3.6 Geology and Soils

This section describes the geology of the project site and surrounding vicinity and analyzes issues such as potential exposure of people and future improvements to geologic hazards, alterations to terrain, and erosion. It also discusses the types of soil that have been identified on the site and their properties as they relate to the proposed project. In addition, potential geologic and seismic hazards such as earthquakes and landslides are discussed. Finally, mineral resources are discussed and analyzed.

3.6.1 SETTING

LOCAL GEOLOGY AND TOPOGRAPHY

The Specific Plan area lies within the geologic region of California referred to as the Coast Ranges geomorphic province. The Coast Ranges province lies between the Pacific Ocean and the Great Valley (Sacramento and San Joaquin valleys) provinces and stretches from the Oregon border to the Santa Ynez Mountains near Santa Barbara. Much of the Coast Ranges province is composed of marine sedimentary deposits and volcanic rocks that form northwest-trending mountain ridges and valleys, running subparallel to the San Andreas Fault Zone. The relatively thick marine sediments dip east beneath the alluvium of the Great Valley. The Coast Ranges can be further divided into the northern and southern ranges, which are separated by the San Francisco Bay. The San Francisco Bay lies within a broad depression created from an east–west expansion between the San Andreas and the Hayward fault systems. (Santa Rosa General Plan 2035 DEIR, 2009)

The Northern Coast Ranges largely comprise the Franciscan Complex or Assemblage, which consists primarily of graywacke, shale, greenstone (altered volcanic rocks), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments. Franciscan rocks are overlain by volcanic cones and flows of the Quien Sabe, Sonoma, and Clear Lake volcanic fields. (Santa Rosa General Plan 2035 DEIR, 2009)

The City of Santa Rosa lies within the northeastern portion of the Cotati valley found along the Santa Rosa Plain and also includes part of the Sonoma Mountains to the east. The Specific Plan area can be characterized by three distinct topographic regimes: gently sloping alluvial plains, upland foothills, and low valleys. The city is situated at the confluence of Matanzas Creek and Santa Rosa Creek, both of which originate from the Sonoma Mountains to the east. The Santa Rosa Plain slopes gently to the west, away from the uplands, toward the lowest elevations of Cotati Valley. Elevations within the Specific Plan area range between 120 and 200 feet above mean sea level. Eastern valleys such as Rincon Valley and Bennett Valley are considered the low intervening valleys at 200 to 300 feet above mean sea level with gentle slopes ranging from 0 to 15 percent. (Santa Rosa General Plan 2035, 2009)

In general, Santa Rosa is underlain by volcanic flow deposits known as the Sonoma Volcanics, sedimentary rocks known as the Petaluma Formation, and alluvial deposits. The Sonoma Volcanics formed during volcanic activity in the region approximately 3 to 6 million years ago and are generally found in the hilly upland areas. The Petaluma Formation is similar in age and consists of claystones, siltsones, and mudstones formed from the deposition of eroded materials in the upland areas. The alluvial deposits have been divided into the younger Huichia Formation and the Glen Ellen Formation, which consist of gravels, silt, sands, and clays found predominantly in the lower valley areas east of Santa Rosa. Recent alluvial sediments deposited after the aforementioned formations are divided into younger and older deposits. The older deposits are considered to be older alluvial fan deposits, dissected by river action, and consist of gravels from the nearby Rodgers Creek Fault Zone. The younger alluvial sediments consist of gravels, sands, silts, and clays. These deposits fill the valleys and originated from continued erosion of the upland areas (Santa Rosa General Plan 2035, 2009). The California Geological Survey (CGS) of the Department of Conservation designates the entire Specific Plan area as Qo (older alluvium) on the Geologic Map of the Santa Rosa Quadrangle (CGS 2012).

SOILS

The United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) (formerly known as the Soil Conservation Service) has characterized the majority of soils in Santa Rosa as clayey alluvial soils and riverwash, as well as some silty and gravelly soils and loams. The most prominent soil type in the city is the Zamora silty claim loam found on 0 to 2 percent slopes, although many other soil units are also mapped in the area including Arbuckle, Clear Lake, Guenoc, Haire Clays, Spreckles, Wright, and Yolo. Zamora soils are moderately permeable and exhibit slow runoff and slight susceptibility to erosion hazards. (Santa Rosa General Plan 2035, 2009)

Site Soils

Soil is generally defined as the unconsolidated mixture of mineral grains and organic material that mantles the land surface. Soils can develop on unconsolidated sediments and weathered bedrock. The characteristics of soil reflect the five major influences on their development: topography, climate, biological activity, parent (source) material, and time. The study area is mantled by surface soils that reflect the characteristics of the underlying materials on which the soil is developed.

The soils of the Specific Plan area are predominantly of the Huichica-Wright-Zamora association. According to the Sonoma County Soils Survey, the Specific Plan area is underlain by Zamora silty clay loam (ZaA) (70 percent), Wright loam (WgC, WhA, WmB) (20 percent), alluvial land (AeA) (8 percent), Clear Lake clay (CfA) (1 percent), and other soils (1 percent). These soils are formed on weathered alluvial deposits and sedimentary alluvium. Specific Plan area soils range from somewhat poorly drained to well drained and are generally described as silty clay loams. Most subtypes are classified as having moderate to high shrink-swell potential. (NRCS 2012)

Site Geology

An area geologic map shows that the Specific Plan area is mapped as old alluvial fan deposits (Qof) of Quaternary Age (greater than 10,000 years old and less than 2 million years old). These fan deposits are described as consisting of deeply weathered and poorly sorted coarse sand and gravel. The deposits are coarse since they are near the sediment source. Since the area has been developed, these deposits are likely to have been significantly graded. There is also a significant volume of imported fill in developed areas that may have a totally different composition. (Santa Rosa General Plan 2035 DEIR, 2009)

Expansiveness

Expansive soils possess a "shrink-swell" characteristic. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may occur over a long period of time, usually the result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils.

Expansion and contraction of volume can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes markedly. As a consequence of such volume changes, structural damage to buildings and infrastructure may occur if the potentially expansive soils were not considered in project design and during construction.

Most of the study area is located on alluvial flatlands. Alluvium and associated materials can result in weak, compressible or expansive soils. The alluvial deposits and soils underlying the study area have moderate to high shrink-swell potential and are generally classified as expansive soils (Santa Rosa General Plan 2035 DEIR, 2009).

Soil Erosion

Soil erosion is a process whereby soil materials are worn away and transported to another area, either by wind or water. Rates of erosion can vary depending on the soil material and structure, placement, and human activity. Soil containing high amounts of silt can be easily eroded, while sandy soils are less susceptible. Excessive soil erosion can eventually damage building foundations and roadways. Erosion is most likely to occur on sloped areas with exposed soil, especially where unnatural slopes are created by cut and fill activities. Soil erosion rates can be higher during the construction phase. Typically, the soil erosion potential is reduced once the soil is graded and covered with concrete, structures, or asphalt. Although the project site is relatively level and existing on-site soils are not characterized as erosion-prone, grading or stockpiling activities during construction could result in soil erosion. (Santa Rosa General Plan 2035 DEIR, 2009)

Settlement

Settlement is the depression of the bearing soil when a load, such as that of a building or new fill material, is placed upon it. Soils tend to settle at different rates and by varying amounts depending on the load weight, which is referred to as differential settlement. Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or loose unconsolidated alluvial sediments.

Differential settlement or subsidence could occur if buildings or other improvements were built on low-strength foundation materials (including imported fill) or if improvements straddle the boundary between different types of subsurface materials (e.g., a boundary between native material and fill). Although differential settlement generally occurs slowly enough that its effects are not dangerous to inhabitants, it can cause significant building damage over time. Any portions of the project area that contain loose or uncontrolled (non-engineered) fill may be susceptible to differential settlement. (Santa Rosa General Plan 2035 DEIR, 2009)

Slope Failure/Landslide Hazards

Slope failures, commonly referred to as landslides, include many phenomena that involve the downslope displacement and movement of material, either triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces. A slope failure is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. Exposed rock slopes undergo rockfalls, rockslides, or rock avalanches, while soil slopes experience shallow soil slides, rapid debris flows, and deep-seated rotational slides. Landslides may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps, slanted vegetation, and transverse ridges. Landslide-susceptible areas are characterized by steep slopes and downslope creep of surface materials. Debris flows consist of a loose mass of rocks and other granular material that, if saturated and present on a steep slope, can move downslope. The rate of rock and soil movement can vary from a slow creep over many years to a sudden mass movement. Landslides occur throughout California, but the density of incidents increases in zones of active faulting. The Specific Plan area is not highly susceptible to slope failure or landslides.

FAULTS AND SEISMICITY

Local Seismic Activity

The San Francisco Bay Area contains both active and potentially active faults and is considered a region of high seismic activity. The United States Geological Survey (USGS), along with the California Geological Survey and the Southern California Earthquake Center, formed the 2007 Working Group on California Earthquake Probabilities, which has evaluated the probability of one or more earthquakes of magnitude 6.7 or higher occurring in California over the next 30 years. The result of the evaluation indicated a 63 percent likelihood that such an earthquake event will occur in the Bay Area between 2003 and 2032 (Santa Rosa General Plan 2035 DEIR, 2009). For Northern California, the combined Hayward-Rodgers Creek Fault has the highest probability (31percent in the next 30 years) for being the source of a magnitude 6.7 or higher seismic event. However, many of the other active faults in the region are also capable of causing significant ground-shaking in the Specific Plan area. (Santa Rosa General Plan 2035 DEIR, 2009)

Santa Rosa lies adjacent to the Rodgers Creek Fault Zone and is approximately 8 miles southeast of the Maacama Fault Zone and 20 miles northeast of the San Andreas Fault Zone. The San Andreas Fault Zone is a major structural feature in the region and forms a boundary between the North American and Pacific tectonic plates. The Hayward-Rodgers Creek and San Andreas fault systems are two principally active Bay Area strike-slip-type faults that within the last 150 years have been responsible for historic earthquakes such as the 1989 Loma Prieta earthquake in Santa Cruz. The Rodgers Creek fault is considered an extension of the Hayward fault and has experienced historic seismic events in 1969 and 1898. The Maacama Fault Zone experienced movement within the last 11,000 years and is capable of producing a maximum moment magnitude 7.1 earthquake. Other principal faults capable of producing ground-shaking in Santa Rosa include the East Bay's Hayward fault, the San Gregorio-Hosgri Fault Zone along the San Mateo Coast, the Calaveras fault, and the Concord-Green Valley fault.

The hazards associated with these regional active faults are related to the estimated potential magnitude of each fault. The estimated (moment) magnitudes represent characteristic earthquakes on particular faults. While magnitude is a measure of the energy released in an earthquake, intensity is a measure of the ground-shaking effects at a particular location. Ground movement during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. The Modified Mercalli intensity scale is commonly used to measure earthquake effects due to ground shaking. The Modified Mercalli values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage. In Santa Rosa, maximum ground shaking intensity resulting from a 7.0 earthquake generated on the Rodgers Creek fault is anticipated to be very strong (Modified Mercalli VIII) to very violent (X) (Santa Rosa General Plan 2035 DEIR, 2009). As a comparison, ground shaking during the 1989 Loma Prieta earthquake (7.1) resulted in light (Modified Mercalli V) ground shaking, whereas the 1906 earthquake produced moderate (VI) to very strong (VIII) ground shaking in the city (Santa Rosa General Plan 2035 DEIR, 2009).

The San Andreas Fault Zone includes numerous active faults found by the California Division of Mines and Geology (now named California Geological Survey) under the Alquist-Priolo Earthquake Fault Zoning Act to be "active" (i.e., to have evidence of fault rupture in the past

11,000 years). Some of the major active faults within the San Andreas Fault Zone include the San Andreas, Hayward, Rodgers Creek, Calaveras, San Gregorio- Seal Cove, Maacama, West Napa, Green Valley, Concord, Greenville, and Calaveras faults. The closest fault to the Specific Plan area is the Rodgers Creek fault, located about 0.5 mile to the east of Santa Rosa.

In a fact sheet published in 2003, the USGS estimated there was a 62 percent probability that between the years 2003 and 2032, a 6.7 or greater magnitude earthquake would occur in the San Francisco Bay Region. The probability of a 6.7 magnitude or greater earthquake occurring along individual faults was estimated to be 21 percent along the San Andreas fault, 10 percent along the San Gregorio fault, 27 percent along the Hayward-Rodgers Creek fault, and 11 percent along the Calaveras fault (Santa Rosa General Plan 2035 DEIR, 2009).

Surface Fault Rupture

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake's seismic waves. The magnitude and nature of fault rupture can vary for different faults or even along different strands of the same fault. Surface rupture can damage or collapse buildings, cause severe damage to roads and pavement structures, and cause failure of overhead as well as underground utilities. As a result of the damage, buildings could become uninhabitable, roads could close, and utility service could be disrupted for an undetermined length of time. Future earthquakes are generally more likely to occur on faults that have had more recent activity and are aligned to relieve accumulating stresses. Ground rupture is typically confined to relatively narrow zones (a few feet to tens of feet wide) and considered more likely along active faults. An Alquist-Priolo Fault Rupture Hazard Zone, as designated through the Alquist-Priolo Earthquake Fault Zoning Act, extends through downtown Santa Rosa.

Ground Shaking

Strong ground movement from a major earthquake could affect the project area during the next 30 years. Earthquakes on the active faults (listed in Table 4.M-1 of the General Plan EIR) are expected to produce a range of ground-shaking intensities at the project area. Ground shaking may affect areas hundreds of miles distant from the earthquake's epicenter. A major seismic event on one of these active faults could cause violent (Modified Mercalli IX) to moderate (VI) ground shaking at the site, as experienced during earthquakes in recent history, namely the 1989 Loma Prieta earthquake. Violent ground shaking from an earthquake on the Rodgers Creek fault could result in considerable damage, with buildings shifted off their foundations and underground pipes broken.

The common way to describe ground motion during an earthquake is with the motion parameters of acceleration and velocity in addition to the duration of the shaking. A common measure of ground motion is the peak ground acceleration. The peak ground acceleration for a given component of motion is the largest value of horizontal acceleration obtained from a seismograph. Peak ground acceleration is expressed as the percentage of the acceleration due to gravity (g), which is approximately 980 centimeters per second squared. In terms of automobile accelerations, one "g" of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds. According to the USGS/CGS Probabilistic Seismic Hazard Assessment Model, peak ground acceleration in the city could reach or exceed 0.63 g (affect a particular site, and expresses the probability of exceeding a certain ground motion) (Santa Rosa General Plan 2035 DEIR, 2009). A probabilistic seismic hazard map represents the severity of ground shaking from earthquakes that geologists and seismologists agree could occur, but has a 90 percent chance of not exceeding in 50 years (an annual probability occurrence of 1 in 475). It is "probabilistic" in the sense that the analysis takes into consideration the uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site, and expresses the probability of exceeding a certain ground motion. (Santa Rosa General Plan 2035 DEIR, 2009)

Liquefaction

Liquefaction is a phenomenon whereby unconsolidated and/or near-saturated soils lose cohesion and are converted to a fluid state as a result of severe vibratory motion. The relatively rapid loss of soil shear strength during strong earthquake shaking results in temporary, fluid-like behavior of the soil. Soil liquefaction causes ground failure that can damage roads, pipelines, underground cables, and buildings with shallow foundations. Liquefaction can occur in areas characterized by water-saturated, cohesionless, granular materials at shallow depths or in saturated unconsolidated or artificial fill sediments located in reclaimed areas along the margin of the San Francisco Bay.

Liquefaction potential is highest in areas underlain by loose fills, Bay mud, and unconsolidated alluvium. The CGS has not investigated the project area or surrounding area for potential designation as a Seismic Hazard Zone for liquefaction. However, according to mapping compiled by the Association of Bay Area Governments (ABAG), the majority of the Specific Plan area has a moderate liquefaction potential, but there are some isolated areas where the potential is greater (Santa Rosa General Plan 2035 DEIR, 2009).

Earthquake-Induced Settlement

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid rearrangement, compaction, and settling of subsurface materials (particularly loose, non-compacted, and variable sandy sediments). Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or loose alluvial sediments. (Santa Rosa General Plan 2035 DEIR, 2009)

3.6.2 REGULATORY FRAMEWORK

FEDERAL

Uniform Building Code

The purpose of the Uniform Building Code (UBC) is to provide minimum standards to preserve the public peace, health, and safety by regulating the design, construction, quality of materials, certain equipment, location, grading, use, occupancy, and maintenance of all buildings and structures. UBC standards address foundation design, shear wall strength, and other structural related conditions.

STATE

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. A direct result of the 1971 San Fernando earthquake and the extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures, the act's main purpose is to prevent the construction of buildings used for human occupancy on the surface of active faults. The act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Seismic Hazards Mapping Act (discussed below) addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.

The law requires the state geologist to establish regulatory zones (known as Earthquake Fault Zones) around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. The law requires that before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults. An evaluation and written report of a specific site must be prepared by a licensed geologist. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault (generally 50 feet) (DOC 2012).

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 (Public Resources Code, Chapter 7.8, Sections 2690–2699.6), passed by the legislature following the 1989 Loma Prieta earthquake, directs the Department of Conservation, California Geological Survey to identify and map areas prone to liquefaction, earthquake-induced landslides, and amplified ground shaking. The purpose of the act is to minimize loss of life and property through the identification, evaluation, and mitigation of seismic hazards.

Staff geologists in the Seismic Hazard Zonation Program gather existing geological, geophysical, and geotechnical data from numerous sources to produce the Seismic Hazard Zone Maps. They integrate and interpret these data regionally in order to evaluate the severity of the seismic hazards and designate as Zones of Required Investigation those areas prone to liquefaction and earthquake-induced landslides. The City of Santa Rosa, including the Specific Plan area, is not affected by Seismic Hazard Zonation Program zones (DOC 2012).

California Building Code

The State of California provides minimum standards for building design through the California Code of Regulations, Title 24, also known as the California Building Standard Code or the California Building Code (CBC). The CBC is based on the Uniform Building Code but modifies UBC regulations for specific conditions found in California and includes a large number of more detailed and/or more restrictive regulations. For example, the CBC includes common engineering practices requiring special design and construction methods that reduce or eliminate potential expansive soil related impacts. The CBC requires structures to be built to withstand ground shaking in areas of high earthquake hazards and the placement of strong motion instruments in larger buildings to monitor and record the response of the structure and the site of seismic activity. Compliance with CBC regulations ensures the adequate design and construction of building foundations to resist soil movement. In addition, the CBC contains drainage requirements in order to control surface drainage and to reduce seasonal fluctuations in soil moisture content.

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System (NPDES) permit program, authorized by Section 402(p) of the federal Clean Water Act, controls water pollution by regulating point sources, such as construction sites and industrial operations that discharge pollutants into waters of the United States. In California, NPDES general permits require filing of a Notice of Intent to discharge and the preparation of a stormwater pollution prevention plan (SWPPP) to control discharges from the site, including soils, to protect waterways. A SWPPP describes the measures or practices to control discharges during both the construction and operational phases of the proposed project. A SWPPP identifies project design features and structural and non-structural best management practices (BMPs) that will be used to control, prevent, remove, or reduce stormwater pollution from the site, including sediment from erosion.

Local

City of Santa Rosa General Plan

The Santa Rosa General Plan 2035 serves as the overall guiding policy document for the City of Santa Rosa. The following is a list of applicable General Plan goals and policies most pertinent to the Specific Plan in regard to geology and soils.

Noise and Safety Element

Goal NS-C: Prohibit development in high-risk geologic and seismic hazard areas to avoid exposure to seismic and geologic hazards.

Policy NS-C-1: Prior to development approval, require appropriate geologic studies to identify fault trace locations within active fault zones as designated by the provisions of the Alquist-Priolo Earthquake Fault Zoning Act. California registered geologists or engineers must conduct these studies and investigation methodologies must comply with guidelines set forth by the Alquist-Priolo Earthquake Fault Zoning Act. Compliance with the Act would insure proper setback or appropriate design to minimize the potential hazards resulting from fault movement and surface displacement.

Policy NS-C-2: Require comprehensive geotechnical investigations prior to development approval, where applicable. Investigations shall include evaluation of landslide risk, liquefaction potential, settlement, seismically induced landsliding, or weak and expansive soils. Evaluation and mitigation of seismic hazards, including ground shaking, liquefaction, and seismically induced landslides, shall comply with guidelines set forth in the most recent version of the California Division of Mines and Geology (CDMG) Special Publication 117. The level of investigation would depend on physical site location, local or regional geologic or seismic hazards, and recommendations by a consulting engineer.

Policy NS-C-3: Restrict development from areas where people might be adversely affected by known natural or manmade geologic hazards. Hazards might include unstable slopes, liquefiable soils, expansive soils or weak poorly engineered fills, as determined by a California registered geologist or engineer.

Policy NS-C-4: Restrict development of critical facilities--such as hospitals, fire stations, emergency management headquarters, and utility lifelines, including broadcast services, sewage treatment plants, and other places of large congregations—in areas determined as high-risk geologic hazard zones (e.g. Rodgers Creek Fault zone, liquefiable soils, areas of slope instability).

Policy NS-C-5: Require identification and evaluation of existing structural hazards related to unreinforced masonry, poor or outdated construction techniques, and lack of seismic retrofit. Abate or remove any structural hazard that creates an unacceptable level of risk, including requiring post-earthquake buildings that are not currently retrofitted and are located within areas determined to experience strong ground shaking during an earthquake.

Policy NS-C-6: Require appropriate and feasible seismic retrofit, as determined by a registered structural engineer, of commercial, industrial, and public buildings that are not currently retrofitted and are located within areas determined to experience strong ground shaking during an earthquake.

Policy NS-C-7: Require inspection for structural integrity of water storage facilities, water conveyance facilities, electricity transmission lines, roadways, water detention facilities, levees, and other utilities after a major seismic event, especially on the San Andreas or Rodgers Creek faults.

Local Hazards Mitigation Plan

The Local Hazards Mitigation Plan is a multijurisdictional document entitled *Taming Natural Disasters*. The City of Santa Rosa adopted the document as its mitigation strategy in May 2006. The goal of the mitigation plan is to maintain and enhance a disaster-resistant region by reducing the potential loss of life, property damage, and environmental degradation from natural disasters, while accelerating economic recovery from those disasters. The City of Santa Rosa is committed to reviewing and updating this plan at least once every five years, as required by the Disaster Mitigation Act of 2000. This plan is currently being updating.

Building Code

Chapter Title 18 of the Santa Rosa Municipal Code addresses general building and construction practices and lists requirements. Building and construction is required to be in accordance with the California Building Code Volumes 1 & 2, 2001 Edition, published by the International Conference of Building Officials and the California Building Standards Commission. Review and abatement of existing buildings considered seismic hazards is included under Chapter 18-48 of the Municipal Code.

Grading and Soils Ordinances

Title 19 of the Santa Rosa Municipal Code discusses grading and soils requirements for structural foundations. Provisions include completion of a preliminary soils report prepared by a licensed civil engineer based upon adequate test borings or excavations for subdivisions. This may be waived if the City's Chief Building Official determines that critically expansive soil or other soils problems which could lead to structural defects do not exist. If the soils report indicates the presence of critically expansive soil or other soil problems which, if not corrected, would lead to structural damage, the City requires a complete soils investigation for each lot in a subdivision prepared by a licensed civil engineer. This report is required to include recommended corrective actions to prevent structural damage to proposed structures. The report and investigation are conditions of approval for subsequent plan-level and building permits.

Santa Rosa Storm Water Management Plan

In 2010, Santa Rosa was issued a joint Municipal Separate Storm Sewer (MS4) NPDES permit with the County of Sonoma and Sonoma County Water Agency (SCWA) by the North Coast Regional Water Quality Control Board (North Coast RWQCB). The City must comply with the provisions of the permit by ensuring that new development and redevelopment mitigate water quality impacts to stormwater runoff both during construction and post construction.

Under direction from the North Coast RWQCB, the City prepared the Storm Water Low Impact Development Technical Design Manual (LID Manual). The LID Manual was adopted in October 2011 and implemented in 2012 as a part of the MS4 NPDES permit for the City of Santa Rosa, the County of Sonoma, and the SCWA. The purpose of the manual is to manage the quality and volume of stormwater runoff in the Santa Rosa area and to aid in the conservation of natural areas in the region. The manual describes and evaluates various best management practices for stormwater management and outlines procedures for BMP maintenance and inspection. Both privately sponsored and public capital improvement projects in the Santa Rosa area are governed by LID Manual requirements.

Additionally, a Notice of Intent with the State Water Resources Control Board (SWRCB) is required for discharges of stormwater associated with construction activity of projects disturbing 1 acre or more of soil. A developer must propose control measures that are consistent with the California Stormwater Quality Association. A stormwater pollution prevention plan (SWPPP) must be developed and implemented for each site covered by the State General Permit.

3.6.3 IMPACTS AND MITIGATION MEASURES

STANDARDS OF SIGNIFICANCE

The impact analysis provided below is based on the following State CEQA Guidelines Appendix G thresholds of significance. An impact to geology, soils, and mineral resources is considered significant if the project would:

1) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.

2) Strong seismic ground shaking.

3) Seismic-related ground failure, including liquefaction.

4) Landslides.

5) Result in substantial soil erosion or the loss of topsoil.

6) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.

7) Locating on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.

8) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

9) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state, or a locally important mineral resource recovery site delineated on a local land use plan.

METHODOLOGY

Evaluation of potential geologic and soil impacts of the proposed Specific Plan was based on review of available documentation, including the City of Santa Rosa General Plan, General Plan EIR, and other documentation. Other documents reviewed include the Downtown Station Area Specific Plan EIR and documentation from ABAG, the USDA, and the USGS.

PROJECT IMPACTS AND MITIGATION MEASURES

Ground Rupture (Standard of Significance 1)

Impact 3.6.1 In the event of a major earthquake in the region, surface fault rupture would cause damage to, destruction of, or injury in development anticipated under the proposed Specific Plan. The impacts of ground rupture on the Specific Plan area are considered **less than significant.**

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 initiated a program of mapping active and potentially active faults. Active and potentially active faults in Sonoma County have undergone extensive investigation in the past. ABAG has summarized results from many of these studies to quantify the potential impact to certain areas, while the CGS has established Earthquake Fault Zone boundaries.

The latest available maps show the nearest Earthquake Fault Zone to the Specific Plan area is the Rodgers Creek fault, with the greatest impact on the commercial corridors along Highway 101 (Santa Rosa General Plan 2035 DEIR, 2009). No other faults considered active or potentially active are mapped across the Specific Plan area. Aside from mapped faults, there could also be a rupture on an undiscovered or blind thrust fault. Such an earthquake caused major damage in the Northridge area of the San Fernando Valley in Southern California in 1994. This risk is difficult to assess, but is considered most likely parallel to a mapped thrust fault zone, particularly where there has been evidence of recent uplift or mountain building. However, this is not the case in the Specific Plan area, so the risk from fault rupture is considered a **less than significant** impact.

Mitigation Measures

None required.

Ground Shaking (Standard of Significance 2)

Impact 3.6.2 In the event of a major earthquake in the region, ground shaking would cause damage to, destruction of, or injury in development anticipated under the proposed Specific Plan. The impacts of ground shaking on the Specific Plan area are considered **less than significant**.

Strong to violent ground shaking can cause foundation or other major structural damage leading to damage or collapse, falling objects endangering people and structures, and creation of general ground instability undermining or weakening structures leading to eventual collapse or requiring major repairs. The San Francisco Bay Area is a seismically active region, and experts consider it likely that Santa Rosa, including the Specific Plan area, would be subjected to at least strong seismically induced ground shaking within the design life of the development in the area. According to a recent study completed by the Working Group on California Earthquake Probabilities assessing the probability of earthquakes in the San Francisco Bay Area, there is a 62 percent probability that a major earthquake of Richter Magnitude 6.7 or greater will strike the region during the next 30 years. (Santa Rosa General Plan 2035 DEIR, 2009)

The intensity of ground shaking will vary with the distance and magnitude of the earthquake causing the ground shaking. There is likely to be at least strong shaking equivalent to a Modified Mercalli intensity of VII due to a major earthquake along the San Andreas, Maacama, Hayward, or other faults. A major earthquake along the nearby Rodgers Creek fault is predicted to generate violent ground shaking equivalent to a Modified Mercalli intensity level of IX. (Downtown Station Area Specific Plan DEIR 2007)

According to ABAG, such shaking could completely destroy or badly damage unreinforced masonry or poorly built structures not meeting the current seismic code. Structures built to meet the current seismic code for resistance to lateral movement, including shear keys, bolted foundations, shear walls, and other precautionary engineering methods, are not predicted to be destroyed, but are likely to suffer at least minor damage, especially from items falling off shelves, cracked facades, damaged utility pipes, etc. Frame structures are predicted to shift off foundations if not bolted.

Actual ground motions resulting from ground acceleration may be amplified or dampened depending on the underlying geologic materials. Deep and soft soils tend to amplify waves, whereas shallow soils overlying hard bedrock tend to dampen shaking intensity. In the Specific Plan area, a relatively thick layer of alluvium from Steele Creek or Paulin Creek could amplify shaking where sedimentary layers are unconsolidated or where there are weak soils. Factors reducing amplification of ground waves include use of engineered fill, shallow rock, and subsurface drains designed to reduce ground saturation underneath foundations.

However, all structures in the Specific Plan area must be designed in accordance with currently adopted building codes and ordinances of the City of Santa Rosa, including the California Building Code. Furthermore, General Plan Policy NS-C-2 requires a comprehensive geotechnical investigation prior to development approval, where applicable. Such investigation must include evaluation of all seismic hazards, including seismic ground shaking. Additionally, Policy NS-C-4 restricts development of critical facilities in high-risk geologic hazard zones. General Plan Policies NS-C-5 and NS-C-6 further require identification, evaluation, and retrofitting of historical buildings. Moreover, Policy NS-C-7 requires inspection of major utilities following earthquakes. In addition, Title 19 of the Santa Rosa Municipal Code requires proper foundation engineering and construction in accordance with recommendations of a licensed civil engineer. Incorporation of seismic construction standards will reduce the potential for significant catastrophic effects of ground shaking such as complete structural failure, but may not eliminate completely the hazard of seismically induced ground shaking. However, subsurface geotechnical investigations would be performed to evaluate soils in the subsurface at each proposed development or redevelopment site within the Specific Plan area. Therefore, seismic shaking is considered a less than significant impact.

Mitigation Measures

None required.

Liquefaction (Standard of Significance 3)

Impact 3.6.3 In the event of a major earthquake in the region, localized liquefaction would cause damage to, destruction of, or injury in development anticipated under the proposed Specific Plan. The impacts of liquefaction on the Specific Plan area are considered **less than significant.**

Liquefaction is the temporary transformation of saturated, cohesionless soil into a viscous liquid as a result of ground shaking. As stated above, the majority of the Specific Plan area, like the rest of the city, has a moderate liquefaction potential, but there are some isolated areas where the potential is greater. This assessment is likely due to the occurrence of deep alluvial soils in close proximity to active faults.

A geotechnical investigation or geologic assessment would assess the site-specific liquefaction potential in more detail. While this may have been done for newer structures or renovations in the Specific Plan area, it has not been comparatively assessed for all sites in the Specific Plan area. However, general soils characteristics used to determine liquefaction potential may be determined from the soils survey. In addition to shallow groundwater causing saturated soils, cohesion is the most important measure determining whether a soil is prone to liquefaction. Cohesion reduces liquefaction potential, with those soils at greatest risk having little or no cohesion, such as sandy or silty soils. While the soils survey did not directly measure cohesion, it is well known that clayey or highly plastic soils have the highest cohesion.

General Plan Policy NS-C-2 requires an investigation prior to development approval for the potential of soil liquefaction during seismic ground shaking to result in damage to structures, pavements, and utilities. Furthermore, subsurface geotechnical investigations will be performed to evaluate soils in the subsurface at each proposed development or redevelopment site within the Specific Plan area. Therefore, liquefaction represents a less than significant impact to development proposed in the Specific Plan area.

Mitigation Measures

None required.

Landslides (Standard of Significance 4)

Impact 3.6.4 In the event of a major earthquake in the region, seismic-related landsliding would cause damage to, destruction of, or injury in development anticipated under the proposed Specific Plan. The impacts of seismic-related landslides on the Specific Plan area are considered **less than significant.**

During earthquake-induced ground shaking, unstable slopes can fail, causing landslides and debris flows. The Specific Plan aea is not known to be located within an earthquake-induced landslide zone. However, very steep slopes greater than 50 percent adjacent to Steele Creek or Paulin Creek may be subject to some type of slope failure as a result of violent ground shaking. Another feature characteristic of slope instability that could result from an earthquake is lurch cracking, the development of fissures or cracks on slopes overlain by weak soils that can result from swaying, rolling, or spreading of the ground during a strong earthquake. This hazard is considered minimal due to lack of slopes, except at the top of bank next to Steele Creek or Paulin Creek where development that encroaches upon the bank top may be susceptible to some sort of slope failure. Although General Plan Policy NS-C-3 requires development restrictions in unstable areas, including any unstable slopes, the policy does not identify the banks of Steele Creek or Paulin Creek as particularly unstable. The greatest chance of such failure would occur in response to strong seismic shaking and therefore seismically induced slope failure and instability adjacent to Steele Creek and Paulin Creek.

In the city, if a project meets the Zoning Code-required creek setback standards, no further stability analysis is required. If there is evidence of a stability problem or if a structure would encroach into the creek setback, the Building Division would require an analysis. Soils reports are required by the Building Division for new structures and additions larger than 500 square feet. A soils engineer would identify if there are stream bank issues. Compliance with these City-mandated requirements would ensure that this impact is less than significant.

Mitigation Measures

None required.

Soil Erosion or Loss of Topsoil (Standard of Significance 5)

Impact 3.6.5 New development anticipated under the proposed Specific Plan would be subjected to erosion and loss of topsoil. The impacts of soil erosion or loss of topsoil on the Specific Plan area are considered **less than significant.**

Redevelopment of sites within the Specific Plan area will involve the removal of existing structures and pavement that currently help to stabilize site soils. The exposure of the soils during land clearing and grading activities may lead to increased surface runoff and erosion, with possible impacts to Steele Creek or Paulin Creek. However, because the Plan area does not contain steep slopes or grades, the potential for soil erosion is slight and soil loss can be easily controlled. To reduce erosion, the City of Santa Rosa Grading and Erosion Control Ordinance requires the preparation and implementation of an erosion control plan. Moreover, General Plan Policy NS-C-8 requires erosion control measures to be implemented to reduce soil erosion from runoff, construction operations, wind, and other causes. These requirements overlap those of the Storm Water Management Plan, which requires the preparation and implementation of a SWPPP for individual development or redevelopment projects proposed under the Specific Plan. Therefore, erosion and loss of topsoil is considered a less than significant impact.

Mitigation Measures

None required.

Soil Settlement (Standard of Significance 6)

Impact 3.6.6 New development anticipated under the proposed Specific Plan would be subjected to differential settlement. The impacts of differential settlement on the Specific Plan area are considered **less than significant.**

Settlement of soils is a primary consideration for the stability of any foundation or structure. Settlement may be due to removal of groundwater trapped in pore spaces within soils. This type of settlement generally occurs in sand and silty sand soils. The reduction in pore pressure would cause the load to compress the pore space, causing settlement. Settlement may also occur due to compressibility of dry soils. Fine-grained soils such as silts and clays may also settle. Settlement of fine-grained soils is generally related to the density and moisture content of the soils. Low-density, high moisture content soils commonly settle during loading. Deep, fine-grained soils are present in the Specific Plan area and may be subject to compression and settlement during loading with fill soils or structural foundations.

According to the Geotracker database maintained by the State of California that contains monitoring well data, the depth to groundwater in the area has been recorded between 2 and 35 feet below the ground surface (SWRCB 2012).

In general, soils conditions are suitable for development and may be engineered in accordance with the California Building Code and other geotechnical requirements to provide sufficient foundation for structures. Requirements include removal of any non-suitable soils consisting of native subgrade or fill soils and replacement with compacted and moisture-conditioned engineered fill in accordance with accepted geotechnical standards. Testing, required under General Plan Policy NS-C-2, will be required prior to development approval, where applicable. Investigations shall include evaluation of landslide risk, liquefaction potential, settlement, seismically induced landsliding, or weak and expansive soils. Proper implementation of these regulations and policies would reduce the impact on development to a less than significant level.

Mitigation Measures

None required.

Unstable Geologic Soils (Standard of Significance 6)

Impact 3.6.7 New development anticipated under the proposed Specific Plan could be subject to erosion. The impacts of erosion on the Specific Plan area are considered **less than significant.**

Slope steepness is generally the dominant factor governing slope stability, along with drainage and soil and bedrock conditions. Steep slopes that exceed 50 percent are especially prone to landslides in areas of weak soil and/or bedrock. Debris flows and shallow slope failures are known to occur on very steep slopes with shallow soils.

Slope failures occur when the shear stress of a soil or rock mass exceeds its shear strength. Shear stress can be increased by adding to the weight of the soil or rock mass through saturation or loading. Shear strength can be reduced by erosion or grading at the toe of a slide mass. Failure can occur due to either an increase in shear stress or a decrease in shear strength. Zones of low shear strength are often associated with the presence of expansive clay soils and weak bedrock units or structural features susceptible to failure. Sandy soils on steep slopes can experience failure during periods of intense rainfall when loading of the soil with water exceeds the rate at which the soil can drain. These types of failures are generally termed debris flows or mudflows when finer material is involved. Landslides involve the discrete or coherent motion of a block of material and frequently occur along fault traces or structural discontinuities.

Geologic maps show no landslides that threaten the project area, so the risk of slope failure in the majority of the Specific Plan area is considered low. However, maps are not detailed enough to show small slope failures such as could occur along the banks of Steele Creek and Paulin Creek.

While existing conditions do not indicate particularly unstable soil conditions, improper compaction of engineered fill, creation of unstable slopes or cuts during mass grading, or unforeseen conditions could be an issue. General Plan Policies NS-C-1 through NS-C-4 generally restrict development in areas of high hazards and require geotechnical investigations to evaluate potential hazards and provide recommendations to mitigate them. These policies require more stringent requirements for critical facilities. In addition, Policy NS-C-8 requires minimum erosion control measures for current properties and those under construction to protect from soil erosion and loss of topsoil. Compliance with the City-mandated creek setback requirements discussed under Impact 3.6.4 above would ensure that this impact is less than significant.

Mitigation Measures

None required.

Expansive Soil (Standard of Significance 7)

Impact 3.6.8 The proposed project will be located on soils that may have the potential for expansion and contraction. Impacts associated with expansive soils are considered **less than significant.**

Soils with moderate to high expansion potential are susceptible to shrinking and swelling due to fluctuations in moisture content and are a common cause of foundation deterioration, especially cracking of concrete slabs. Expansive soils are defined in Table 18-1-B of the Uniform Building Code (1994), later adapted in the California Building Code adopted by the City of Santa Rosa. According to these criteria, highly expansive soils have an expansion index exceeding 90. Such soils are highly plastic, as they will deform constantly under a constant stress, not the case for brittle or visco-elastic solids and liquids. Highly plastic soils have a large plasticity index and behave plastically over a wide range of moisture conditions. In the Specific Plan area, soils are considered moderately plastic and are therefore considered to have at least moderate expansion and shrink-swell potential. Compliance with the City-mandated requirements discussed under Impact 3.6.4 above would ensure that this impact is less than significant.

Mitigation Measures

None required.

Septic Tank Support (Standard of Significance 8)

Impact 3.6.9 Land uses in the Specific Plan would not use septic tanks. There is **no impact**.

The area wastewater will be serviced by the City of Santa Rosa's sewer system. Therefore, the project is considered to have no impact related to septic tanks.

Mitigation Measures

None required.

Mineral Resources (Standard of Significance 9)

Impact 3.6.10 No significant mineral resources exist within the Specific Plan area. There is **no impact**.

According to the Santa Rosa General Plan 2035, no significant mineral resources are identified with the Specific Plan area (Santa Rosa General Plan 2035 DEIR, 2009). Therefore, no impact would occur.

Mitigation Measures

None required.

3.6.4 CUMULATIVE SETTING, IMPACTS, AND MITIGATION MEASURES

CUMULATIVE SETTING

Impacts associated with geology and soils generally are site-specific (determined by a particular site's soil characteristics, topography, and proposed land uses) rather than cumulative in nature. Individual development projects in the region would be subject to, at a minimum, uniform site development and construction standards relative to seismic and other geologic conditions that are prevalent in the region. Impacts regarding surficial deposits, namely erosion and sediment deposition, can be cumulative in nature within a watershed.

CUMULATIVE IMPACTS AND MITIGATION MEASURES

Cumulative Geology and Soils Impacts

Impact 3.6.11 Development described by the proposed Specific Plan in addition to other proposed and approved projects in the vicinity would not result in creation or exacerbation of any identified geological or soils impacts. This impact is **less than cumulatively considerable.**

Development within the Santa Rosa Urban Growth Boundary has the potential to result in a cumulative impact related to geology and seismicity. However, the General Plan 2035 EIR identified that with the policies included in the General Plan, the General Plan would result in a less than cumulatively considerable impact related to geologic and seismic impacts. Given that the Specific Plan area is relatively flat, there is low potential for the Specific Plan to cumulatively contribute to erosion or landslides. Soils in the Specific Plan area are not designated for protection; therefore, there is no impact if they are graded in compliance with existing policies and regulations. There is a potential impact from increased population in a seismic zone. However, this impact is discussed under the risk from seismic shaking and would be adequately addressed through compliance with the City's General Plan policies and ordinances. In addition, the Specific Plan would result in no impact to mineral resources. Overall development is unlikely to change the geology of the region; therefore, the Specific Plan would not contribute to a cumulative impact regarding geological and soil concerns. This impact is less than cumulatively considerable.

Mitigation Measures

None required.

REFERENCES

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