This section describes the geology of the Planning Area and analyzes issues such as potential exposure of people and property to geologic hazards, landform alteration, and erosion. In addition, potential seismic/geologic hazards such as earthquakes and soil erosion are discussed.

4.9.1. EXISTING SETTING

TOPOGRAPHY & LOCAL GEOLOGY

Planning Area Setting

The Planning Area includes approximately 146 square miles of land area (including the City), and is generally bounded by Jackson Highway (Highway 16) to the north, the Sacramento River to the west, Twin Cities Road to the south and the Cosumnes River to the east. The topography of the Planning Area is generally flat with very minor slope increases.

The Planning Area is located within the Great Valley geomorphic province, which is primarily described as a relatively flat alluvial plain, about 50 miles wide and 400 miles long, with thick sequences of sedimentary deposits of Jurassic through Holocene age. The Great Valley geomorphic province is bounded on the north by the Klamath and Cascade mountain ranges, on the east by the Sierra Nevada Mountains, and on the west by the California Coast Mountain Range.

Surface elevations within the Great Valley generally range from several feet below mean sea level (msl) to more than 1,000 feet above sea level. The major topographical feature in the Sacramento Valley is the Sutter Buttes (a volcanic remnant), which rises approximately 1,980 feet above the surrounding valley floor. The ground surface elevation in the vicinity of the Planning Area, as shown on a collection of USGS Topographic Map quadrangles, ranges from approximately 10 to 150 feet above msl.

GEOTECHNICAL CONDITIONS

Structural Support

The San Joaquin soil type is the predominant soil series in the developable portion of the Planning Area. The Soil Conservation Service, United States Department of Agriculture, has classified these soils as moderately well drained and as moderately deep over a cemented hardpan. This base geologic condition does not lend to structural failures such as sinkholes. Since these soils are located at shallow depths, they are conducive to urban development. Properly designed foundations, buildings, and roads, can help to prevent potential damage caused by the high shrink-swell potential and low subsoil strength.

GEOLOGIC HAZARDS FAULTS AND SEISMICITY

The severity of an earthquake can be expressed in terms of both *intensity* and *magnitude*. For detailed descriptions of these terms, please see **Table 4.9-1**.

TABLE 4.9-1
MAGNITUDE AND INTENSITY

Magnitude	Intensity	Description
1.0 – 3.0	I	I. Not felt except by a very few under especially favorable conditions.
3.0 – 3.9	II – III	II. Felt only by a few persons at rest, especially on upper floors of buildings. III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
4.0 – 4.9	IV – V	IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably. V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
5.0 – 5.9	VI – VII	VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
6.0 – 6.9	VIII – IX	VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
7.0 and higher	VIII or higher	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

No known active faults or Alquist-Priolo earthquake hazard zones (formerly known as special study zones) occur in the City of Elk Grove Planning Area, although several inactive subsurface faults are identified in the Delta. **Table 4.9-2** identifies known faults in the vicinity of the Planning Area and the maximum magnitude associated with each fault.

TABLE 4.9-2
FAULTS IN THE VICINITY OF ELK GROVE

Name	Approximate Distance from Planning Area (in miles)	Maximum Magnitude (MW)
Foothills Fault System	21	6.5
Great Valley Fault (segment 5)	27	6.5
Great Valley Fault (segment 4)	29	6.6
Greenville Fault	41	6.9
Concord-Green Valley Fault	42	6.9
Hunting Creek – Berryessa Fault	45	6.9
West Napa Fault	49	6.5
Calaveras Fault	50	6.8
Rodgers Creek Fault	56	7.0
Hayward Fault	59	7.1
Bartlett Springs Fault	72	7.1
Maacama Fault (south)	73	6.9
Collayomi Fault	76	6.5
Ortigalita Fault	76	6.9
San Andreas Fault (1906)	76	7.9
San Gregorio Fault	78	7.3
Monte Vista – Shannon Fault	80	6.8
Mohawk Valley – Honey Lake Fault Zone	82	7.3
Point Reyes Fault	82	6.3
Genoa	87	6.9
Sargent	91	6.8
Zayante-Vergeles	94	6.8

According to the *Fault Activity Map of California*, the nearest faults to the City with activity within the last 200 years are the Concord, Hayward, and Cleveland Hill faults. The closest known fault to the City of Elk Grove is the Willows fault zone, located approximately 10 miles north of the City. The *Safety Element of the County of Sacramento General Plan* (1993) identified two major subsurface fault zones on the eastern and western sides of the Planning Area. The Midland Fault Zone is located approximately 20 miles west of the Planning Area, while the Bear Mountain Fault Zone is located approximately 20 miles east of the Planning Area. The closest known active subsurface fault is the Dunnigan Hills Fault, located approximately 25 miles northwest of the City of Elk Grove.

Ground Shaking

In populated areas, the greatest potential for loss of life and property damage is a result of ground shaking from a nearby earthquake. The degree of damage depends on many interrelated factors. Among these factors are the Richter magnitude, focal depth, distance from the causative fault, source mechanism, duration of shaking, high rock accelerations, type of surficial deposits or bedrock, degree of consolidation of surficial deposits, presence of high ground water, topography, and design, type, and quality of building construction.

No active or potentially active faults underlie the City of Elk Grove based on published geologic maps. The Planning Area is not located within an Alquist-Priolo Fault Study Zone and surface evidence of faulting has not been observed. However, due to the proximity to the San Andreas Fault Zone and other active faults, the Planning Area may experience ground shaking, but would not experience major catastrophes.

Liquefaction

Liquefaction is the loss of soil strength due to seismic forces generating various types of ground failure. The potential for liquefaction must account for soil types and density, the groundwater table, and the duration and intensity of ground shaking.

Based upon known soil, groundwater, and ground shaking conditions within the Planning Area, the potential for liquefaction beneath the Planning Area is considered low. The potential for ground lurching, differential settlement, or lateral spreading occurring during or after seismic events in the Planning Area is also considered to be low.

Expansive Soils

Soils that contain a relatively high percentage of clay minerals have the potential to shrink and swell with changing moisture conditions. The main soil types found in the Planning Area, specifically the San Joaquin soil group, contain approximately 5 inches of claypan in the subsoil, and contain a surface layer of brown silt loam between 11 and 23 inches thick. The shrink-swell potential is high in this soil type due to the high percentage of claypan.

Other Potential Geologic Hazards

There is a risk for subsidence, the gradual settling or sinking of the earth's surface with little or no horizontal motion, within the Elk Grove Planning Area. There are five causes of subsidence that affect the Planning Area – compaction by heavy structures, erosion of peat soils, peat oxidation, fluid withdrawal, and compaction of unconsolidated soils by earthquake shaking. The pumping of water from subsurface water tables for residential, commercial, and agricultural uses causes the greatest amount of subsidence within the Planning Area.

There is little potential in the Planning Area for landslides to occur, since there are no major slopes in the area. The maximum land surface slope within the Planning Area is approximately 3 percent. There are no oceans, large bodies of water, or volcanoes in the Planning Area, so there is little or no possibility for seiches, tsunamis, or volcanic eruptions to occur.

SOIL CONDITIONS

The City of Elk Grove Planning Area mostly consists of the San Joaquin soil group, as classified by the Sacramento County Soil Survey, prepared by the United States Department of Agriculture. Soils within this group were formed in alluvium derived from granitic rock and are suited to hay, pasture and other irrigated crops. The specific soil types found in the Planning Area primarily consist of San Joaquin silt loam (0 to 1 and 0 to 3 percent slopes), the San Joaquin-Durixeralfs complex (0 to 1 percent slopes), the San Joaquin-Galt complex (0 to 1 and 0 to 3 percent slopes), and Redding gravelly loam (0 to 8 percent slopes).

A listing of their physical constraints, hydrologic capacities and engineering characteristics are tabulated in **Table 4.9-3**.

TABLE 4.9-3
SOIL MAPPING UNITS

Map Unit Name	Erosion Potential	Drainage	Sub Soil Permeability	Effective Depth	Limitations For Road Construction
Redding gravelly loam - 0-8% slopes	Low/Moderate	Well	Very Slow	20-40"	Moderate
San Joaquin silt loam, leveled - 0-1% slopes	None/Low	Well	Very Slow	23-40"	Severe
San Joaquin silt loam - 0-3% slopes	Low	Well	Very Slow	23-40"	Severe
San Joaquin-Durixeralfs complex - 0-1% slopes	None/Low	Well	Very Slow	23-40"	Severe
San Joaquin-Galt complex, leveled - 0-1% slopes	None/Low	Well	Very Slow	24-40"	Severe
San Joaquin-Galt complex - 0-3% slopes	None	Well	Very Slow	23-40"	Severe

ND = No data

Mineral Resources

Using data contained in SMARA Special Report 156, titled *Mineral Land Classification: Portland Cement Concrete Grade Aggregate in the Sacramento-Fairfield Production Consumption Region* (1988), the Planning Area was classified for its mineral resource potential. According to SR 156, a large portion of the northern section of the Planning Area is covered by the MRZ-2 classification. Sites described by this classification are considered to be "areas for which data indicate there is a high likelihood that significant deposits of PCC-grade aggregate exist." This area is located north of Gerber Road, south of Jackson Highway (Highway 16), east of Grant Line Road, and west of Elk Grove-Florin Road.

Both the City of Elk Grove as well as the remainder of the Planning Area are covered by the MRZ-3 classification. These areas are those "containing aggregate deposits, the significance of which cannot be evaluated from available data."

4.8.2. REGULATORY FRAMEWORK

STATE

California Division Of Mines & Geology

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 (prior to January 1, 1994 called the Alquist-Priolo Special Studies Zones Act – CCR, Title 14, Section 3600) sets forth the policies and Criteria of the State Mining and Geology Board that governs the exercise of governments' responsibilities to prohibit the location of developments and structures for human occupancy cross the trace of active faults. The policies and criteria are limited to potential hazards resulting from surface faulting or fault creep within Earthquake Fault Zones delineated of maps officially issued by the State Geologist. Working definitions include:

- *Fault* – a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side;
- *Fault Zone* – a zone of related faults, which commonly are braided, and sub parallel, but may be branching and divergent. A fault zone has a significant with (with respect to the

scale at which the fault is being considered, portrayed, or investigated), ranging from a few feet to several miles;

- *Potentially Active Fault* – a fault that showed evidence of surface displacement during Quaternary time (last 1.6 million years) for the purpose of evaluation for possible zonation. No longer used.
- *Sufficiently Active Fault* – a fault that has evidence of Holocene surface displacement along one or more of its segments or branches; and,
- *Well-Defined Fault* – a fault whose trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface. The geologist should be able to locate the fault in the field with sufficient precision and confidence to indicate that the required site-specific investigations would meet with some success.

"Sufficiently Active" and "Well Defined" are the two criteria used by the State to determine if a fault should be zoned under the Alquist-Priolo Act.

LOCAL

Sacramento County General Plan

The 1993 Sacramento County General Plan Conservation Element provided the following policies relevant to geology and soils and mineral resources within the larger Sacramento County area, and are only applicable to the Elk Grove Planning Area.

CO-57: Curtail tillage of peat-rich Delta soils to retard erosion and subsidence, and protect the agricultural productivity of Delta islands.

CO-58: Work with rural landowners and existing Resource Conservation Districts to promote soil conservation practices.

CO-59: In areas where top soil mining is permitted, it shall be done so as to maintain the long-term productivity of the soil.

SA-1 The County shall require geotechnical reports and impose appropriate mitigation measures for new development located in seismic and geologically sensitive areas.

SA-2 The County shall draft and have considered for adoption an ordinance that would require the removal or strengthening of poorly anchored parapets or architectural detailing and unreinforced masonry construction on existing buildings.

SA-3 The County shall support 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-4 The County shall prohibit development on ground surfaces which exceed 40 percent in slope, such as the bluff areas along the American River. Development shall be set back from these slopes at a distance to be determined by the Public Works Department.

AG-26 The County shall actively encourage conservation of soil resources.

CO-41: Apply the aggregate resources combining land use category to additional areas as subsequent studies determine them to contain mineral resources which are feasible and appropriate for mining. The aggregate resources combining land use category shall not be a prerequisite to (SM) surface mining combining zoning in conjunction with proposed surface mining.

CO-42: Sewer interceptor and trunk alignments shall be routed to avoid areas planned for aggregate resource mining to the extent practical. Where such alignments are impractical, they shall be designed to minimize aggregate resources which would be precluded from mining, and make reasonable attempt to preserve the future use of mined areas for flood control or recharge purposes.

CO-43: Surface mining operations shall not, after mitigation measures are accounted for, create any significant nuisances, hazards, or adverse environmental impacts.

CO-44: Surface mining shall maintain substantial minimum setbacks from adjoining rural residential land uses.

CO-45: Surface mining shall not be allowed without adequate plans for reclamation of mined areas.

CO-46: Reclamation plans associated with use permits for mining in Sector I-3 shall be based on a comprehensive reclamation plan for moderate density use.

CO-47: Gold extraction utilizing cyanide leaching systems shall not be permitted.

CO-48: Sector I-3 (Figure 2, Page 38) south of Elder Creek Road shall be a high priority area for mining to allow for its future urban use.

City of Elk Grove Land Grading and Erosion Control Ordinance

The City's Land Grading and Erosion Control Ordinance (Title 16 Chapter 16.44 of the City 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 and grubbing, grading, filing, and land excavation activities. The ordinance applies to projects that will 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, the degradation of the water quality of water courses, and the disruption of natural or City authorized drainage flows caused by construction activities, and to comply with the provisions of the City's National Pollutant Discharge Elimination System (NPDES) Permit.

4.9.3 IMPACTS AND MITIGATION MEASURES

STANDARDS OF SIGNIFICANCE

The CEQA Guidelines (Appendix G) indicate that a proposed project may have potentially significant geologic impacts if it results in any of the following:

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

i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;

ii) Strong seismic ground shaking;

iii) Seismic-related ground failure, including liquefaction;

iv) Landslides.

2. Result in substantial soil erosion of 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 following geologic hazards are not present in the Planning Area: tsunami, seiche, or land subsidence. Also, since geologic conditions in the Planning Area do not include ultramafic rock conditions that could support naturally occurring asbestos, no public health exposure impacts to asbestos are expected to occur.

METHODOLOGY

The evaluation of geology and related soils located within the proposed Planning Area was based on a review of regional reports prepared by Sacramento County, the State of California, and various consultants.

PROJECT IMPACTS AND MITIGATION MEASURES

Soil Erosion

Impact 4.9.1 Implementation of the proposed General Plan could result in increased soil, wind, and water erosion, due to minor or major grading over large areas of land. This would result in potential soil erosion. This is considered a **less than significant** impact.

Construction within the City would result in the moving and grading of topsoil. This would lead to disturbed soils that are more likely to suffer from erosion from a variety of sources, such as wind and water.

Development of proposed projects in the City would include grading of sites (e.g., cut and fill). Construction activities could result in sedimentation of the various branches of Laguna Creek and adjoining waterways. The reader is referred to Section 4.8 (Hydrology and Water Quality) regarding a further description of anticipated surface water quality impacts associated with development of the City.

The City's Land Grading and Erosion Control Ordinance established procedures to minimize erosion and sedimentation during construction activities. The Regional Water Quality Control

Board (RWQCB) requires that a National Pollutant Discharge Elimination System (NPDES) construction activity permit be issued prior to construction. The permit requires that the City impose water quality and watershed protection measures for all development projects. Under the City's NPDES permit (#CAS082597), the City of Elk Grove is required to implement the Construction Element of its Stormwater Quality Improvement Plan (SQIP) to reduce pollutants in runoff from construction sites during all construction phases. In addition, the City is required to adopt a Development Standards Plan (DSP) describing measures to reduce pollutant discharges to the maximum extent practical from all new development projects.

General Plan Policies and Action Items

CAQ-6 *Roads and structures shall be designed, built and landscaped so as to minimize erosion during and after construction.*

CAQ-26 *The City shall seek to ensure that the quality of groundwater and surface water is protected to the extent possible.*

CAQ-26-Action 2 *Implement the City's NPDES permit on al public and private development projects and activities.*

Implementation of Policy CAQ-6, CAQ-26 and CAQ-26-Action 1 would reduce soil erosion hazards in the City. Compliance with the City's Land Grading and Erosion Control Ordinance would further reduce the impacts to soil erosion and sedimentation. Therefore, impacts to soil erosion are considered **less than significant**.

Mitigation Measures

None required.

Expansive and Unstable Soils

Impact 4.9.2 Implementation of the proposed General Plan could expose buildings, pavements, and utilities to significant damage as a result of underlying expansive or unstable soil properties. This is considered a **potentially significant** impact.

Implementation of the proposed General Plan could result in construction activities overlying expansive or unstable soils. Newly constructed buildings, pavements, and utilities 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 shrink during the dry season. Movements can vary under the structures, which in turn create new stresses on various sections of the foundation and connected utilities. These variations in ground settlement can lead to structural failure and damage to infrastructure.

As previously noted, the soil types found in the City of Elk Grove contain a high shrink-swell potential.

General Plan Policies and Action Items

SA-23 *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-23-Action 1 *Implement the Uniform Building Code to ensure that structures meet all applicable seismic standards.*

Mitigation Measures

The following mitigation measure shall be incorporated into the City of Elk Grove General Plan as an action item under Policy SA-23 in the Conservation and Air Quality Element.

MM 4.9.2 Require a geotechnical report or other appropriate analysis be conducted that determines the shrink/swell potential and stability of the soil for public and private construction projects and identifies measures necessary to ensure stable soil conditions.

Implementation of the above Policy SA-23 and its associated action item, as well as mitigation measure MM 4.9.2 would reduce the impacts of expansive soils to **less than significant**.

Seismic Hazards

Impact 4.9.3 Implementation of the proposed General Plan could result in the construction of projects over a seismically hazardous area. This is considered a **less than significant** impact.

The geologic literature indicates that no major active faults transect the City of Elk Grove; however, there are several subsurface faults in the Delta region. While the City has experienced little seismic activity, faulting in neighboring regions, especially the San Francisco Bay Area and the Sierra Nevada mountains and foothill areas, suggests that the City could be affected by future ground motion originating elsewhere.

General Plan Policies and Action Items

The following City of Elk Grove General Plan policies and action items would reduce potential impacts related to seismic hazards.

SA-23 *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-23-Action 1 *Implement the Uniform Building Code to ensure that structures meet all applicable seismic standards.*

Implementation of Policy SA-23 and its associated action item reduces potential impacts related to seismic hazards to **less than significant**.

Mitigation Measures

None required.

4.9.4 CUMULATIVE SETTING, IMPACTS, AND MITIGATION MEASURES

CUMULATIVE SETTING

Geotechnical impacts relative to expansive soils and seismic hazards tend to be site specific rather than cumulative in nature and each development site would be subject to, at a minimum, uniform site development and construction standards relative to seismic and other geologic conditions that are prevalent within the region.

Impacts regarding surficial deposits, however, namely erosion and sediment deposition, can be cumulative in nature within a watershed. The reader is referred to Section 4.8 (Hydrology and Water Quality) regarding cumulative water quality impacts from soil erosion.

As discussed in Section 4.0 (Introduction to the Environmental Analysis and Assumptions Used), potential development of the Urban Study Areas could have an affect on geology and soils in those areas. This could also result in potential affects to geology and soils in the Planning Area, as well as to the geographic extent of Sacramento County.

CUMULATIVE IMPACTS AND MITIGATION MEASURES

Soil Erosion

Impact 4.9.4 Implementation of the proposed General Plan along with potential development of the Urban Study Areas could contribute to cumulative soil erosion impacts. This is considered a **less than significant** cumulative impact.

Implementation of the General Plan along with potential development in the Urban Study Areas as well as continued development within Sacramento County would result in cumulative soil erosion impacts. Compliance with the City's Land Grading and Erosion Control Ordinance as well as the City's NPDES permit would reduce the City's contribution to cumulative soil erosion impacts. The Sacramento County General Plan provides policies that mitigate impacts to geology and soils within the remainder of the Planning Area, which includes the Urban Study Areas as discussed in Section 4.0.

General Plan Policies and Action Items

CAQ-6 *Roads and structures shall be designed, built and landscaped so as to minimize erosion during and after construction.*

SA-23 *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-23-Action 1 *Implement the Uniform Building Code to ensure that structures meet all applicable seismic standards.*

Implementation of Policy CAQ-6 as well as Policy SA-23 and its associated action item would further mitigate the City's contribution to cumulative soil erosion impacts to **less than significant**.

Mitigation Measures

None required.

Expansive Soils and Seismic Hazards

Impact 4.9.5 Implementation of the proposed General Plan along with potential development of the Urban Study Areas could result in cumulative impacts to expansive soils and seismic hazards. This is considered a **less than significant** cumulative impact.

Any impacts associated with expansive soils and seismic hazards would be site-specific, however, implementation of Policy SA-23 as well as mitigation measure MM 4.9.2 would contribute to the reduction of site-specific impacts.

General Plan Policies and Action Items

SA-23 *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-23-Action 1 *Implement the Uniform Building Code to ensure that structures meet all applicable seismic standards.*

Mitigation Measures

Implementation of Policy SA-23 and its associated action item as well as mitigation measure MM 4.9.2 would reduce soil stability impacts to **less than significant**.

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