Geology and Soils

Chapter 5

This chapter describes existing conditions and the regulatory framework associated with geology and soils and potential risks associated with fault rupture, seismic hazards, ground shaking, liquefaction, soil erosion or the loss of topsoil, expansive soils, and landform/landslide within the Planning Area, in addition to prime agricultural lands. Information in this section is based on publicly available information, including information provided by the California Geological Survey, the United States Geological Survey, and the Natural Resources Conservation Service.

5.1 Geology and Seismicity

Background

Fairfield is situated along the eastern margin of the seismically active Coast Ranges geomorphic province of California. The area is characterized by folded and faulted sedimentary and volcanic rocks that forms the hills to the west and north and range in age from Mesozoic to Pliocene, while more recent alluvial and intertidal deposits are found in the southeast. Four major formations make up the local geologic units: alluvial deposits that fill the level Suisun and Green valleys; the Sonoma volcanics, which are relatively young (Pliocene age) and comprise the steeper, higher hills north and east of Green Valley; Markley sandstone deposited during the Eocene Epoch, which comprises the north-trending hills west of Interstate 680; and the Great Valley sequence rocks, which are Cretaceous and Jurassic in age and mainly comprise the hills in the north of the Planning Area.

Agriculture

Agriculture is an important part of Fairfield's history, economy, and way of life. The fertile regional soils support an abundant variety of crops, which are showcased by local farmers at weekly markets and stands throughout the Planning Area. The preservation of Fairfield's farmlands and agricultural viability is critical to the City's success; as such, the City has maintained policies to preserve the agricultural land and open space around the city limits. In 2003, the City of Fairfield passed Resolution No. 2003-204, which, pursuant to the 2002 General Plan and EIR, established an agricultural mitigation fee of $11,000 per acre of conversion for all projects that would convert prime farmland, farmland of statewide importance, or unique farmland to urban uses. Resolution No. 2006-81 strengthened this requirement by requiring that all potential conversions of farmland be assessed by the same standard, the 2002 California Department of Conservation Important Farmlands Map, which was used in the 2002 General Plan EIR analysis. This resolution may be amended after the adoption of the General Plan Update, as the updated General Plan will use a more recent DOC Farmlands map for its land use classification and policies.

FARMLAND MONITORING AND MAPPING PROGRAM

The California Department of Conservation supports the preservation of agricultural land by classifying farmland into several categories based on soil type and current land use. Important Farmland Maps are compiled by the Farmland Mapping and Monitoring Program (FMMP), which defines the following categories: Prime Farmland, Farmland of Statewide Importance, Unique Farmland, Farmland of Local Importance, and Grazing Land. All categories exclude publicly owned land for which there is an adopted policy preventing agricultural use. The FMMP designations are informational only and do not constitute any regulatory policy.

- **Prime Farmland** is land that has the best combination of physical and chemical characteristics for crop production. It has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops when managed (including water management) according to current farming methods. Prime Farmland must have been used for the production of crops within the last three years. Sometimes land is classified by its agricultural potential, for example, "Prime Farmland if Irrigated."

- **Farmland of Statewide Importance** is land other than Prime Farmland that has a good combination of physical and chemical characteristics for crop production. It must have been used for crop production within the last three years.

- **Unique Farmland** is that which does not meet the criteria for Prime Farmland or Farmland of Statewide Importance, but which is currently used for the production of specific high economic value crops (as listed in the last three years of California Agriculture, produced by the California Department of Food and Agriculture). It has the special combination of location, soil quality, growing season, and moisture supply to produce sustained high quality or high yields of a specific crop when treated and managed according to current farming practices. Examples may include oranges, olives, avocados, rice, grapes, and cut flowers.

- **Farmland of Local Importance** is either currently producing crops or has the capability to do so. It is land other than Prime Farmland, Farmland of Statewide Importance, or Unique Farmland, but it may be important to the local economy due to its productivity.

- **Grazing Land** is that on which the existing vegetation, whether grown naturally or through management, is suitable for livestock grazing.

Figure 5-1 shows the FMPP designations for the existing farmland in and around Fairfield. Within the Planning Area, farmland is found primarily between central Fairfield and the western neighborhoods including the Cordelia area. Most of the farmland within Fairfield's city limits is classified as prime farmland, though the State recommends irrigation or drainage of some land in order to achieve a prime rating. South of the urban core there are parcels of Farmland of Statewide Importance, as well as Grazing Land. The Planning Area is surrounded on all sides except for the South, where the Suisun Marsh is located, by Grazing Land with patches of Unique Farmland and Prime Farmland found on the hills to the north, and towards Vacaville. Table 5-1 lists the acres by farmland type.

TABLE 5-1: Farmland Types and Acreages

	City of Fairfield		Unincorporated Area		Total Planning Area	
Farmland Classification	***Acres***	***Percentage***	***Acres***	***Percentage***	***Acres***	***Percentage***
Prime Farmland	216.6	0.8%	7455.6	4.9%	7672.2	4.3%
Farmland of Statewide Importance	19.8	0.1%	676.9	0.4%	696.7	0.4%
Unique Farmland	31.8	0.1%	1643.9	1.1%	1675.7	0.9%
Grazing Land	8011.3	29.9%	50744.0	33.5%	58755.3	33.0%
Total Farmland	**8279.5**	**30.9%**	**60520.5**	**40.0%**	**68799.9**	**38.6%**
Total Land Area (Acres)	**26761.0**		**151334**		**178095**	

Source: USDA Soil Series, 2021, FMMP 2017

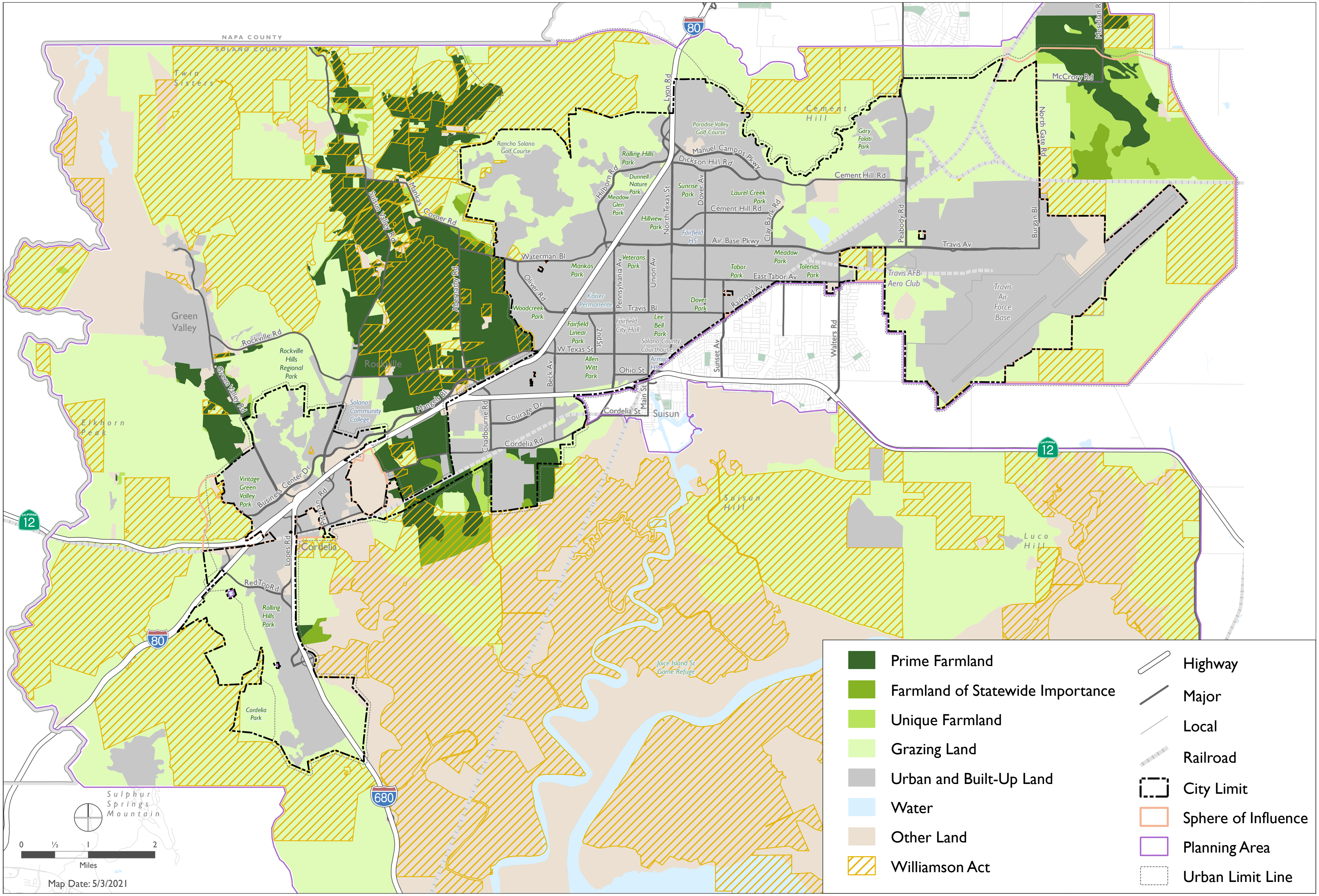
Williamson Act

CALIFORNIA LAND CONSERVATION ACT OF 1965 (WILLIAMSON ACT)

The California Land Conservation Act of 1965, also known as the Williamson Act, aims to discourage the unnecessary and premature conversion of productive agricultural land to other land uses. Farmers with land under Williamson Act contracts agree not to develop their land for a minimum of 10 years, and in exchange, they are taxed according to the land's farm income-producing value, as opposed to its "highest and best use." Contracts are automatically renewed every year; however, the contract can be terminated through the nonrenewal process, in which a "notice of nonrenewal" starts the nine-year nonrenewal period and the annual tax assessment continually increases each year until it is equivalent to current tax rates at the end of the nonrenewal period. Cancellation of the contract requires "extraordinary circumstances," payment of a penalty of 12.5 percent of the land's fair market value, and a public hearing. Local governments receive an annual subvention of foregone property taxes from the State, through the Open Space Subvention Act of 1971.

Figure 5-1 shows land under Williamson Act contracts. Within the city limits, there are 98.6 acres of land under Williamson Act contracts (0.4 percent of total incorporated area). Outside of the city limits but within the Sphere of Influence, there are 62,933.6 acres of land under Williamson Act contracts (41.6 percent of this area). Outside of the Planning Area, many parcels are under Williamson Act contracts, many of which border the Planning Area boundary.

Figure 5-1: Farmlands



Seismic Conditions and Hazards

The term "seismicity" describes the effects of seismic waves that are radiated from an earthquake as it ruptures. The Planning Area is seismically dominated by the presence of the active San Andreas fault system (SAFS). The San Andreas fault system is the general boundary between the northward moving Pacific Plate and the southward moving North American Plate. Movement of the plates relative to one another results in the accumulation of strain along the faults, which is released during earthquakes. Numerous moderate to strong historic earthquakes have been generated in northern California by the SAFS. This level of active seismicity results in a relatively high seismic risk in the San Francisco Bay Area. In their most recent evaluation, the U.S. Geological Survey's (USGS) Working Group on California Earthquake Probabilities estimated that there is a 72 percent likelihood that a 6.7 or greater magnitude earthquake will occur in the San Francisco Bay Area between 2014 and 2044. The faults with a greater probability of movement, with a magnitude of 6.7 or higher earthquake, are the Hayward fault at 14 percent, the Calaveras fault at 7.4 percent, and the San Andreas fault at 6.4 percent.

The SAFS includes numerous faults found by the California Geological Survey in the Bay Area under the Alquist-Priolo Earthquake Fault Zoning Act (A-PEFZA) to be "active" (i.e., to have evidence of fault rupture in the past 11,000 years). Active regional faults include the San Andreas, Hayward, Calaveras, Greenville, Rodgers Creek, and Green Valley faults. In addition to the regional faults, the Cordelia fault poses a potential risk to city residents and property. The Cordelia fault zone crosses the western portion of the Planning Area through Rockville Regional Park and the Cordelia neighborhood. The Vaca-Kirby Hills fault also passes through the eastern portion of the Planning Area, but has not experienced displacement within the past 11,700 years. Due to its proximity to regional and local fault systems, the Planning Area is subject to various seismic and geologic hazards, including surface rupture, ground shaking, liquefaction, and landslides.

SURFACE FAULT RUPTURE

Surface fault rupture can occur during significant seismic events. The process generally involves the sudden failure and displacement of the Earth's surface along a fault trace or fault zone. The magnitude and geometry of such ground displacement is highly variable. Buildings or other manmade structures that lie atop the fault can experience serious damage or catastrophic failure during a strong earthquake.

If an earthquake would occur along the Green Valley or Cordelia faults, which run through the western portion of the Planning Area and city, fault rupture could occur along that fault line. To prevent the construction of buildings used for human occupancy on the surface trace of active faults, the Alquist-Priolo Earthquake Fault Zoning Act was passed to address the hazards of surface fault rupture. Fairfield has two Alquist-Priolo Fault Zones as shown in Figure 5-2, one surrounding the Green Valley fault line, and one surrounding the Cordelia fault line.

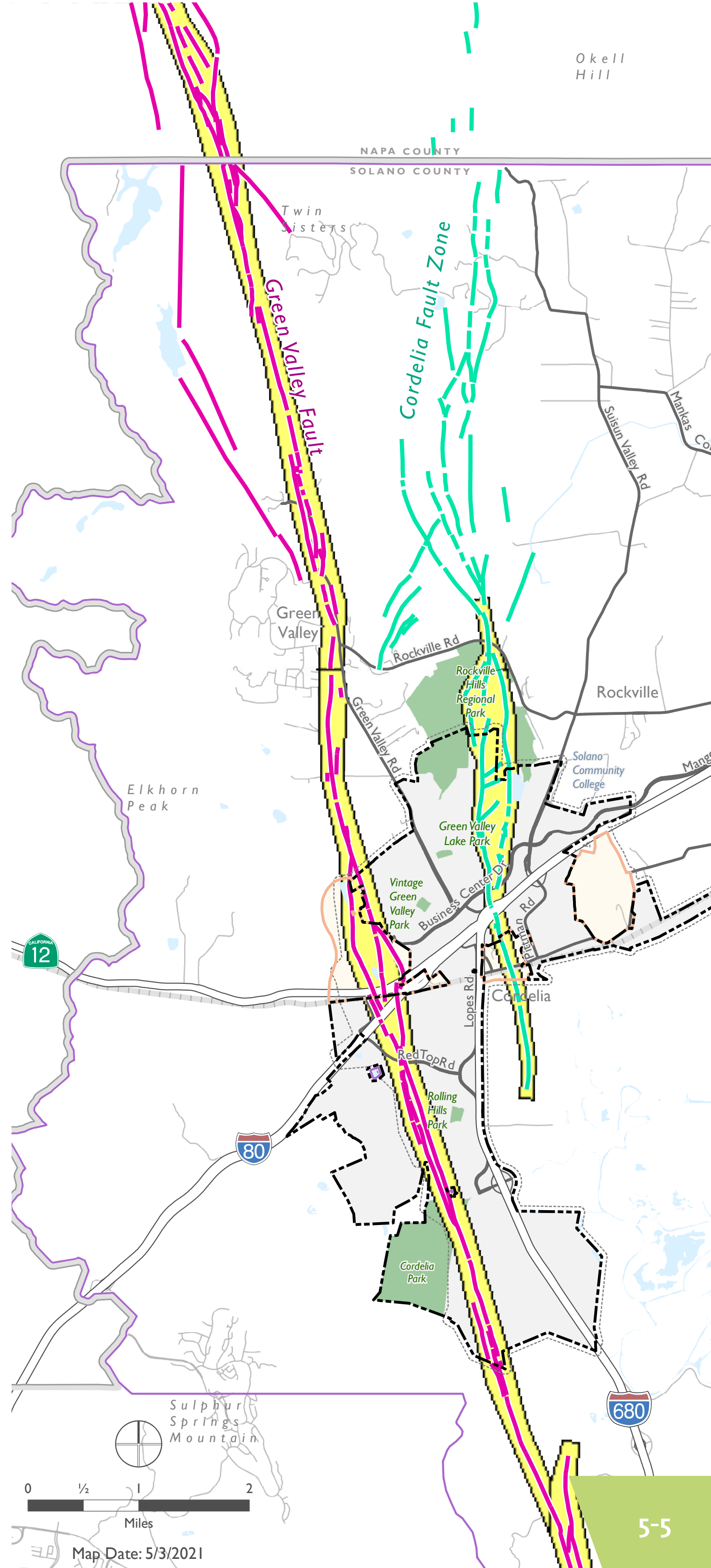
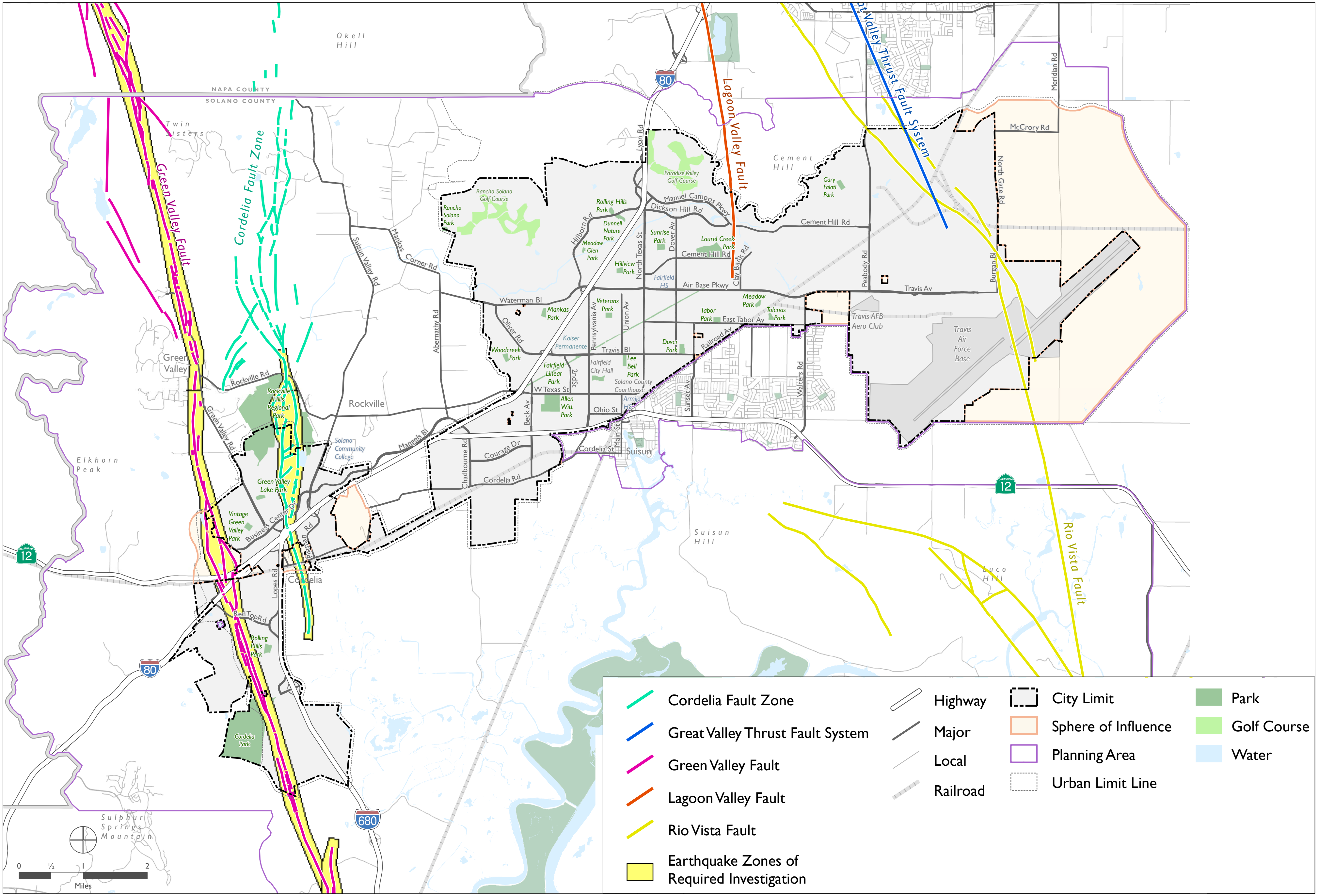


Figure 5-2: Faults and Alquist-Priolo Earthquake Zones of Required Investigation



GROUND SHAKING

Fairfield is located within a seismically active region and earthquakes have the potential to cause ground shaking of significant magnitude. Ground shaking is a general term referring to all aspects of motion of the Earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the rupture, and local geologic conditions. Intensity is a subjective measure of the perceptible effects of seismic energy at a given point and varies with distance from the epicenter and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) is a commonly used scale for measurement of the subjective effects of earthquake intensity. It reports the intensity of shaking on a scale from not felt, "not felt except by a few under especially favorable circumstances" (I), to extreme, "damage total" (XII). The moment magnitude scale, abbreviated MW, is the scale typically used to report the objective size of an earthquake. It measures the total moment release of the earthquake, where movement is a product of the distance a fault moved and the force required to move it. Seismic ground shaking, if sufficiently intense and sustained, can result in significant damage to, or catastrophic failure of buildings or other man-made structures.

Seismic activity along nearby or more distant fault zones is likely to cause ground shaking within the city limits. If an earthquake were to occur, Fairfield could potentially feel ground shaking at a Modified Mercalli intensity of VII, very strong shaking with moderate damage, though it would most likely be at a lower intensity.[3]

LIQUEFACTION

Liquefaction occurs when loosely packed sandy or silty materials saturated with water experience ground shaking extreme enough to lose strength and stiffness. Liquefied soils behave like a liquid and are responsible for tremendous damage in an earthquake. For example, it can cause buildings to collapse, pipes to leak, and roads to buckle. Since saturated soils are a necessary condition for liquefaction, soil layers in areas where the groundwater table is near the surface have higher liquefaction potential than those in which the water table is located at greater depths.

As shown in Figure 5-3, the Planning Area includes areas ranging from low to moderate liquefaction susceptibility. Due to their proximity to the Suisun Marsh, much of the Central Fairfield and Cordelia neighborhoods have a moderate liquefaction susceptibility.[4]

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3 United States Geological Survey, 2017. USGS Forecast for Ground Shaking Intensity from Earthquakes in 2017. Online. https://www.usgs.gov/media/images/usgs-forecast-ground-shaking-intensity-earthquakes-2017

4 United States Geological Survey, 2006. Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco bay Region, California. Online. https://earthquake.usgs.gov/hazards/urban/sfbay/liquefaction/sfbay/

LANDSLIDES

Earthquake-induced landslides are a secondary earthquake hazard that occurs from ground shaking. They can destroy roads, buildings, utilities, and other critical facilities necessary to respond and recover from an earthquake. Many communities in the Bay Area have a high likelihood of encountering such risks, especially in areas with steep slopes. While much of the city's populated land area is relatively flat and has little to no identified landslide potential hazards, hilly areas around Planning Area have varying degrees of landslide susceptibility. As shown in Figure 5-4, the slopes to the east and west of Green Valley are particularly vulnerable to landslides. The hills of the Rancho Solano area have a lower landslide susceptibility.

Figure 5-3: Liquefaction

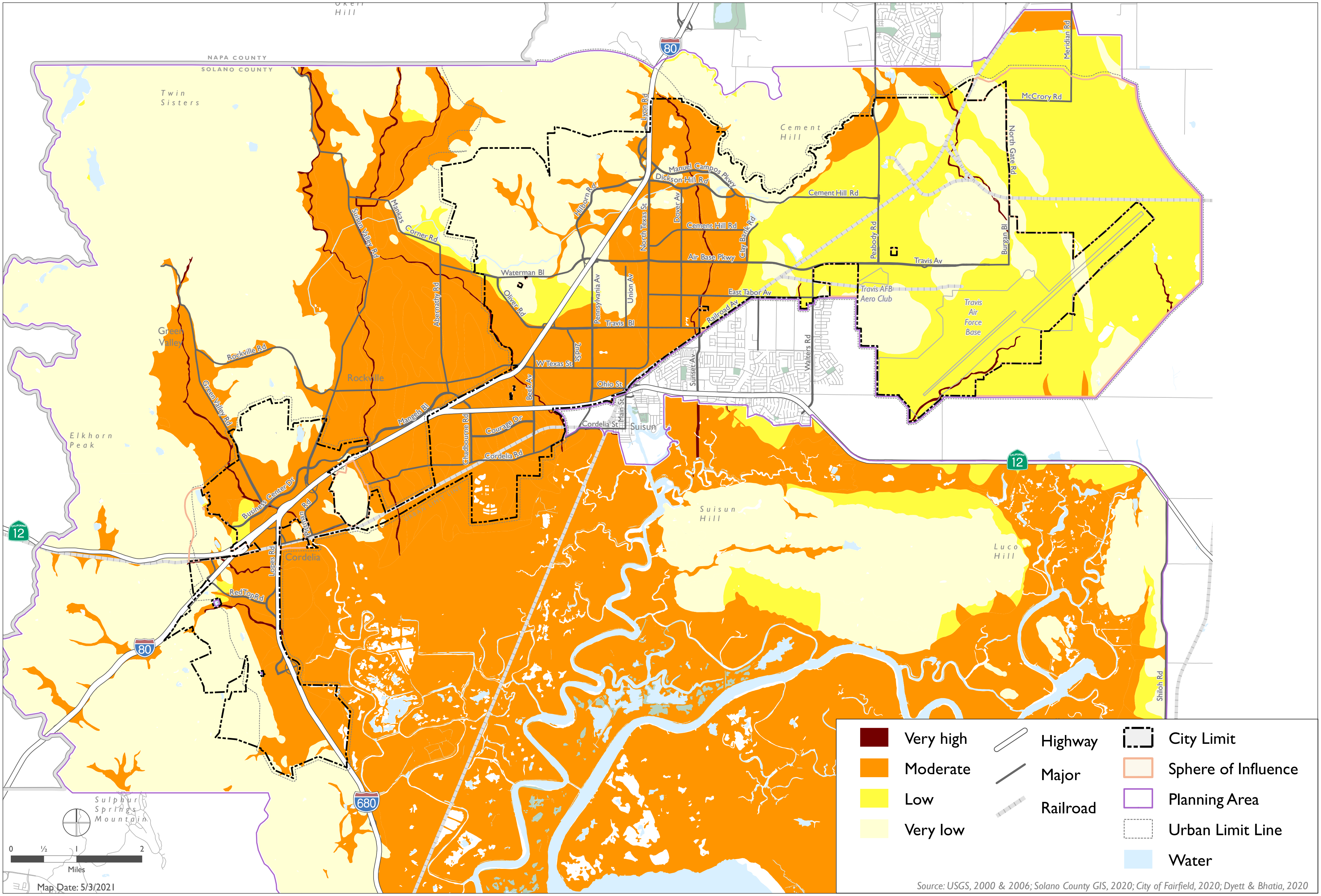
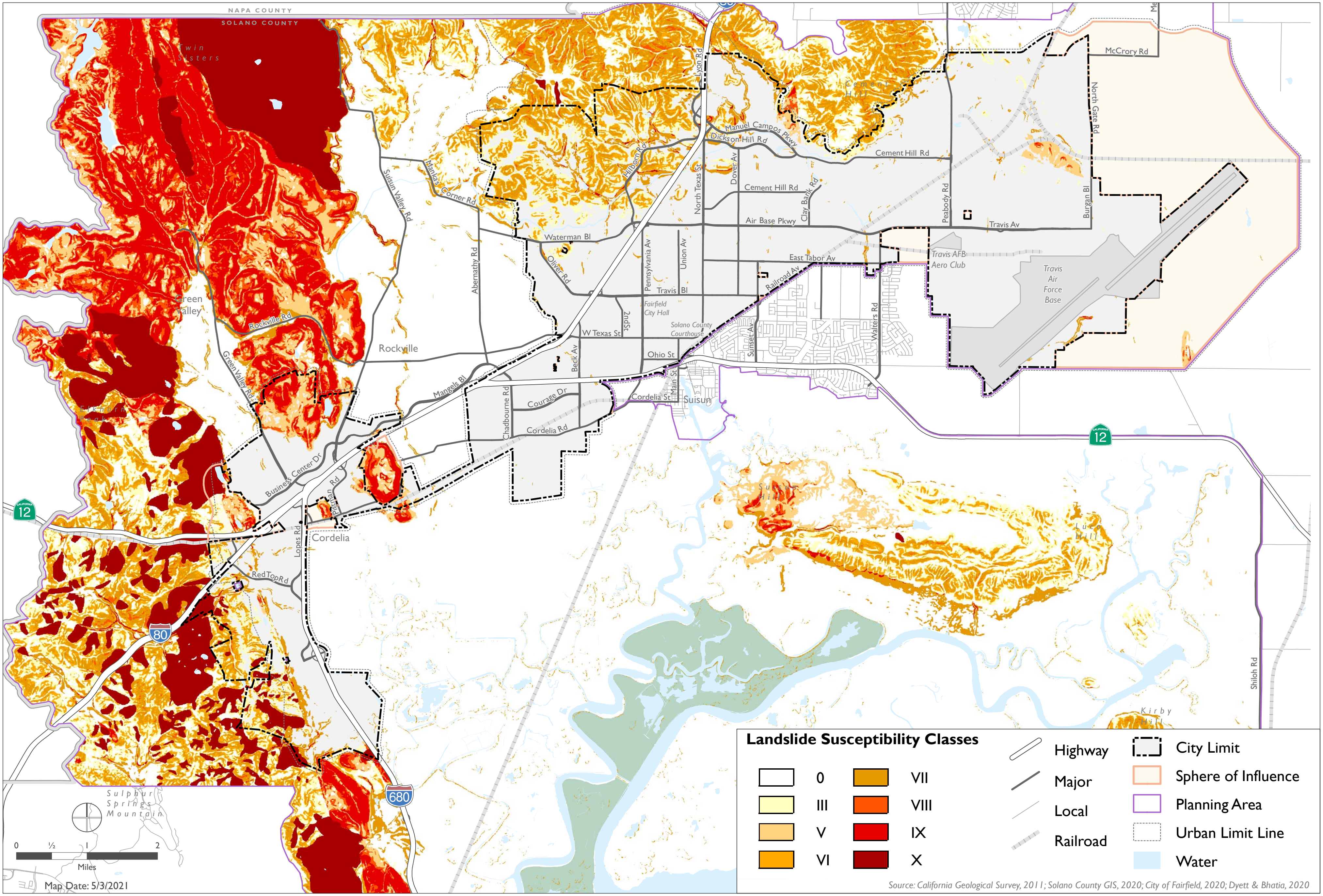


Figure 5-4: Landslides



5.2 Soils

Soil Types

Soil types within the Planning Area are shown in Figure 5-5. Table 5-2 provides a breakdown of the soil type by acreage and percent of planning area. The surface soils in the Planning Area have been mapped by the Natural Resources Conservation Service (NRCS) and consist of many soil types. The Planning Area is primarily underlain by Loam, Clay, Clay Loam, Muck, and Silty Clay. Descriptions of the general characteristics of the primary soils are presented below

TABLE 5-2: Soils Information

Soil Type	Acres	Percentage of Planning Area
Borrow Pit	428	0.24%
Quarries	158	0.09%
Borrow Areas and Quarries	**587**	**0.33%**
Altamont clay	402	0.23%
Altamont-Diablo clays	833	0.47%
Anita cobbly clay	1,642	0.92%
Clear Lake clay	2,268	1.27%
Diablo clay	5,284	2.97%
Diablo-Ayer clays	1,233	0.69%
Pescadero clay	67	0.04%
Ramelli clay	174	0.10%
Stockton clay	12,602	7.08%
Willows clay	28	0.02%
Clay	**24,532**	**13.77%**
Altamont-Nacimiento association	870	0.49%
Altamont-San Ysidro-San Benito complex	628	0.35%
Antioch-San Ysidro complex	5,082	2.85%
Brentwood clay loam	294	0.17%
Bressa-Dibble complex	65	0.04%
Conejo clay loam	300	0.17%
Dibble-Los Osos clay loams	11,916	6.69%
Fagan clay loam	69	0.04%
Goulding cobbly clay loam	1,114	0.63%
Joice muck	137	0.08%

Soil Type	Acres	Percentage of Planning Area
Kang-Beaughton families association	1	0.00%
Pescadero clay	0	0.00%
Pescadero soils	1,315	0.74%
Rincon clay loam	1,624	0.91%
Solano-Pescadero complex	213	0.12%
Clay Loam	**23,627**	**13.27%**
Lava flows	11	0.01%
Searles-Gwin families-Lava flow complex	2	0.00%
Lava Flows	**12**	**0.01%**
Aiken very stony loam	1,387	0.78%
Arbuckle gravelly loam	7,626	4.28%
Churn gravelly loam	2,111	1.19%
Columbia loam	210	0.12%
Conejo soils	437	0.25%
Coombs gravelly loam	1	0.00%
Corning gravelly loam	128	0.07%
Dibble-Los Osos loams	16	0.01%
Endlich-Buell families association	0	0.00%
Guemes family	3	0.00%
Hambright loam	1	0.00%
Hambright-Toomes stony loams	2	0.00%
Henneke very rocky loam	8,458	4.75%
McCarthy very cobbly loam	377	0.21%
Millsholm loam	1,539	0.86%
Orland loam	41	0.02%

Soil Type	Acres	Percentage of Planning Area
Reiff gravelly loam	2,104	1.18%
Rincon loam	274	0.15%
San Ysidro loam	2,720	1.53%
Sobrante loam	226	0.13%
Tehama loam	14,366	8.07%
Toomes stony loam	2,958	1.66%
Vina loam	8	0.00%
Yolo loam	2,630	1.48%
Loam	**47,624**	**26.74%**
Haypress-Toiyabe loamy coarse sands	1,159	0.65%
Loamy Sand	**1,159**	**0.65%**
Joice muck	13,863	7.78%
Muck	**13,863**	**7.78%**
Hambright rock-Outcrop complex	451	0.25%
Rock outcrop	3	0.00%
Rock outcrop-Teewinot family association	0	0.00%
Rock Outcrop	**454**	**0.25%**
Ahwahnee coarse sandy loam	1,121	0.63%
Arbuckle gravelly loam	11	0.01%
Auberry rocky coarse sandy loam	1,529	0.86%
Bidwell sandy loam	1,001	0.56%
Clallam, deep-Goldridge, gravelly families association	3	0.00%
Columbia fine sandy loam	345	0.19%
Gaviota sandy loam	481	0.27%

Soil Type	Acres	Percentage of Planning Area
McCarthy stony sandy loam	1,134	0.64%
McCarthy-Iron Mountain complex	110	0.06%
Millsap sandy loam	815	0.46%
Ruclick-Deven families complex	4	0.00%
San Ysidro sandy loam	2,871	1.61%
Trojan stony sandy loam	676	0.38%
Tyndall very fine sandy loam	1,819	1.02%
Sandy Loam	**11,918**	**6.69%**
Dibble silt loam	2,379	1.34%
Valdez silt loam	265	0.15%
Silt Loam	**2,644**	**1.48%**
Capy silty clay	2,116	1.19%
Marvin silty clay	58	0.03%
Reyes silty clay	11,717	6.58%
Silty Clay	**13,892**	**7.80%**
Sycamore silty clay loam	2,118	1.19%
Valdez complex	56	0.03%
Valdez silty clay loam	6,931	3.89%
Yolo silty clay loam	0	0.00%
Silty Clay Loam	9,105	5.11%
Water	28,619	16.07%
Water (Miscellaneous)	58	0.03%
Water	**28,677**	**16.10%**
GRAND TOTAL	**178,094***	**100.00%**

* Totals have been rounded to a range within +/- one acre.
Source: USDA 20180920 (FY2019 official release)

Loam soils comprise 26.74 percent of the Planning Area. Loam soils are composites that contain relatively 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. Loam soils are widely considered to be the best type of soil for plant growth because their composition of sand, silt, and clay provide desirable texture and drainage characteristics.[3] Tehama Loam and Henneke Very Rocky Loam are the most common types of loam soils in the Planning Area; Tehama Loam is found in the southern portion of the Planning Area surrounding the Suisun Marsh and Henneke Very Rocky Loam tops large portions of the Rockville Hills. Tehama soils are very deep, well drained soils that are formed in mixed alluvium. They are considered farmland of statewide importance, meaning that they are considered by the state to be important soils for growing crops. Henneke Very Rocky Loam is a shallow, well drained soil that is found on hills with slopes of 15 to 60 percent and rock fragments comprise 35 to 60 percent of the soil volume.[4]

Clay soils, primarily categorized as Stockton Clay, comprise 13.77 percent of the Planning Area. These soils are characterized as well draining with slow runoff when soil is dry, medium to rapid when soils are moist, and slow permeability.

3 Michigan State University Geology Department, Soils. Accessed at: https://project.geo.msu.edu/geogmich/soils.html, March 2021.

4 University of Michigan, Guide for Preparing Soil Profile Descriptions, 2003. Accessed at: http://www.umich.edu/~nre430/PDF/Soil_Profile_Descriptions.pdf, March 10, 2021.

Clay loam soils, primarily categorized as Dibble Los Osos soils, are a composite soil that contain 27 to 40 percent clay and 20 to 45 percent sand. These soils are located along the slopes of the Vaca Mountains north of I-80 and Downtown Fairfield, and are characterized as well drained, slow to rapid runoff, and slow permeability. This soil type covers 13.2 percent of the Planning Area.

Silty clay soils, primarily categorized as Reyes silty clay, cover 7.8 percent of the Planning Area. Reyes soil is very deep and poorly drained soil that formed in alluvium along the margin of bays, and they are found in the Suisun Marsh wetlands in the Planning Area. Reyes silty clay found in the Suisun Bay have a more than 50 percent organic matter composition, and are capable of supporting vegetation.

Muck is an organic soil that is saturated for more than 30 cumulative days of the year, and comprises 7.78 percent of the Planning Area, all of it Joice Muck. Joice Muck is located in the Suisun Marsh wetlands. This type of soil is nutritionally rich and therefore ecologically important; muck is not suitable for building upon as it cannot support heavy loads.[5]

5 USDA Soil Series, 2020.

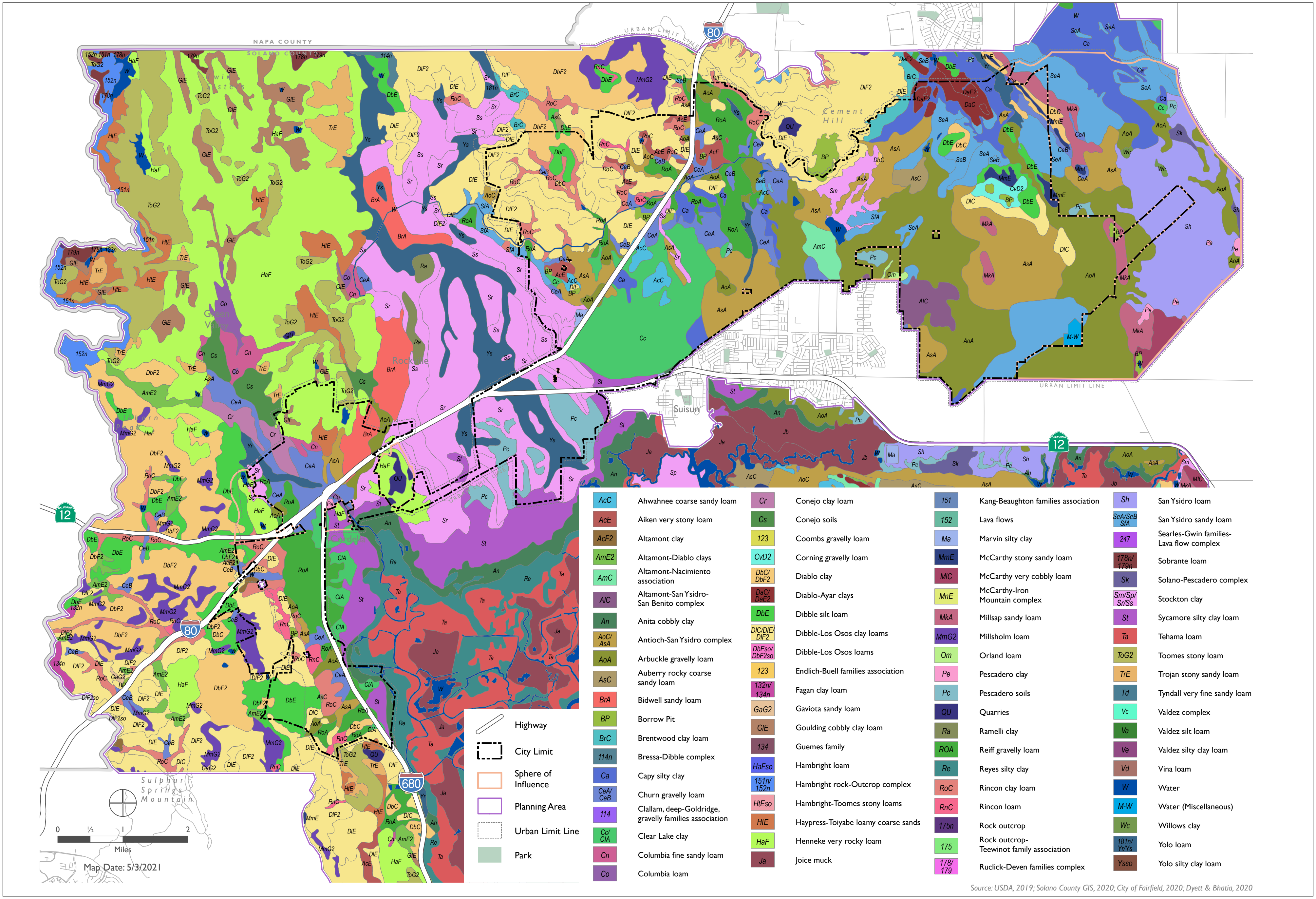
SOIL EROSION

Soil erosion is the process by which soil materials are worn away and transported to another area, either by wind or water. Not accounting for slope and groundcover factors, soils high in clay have low susceptibility to erosion because they are resistant to detachment. Coarse textured soils, such as sandy soils, also have low erosion potential despite their easy detachment, because of low runoff. Medium textured soils, such as the silt loam soils, are moderately susceptible to erosion, while soils with a high silt content are the most susceptible.[6]

Most of the Planning Area—92,768 acres, or 64 percent—is underlain by soils have low erosion susceptibility. Further, since the Planning Area is primarily flat, the risk of soil erosion due to water runoff is relatively low. Stormwater drainage can be a significant cause of soil erosion, if stormwater is not managed well, especially during construction. Excessive soil erosion can eventually damage building foundations and roadways.

6 Institute of Water Research. (2002). RUSLE On-line Soil Erosion Assessment Tool. Retrieved from Michigan State University Institute of Water Research: http://www.iwr.msu.edu/rusle/

Figure 5-5: Soils



Source: USDA, 2019; Solano County GIS, 2020; City of Fairfield, 2020; Dyett & Bhatia, 2020

5.3 Key Findings and Planning Considerations

1 FAIRFIELD MUST BALANCE PROTECTION OF FARMLAND WITH NEW DEVELOPMENT AREAS.

Preservation of viable agricultural land is an important part of Fairfield's regional economy and an important factor in defining the visual character of the city. Nearly a third of the city is classified as farmland, and there are 98.6 acres of land under Williamson Act contracts (0.4 percent of total incorporated area), and outside the City limits are extensive extents of Prime Farmland, as well as farmland in other categories. As the General Plan Update considers new growth areas to meet housing and economic needs, it will also need to balance protection of valuable agricultural lands around Fairfield from the rapidly increasing development pressures within the region, as well as maintain and enhance the City's desired image through a well-balanced pattern of development.

2 FAIRFIELD MUST ACCOUNT FOR SEISMIC RISK IN NEW DEVELOPMENT AND LAND USE DESIGNATIONS.

The SAFS is a significant active regional fault capable of causing a large earthquake. Areas located on or immediately adjacent to the fault require thorough investigation in accordance with the Alquist-Priolo Act and California Building Code (CBC) prior to any development to ensure that fault rupture hazards can be avoided or mitigated to a less than significant impact. Throughout the Planning Area there is potential for strong ground shaking. Current geotechnical practices and seismic design criteria in State regulations and the CBC can minimize potential damage and injury from seismicity. Land use designations in the General Plan should be considerate of seismic risks, especially in areas that are more susceptible to landslides, liquefaction, and along active fault lines, including the hilly areas around the Planning Area, areas near the Suisun Marsh, and the Cordelia neighborhood. However, because soil types can vary considerably and depth to groundwater is an important factor in liquefaction potential, site-specific geotechnical studies should be used to determine whether a specific location may be subject to liquefaction hazard.

3 LANDSLIDES POSE A THREAT TO SAFETY IN THE PLANNING AREA AND SHOULD BE ADDRESSED THROUGH POLICIES IN THE GENERAL PLAN.

Geographic areas containing weaker soils are more susceptible to landslide. Development in areas that are at risk of landslide, including seismically induced landslide, may require special techniques during excavation to shore up excavated areas and reduce likelihood of inducing future landslide. The General Plan Update provides an opportunity to emphasize constraints within hazard zones and provide policy direction for future development within and in close proximity to sensitive and hazardous areas.