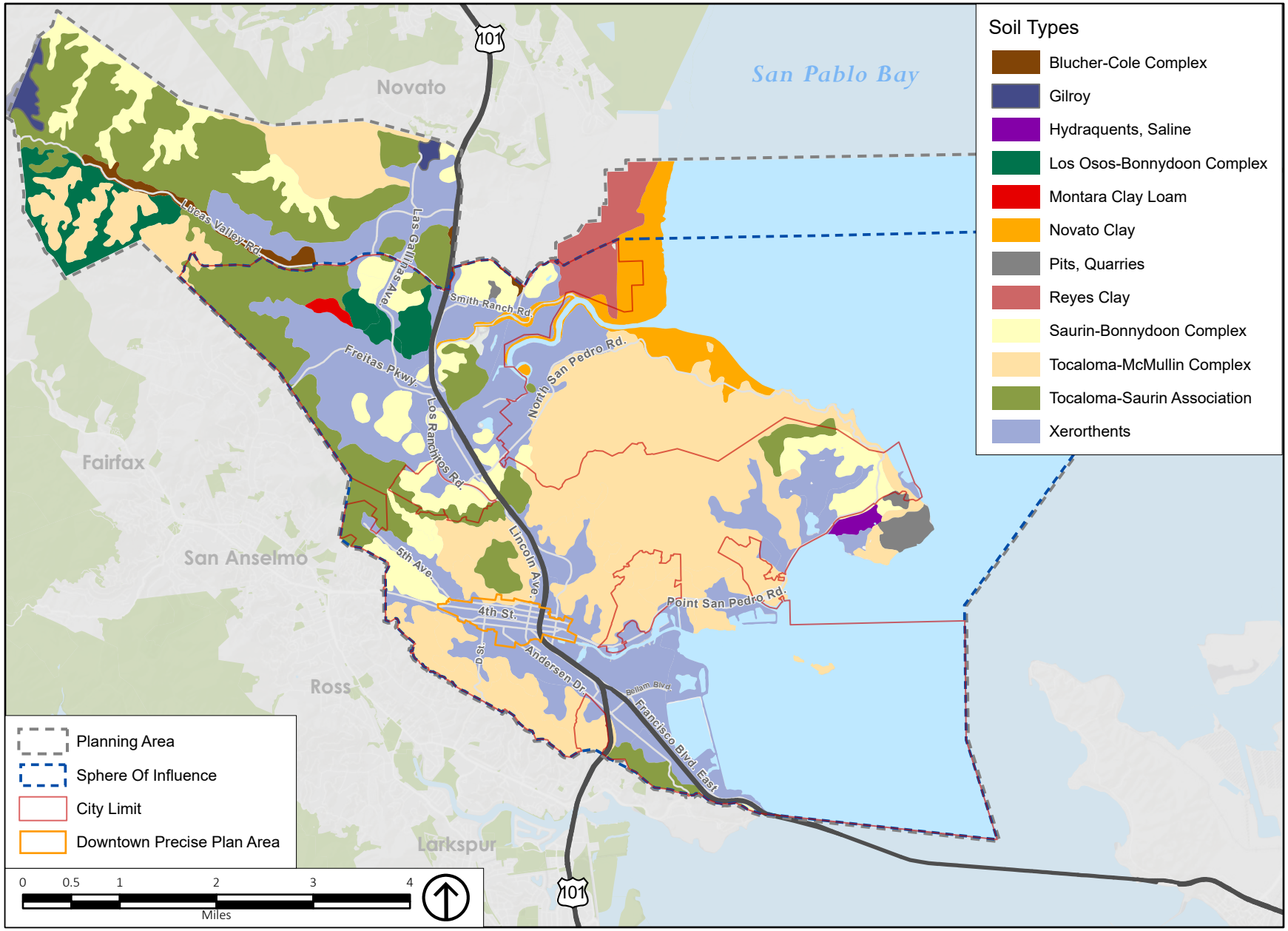
[13] USDA Soil Conservation Service, 1985, Soil Survey of Marin County California.

[14] United States Department of Agriculture, Natural Resources Conservation Service, 2019, Custom Soil Resource Report for San Rafael, from United States Department of Agriculture Web Soil Survey website.



Source: ESRI, 2017; County of Marin, 2009; City of San Rafael, 2019; PlaceWorks, 2019.

Figure 4.7-1
Geology Map



Source: ESRI, 2017; County of Marin, 2009; City of San Rafael, 2019; PlaceWorks, 2019.

Figure 4.7-2
Soils Map

The properties of these soils are variable, ranging from fine-loamy soils of the Tocaloma-McMillin series and Saurin-Bonnydoon series, to completely urbanized in the Xerorthents-urban complex, to 100 percent water. According to published soil data, several soil types, notably the Tocaloma-McMillin, are characterized by steep slopes and erosion hazards, where landslides and flows are possible.[15]

Regional Seismicity

The Earth's crust includes tectonic plates that collide or slide past one another along plate boundaries. California is particularly susceptible to such plate movements, notably the largely horizontal or "strike-slip" movement of the Pacific Plate as it impinges on the North American Plate. In general, earthquakes occur when the accumulated stress along a plate boundary or fault is suddenly released. This slippage can vary widely in magnitude, from a few millimeters or centimeters to tens of feet.

The performance of human-made structures during a major seismic event varies widely due to a number of factors, including location with respect to active fault traces or areas prone to liquefaction or seismically induced landslides; the type of building construction (e.g., wood frame, unreinforced masonry, nonductile concrete frame); and the proximity, magnitude, depth, and intensity of the seismic event itself. In general, evidence from past earthquakes shows that wood-frame structures tend to perform well, especially when their foundations are properly designed and anchored. Conversely, older, unreinforced masonry structures and nonductile reinforced concrete buildings (especially those built in the 1960s and early 1970s) do not perform well, especially if they have not undergone appropriate seismic retrofitting. Applicable building code regulations, such as those in the CBC, include seismic requirements that are designed to ensure the satisfactory performance of building materials under prescribed seismic conditions.

The EIR Study Area, like much of the San Francisco Bay Area, is vulnerable to seismic activity due to the presence of active faults in the region. The most prominent active fault near the EIR Study Area is the San Andreas Fault approximately 10 miles to the west. Other active faults in the region include the Hayward Fault approximately 9 miles to the east, the San Gregorio Fault 16 miles to the southwest, and Rodgers Creek Fault 15 miles to the northeast, as shown on Figure 4.7-3.[16] There are no known active faults in the EIR Study Area, so surface fault rupture is not considered a significant hazard.

The severity of ground shaking depends on several variables, such as earthquake magnitude and origin; local geology, including the properties of unconsolidated sediments; groundwater conditions; and topographic setting. In general, ground shaking hazards are most pronounced in areas that are underlain by loosely consolidated soil/sediment.[17]

When earthquake faults within the San Francisco Bay Area's nine-county area were considered, the USGS estimated that the probability of a magnitude (M) 6.7 or greater earthquake prior to year 2032 is 62 percent, or roughly a two-thirds probability. The forecast probability for each individual fault to produce a

[15] USDA Soil Conservation Service, 1985, Soil Survey of Marin County California.

[16] Quaternary faults are faults which are known to have been active in the past 2.6 million years.

[17] Southern California Earthquake Center (SCEC), 2011, *Putting Down Roots in Earthquake Country*, Lucile M. Jones, United States Geological Survey (USGS), and Mark Benthien, SCEC.

M 6.7 or greater seismic event by the year 2032 is 27 percent for the Hayward Fault, 21 percent for the San Andreas Fault, 11 percent for the Calaveras Fault, and 10 percent for the San Gregorio Fault.[18] Earthquakes of this magnitude can create ground accelerations severe enough to cause major damage to structures and foundations not designed to resist earthquakes. Underground utility lines are also susceptible where they lack sufficient flexibility to accommodate the seismic ground motion.[19] In the event of a M 7.8 earthquake on the San Andreas Fault, the seismic forecasts on the Association of Bay Area Governments' interactive GIS website (developed by a cooperative working group that included the USGS and the CGS) suggest that most parts of the EIR Study Area are expected to experience "strong" shaking, and the central, eastern, and southeasternmost portions of the EIR Study Area are expected to experience "very strong" shaking, as shown on Figure 4.7-4.[20] The April 1906 earthquake on the San Andreas Fault, estimated between M 7.7 and M 8.3, was the largest seismic event in recent history that affected the EIR Study Area. More recently, the M 6.9 Loma Prieta earthquake of October 1989 on the San Andreas Fault caused significant damage throughout the San Francisco Bay Area, although no deaths were reported in Marin County.

Liquefaction typically occurs in areas where moist, fine-grained, cohesionless sediment or fill materials are subjected to strong, seismically induced ground shaking. Under certain circumstances, the ground shaking can temporarily transform an otherwise solid material to a fluid state, which can result in the horizontal movement of soils on gentle slopes, called lateral spreading. Liquefaction is a serious hazard and may result in buildings that subside and suffer major structural damage. Liquefaction is most often triggered by seismic shaking, but it can also be caused by improper grading, landslides, or other factors. In dry soils, seismic shaking may cause soil to consolidate rather than flow, a process known as densification. Liquefaction in the EIR Study Area ranges from very low in the hillsides of the city to very high in the marshland and tidal marshes on the eastern side of the EIR Study Area, as shown on Figure 4.7-5.

The northeastern and southeastern portions of the EIR Study Area along the San Pablo Bay and San Rafael Bay, respectively, are predominantly Artificial Fill/Bay Mud soils, which consist of soft, unconsolidated, water-saturated, silty clay with peaty material, plant material, and mollusk shells.[21] These low-lying areas that front the bay are particularly susceptible to liquefaction. According to the hazard maps published by USGS, areas surrounding Miller Creek and the outlets to Gallinas Creek and San Rafael Creek have been designated as liquefaction hazard zones.[22] In the central-northern and eastern portions of the EIR Study Area, the soils consist of colluvium and bedrock, which have a low susceptibility to liquefaction. As shown on Figure 4.7-5, the majority of the high and very high liquefaction susceptibility areas in the EIR Study Area are in urbanized, low-lying areas near creeks or the waterfront. Many of the open space areas and hillside neighborhoods are in low or very low liquefaction susceptibility areas.

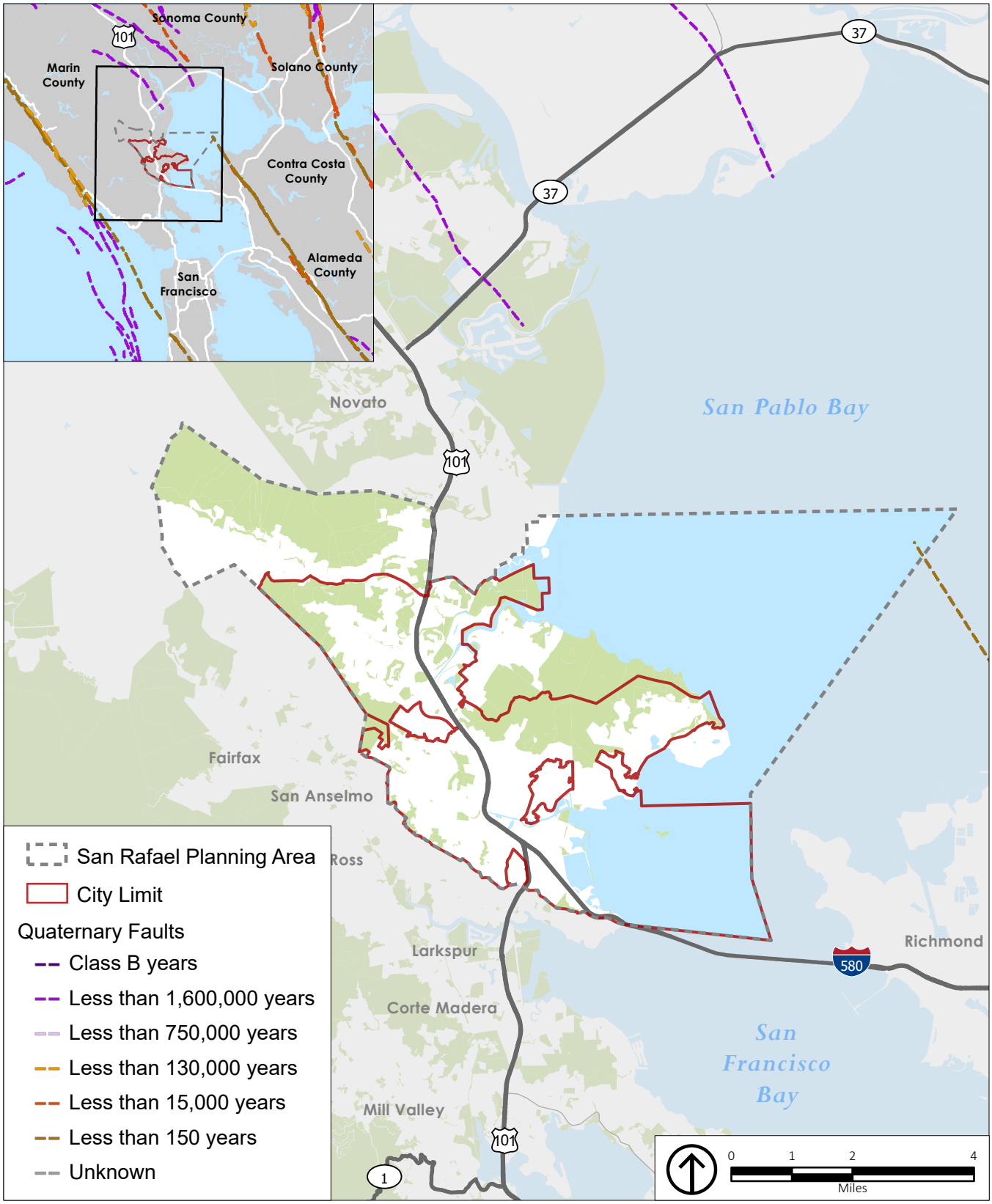
[18] United States Geological Survey (USGS), San Francisco Region Earthquake Probability, http://earthquake.usgs.gov/regional/nca/wg02/images/percmap-lrg.html, accessed on May 4, 2019.

[19] Association of Bay Area Governments (ABAG), 1995, *The San Francisco Bay Area On Shaky Ground*, Publication Number P95001EQK, 13 maps, scale 1:1,000,000.

[20] Association of Bay Area Governments (ABAG), 2013, Interactive Hazards Map, Earthquake Shaking Scenarios, http://gis.abag.ca.gov/website/Hazards/?hlyr=northSanAndreas, accessed on May 6, 2019.

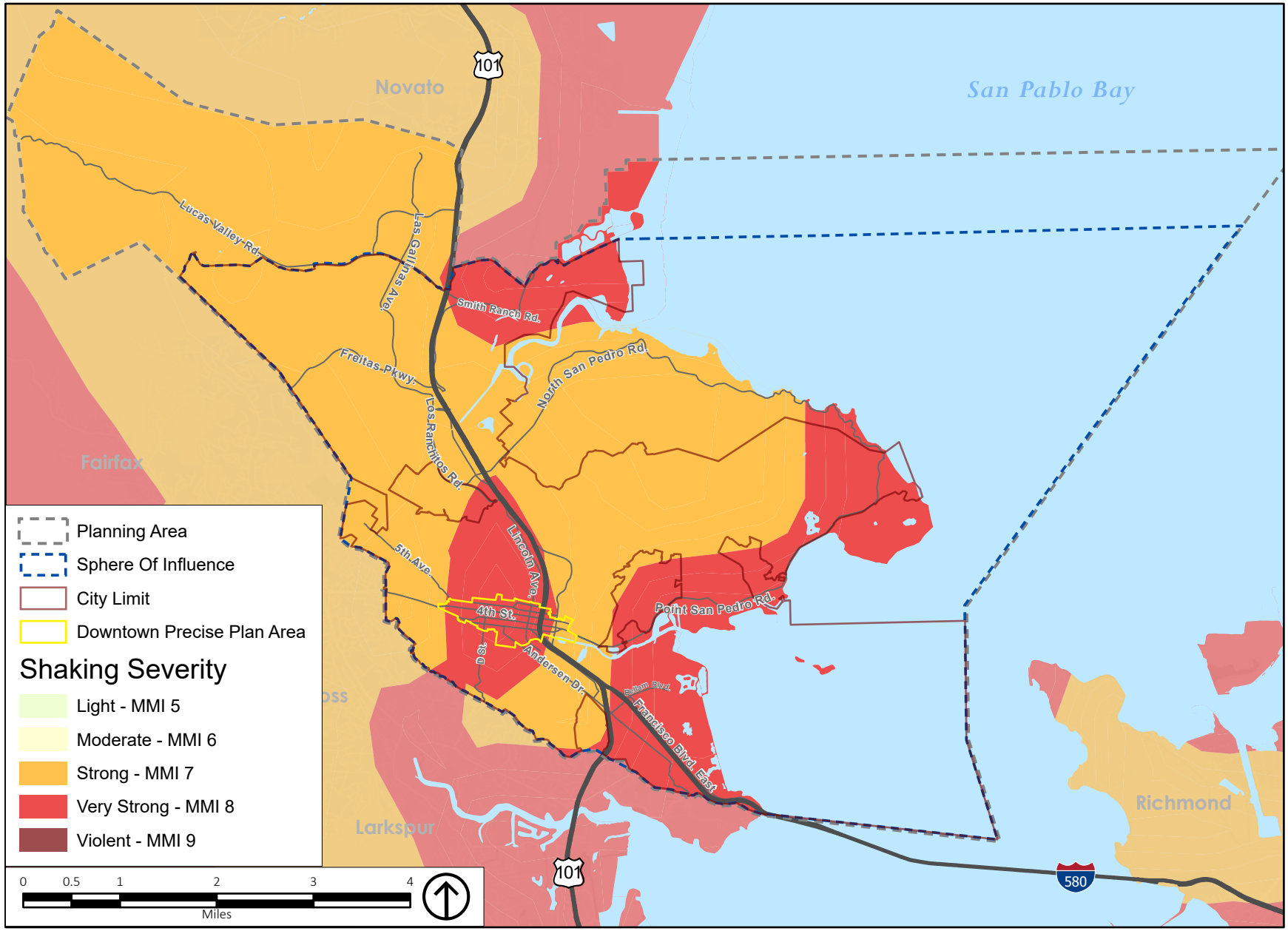
[21] City of San Rafael, 2017, Local Hazard Mitigation Plan. Page 4-51.

[22] ABAG Resilience Program, 2019, Liquefaction Susceptibility, http://gis.abag.ca.gov/website/Hazards/?hlyr=northSanAndreas&co=6041#nogo1, accessed on May 6, 2019.



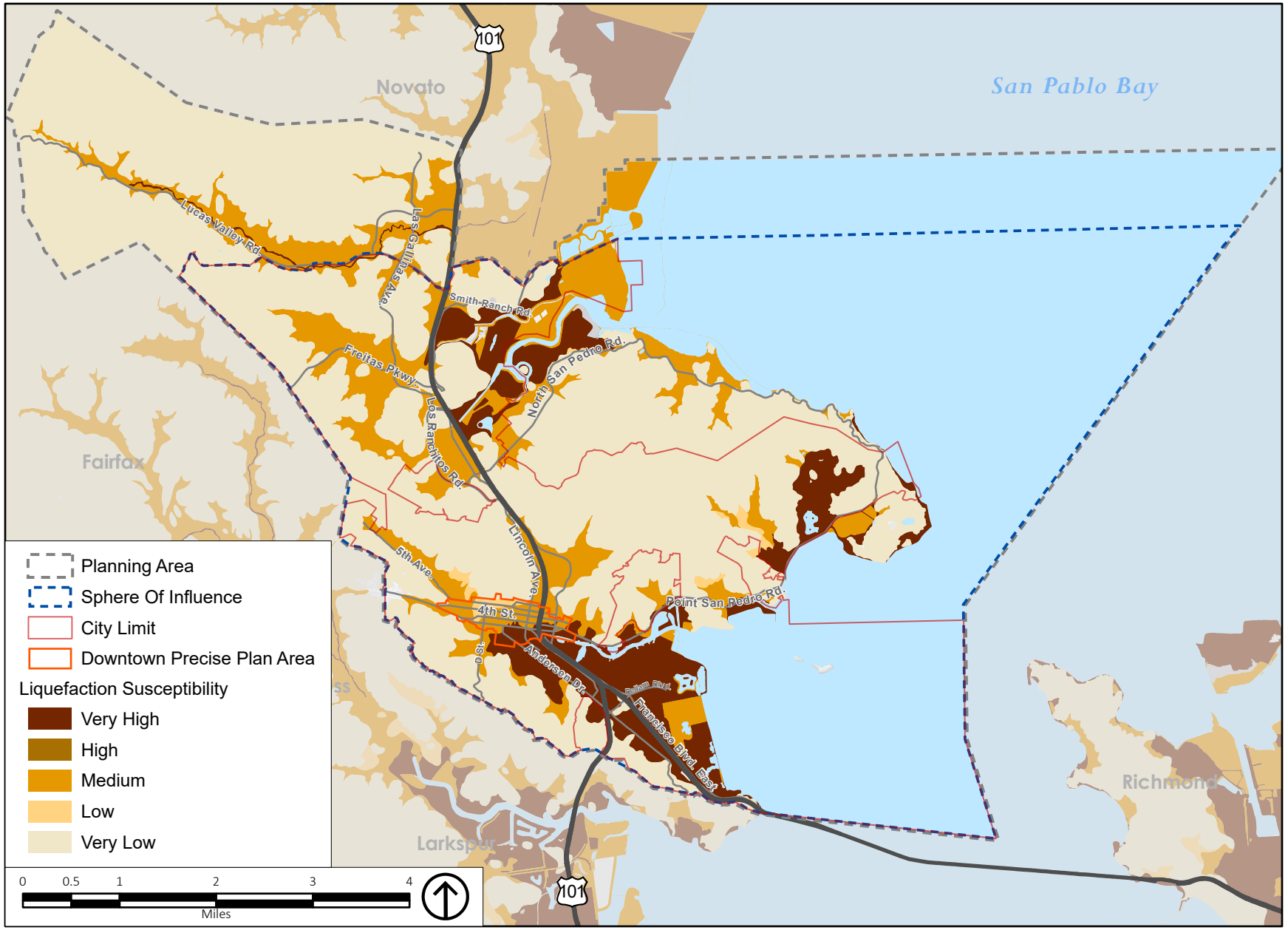
Source: City of San Rafael, 2019; ESRI, 2017; PlaceWorks, 2019; USGS, 2018.

Figure 4.7-3
Quaternary Faults



Source: ESRI, 2017; County of Marin, 2009; City of San Rafael, 2019; PlaceWorks, 2019.

Figure 4.7-4
Ground Shake Potential Map



Source: ESRI, 2017; County of Marin, 2009; City of San Rafael, 2019; USGS, 2006; PlaceWorks, 2019; California Geological Survey, 2017.

Figure 4.7-5
Liquefaction Map

Landslides

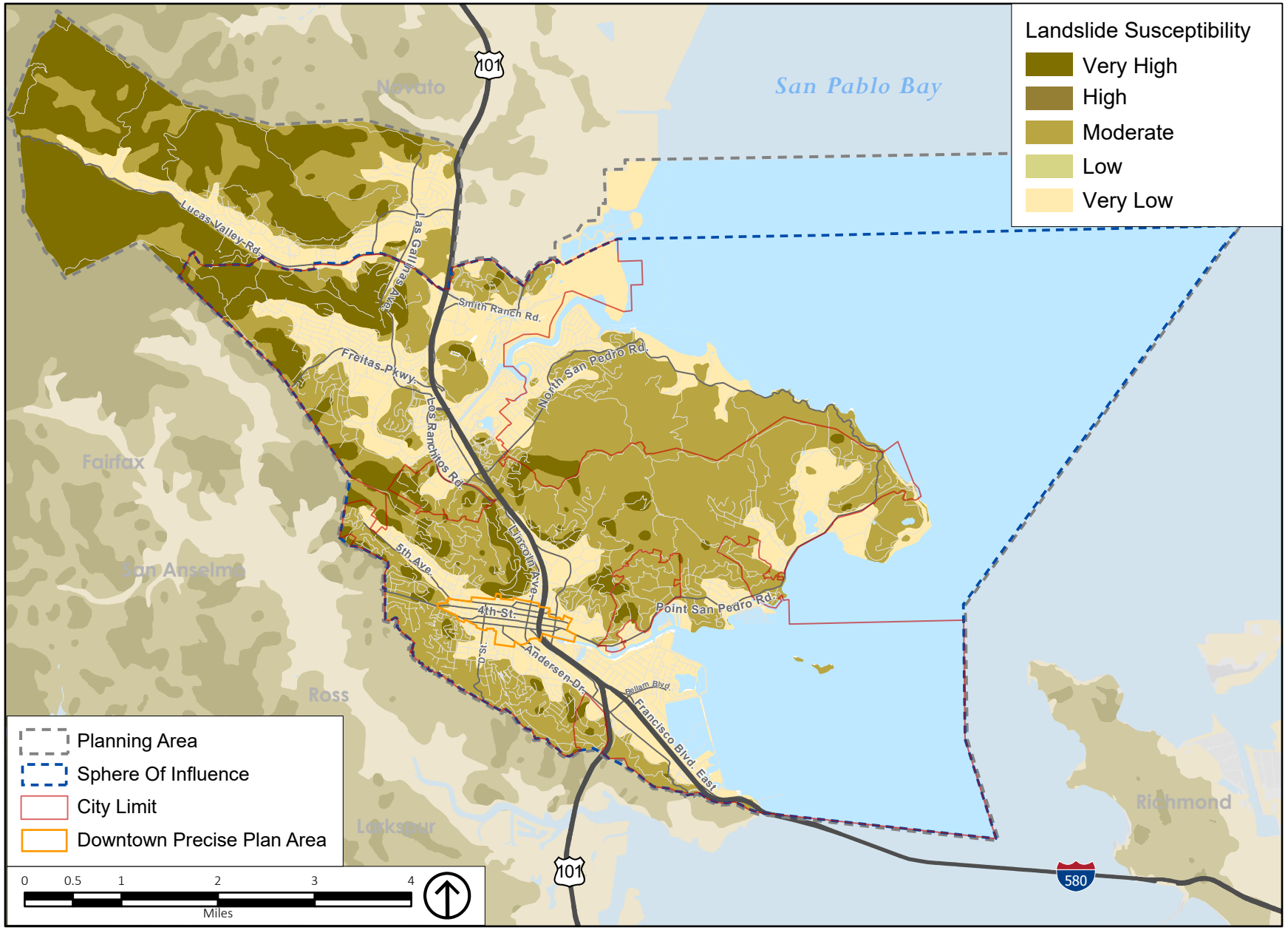
Landslides are gravity-driven movements of earth materials that can include rock, soil, unconsolidated sediment, or combinations of such materials. The rate of landslide movement can vary considerably; some move rapidly, as in a soil or rock avalanche, and others "creep," or move slowly for long periods of time. The susceptibility of a given area to landslides depends on many variables, although the general characteristics that influence landslide hazards are widely acknowledged. Some of the more important contributing factors are:

- Slope Material. Loose, unconsolidated soils and soft, weak rocks are more hazardous than are firm, consolidated soils or hard bedrock.
- Slope Steepness. Most landslides occur on moderate to steep slopes.
- Structure and Physical Properties of Materials. This includes the orientation of layering and zones of weakness relative to slope direction.
- Water Content. Increased water content increases landslide hazard by decreasing friction and adding weight to the materials on a slope.
- Vegetation Coverage. Abundant vegetation with deep roots promotes slope stability.
- Proximity to Areas of Erosion or Man-Made Cuts. Undercutting slopes can greatly increase landslide potential.
- Earthquake Ground Motions. Strong seismic ground motion can trigger landslides in marginally stable slopes or loosen slope materials, which increases the risk of future landslides.

Landslides have the potential to occur in the EIR Study Area, most notably on the steeper slopes that lie on the western edge of the EIR Study Area, in addition to hilly areas surrounding China Camp State Park, Boyd Park, and Harry Barbier Memorial Park (see Figure 4.7-6). In these areas, landslides are commonly associated with slopes underlain with Franciscan Melange and pre-existing landslide deposits, which indicate unstable underlying materials.[23] Historically, five major landslide events have been recorded in the EIR Study Area in 1925, 1982, April 2006, January 2017, and February 2017.[24]

Shale is the most unstable of the many rock types within the Franciscan Formation, whereas sandstone and conglomerate units tend to be more stable with a lower landslide risk. Many of the upland areas in the EIR Study Area are characterized by steep slopes and soils that overlie Franciscan bedrock. Landslides are not an issue in parts of the EIR Study Area where the topography is flat. Due to the differences in the physical characteristics of slope materials, which markedly influence landslide potential, some superficially similar areas may differ widely in terms of landslide hazards. For this reason, site-specific geotechnical investigations are essential to the accurate assessment of potential landslide hazards at any given site.

[23] City of San Rafael, 2017, Local Hazard Mitigation Plan, Page 4-81.
[24] City of San Rafael, 2017, Local Hazard Mitigation Plan, Page 4-81 to 4-85.



Source: ESRI, 2017; County of Marin, 2009; City of San Rafael, 2019; PlaceWorks, 2019.

Figure 4.7-6
Landslide Areas

Erosion

Erosion occurs when the upper layers of soil are displaced by erosive agents such as water, ice, snow, air, plants, animals, or anthropogenic forces. Sandy soils on moderate slopes or clayey soils on steep slopes are susceptible to erosion when exposed to these forces.[25] Erosion can become more frequent when established vegetation is disturbed or removed due to grading, wildfires, or other factors. Within the valley areas of the EIR Study Area, water flow in streams and rivers can erode the banks of waterways, causing the stream or river to meander. Erosion can cause the soil underneath buildings and structures to become compromised or fail, which is typically limited to localized areas.

Land Subsidence

Subsidence hazards are known to be present in the EIR Study Area. In areas containing Artificial Fill/Bay Mud materials, including the northeastern and southeastern edge of the EIR Study Area and the area around Northgate Business Park, historical subsidence has been attributed to the highly compressible nature of the underlying fill and sediments. This has caused development in the southeastern portions of the EIR Study Area to subside below the 100-year flood elevation.[26] With sea level rise, subsidence rates could increase in the EIR Study Area.[27] These areas are also susceptible to differential settlement, which is when a building's support foundation settles in an uneven fashion, often leading to structural damage. Differential settlement occurs on soils that are loosely compacted or have weak bearing capacity, and in cases where soil moisture changes. Such characteristics are common in Artificial Fill/Bay Mud soils.

Expansive Soils

Expansive soils can change dramatically in volume depending on moisture content. When wet, these soils can expand; when dry, they can contract or shrink. Sources of moisture that can trigger this shrink-swell phenomena can include seasonal rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soil can exhibit wide cracks in the dry season, and changes in soil volume have the potential to damage concrete slabs, foundations, and pavement. Special building/structure design or soil treatment are often needed in areas with expansive soils.

Expansive soils are typically very fine grained with a high to very high percentage of clay, typically montmorillonite, smectite, or bentonite clay. Linear extensibility soil tests are often used to identify expansive soils, wherein soil sample volume/length changes in response to reduced moisture content.[28] A linear extensibility of 3 percent or greater connotes moderate to high shrink-swell potential. This soil behavior has the potential to cause damage to buildings, roads, and other structures.

[25] City of San Rafael, 2004, General Plan 2020 Background Report.

[26] City of San Rafael, 2004, General Plan 2020 Background Report.

[27] City of San Rafael, 2017, Local Hazard Mitigation Plan. Page 4-145.

[28] Army Corps of Engineers Field Manual TM 5-818-7, 1985, http://armypubs.army.mil/eng/DR_pubs/dr_a/pdf/tm5_818_7.pdf, accessed on May 7, 2019.

Expansive soils are not common in the EIR Study Area; however, they can exist in localized areas such as the Bay Mud geologic units that underlie eastern San Rafael.[29] The USDA Web Soil Survey (a nationwide data repository) for the EIR Study Area demonstrates low ratings of linear extensibility and plasticity for the majority of the soils in the EIR Study Area, with moderate or high ratings dispersed throughout the northern and eastern areas of the EIR Study Area.[30] Expansive soils are typically identified during project review stages prior to construction, and require specific engineering methods to reduce stresses to buildings and infrastructure. A geotechnical investigation generally provides the most reliable means of evaluating and mitigating such soil characteristics.

Paleontological Resources

Paleontological resources are the fossilized remains of organisms from prehistoric environments found in geologic strata. They are valued for the information they yield about the history of the earth and its past ecological settings. Paleontological resources include vertebrates (i.e., animals with backbones), invertebrates (e.g., starfish, clams, ammonites, and marine coral), microscopic plants and animals (microfossils), and trace fossils (footprints, burrows, etc.). These resources are found in geologic strata conducive to their preservation, typically sedimentary formations. Paleontological sites are areas that show evidence of prehuman activity. Often, they are simply small outcrops visible on the surface or sites encountered during grading. While the sites are important indications, it is the geologic formations that are the most important since they may contain important fossils. The Society of Vertebrate Paleontology defines a significant fossil resource as, "identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information. Paleontological resources are considered to be older than recorded human history and/or older than middle Holocene (i.e., older than about 5,000 radiocarbon years)."[31] Because, potentially sensitive areas for the presence of paleontological resources are based on the underlying geologic formation, it is likely that paleontological resources would be found within the EIR Study Area.

Downtown Precise Plan Area

In the Downtown Precise Plan Area, the majority of soils are characterized as Franciscan Complex soils, and the southeastern portion is composed of Artificial Fill/Bay Mud.[32]

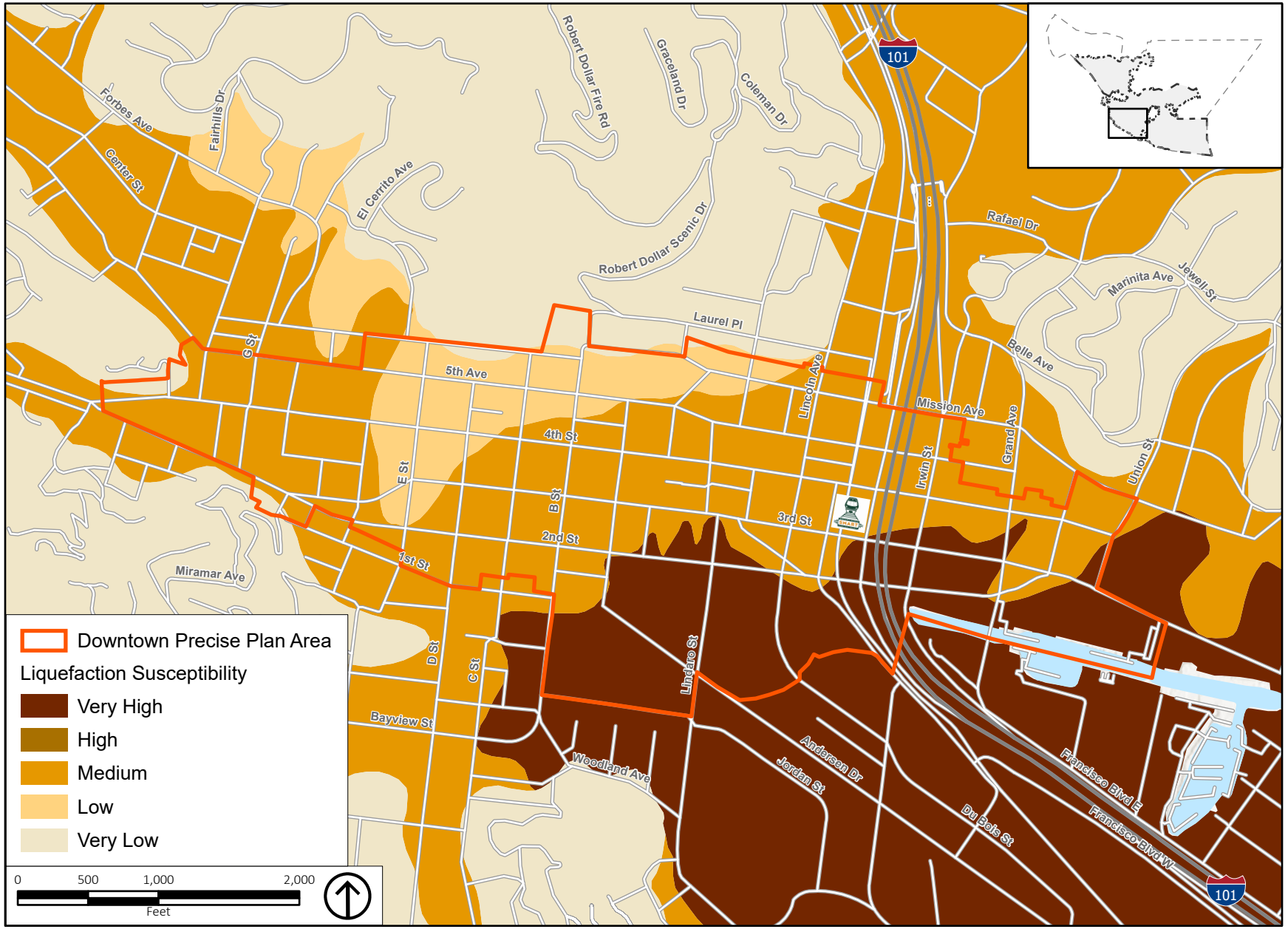
The most prominent active fault near the Downtown Precise Plan Area is the San Andreas Fault, approximately 10 miles to the west. As shown on Figure 4.7-7, the southern portion of the Downtown Precise Plan Area is in a very high liquefaction area, which transitions to moderate and low liquefaction zones as the elevation becomes higher in the northern areas of the Downtown Precise Plan Area.

[29] City of San Rafael, 2004, General Plan 2020 Background Report, Environmental Context.

[30] USDA, 2018, Web Soil Survey, https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx, accessed on May 7, 2019.

[31] Society of Vertebrate Paleontology, 2010*, Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources,* page 11. Society of Vertebrate Paleontology. Impact Mitigation Guidelines Revision Committee.

[32] United States Department of Agriculture, Natural Resources Conservation Service, 2019, Custom Soil Resource Report for San Rafael, from United States Department of Agriculture Web Soil Survey website.



Source: ESRI, 2017; County of Marin, 2009; City of San Rafael, 2019; PlaceWorks, 2019; California Geological Survey, 2017

Figure 4.7-7
Downtown Liquefaction Map

4.7.2 STANDARDS OF SIGNIFICANCE

Pursuant to Appendix G, Environmental Checklist Form, of the CEQA Guidelines, implementation of the proposed project would result in significant geology and soils impacts if it would:

1. 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; ii) Strong seismic ground shaking; iii) Seismic-related ground failure, including liquefaction; iv) Landslides.
2. Result in substantial soil erosion or the loss of topsoil.
3. 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.
4. Be located on expansive soil, as defined by Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.
5. 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.
6. Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.
7. Result in significant cumulative impacts to geology and soils.

4.7.3 IMPACT DISCUSSION

GEO-1	**Implementation of the proposed project could directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving: i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault; ii) Strong seismic ground shaking; iii) Seismic-related ground failure, including liquefaction; iv) Landslides.**

General Plan 2040

Earthquake Fault Rupture

As discussed in Section 4.7.1.2, Existing Conditions, there are no known active faults in the EIR Study Area, and the nearest fault is the Hayward Fault, approximately 9 miles to the east. The EIR Study Area is not in

an Alquist-Priolo Fault Zone.[33] Based on the lack of known active faults in the EIR Study Area and the required geotechnical investigations for all grading within the EIR Study Area, implementation of proposed General Plan 2040 would not directly or indirectly cause the risk of loss, injury, or death involving rupture of a known earthquake fault. Therefore, the impact would be *less than significant.*

Seismic Ground Shaking

The intensity of ground shaking at a given location depends on several factors, primarily on the earthquake magnitude, the distance from the epicenter, and the characteristics of the soils or bedrock units underlying the site. The Hayward and San Andreas Faults, which are closest to the EIR Study Area, are potentially capable of producing the most intense ground accelerations in the EIR Study Area due to their proximity. Secondary effects of earthquakes are nontectonic processes such as liquefaction, lateral spreading, seismically induced landslides, and ground lurching, which can lead to ground deformation. Ground deformation, including fissures, settlement, displacement, and loss of bearing strength, are the leading causes of damage to structures during a moderate to large earthquake.

In northern California, there is no method to completely avoid earthquake hazards. However, appropriate measures to minimize the effects of earthquakes are included in the most recent CBC, with specific provisions for seismic design. The design of structures in accordance with the CBC would minimize the effects of ground shaking to the greatest degree feasible, except for during a catastrophic seismic event. Additionally, development projects under the proposed General Plan 2040 would be required to comply with the standards in the San Rafael Geotechnical Review Matrix, which requires a geotechnical report defining and delineating seismic hazards on a project-by-project basis. Because potential future development would be required to comply with both the CBC and the Geotechnical Review Matrix, implementation of the proposed General Plan 2040 would not cause or worsen seismic ground shaking; therefore, the impact would be *less than significant*.

Liquefaction

The EIR Study Area contains a range of geological and soil profiles. Within the EIR Study Area, liquefaction susceptibility ranges from low in steeply sloped areas to moderate and very high in the marshland and tidal marshes on the eastern side of the EIR Study Area, as shown on Figure 4.7-5. As discussed in Chapter 3, Project Description, of this Draft EIR, potential future development under the proposed General Plan 2040 is expected to occur in existing urban areas and would be concentrated on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. These urban areas are generally located in portions of the EIR Study Area that have low liquefaction susceptibility. However, some existing urban areas in the EIR Study Area are built atop Artificial Fill/Bay Mud soil materials, which have a high liquefaction susceptibility. In the event that future development is proposed on Artificial Fill/Bay Mud materials, the development would be required to comply with existing regulations in the CBC and undergo a geotechnical review in accordance with Appendix F, Geotechnical Review Matrix, of the proposed General Plan 2040. Compliance with these regulations would minimize

[33] California Geological Survey, Alquist-Priolo Earthquake Fault Zoning Act, https://www.conservation.ca.gov/cgs/alquist-priolo, accessed on March 24, 2020.

the risk of loss, injury, or death involving liquefaction after a seismic-related ground failure, and impacts would be *less than significant*.

Landslides

Portions of the EIR Study Area susceptible to landslides are on the steep slopes to the west and in hilly areas surrounding China Camp State Park, Boyd Park, and Harry Barbier Memorial Park. As discussed in Chapter 3, Project Description, of this Draft EIR, potential future development under General Plan 2040 is expected to occur in existing urban areas and would be concentrated on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. New development or redevelopment in any of the portions of the EIR Study Area deemed to be within landslide-susceptible areas would be required to comply with grading, erosion, and sediment control regulations in the CBC and the provisions in SRMC Chapter 14.12, Hillside Development Overlay District, and Chapter 15.06, Grading and Drainage.

The proposed Safety (S) Element contains goals, policies, and programs that require local planning and development decisions to consider impacts that contribute to the risk of loss, injury, or death as a result of earthquakes. The following General Plan goals, policies, and programs would serve to minimize potential adverse impacts from earthquakes:

Goal S-1: A Safer, More Resilient City. Minimize San Rafael's vulnerability to the impacts of environmental hazards and public health emergencies.

- Policy S-1.1: Local Hazard Mitigation Plan (LHMP). The San Rafael LHMP is adopted by reference into the General Plan. Policies and actions throughout the General Plan shall be consistent with the LHMP and support its goals and objectives.
  - Program S-1.1A: LHMP Mitigation Action Plan. Implement the Mitigation Action Plan in the LHMP. The City will consider opportunities to advance each action through operating procedures, development approvals, budgets, public education, and capital improvement projects.
  - Program S-1.1B: Mitigation Program Funding. Develop an overall funding strategy to prioritize and pursue mitigation projects, including identification and tracking of grants and regular coordination with FEMA and State hazard mitigation agencies.
  - Program S-1.1C: LHMP Updates. Periodically update the Local Hazard Mitigation Plan to reflect new data, technology, available resources, partnership opportunities, and state and federal requirements.
- Policy S-1.2: Location of Future Development. Permit development only in those areas where potential danger to the health, safety, and welfare of the community can be adequately mitigated. Land uses and densities should take environmental hazards such as earthquakes, flooding, sea level rise, and wildfires into consideration.
  - Program S-1.2A: Entitlement Process. Use the entitlement process to evaluate the potential for hazards and to require appropriate mitigation measures and approval conditions.
  - Program S-1.2B: Use of Hazard Maps in Development Review. Review slope stability, seismic, flood hazard, sea level rise, wildfire, and other environmental hazard maps when development is

proposed. Require appropriate studies and actions to ensure that hazards are identified and mitigated.

- Policy S-1.3: Location of Public Improvements. Avoid locating public improvements and utilities in areas with high hazard levels. When there are no feasible alternatives, require effective mitigation measures to reduce the potential for damage.
  - Program S-1.3A: Critical Facilities in Vulnerable Areas. Prepare a Public Facility Vulnerability Assessment to identify City buildings and other infrastructure that are susceptible to environmental hazards. Measures should be taken to avoid extraordinary maintenance and operating expenses associated with hazardous conditions and minimize damage potential and interruption of service following a disaster.

Goal S-2: Resilience to Geologic Hazards. Minimize potential risks associated with geologic hazards, including earthquake-induced ground shaking and liquefaction, landslides, erosion, sedimentation, and settlement.

- Policy S-2.1: Seismic Safety of New Buildings. Design and construct all new buildings to resist stresses produced by earthquakes. The minimum level of seismic design shall be in accordance with the most recently adopted building code as required by State law.
  - Program S-2.1A: Seismic Design. Adopt and enforce State building codes which ensure that new or altered structures meet the minimum seismic standards set by State law. State codes may be amended as needed to reflect local conditions.
  - Program S-2.1B: Geotechnical Review. Continue to require geotechnical studies and peer review for proposed development as set forth in the City's Geotechnical Review Matrix (Appendix F). Such studies should determine the extent of geotechnical hazards, optimum design for structures and the suitability of proposed development for its location, the need for special structural requirements, and measures to mitigate any identified hazards. Periodically review and update the Geotechnical Review Matrix to ensure that it supports and implements the Local Hazard Mitigation Plan.
  - Program S-2.1C: Earthquake Hazard Study. As recommended by the Local Hazard Mitigation Plan, complete an Earthquake Hazard Study that examines geologic hazards in the city.
- Policy S-2.2: Minimize the Potential Effects of Landslides. Development proposed in areas with existing or potential landslides (as identified by a registered geologist or geotechnical engineer) shall not be endangered by, or contribute to, hazardous conditions on a site or adjoining properties. The City will only approve new development in areas of identified landslide hazard if the hazard can be appropriately mitigated, including erosion control and replacement of vegetation. Landslide mitigation should include measures to reduce secondary impacts such as loss of vegetation and soil erosion.
  - Program S-2.2A: Landslide Mitigation and Repair Projects. Undertake landslide hazard mitigation and repair projects, as outlined in the LHMP. These projects include a landslide identification and management program, repair of the Fairhills Drive landslide, and repair of the Bret Harte sewer easement.
- Policy S-2.3: Seismic Safety of Existing Buildings. Encourage the rehabilitation or elimination of structures susceptible to collapse or failure in an earthquake. Historic buildings shall be treated in

accordance with the Historic Preservation Ordinance and Historic Building Code (see also Program CDP-5.5A).

- Program S-2.3A: Seismic Safety Building Reinforcement. Enforce State and local requirements for reinforcement of existing buildings, including the City's remaining unreinforced masonry (URM) buildings.
- Program S-2.3B: Soft-Story Building Mitigation Plan. Complete a citywide assessment of soft-story buildings and develop a mitigation strategy and cost-benefit analysis to modify these structures to reduce their potential to collapse during an earthquake.

Implementation of the above goals, policies, and programs, as well as compliance with State, regional, and local regulations pertaining to structural safety regarding fault rupture, ground shaking, liquefaction, and landslides, would ensure that potential future development that results from implementation of the proposed project would not directly or indirectly cause substantial adverse effects, including the risk of loss, injury, or death. Therefore, impacts would be *less than significant*.

Significance without Mitigation: Less than significant.

Downtown Precise Plan

Earthquake Fault Rupture

As discussed in Section 4.7.1.2, Existing Conditions, there are no known active faults within the Downtown Precise Plan Area, and the nearest fault is the Hayward Fault, approximately 9 miles to the east. The Downtown Precise Plan Area is not in an Alquist-Priolo Fault Zone.[34] Based on the lack of known active faults within the Downtown Precise Plan Area and the required geotechnical investigations for all grading within the Downtown Precise Plan, implementation of the Downtown Precise Plan would not directly or indirectly cause the risk of loss, injury, or death involving rupture of a known earthquake fault. Therefore, the impact would be *less than significant.*

Seismic Ground Shaking

There is no way to entirely avoid earthquake hazards in northern California. However, earthquake hazard mitigation is addressed in many State, regional, and local regulations. Appropriate measures to minimize the effects of earthquakes are included in the most recent CBC, with specific provisions for seismic design. Potential future development under the Downtown Precise Plan would be required to comply with the CBC. The design of structures in accordance with the CBC would minimize the effects of ground shaking to the greatest degree feasible. As discussed in Section 4.7.1.1, Regulatory Framework, the SRMC includes Chapter 12.340, which provides minimum standards for structural seismic resistance and systematic procedures for identification and classification of unreinforced masonry buildings and requires qualified Historical Buildings to comply with the State Historical Building Code. Additionally, potential future development would be required to comply with the procedures set forth in the Geotechnical Review Matrix, included as Appendix F of the proposed General Plan 2040, which requires a geotechnical report

[34] California Geological Survey, Alquist-Priolo Earthquake Fault Zoning Act, https://www.conservation.ca.gov/cgs/alquist-priolo, accessed on March 24, 2020.

defining and delineating seismic hazards on a project-by-project basis. Therefore, implementation of the Downtown Precise Plan would not cause or worsen seismic ground shaking, and the impact would be *less than significant*.

Liquefaction

Liquefaction susceptibility is very high in the southeastern portion of the Downtown Precise Plan Area, and moderate to low as the slopes increase in the western and northern portions of the Downtown Precise Plan Area. Although liquefaction susceptibility is very high within the Downtown Precise Plan Area, potential future development would be required to comply with existing regulations. Compliance with these regulations would minimize the risk of loss, injury, or death involving liquefaction due to a seismic-related event, and impacts would be *less than significant*.

Landslides

Areas susceptible to landslides are largely located on the western and southwestern edges of the Downtown Precise Plan Area. New development or redevelopment in any of the portions of the Downtown Precise Plan Area deemed to be within landslide-susceptible areas would be required to comply with grading, erosion, and sediment control regulations in the CBC and provisions in SRMC Chapter 14.12, Hillside Development Overlay District, and Chapter 15.06, Grading and Drainage. Compliance with existing regulations would minimize the risk of loss, injury, or death, and impacts due to landslides would be *less than significant.*

Significance without Mitigation: Less than significant.

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

General Plan 2040

As discussed in Chapter 3, Project Description, of this Draft EIR, potential future development under General Plan 2040 is expected to occur in urban areas and would be concentrated on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. Substantial soil erosion or the loss of topsoil during construction of future development could undermine structures or minor slopes, which would be a concern during implementation of the proposed General Plan 2040.

The CBC provides regulations for construction to provide proper grading, drainage, and erosion and sediment control. In addition, SRMC Section 9.30.150, Erosion and Sediment Control Plan Requirements, requires erosion and sediment control plans for projects that are subject to a grading permit; projects that are subject to a building permit or other permit with the potential for significant erosion or non-stormwater discharges of sediment or construction site waste; and as required by the City based on project characteristics, such as location on hillsides or near creeks, or construction during rainy seasons. Erosion control measures in an erosion and sediment control plan can include seeding slopes, installation

of temporary dikes and swales, placement of straw bales and filter fences, outlet protection, grass-lined swales, and installation of sediment retention structures, as appropriate for specific sites. In addition, SRMC Section 15.06.110, Grading and Drainage, requires grading of development to conform to site-specific soil and geologic conditions with minimal tree removal.

Furthermore, because future development is anticipated to occur as infill or redevelopment in urban areas, development is not likely to result in substantial soil erosion or loss of topsoil. Adherence to existing regulatory requirements that include, but are not limited to, the CBC and the SRMC grading and drainage requirements for new developments, would ensure that impacts associated with substantial erosion and loss of topsoil from potential future development would be *less than significant*.

Significance without Mitigation: Less than significant.

Downtown Precise Plan

As discussed in Chapter 3, Project Description, of this Draft EIR, the Downtown Precise Plan Area is an existing urban area in the city of San Rafael and potential future development would occur on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. Substantial soil erosion or the loss of topsoil during construction of future development could undermine structures or minor slopes, which would be a concern during implementation of the Downtown Precise Plan. However, development in the Downtown Precise Plan Area is subject to the same CBC and SRMC regulations as development under the proposed General Plan 2040, detailed above. Adherence to these regulations would ensure that impacts associated with substantial erosion and loss of topsoil from potential future development would be *less than significant*.

Significance without Mitigation: Less than significant.

GEO-3	**Implementation of the proposed project could 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.**

General Plan 2040

Unstable geologic units are known to be present within the EIR Study Area. As discussed under Impact Discussion GEO-1, landslides have historically occurred and could continue to occur in areas with steeper slopes and less stable soil types. These include areas with Franciscan bedrock, particularly in the upland areas, on the steeper slopes to the west, and on the hillside areas surrounding China Camp State Park, Boyd Park, and Harry Barbier Memorial Park. Subsidence hazards are also known to be present in the EIR Study Area in areas containing Bay Mud and fill materials on the eastern edge of the EIR Study Area. Liquefaction susceptibility ranges from low in upland and hillside areas, to very high in the marshland and tidal marshes along the San Pablo and San Rafael Bay.

As discussed in Chapter 3, Project Description, of this Draft EIR, potential future development as a result of implementation of the proposed General Plan 2040 would occur in existing urban areas and would be concentrated on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. The areas of high liquefaction susceptibility are not located in the highly urbanized portions within the EIR Study Area where potential future development is anticipated to occur; therefore, implementation of General Plan 2040 would not be intentionally located on a geologic unit or on soil that is unstable. However, there is the potential that future development could occur near areas of potential landslides, lateral spreading, subsidence, liquefaction, or collapse.

As determined in Impact Discussions GEO-1 and GEO-2, future development under General Plan 2040 would be required to comply with the CBC, which provides regulations for building design and construction to ensure geologic and soil stability. Additionally, the City requires that geotechnical reports be prepared and submitted to the City prior to approval or construction of applicable projects pursuant to the requirements set forth in the Geotechnical Review Matrix (see Appendix F of the General Plan 2040). In addition to protections afforded by State laws, General Plan goals, policies, and programs listed under Impact Discussion GEO-1 would require local planning and development decisions to consider potential risks of development on unstable soils or geologic units. Policy S-1.2, Program S-1.2A, Policy S-1.3, Program S-1.3A, and Program S-1.3B, listed in Impact Discussion GEO-1, specifically address the location of future development and include development standards that prohibit development in areas where there is a potential danger from geologic hazards.

All potential future development under implementation of the proposed General Plan 2040 would be required to comply with State and local regulations, including SRMC provisions and General Plan goals, policies, and programs that minimize impacts related to unstable geologic units and soils where landslide, lateral spreading, subsidence, liquefaction, or collapse could occur in the EIR Study Area. General Plan 2040 goals, policies, and programs would also require ongoing review, identification, and maintenance of maps and regulations related to geologic and seismic hazards. Therefore, implementation of proposed General Plan 2040 would not result in development on a geologic unit or on soils that are unstable and could result in landslides, lateral spreading, subsidence, liquefaction, or collapse, and impacts would be *less than significant*.

Significance without Mitigation: Less than significant.

Downtown Precise Plan

As discussed in Chapter 3, Project Description, of this Draft EIR, the Downtown Precise Plan Area is an existing urban area in the city of San Rafael and potential future development would occur on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. The Downtown Precise Plan Area contains both landslide and liquefaction susceptibility areas. However, future development under the proposed Downtown Precise Plan would be required to comply with the CBC, which provides regulations for building design and construction to ensure geologic and soil stability. Additionally, the City's Geotechnical Review Matrix requires that geotechnical reports be prepared and

submitted to the City prior to approval or construction of projects in areas with known geological hazards. Therefore, impacts would be *less than significant.*

Significance without Mitigation: Less than significant.

GEO-4 Implementation of the proposed project could be located on expansive soil, as defined by Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.

General Plan 2040

As discussed in Chapter 3, Project Description, of this Draft EIR, potential future development as a result of implementation of the proposed General Plan 2040 would occur in existing urban areas, would be concentrated on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed, underutilized, and/or in close proximity to existing residential and residential-serving development. While expansive soils are not common in the EIR Study Area, they could potentially exist in localized areas such as the Artificial Fill/Bay Mud geologic units underlying the northeastern and southeastern portions of the EIR Study Area. These soils are typically identified during project review stages and require specific engineering methods to reduce stresses to buildings and infrastructure.

The EIR Study Area consists of some State- or County-owned land where future development would not be under the purview of the City of San Rafael. Furthermore, because potential future development under the proposed General Plan 2040 is anticipated to occur in urbanized areas, it is not likely that development would occur in these portions of the EIR Study Area. However, in the event that future development is proposed in these portions of the EIR Study Area and is located on an Artificial Fill/Bay Mud geologic unit, a geotechnical investigation would be required to evaluate soil characteristics and identify mitigation if the soils are determined to be expansive. Such investigations are required both by the SRMC Chapter 12.100 and the proposed General Plan 2040. Both the SRMC and the proposed General Plan 2040 would require that future development proposed on expansive soils follow regulations imposed by the CBC, such as standards for seismic safety, excavation, foundations, retaining walls, site demolition, and grading activities including drainage and erosion control. Furthermore, requirements for geotechnical investigations at development site locations where potential hazards, including land instability, have already been identified are bolstered by various goals, policies, and programs of the proposed General Plan 2040 ,as listed in Impact Discussion GEO-1.

As discussed, potential future development under the proposed General Plan 2040 would be required to comply with existing regulations adopted to minimize development on expansive soils in the EIR Study Area as part of the City's project approval process. Potential future development would also comply with the proposed General Plan goals, policies, and programs that require ongoing review, identification, and maintenance of maps and regulations related to geologic and seismic hazards, impacts would be *less-than-significant*.

Significance without Mitigation: Less than significant.

Downtown Precise Plan

As determined above, expansive soils are located to the east of the EIR Study Area, several miles away from the Downtown Precise Plan Area. Therefore, potential future development in the Downtown Precise Plan Area would not occur on expansive soils and *no impact* would occur.

Significance without Mitigation: No impact.

GEO-5	**Implementation of the proposed project could utilize septic tanks or alternative wastewater disposal systems where soils would be incapable of adequately supporting the in cases where sewers are not available for the disposal of wastewater.**

General Plan 2040

As discussed in Section 4.7.1.1, Regulatory Framework, of this Draft EIR, SRMC Chapter 15.06 prohibits the creation of an individual on-site septic system intended to serve a new lot or parcel. Wastewater from new lots or parcels would be discharged into the existing public sanitary sewer system serviced by the San Rafael Sanitation District and Las Gallinas Valley Sanitation District. Therefore, development in the EIR Study Area would not result in the use of septic tanks or alternative wastewater disposal systems. Additionally, the proposed General Plan 2040 includes Policy S-2.6, Septic Systems, which discourages the use of septic systems in the EIR Study Area, and in the event that no other alternatives exist, on-site soil tests would be required to determine if the soils are suitable for a septic system. Therefore, potential future development would not result in septic tanks or alternative wastewater disposal systems where soils are not capable of adequately supporting such systems, and the impact would be *less than significant*.

Significance without Mitigation: Less than significant.

Downtown Precise Plan

As discussed in Chapter 3, Project Description, of this Draft EIR, the Downtown Precise Plan Area is an existing urban area in San Rafael, and potential future development would occur in an urban area where septic systems are not permitted. Potential future development in the Downtown Precise Plan Area are either already connected to the San Rafael Sanitary District's system or would be required to be as a condition of project approval. Therefore, *no impact* would occur.

Significance without Mitigation: No impact.

GEO-6 Implementation of the proposed project could directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

General Plan 2040

No fossils, unique paleontological resources, or unique geologic features have been recorded in the EIR Study Area. The geology and soils in the EIR Study Area are common throughout the city and region and are not considered to be unique. However, geological formations underlying the EIR Study Area have the potential to contain unique paleontological resources. Potential future development would be required to comply with the federal Paleontological Resources Preservation Act that limits the collection of vertebrate fossils and other rare and scientifically significant fossils to qualified researchers who have obtained a permit from the appropriate state or federal agency and the California Public Resources Code Section 5097 that prohibits the removal of any paleontological site or feature from public lands without the permission of the jurisdictional agency. Ground-disturbing construction activities (e.g., grading and excavation) associated with potential future development in the EIR Study Area could uncover fossilized remains of organisms from prehistoric environments that have not been recorded. The implementation protocols and adherence to the Society of Vertebrate Paleontology standards would ensure the protection of unique paleontological resources during construction of future development. Some protocol include, but are not limited to:

- Excavations within a 50-foot radius of the find shall be temporarily halted or diverted.
- Ground-disturbance work shall cease until a City-approved, qualified paleontologist determines whether the resource requires further study.
- The paleontologist shall document the discovery as needed, in accordance with Society of Vertebrate Paleontology standards (Society of Vertebrate Paleontology 1995) as appropriate, evaluate the potential resource, and assess the significance of the finding under the criteria set forth in CEQA Guidelines Section 15064.5.
- The paleontologist shall notify the appropriate agencies to determine procedures that would be followed before construction activities are allowed to resume at the location of the find.
- If is not feasible, the paleontologist shall prepare an excavation plan for mitigating the effect of construction activities on the discovery. The excavation plan shall be submitted to the City of San Rafael for review and approval prior to implementation.
- All construction activities shall adhere to the recommendations in the excavation plan.

Until such protocol are adopted by the City, ground-disturbing activities could cause damage to, or destruction of, unique paleontological resources. This is considered a *significant* impact.

Impact GEO-6: Construction activities associated with potential future development could have the potential to directly or indirectly affect a unique paleontological resource.

> Mitigation Measure GEO-6: To ensure sensitive and unique paleontological resources are not directly or indirectly affected in the event that such resources are unearthed during project grading, demolition, or building (such as fossils or fossil-bearing deposits), the City shall adopt the following new General Plan Policy and associated Program:

- New Policy: Paleontological Resource Protection. Prohibit the damage or destruction of paleontological resources, including prehistorically significant fossils, ruins, monuments, or objects of antiquity, that could potentially be caused by future development.
  - New Program: Paleontological Resource Mitigation Protocol. The City shall prepare and adopt a list of protocols in accordance with Society of Vertebrate Paleontology standards 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.

Significance with Mitigation: Less than significant.

Downtown Precise Plan

Although the Downtown Precise Plan Area is urban and built out, future development could require substantial excavation that could reach significant depths below the ground surface, where no such excavation has previously occurred. Such excavation could result in the unearthing of unrecorded fossils of potential scientific significance and other unique geologic features. This could result in damage to or destruction of unknown paleontological resources or unique geologic features, and impacts would be *significant*. However, potential future development in the Downtown Precise Plan Area would be required to comply with the Policy and associated Program adopted in the General Plan 2040 as required by Mitigation Measure GEO-6, which would reduce impacts to *less-than-significant* levels.

Significance with Mitigation: Less than significant.

GEO-7 Implementation of the proposed project could result in a cumulatively considerable impact to geological resources.

As discussed in Chapter 4, Environmental Analysis, of this Draft EIR, the cumulative setting includes growth within the EIR Study Area in combination with projected growth in the rest of Marin County and the surrounding region. Anticipated development in the EIR Study Area would be subject to regulations pertaining to seismic safety, including the CBC and SRMC requirements. Compliance with these requirements would, to the maximum extent practicable, reduce cumulative, development-related impacts that pertain to seismic shaking, seismic-related ground failure, seismically induced landslides, soil erosion, and unstable soils. Similarly, compliance with relevant SRMC requirements, as well as the requirements of the CBC, would minimize the cumulative impacts associated with substantial erosion or loss of topsoil. While none of the soils in the EIR Study Area are considered to have unique geological resources, unique paleontological resources may occur. Site specific evaluation in the event that previously unknown resources are discovered during construction activities for new development or redevelopment would be required. Future development would be focused on specific sites or areas, which would be evaluated for site development constraints on a case-by-case basis and required to implement Mitigation Measure GEO-6, which would ensure the projection of unearthed unique paleontological resources. Therefore, the proposed project would not result in a cumulatively considerable impact to geology and soils and cumulative impacts would be *less than significant.*

Significance with Mitigation: Less than significant.