5.6 Geology, Soils, and Seismicity

This section discusses the geology of the Project area and general vicinity and analyzes hazards related to geology and soils, such as potential exposure of people and property to geologic hazards, landform alteration, and erosion. Water quality issues are addressed in Section 5.9, Hydrology and Water Quality.

5.6.1 EXISTING SETTING

LOCAL GEOLOGY AND TOPOGRAPHY

Regional Setting

The majority of Sacramento County, including the entire City of Elk Grove and the Project area, lies in the Great Valley geomorphic province. A geomorphic province is defined as an area with similar geologic origin and erosional/depositional history. The Great Valley geomorphic province is an alluvial plain approximately 50 miles wide and 400 miles long located in central California (CGS 2002a). The Great Valley province is bounded on the north by the Klamath and Cascade mountain ranges, on the east by the Sierra Nevada, and on the west by the Coast Range. The Great Valley is a trough in which sediments consisting of Cenozoic non-marine (continental) sedimentary rocks and alluvial deposits have been deposited almost continuously since the Jurassic period approximately 160 million years ago. Elk Grove is in the northern portion of the Great Valley geomorphic province, the Sacramento Valley, and is drained by the Sacramento River (CGS 2002a, 2010).

Surface elevations in the Great Valley generally range from several feet below mean sea level (msl) to more than 1,000 feet above msl. The ground surface elevation in the vicinity of Elk Grove ranges from approximately 10 to 150 feet above msl (City of Elk Grove 2003a).

Project Area

The Project area and the surrounding area are underlain with quaternary alluvium terraces. Based on the US Geologic Survey (USGS) 7.5-minute quadrangle map of Elk Grove, the Project area generally ranges between 31 and 43 feet above mean sea level with topography that is generally level throughout the site. State Route (SR) 99 is located to the east of the Project area. There are no distinctive geological features, such as rock outcroppings, within the proposed Project area.

Faults and Seismicity

Sacramento County is less affected by seismic events and geologic hazards than some other portions of the State. The county generally experiences little seismic activity, but could be affected by ground motion originating in other regions that experience more seismic activity, such as the San Francisco Bay Area and the Sierra Nevada (Sacramento County 1993, p. 7). Some property damage has occurred as a result of seismic events in the past, largely the result of major seismic events occurring in adjacent areas, especially the San Francisco Bay Area and, to a lesser extent, the foothills of the Sierra Nevada. The areas of Sacramento County most vulnerable to seismic and geologic hazards are typically those areas subject to liquefaction, expansive soils, shaking, and subsidence.

Earthquakes can cause strong ground shaking that may damage property and infrastructure. The severity of ground shaking at any particular point is referred to as intensity and is a subjective measure of the effects of ground shaking on people, structures, and earth materials. The intensity of shaking generally decreases with distance from the source of an earthquake. The level of intensity is commonly defined by comparison to the Modified Mercalli Scale that subjectively categorizes the intensity on the basis of observed effects of seismic shaking on people and objects. Quantitative measurements of the level of ground motion during an earthquake are made by strong-motion seismographs that measure the acceleration of objects at the ground surface caused by seismic shaking. These measurements are made relative to, and are expressed as a fraction of, the acceleration of gravity.

The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and, finally, total destruction. Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead, it is an arbitrary ranking based on observed effects.

Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments that have a common calibration. The magnitude or strength of earth movement associated with seismic activity is typically quantified using the Richter scale. This scale is a measure of the strength of an earthquake or strain energy released by it, as determined by seismographic observations.

Table 5.6-1 compares the effects of Mercalli intensity to Richter magnitude for earthquakes.

TABLE 5.6-1
COMPARISON OF RICHTER MAGNITUDE AND MODIFIED MERCALLI INTENSITY

Richter Magnitude Scale	Modified Mercalli Scale	Effects of Intensity
2	I–II	Usually detected only by instruments.
3	III	Felt indoors.
4	IV–V	Felt by most people; slight damage.
5	VI–VII	Felt by all; many frightened and run outdoors; damage minor to moderate.
6	VII–VIII	Everybody runs outdoors; damage moderate to major.
7	IX–X	Major damage.
8+	X–XII	Major to total damage.

Source: CGS 2002b

Local Seismic Activity

Table 5.6-2 identifies known faults in the vicinity of Elk Grove and their maximum magnitudes. There are no known active faults in the City, and no active or potentially active faults underlie the City. Elk Grove is not located in an Alquist-Priolo Earthquake Fault Zone (City of Elk Grove 2003b).

TABLE 5.6-2
FAULTS IN THE VICINITY OF ELK GROVE

Fault Name	Approximate Distance from Elk Grove (in miles)	Maximum Magnitude (MW)
Foothills Fault System	21	6.5
Great Valley (segment 5)*	27	6.5
Great Valley (segment 4)*	29	6.6
Greenville	41	6.9
Concord-Green Valley	42	6.9
Hunting Creek-Berryessa	45	6.9
West Napa	49	6.5
Calaveras	50	6.8
Rodgers Creek	56	7.0
Hayward	59	7.1
Bartlett Springs	72	7.1
Maacama (south)	73	6.9
Collayomi	76	6.5
Ortigalita	76	6.9
San Andreas (1906)	76	7.9
San Gregorio	78	7.3
Monte Vista-Shannon	80	6.8
Mohawk Valley-Honey Lake Fault Zone	82	7.3
Point Reyes	82	6.8
Genoa	87	6.9
Sargent	91	6.8
Zayante-Vergeles	94	6.8

Source: City of Elk Grove 2003b

**Nine segments of the Great Valley Fault are located approximately 27 to 91 miles west of the City and have maximum magnitudes of 6.4 to 6.8.*

Surface Rupture

In major earthquakes, fault displacement can cause rupture along the surface trace of the fault, leading to severe damage to any structures, roads, and utilities located on the fault trace. Surface rupture generally occurs along an active fault trace, but occasionally displacement along presumably inactive faults also occurs. No known faults traverse the Project area. Therefore, the risk of surface rupture at the Project area is considered low.

Ground Shaking

Ground shaking is motion that occurs as a result of energy released during faulting. The damage or collapse of buildings and other structures caused by ground shaking is among the most serious seismic hazards. The intensity of shaking and its potential impact on buildings is determined by the physical characteristics of the underlying soil and rock, the building materials and workmanship, the earthquake magnitude and location of the epicenter, and the character and duration of ground motion. Much of Sacramento County is located on alluvium, which increases the amplitude of an earthquake wave. Ground motion lasts longer and waves are amplified on loose, water-saturated materials as compared to solid rock. As a result, structures located on alluvium typically suffer greater damage than those located on solid rock.

The California Geological Survey's map of seismic shaking hazards in California shows the vast majority of Sacramento County, including the Project area, as located in a relatively low intensity ground shaking zone. While Sacramento County has experienced relatively little seismic activity, faulting in neighboring regions, especially the San Francisco Bay and Sierra Nevada areas, suggests that the county could be affected by future ground motion originating elsewhere.

Liquefaction

Liquefaction is the loss of soil strength due to seismic forces generating various types of ground failure. The evaluation of potential for liquefaction is complex, and factors that must be considered include soil type, soil density, groundwater, and the duration and intensity of shaking. Liquefaction is most likely to occur in deposits of water-saturated alluvium or similar deposits of artificial fill. In Sacramento County, the Delta and downtown Sacramento are the two areas most susceptible to liquefaction in the event of an earthquake.

The soils underlying the proposed Project area are relatively dense/stiff and the upper 15 meters (50 feet) of soil lack groundwater; therefore, the potential for liquefaction on the proposed Project area is considered to be low (City of Elk Grove 2003b). The potential for ground lurching, differential settlement, or lateral spreading to occur during or after seismic events in the Project area is also considered to be low.

Expansive Soils

Expansive soils are soils that shrink or swell depending on the level of moisture they absorb. These swelling soils typically contain clay minerals. As they get wet, the clay minerals absorb water molecules and expand; conversely, as they dry they shrink, leaving large voids in the soil. Settlement caused by soils with a high shrink-swell potential can occur at structures, and structures could be damaged by differential settlement due to soil expansion and contraction. When structures are located on expansive soils, foundations have the tendency to rise during the wet season and drop during the dry season. This movement can create new stresses on various sections of the foundation and connected utilities and can lead to structural failure and damage to infrastructure. The City's (2003b) General Plan Background Report identifies a high shrink-swell potential in the main soil type found at the Project area, the San Joaquin soil series. San Joaquin soils generally contain approximately 5 inches of claypan in the subsoil and a surface layer of brown silt loam, a soil that has a high percentage of claypan.

SOILS

According to the Sacramento County Soil Survey prepared by the US Department of Agriculture, Natural Resources Conservation Service (NRCS), the following soil types were mapped in **Figure 5.6-1**.

"Official soil series description" is a term applied to a description approved by the NRCS that defines a specific soil series in the United States. The descriptions include soil properties that define the soil series, distinguish it from other soil series, serve as the basis for the placement of that soil series in the soil family, and provide a record of soil properties needed to prepare soil interpretations (NRCS 2013). The soil types mapped in the Project area are listed below in **Table 5.6-3**, along with the numbers of acres found within the Project area.

TABLE 5.6-3
PROJECT AREA SOILS

NRCS Soils	Acreage
111 – Bruella sandy loam, 0 to 2 percent slopes	103.11
137 – Durixeralfs, 0 to 1 percent slopes	52.12
151– Galt clay, leveled, 0 to 1 percent slopes	79.32
152 – Galt clay, 0 to 2 percent slopes	32.40
164 – Kimball silt loam, 0 to 2 percent slopes	22.75
176 – Madera-Galt complex, 0 to 2 percent slopes	51.48
213 – San Joaquin silt loam, leveled, 0 to 1 percent slopes	615.67
214 – San Joaquin silt loam, 0 to 3 percent slopes	32.68
216 – San Joaquin-Durixeralfs complex, 0 to 1 percent slopes	71.30
217 – San Joaquin-Galt complex, leveled, 0 to 1 percent slopes	37.92
218 – San Joaquin-Galt complex, 0 to 3 percent slopes	11.52
221 – San Joaquin-Xerarents complex, leveled, 0 to 1 percent slopes	0.42
238 – Xerarents-San Joaquin complex, 0 to 1 percent slopes	73.76

Source: NRCS 2013

The following soil type descriptions are taken directly from the NRCS's (2013) Official Soil Series Descriptions. Series descriptions are not provided for Durixeralfs and Xerarents soils.

The **Bruella** series consists of very deep, well and moderately well drained soils formed in alluvium from granitic rock sources. Bruella soils are on low terraces and fans and have slopes of 0 to 5 percent. The mean annual precipitation is about 18 inches and the mean annual temperature is about 60 degrees Fahrenheit (°F).

The **Galt** series consists of moderately deep, moderately well drained soils that formed in fine textured alluvium from mixed but dominantly granitic rock sources. Galt soils are on low terraces, basins, and basin rims and have slopes of 0 to 5 percent. The mean annual precipitation is about 16 inches and the mean annual temperature is about 60°F.

The **Kimball** series consists of very deep, well drained soils formed in alluvium from mixed sources. Kimball soils are on low terraces and have slopes of 0 to 15 percent. The mean annual precipitation is about 22 inches and the mean annual temperature is about 61°F.

The **Madera** series consists of moderately deep to hardpan, well or moderately well drained soils that formed in old alluvium derived from granitic rock sources. Madera soils are on undulating low terraces with slopes of 0 to 9 percent. The mean annual precipitation is about 11 inches and the mean annual temperature is about 63°F.

San Joaquin soils make up nearly 850 acres, or over 70 percent of the Project area. San Joaquin soils are distributed throughout the Project area, as shown in **Figure 5.6-1**.

5.6.2 REGULATORY FRAMEWORK

STATE

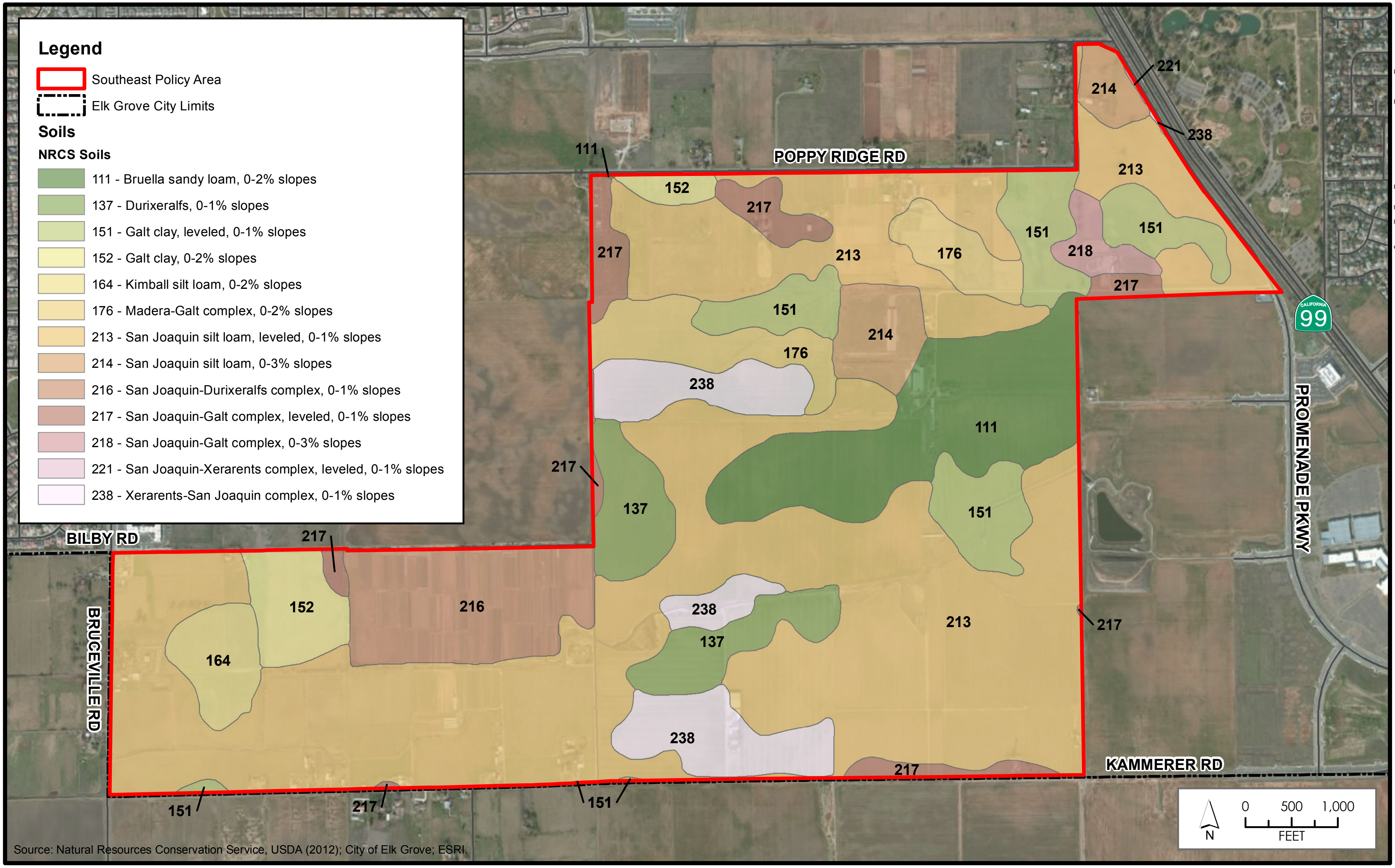
California Building Code

The City of Elk Grove has adopted the 2013 Edition of the California Building Code, Title 24, Part 2, Volumes 1 and 2 as set forth by the State of California Building Standards Commission (City of Elk Grove Municipal Code Section 16.04.010) . Building codes provide the first line of defense against future earthquake damage and help to ensure public safety. Records of building response to earthquakes, especially those from structures that failed or were damaged, have led to many revisions and improvements in building codes. The California Building Code (CBC) specifies the levels of earthquake forces that structures must be designed to withstand. These specifications are based on current information from strong-motion instruments. As ground motions of greater intensity have been recorded, the minimum earthquake requirements have been raised. In addition, provisions for different soil conditions have been added to the CBC as scientists have documented the significant influence of soil type on shaking intensity. In recent earthquakes, buildings built to modern codes have generally sustained relatively little damage.

LOCAL

Grading Provisions

Chapter 16.44 of the City Municipal Code establishes administrative procedures, minimum standards of review, and implementation and enforcement procedures for controlling erosion, sedimentation, and other pollutant runoff, including construction debris and hazardous substances used on construction sites, and disruption of existing drainage and related environmental damage caused by land clearing, grubbing, grading, filling, and land excavation activities. The Chapter applies to projects that would disturb 350 cubic yards or more of soil. The intent of the ordinance is to minimize damage to surrounding properties and public rights-of-way, minimize degradation of water quality in watercourses, minimize disruption of natural or City-authorized drainage flows caused by construction activities, and make projects comply with the provisions of the City's National Pollutant Discharge Elimination System (NPDES) Permit Number CA0082597, issued by the California Regional Water Quality Control Board (RWQCB). The City of Elk Grove is a co-permittee on an NPDES permit along with Sacramento County and the Cities of Sacramento, Folsom, Galt, and Citrus Heights



City of Elk Grove
Development Services

Figure 5.6-1

NRCS Soils

City of Elk Grove General Plan

The City of Elk Grove General Plan contains the following policies and actions related to geology, soils, and seismicity that apply to the proposed Project. These policies and goals are contained in the Conservation and Air Quality Element and the Safety Element (City of Elk Grove 2003c). The Project does not include any actions or components that conflict with these General Plan policies. However, it should be noted that the final authority for interpretation of a policy statement, determination of the Project's consistency, ultimately rests with the Elk Grove City Council.

"CAQ-5: Roads and structures shall be designed, built and landscaped so as to minimize erosion during and after construction."

"SA-25: The City supports efforts by Federal, State, and other local jurisdictions to investigate local seismic and geological hazards and support those programs that effectively mitigate these hazards."

> **"SA-25-Action 1:** Implement the Uniform Building Code to ensure that structures meet all applicable seismic standards."

"SA-26: The City shall seek to ensure that new structures are protected from damage caused by geologic and/or soil conditions."

> **"SA-26 Action 1:** Require that a geotechnical report or other appropriate analysis be conducted to determine the shrink/swell potential and stability of the soil for public and private construction projects and identifies measures necessary to ensure stable soil conditions."

5.6.3 IMPACTS AND MITIGATION MEASURES

STANDARDS OF SIGNIFICANCE

The impact analysis provided below is based on the following California Environmental Quality Act (CEQA) Guidelines Appendix G thresholds of significance. An impact is considered significant if implementation of the Project will:

1) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

    a) 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.

    b) Strong seismic ground shaking.

    c) Seismic-related ground failure, including liquefaction.

    d) 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 in Table 18-1-B of the Uniform Building Code (1994), creating substantial 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.

The Notice of Preparation (NOP) for this Project found that the implementation of the Project would result no impacts associated with seiche, tsunami, and mudflow and the use of septic systems. These issues are not addressed further in this Draft EIR.

METHODOLOGY

Evaluation of potential geologic and soil impacts of the proposed Project was based on review of NRCS soil survey maps and data, the Elk Grove Municipal Code, the City of Elk Grove General Plan, the City of Elk Grove General Plan Draft EIR, the City of Elk Grove General Plan Background Report, and a field review of the Project area and surrounding area. This analysis assumes that the Project would comply with all applicable laws, regulations, and building codes pertaining to seismic and geological safety. Where compliance with these required regulations would mitigate potential environmental impacts, no further mitigation is proposed unless it is above and beyond what is required by existing laws and regulations.

PROJECT IMPACTS AND MITIGATION MEASURES

Seismic Hazards (Standard of Significance 1)

Impact 5.6.1 The Project area is not located in an area that is susceptible to adverse impacts associated with seismic ground failure, including surface rupture, ground shaking, liquefaction, or landslides. This impact is **less than significant**.

The Project area is not located within an Alquist-Priolo Earthquake Fault Zone or in an area with any known faults. As shown in **Table 5.6-2**, the nearest fault to the Project area is the Foothills Fault System, located 21 miles from the City. For this reason, it is unlikely that an earthquake would result in surface rupture within the Project area.

Other kinds of seismic-related ground failure, such as liquefaction, are also unlikely due to the lack of liquefiable soils underlying the Project area. The flat nature of the Project area and surrounding areas would preclude the possibility of landslide within and off of the Project area. Because of the distance from active earthquake faults that are capable of producing significant ground shaking, it is highly unlikely that seismic ground failure associated with ground shaking or seismic activity would occur at or near the Project area. In addition, adherence to the California Building Code as set forth in Elk Grove Municipal Code Section 16.04.010 will ensure that any possible adverse impacts, however unlikely, are fully mitigated. This is a **less than significant** impact.

Mitigation Measures

None required.

Soil Erosion and Loss of Topsoil (Standard of Significance 2)

Impact 5.6.2 Future development resulting from the proposed Project, including buildings, pavement, and utilities, would require grading activities that could result in the potential for loss of topsoil and erosion. This impact is **less than significant**.

Development of the proposed Project would result in future development and construction activities that would require large-scale grading activities, which, if done improperly, could result in loss of topsoil and erosion that could adversely affect water quality in streams and increase the amount of particulate matter in the air, resulting in adverse air quality impacts. For analyses specific to those issue areas, the reader is referred to Section 5.3, Air Quality and Section 5.9, Hydrology and Water Quality. This analysis specifically addresses the potential erosion impacts associated with geology and soils.

Compliance with City General Plan Policy CAQ-5 would ensure that all roads and structures constructed as part of the Project are designed to minimize impacts associated with erosion. Future developments within the Project area would be required to prepare grading plans and erosion control plans, which would mandate appropriate erosion control measures.

Under the requirements of the Clean Water Act amendments of 1972, the Project construction contractor would be required to file a Notice of Intent under the State's NPDES General Construction Permit (CAS0002). The Project applicant would be required to adhere to conditions under the City's NPDES permit set forth by the Regional Water Quality Control Board (RWQCB) and also prepare and submit a stormwater pollution prevention plan (SWPPP) to be administered throughout all phases of grading and project construction. The SWPPP would incorporate best management practices (BMPs) to ensure that potential water quality impacts during construction are minimized. Compliance with these existing regulations would ensure that the Project would not result in a substantial erosion or loss of topsoil. This impact is **less than significant.**

Mitigation Measures

None required.

Unstable and Expansive Soils (Standards of Significance 3 and 4)

Impact 5.6.3 Future development resulting from the proposed Project, including buildings, pavement, and utilities, could incur damage as a result of underlying expansive or unstable soil properties. All development is required to comply with applicable building codes and commonly accepted engineering practices that address these conditions. Therefore, impacts associated with expansive or unstable soils are considered **less than significant**.

The City's (2003b) General Plan Background Report identifies a high shrink-swell potential in the San Joaquin soil series, which is the primary soil type found in the Project area. When structures are located on expansive soils, movements can occur under the structures, creating new stresses on various sections of the foundations and connected utilities. These variations in ground settlement can lead to structural failure and damage to infrastructure.

Subsidence, the gradual sinking or settling of the earth's surface with little or no horizontal motion could also occur in the Project area (City of Elk Grove 2003b). Land subsidence is most often caused by human activities, mainly from the removal of subsurface water (NRCS 2013). The General Plan Background Report identifies the pumping of water for residential, commercial, and agricultural uses as the greatest cause of subsidence in the City. Subsidence can also be caused by compaction by heavy structures, erosion of peat soils, peat oxidation, and compaction of unconsolidated soils by earthquake shaking. Subsidence causes a loss of soil stability and can result in structural and infrastructure damage.

Implementation of the proposed Project would increase the intensity of uses in the Project area by developing urban uses including office, light industrial/flex space, commercial, residential, and school uses, thereby resulting in an increased risk associated with expansive and unstable soils. The accepted engineering practices in the California Building Code require special design and construction methods for dealing with expansive soil behavior. The two most common methods to prevent damage due to expansive soil behavior are to design the building's foundation to resist soil movement and to control surface drainage in order to reduce seasonal fluctuations in soil moisture content. Future projects would be required to submit a geotechnical report for the site. In addition, all development proposed on the site would be required to comply with the California Building Code and commonly accepted engineering practices.

Compliance with recommendations included in the geotechnical reports and applicable building codes would ensure that soils at future development sites would be capable of supporting the structures in the Project area. Therefore, impacts resulting from expansive and unstable soils would be reduced to a **less than significant** level.

Mitigation Measures

None required.

5.6.4 CUMULATIVE SETTING, IMPACTS, AND MITIGATION MEASURES

CUMULATIVE SETTING

The geology, soils, and seismicity cumulative setting includes the Great Valley geomorphic province of California, which is bounded on the north by the Klamath and Cascade mountain ranges, on the east by the Sierra Nevada, and on the west by the Coast Range. Impacts associated with geology and soils are generally site-specific rather than cumulative in nature as geologic properties can vary by site. Individual development projects 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. The reader is referred to Section 5.9, Hydrology and Water Quality, regarding cumulative water quality impacts from soil erosion.

CUMULATIVE IMPACTS AND MITIGATION MEASURES

Cumulative Geologic and Soil Impacts (Standards of Significance 1, 2, 3, and 4)

Impact 5.6.4 Implementation of the proposed Project, in combination with other reasonably foreseeable development, would not contribute to cumulative geologic and soil impacts, as the impacts would be site-specific. This would be a **less than cumulatively considerable** impact.

Impacts associated with geology and soils, including expansive and unstable soils, are based on existing site-specific conditions in the subsurface materials that underlie the Project area. Implementation of the Project would allow an increase in the number of structures that could be subject to the effects of expansive soils or other soil constraints which could affect structural integrity, roadways, or underground utilities. Potentially adverse environmental effects associated with seismic hazards, as well as those associated with expansive soils, topographic alteration, and erosion, are site-specific and generally do not combine with similar effects that could occur with other projects in the City or elsewhere. Implementation of the provisions of the City's Building Code, the National Pollutant Discharge Elimination System permit requirements, and General Plan policies would ensure that potential site-specific geotechnical conditions and soil conditions would be addressed fully in the design of future development and that potential impacts would be maintained at less than significant levels. Therefore, the proposed Project's contribution to cumulative geology and soil-related impacts would be considered **less than cumulatively considerable**.

Mitigation Measures

None required.

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