IV. ENVIRONMENTAL IMPACT ANALYSIS
F. GEOLOGY AND SOILS

INTRODUCTION

This section of the DEIR evaluates potential impacts to the project site's geologic environment that may result from implementation of the Stonegate Vesting Subdivision Map and General Plan Amendment/Rezone ("proposed project"). The information and analysis in this section is based published and unpublished geologic reports and maps from the United States Geological Survey (USGS) and California Geological Survey (CGS).

ENVIRONMENTAL SETTING

Geology

The project site is located within the Great Valley Geomorphic Province (Great Valley Province). The Great Valley Province extends 400 miles north to south and 50 miles east to west and is emcompassed by the Coast Ranges to the west, the Klamath Mountains and Cascade Range to the north, and the Sierra Nevada to the east. The Great Valley Province is a trough in which sediments have been deposited almost continuously since the Jurassic (about 160 million years ago).[1]

Topography

The topography of the City of Chico varies from relatively gently sloped terrain in the western portion to increasingly hilly terrain at the eastern edge of the city.[2] The project site is generally level undeveloped land, gradually sloping up to the northeast from elevations of 225 feet at its south border along Skyway to 267 feet on the north border along E. 20th Street.

Seismic Conditions

The severity of an earthquake is measured by magnitudes and intensities. Magnitude is a measure of the energy released by an earthquake. Intensity is a subjective measure of the perceptible effects of an earthquake at a given point and varies with distance from the epicenter and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) is the most commonly used scale for measurement of earthquake intensity and is shown in Table IV.F-1 below.

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1 *CGS, 2002. California Geomorphic Provinces, Note 36. Revised December*.

2 *City of Chico, 2010. General Plan Update Draft Environmental Impact Report, Geology and Soils. September*.

Table IV.F-1
Modified Mercalli Intensity (MMI) Scale

Category	Description (Subjective Effects of Earthquake Intensity) [3]
I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	During the day felt indoors by many, outdoors by few. 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, etc., broken; unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken.
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.
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.

The nearest active fault to the project site is the Cleveland Hills Fault, approximately 22 miles southeast of the project site.[4] According to CGS and USGS, the project site is located in areas distant from known, active faults and is expected to experience infrequent low levels of shaking relative to many parts of the state. During most earthquakes, only weaker, masonry buildings would likely be damaged. However, very infrequent more intense earthquakes could still cause strong shaking at the project site.[5]

[3] *USGS, 2016. The Severity of an Earthquake. Website: http://pubs.usgs.gov/gip/earthq4/severitygip.html. Accessed June 19, 2017.*
[4] *California Department of Conservation, 2010. Fault Activity Map of California. Website: http://maps.conservation.ca.gov/cgs/fam/. Accessed June 19, 2017.*
[5] *CGS and USGS, 2016. Earthquake Shaking Potential for California.*

Geologic Hazards

Active Faults and Fault Rupture

An active fault is defined by the CGS as one which has had surface displacement in the past 11,000 years. No active faults have been mapped at the project site. Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. The location of surface rupture generally occurs along an existing (usually active) fault trace. Areas susceptible to surface fault rupture are delineated by the CGS Alquist-Priolo Earthquake Fault Zones and require specific geological investigations prior to development to reduce the threat to public health and safety and to minimize the loss of life and property posed by earthquake induced ground failure. The project site is not located within or adjacent to a mapped Alquist-Priolo Earthquake Fault Zone.[6]

Ground Shaking

Ground shaking is a general term referring to the motion of the earth's surface resulting from an earthquake. Ground shaking is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of an earthquake, distance from the epicenter, and local geologic conditions.

According to the City of Chico General plan, Chico and the surrounding area are relatively free from significant seismic and geologic hazards. There are no known or inferred active faults, however, faults located outside of the City could result in strong ground shaking within the City. The City enforces the state building code which mandates construction techniques that minimize seismic hazards.[7]

Liquefaction

Liquefaction is the temporary transformation of loose, saturated granular sediments from a solid state to a liquefied state as a result of seismic ground shaking. In the process, the soil undergoes a temporary loss of strength, which commonly causes ground displacement or ground failure to occur.

CGS has mapped Seismic Hazard Zones that delineate areas susceptible to liquefaction that require additional investigation to determine the extent and magnitude of potential ground failure. According to CGS, the project site is not located within or adjacent to a mapped Seismic Hazard Zones for liquefaction.[8]

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6 *California Department of Conservation, 2017. Website: http://maps.conservation.ca.gov/cgs/informationwarehouse/. Accessed June 27*

7 *City of Chico, 2011, General Plan Safety Element, page 12-11*

8 *California Department of Conservation, 2017. Op. cit.*

Based on the Butte County Liquefaction Potential Map, most of the project site has a generally low susceptibility to liquefaction hazards. However, a small portion of the project site has a generally moderate susceptibility to liquefaction hazards.[9]

Landslides

Slope failure can occur as either rapid movement of large masses of soil (landslide) or imperceptibly slow movement of soils on slopes (creep). The primary factors influencing the stability of a slope are the nature of the underlying soil or bedrock, the geometry of the slope (height and steepness), and rainfall. The presence of historic landslide deposits is a good indicator of future landslides. Landslides are commonly triggered by unusually high rainfall and the resulting soil saturation, by earthquakes, or a combination of these conditions.

CGS has mapped Seismic Hazard Zones that delineate areas susceptible to landslides that require additional investigation to determine the extent and magnitude of potential ground failure. According to CGS, the project site is not located within or adjacent to a mapped Seismic Hazard Zones for landslides.[10] In addition, the project site is generally level. Based on the Butte County Landslide Potential Map, the project site has a low susceptibility to landslides hazards.[11]

Expansive Soils

Expansive soils expand and contract in response to changes in soil moisture, most notably when near-surface soils change from saturated to a low moisture content condition, and back again. These changes can result in damage to building foundations, pavement, and other structural elements. Based on the City of Chico General plan Safety Element, the project site is located in an area of highly expansive soils.[12]

9 *Butte County, 2007. Butte County General Plan, Setting & Trends Report Public Draft. August 2.*
10 *California Department of Conservation, 2017. Op. cit.*
11 *Butte County, 2007. Op. cit*
12 *City of Chico, 2011, General Plan Safety Element, Figure S-3.*

REGULATORY SETTING

The following discussion describes the regulatory context (including regulatory agencies and policy documents) for geologic and seismic issues as they relate to development on the project site.

Federal Regulations

National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) was established by the US Congress when it passed the Earthquake Hazards Reduction Act of 1977, Public Law (PL) 95–124. In establishing NEHRP, Congress recognized that earthquake-related losses could be reduced through improved design and construction methods and practices, land use controls and redevelopment, prediction techniques and early-warning systems, coordinated emergency preparedness plans, and public education and involvement programs. The four basic NEHRP goals are:

- Develop effective practices and policies for earthquake loss reduction and accelerate their implementation.
- Improve techniques for reducing earthquake vulnerabilities of facilities and systems.
- Improve earthquake hazards identification and risk assessment methods, and their use.
- Improve the understanding of earthquakes and their effects.

Implementation of NEHRP priorities is accomplished primarily through original research, publications, and recommendations to assist and guide State, regional, and local agencies in the development of plans and policies to promote safety and emergency planning.

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act (AP Act)

The AP Act was passed in 1972, and its main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active earthquake faults. The AP Act 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. "Earthquake Fault Zones" were called "Special Studies Zones" prior to January 1, 1994. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. The AP Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. Surface rupture is the most easily avoided seismic hazard. As discussed above, the project site is not located within or adjacent to a mapped Alquist-Priolo Earthquake Fault Zone. As discussed below, the Seismic Hazards Mapping Act (SHMA), passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically-induced landslides.

Seismic Hazards Mapping Act (SHMA)

The SHMA of 1990 (Public Resources Code, Section 2690- 2699.6) directs the Department of Conservation, CGS to identify and map areas prone to liquefaction, earthquake-induced landslides and amplified ground shaking. The purpose of the SHMA is to minimize loss of life and property through the identification, evaluation and mitigation of seismic hazards. The SHMA was passed by the legislature following the 1989 Loma Prieta earthquake. 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 (ZORI) those areas prone to liquefaction and earthquake–induced landslides. Cities and counties are then required to use the Seismic Hazard Zone Maps in their land use planning and building permit processes. The Seismic Hazards Mapping Act requires site-specific geotechnical investigations be conducted within ZORI areas to identify and evaluate seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy. As discussed above, the project site is not located within or adjacent to a mapped Seismic Hazard Zones for liquefaction and/or landslides.

California Building Code

The 2016 California Building Code (CBC), which refers to Part 2 of the California Building Standards Code in Title 24 of the California Code of Regulations, is based on the 2012 International Building Code. The 2016 CBC covers grading and other geotechnical issues, building specifications, and non-building structures. The CBC requires that a site-specific geotechnical investigation report be prepared by a licensed professional for proposed developments of one or more buildings greater than 4,000 square feet to evaluate geologic and seismic hazards. Buildings less than or equal to 4,000 square feet also are required to prepare a geologic engineering report, except for one-story, wood-frame and light-steel-frame buildings of Type V construction that are located outside of the Alquist-Priolo Earthquake Faults Zones.

The purpose of a site-specific geotechnical investigation is to identify seismic and geologic conditions that require project mitigation, such as surface fault ruptures, ground shaking, liquefaction, differential settlement, lateral spreading, expansive soils, and slope stability. Requirements for the geotechnical investigation are presented in Chapter 16 “Structural Design” and Chapter 18 “Soils and Foundation” of the 2016 CBC.

City of Chico enforces the CBC. Therefore, the project design and construction is required to conform with, or exceed, current best standards for earthquake resistant construction in accordance with the 2016 CBC and with the generally accepted standards of geotechnical practice for seismic design in Northern California. In addition, because the project would involve developments of one or more buildings greater than 4,000 square feet, a site specific geotechnical investigation is required for the project by the 2016 CBC.

Local Regulations

City of Chico General Plan

The following goals, policies and actions are included in the City of Chico General Plan.

Goal S-3: Protect lives and property from seismic and geologic hazards.

Policy S-3.1 (Potential Structural Damage) – Prevent damage to new structures caused by seismic, geologic, or soil conditions.

> Action S-3.1.1 (California Building Code) – Require all new buildings in the City to be built under the seismic requirements of the California Building Code.
>
> Action S-3.1.2 (Potential Soil Hazards) – In areas with highly expansive soils, require appropriate studies and structural precautions through project review.

ENVIRONMENTAL IMPACTS

Methodology

Thresholds of Significance

In accordance with Appendix G of the CEQA Guidelines, the proposed project could have a significant environmental impact if it would:

a) 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? Refer to Division of Mines and Geology Special Publication 42.

   ii. Strong seismic ground shaking?

   iii. Seismic-related ground failure, including liquefaction?

   iv. Landslides?

b) Result in substantial soil erosion or the loss of topsoil?

c) 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?

d) 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?

e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

Geology and Soils Issues not Further Analyzed

The following issues were addressed in the Initial Study (see Appendix A) and Section IV.A of the Draft EIR, and were determined to result in a less-than-significant impact and not warrant further analysis:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: landslides.
- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

Project Impacts and Mitigation Measures

Impact GEO-1: The proposed project would not expose people or structures to potential substantial adverse effects associated with seismic hazards.

Fault Rupture

The project site is not located within or adjacent to a mapped Alquist-Priolo Earthquake Fault Zone, and therefore the project would have a ***less-than-significant*** impact on people and structures related to fault rupture.

Seismic Ground Shaking

The project site is located in areas distant from known, active faults and is expected to experience infrequent low levels of shaking relative to many parts of the state. However, very infrequent and more intense earthquakes could still cause strong shaking at the project site.

The potential impacts related to injuries of future site users resulting from seismic ground shaking would be reduced by adherence to the design and materials standards set forth in the 2016 CBC. The City enforces the state building code which mandates construction techniques that minimize seismic hazards. Therefore, impacts related to seismic ground shaking would be ***less than significant.***

Seismic-Related Ground Failure

As discussed above, the project site is not located within or adjacent to a mapped Seismic Hazard Zones for liquefaction. In addition, most of the project site has a generally low susceptibility to liquefaction hazards based on the Butte County Liquefaction Potential Map, However, a small portion of the project site has a generally moderate susceptibility to liquefaction hazards (based on regional mapping).

It is possible that regional seismic shaking could result in liquefaction and failure of project site soils, which could cause significant damage to proposed project structures. This type of damage could also injure building occupants. While liquefaction could occur on the project site, the proposed project would not increase or exacerbate the liquefaction hazards. Based on the rulings of the California Second District Court of Appeals (Ballona Wetlands Land Trust v. City of Los Angeles, 201 Cal. App. 4th 455) and the California Supreme Court (California Building Industry Association vs. Bay Area Air Quality Management District), a CEQA analysis of the effects of geologic hazards on a proposed project is not required if the project does not exacerbate the existing condition. Therefore, potential liquefaction hazard on the project would result in a ***less than significant*** impact. However, it is recommended that the City require the applicant to prepare a site-specific geotechnical report which includes an evaluation of the potential liquefaction hazard (and if a hazard is confirmed, appropriate measures to address the hazard).

Impact GEO-2: The proposed project may result in substantial soil erosion or the loss of topsoil.

During the construction phase of the proposed project, grading would result in the disturbance of surface soils.

As described in detail in Section IV.I Hydrology and Water Quality, compliance with the Construction General Permit, including the preparation and implementation of a Stormwater Pollution Prevention Plan, would reduce the potential impacts related to erosion of topsoil to a ***less-than-significant*** level.

During the operation phase of the project, soils would be covered with buildings, pavement, and landscaping and not subject to erosion, therefore potential post-construction impacts related to erosion of topsoil would be ***less than significant***.

Impact GEO-3: The proposed project would not be exposed to hazards associated with unstable geologic units or soils.

Since the project site is relatively flat and regional mapping indicates that landslide hazards are low to non-existent in the vicinity, the impacts related to landslides on the project site would be ***less than significant***.

Lateral spreading (or liquefaction-induced lateral spreading) refers to the horizontal movement of sloping ground as a result of pore pressure build-up or liquefaction in shallow soils during an earthquake. Lateral spreading hazards tend to occur where liquefaction hazards are present. While liquefaction is a potential concern at the project site (discussed above under the Seismic Shaking subsection), the site is relatively flat and therefore the lateral spreading hazard is considered low.

Subsidence is a form of settlement, resulting in the lowering of the land surface elevation due to groundwater pumping and subsequent consolidation of loose aquifer sediments. No groundwater pumping is proposed under the project, and therefore this potential impact is ***less than significant.***

The impacts related to liquefaction on the project site is discussed above under “Seismic-Related Ground Failure”.

Impact GEO-4: The proposed project would not be exposed to hazards associated with expansive soils.

Based on the City of Chico General plan Safety Element, the project site is located in an area of highly expansive soils. General Plan Action S-3.1.2 (Potential Soil Hazards) states that “in areas with highly expansive soils, require appropriate studies and structural precautions through project review.” In accordance with Action S-3.1.2, the City would require the applicant to prepare and submit a geotechnical investigation report that characterizes the expansive soil hazards and specifies geotechnical treatments to address any hazards identified. These treatments may include removal and replacement of expansive soils in areas of building foundations, pavements, and utility trenches or injecting or mixing of lime or other solutions into existing expansive soils.

Since preparation of appropriate studies and implementation of structural precautions are required under existing programs, the impact related to expansive soils is ***less than significant***.

LEVEL OF SIGNIFICANCE AFTER MITIGATION

All project impacts related to geology and soils are ***less-than-significant***. No mitigation is required.

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