14
GEOLOGY, SOILS, AND SEISMICITY

14.1 INTRODUCTION

This section addresses the potential impacts to geology, soils, and seismicity from implementation of the proposed Santa Clarita Valley Sanitation District (SCVSD) Chloride Compliance Project (proposed project). This section provides a description of the regional geology, a summary of the regulations related to geologic and seismic hazards, an evaluation of the potential impacts that may result from implementing the proposed project, and identifies mitigation to minimize potential effects. This section incorporates geologic information contained in the Site Study Report for Brine Disposal via Deep Well Injection prepared by the SCVSD (SCVSD 2013), which is included in Appendix 6-C. This section also incorporates geologic information included in the Resumption of Wellfield Feasibility Study prepared by CH2M HILL (CH2M HILL 2012), which is included as an appendix to the Site Study Report within Appendix 6-C. Furthermore, this section incorporates information on induced seismicity in the Deep Well Injection Induced Seismicity technical memorandum prepared by CH2M HILL (CH2M HILL 2013), which is included in Appendix 14-A.

14.1.1 Overview of Geology

An overview of the geology is described earlier in Section 2, including the general geography and topography, geology and lithologic units, and seismic hazards. The general surface geology of the Santa Clarita Valley (SCV) is shown on Figure 2-3 and faults are shown on Figure 2-5. A detailed description of the hydrology is provided in Section 16.

14.1.2 Overview of Deep Well Injection

Deep well injection (DWI) is a proven method for the disposal of waste fluids. This technology has been successfully used for decades by the oil and natural gas industry throughout California and the United States. There are over 47,000 injection wells (Classes I through V) in California alone (EPA 2013). The entire design and operation is closely regulated by the U.S. Environmental Protection Agency (EPA) under its Underground Injection Control (UIC) Program to ensure that potential drinking water sources are not affected. Injection wells installed by the SCVSD would be permitted as Class I non-hazardous waste injection wells.

A Class I DWI system consists of wells typically over one mile deep that inject brine into a porous layer called the “injection zone.” The injection zone contains groundwater that is nearly as salty as seawater and not suitable for drinking. The brine injected by the SCVSD would be similar to, or less salty than, the naturally occurring groundwater in the injection zone. The injection zone is isolated from potential drinking water sources – what the EPA refers to as "underground sources of drinking water" (USDW) – by a thick, low-permeability soil layer called the "confinement zone." USDW are further protected by alternating permeable and impermeable soil layers called the "containment zone." The containment zone would be above the confinement zone and would accept any fluid escaping the injection zone. Unlike the hydraulic fracturing (or "fracking") process used by the natural gas industry, DWI injection pressures are maintained below fracture pressure to ensure that the confinement and containment zones are not fractured and the injected brine cannot penetrate these zones.

Injection wells are constructed with multiple levels of protection to prevent the injected fluid from reaching potential drinking water sources. A schematic of an injection well is shown on Figure 6-3. The fluid is injected through tubing inside an inner steel casing surrounded by cement, all contained within an outer steel casing that extends from the ground surface to the base of the USDW. The space between the outer casing and borehole is also sealed with cement. The space between the tubing and the inner steel casing is filled with an inert fluid, which is continuously monitored for signs of a tubing leak. Temperature sensors are also placed along the inside of the inner steel casing to detect potential leaks.

14.2 ENVIRONMENTAL SETTING

14.2.1 Topography

The general geography and topography in the project vicinity is described in Section 2.2.2. The elevation of the Valencia Water Reclamation Plant (VWRP), where much of the proposed project would be constructed, is approximately 1,025 feet above mean sea level (amsl), and the topography is flat. Much of the surrounding area displays rugged topography, with steep ridges and mountain peaks bordering narrow drainages. The surface elevations of the project components and points of interest are provided in Table 14-1.

Table 14-1. Approximate Surface Elevations of Proposed Project Components

Location	Feet Above Mean Sea Level
Saugus WRP	1,165
Valencia WRP	1,025
East Piru Well Field	630
West Piru Well Field	600
Brine Pipeline to JOS at high point	1,800
Brine Pipeline at JOS	370
DWI Site	1,340

Source: Google Earth 2013.

14.2.2 Regional Geology

The majority of the proposed project is located in the geologically complex and seismically active region of California referred to as the Transverse Ranges Geomorphic Province. California's geomorphic provinces are naturally defined geologic regions that display a distinct landscape or landforms with unique, defining features based on geology, faults, topographic relief, and climate. This province consists of an east-west trending series of steep mountain ranges and valleys that deviate from the normal northwest trend of other Coastal California geomorphic provinces due to intense north-south compression squeezing the ranges within this province. Its eastern extension, the San Bernardino Mountains, has been displaced to the south along the San Andreas Fault. Cenozoic petroleum-rich sedimentary rocks have been folded and faulted, which made this province one of the most important oil producing areas in the United States (California Geologic Survey [CGS] 2012).

14.2.3 Project Area Geology and Structure

The watershed drains into the Santa Clara River (SCR) and then flows east to west, sequentially from the SCR Valley East (East) Subbasin to and through the Blue Cut (a narrow and shallow geological structural gap just west of the Los Angeles-Ventura County line) into the Piru Subbasin and to the Piru Narrows (a narrower portion of the Piru Subbasin) which then drains into the Fillmore Subbasin and eventually into the Pacific Ocean through several other downstream subbasins. The geology, structure, and flow patterns of surface water and groundwater in the Santa Clarita and Piru Valleys (East and Piru Subbasins, respectively) are shown on Figure 2-7 and Figure 2-8. The majority of the proposed project components are situated within the East Subbasin, while the following components are situated within the Piru Subbasin: the East and West Piru well fields, pump stations, and extraction pipelines; the blended groundwater pipeline; and a portion of the Ventura County reverse osmosis (RO) product water pipeline. The geology and structure of the subbasins are summarized in the following sections, with focus on the freshwater-bearing geologic materials.

14.2.3.1 East Subbasin

Extensive investigations of the East Subbasin have been conducted beginning in the mid-1980s. The following paragraphs contains a summary of the East Subbasin descriptions from Richard C. Slade and Associates (RCS 2002) and CH2M HILL and HydroGeoLogistics (CH2M-HGL 2006), unless otherwise cited.

The East Subbasin consists of an alluvial trough bounded by granite and granodiorite of the San Gabriel Mountains to the east and southeast, the Santa Susana Mountains to the south, the Topatopa and Piru Mountains to the north and northwest, and the Sierra Pelona Mountains to the northeast. Lithologic units, from the stratigraphic top to the stratigraphic bottom, include alluvium, terrace deposits, and the Saugus Formation, which comprises the deepest freshwater-bearing formations in the SCV. The Saugus Formation is underlain by various non-freshwater-bearing formations. A schematic geologic block diagram for the East Subbasin is shown on Figure 2-7. The geologic units are summarized below.

Freshwater-Bearing Formations

Alluvium

Quaternary to Holocene (recent) age alluvial sediments occur at and near the surface and are composed of extensively inter-layered and inter-fingered mixtures of gravel, sand, silt, and clay, with variable amounts of cobbles and boulders. Due to its unconsolidated to poorly consolidated condition, lack of cementation, and texture, the alluvium is highly permeable. The recent alluvial sediments lie within and along the course of the SCR and its main tributaries, extending continuously east to west from the East Subbasin to the Piru Subbasin to the Fillmore Subbasin and other subbasins further downstream. The maximum thickness of the alluvium varies along the SCR, but is generally up to 200 feet thick, with the greatest thicknesses occurring near the central portion of the river, and thinning or pinching out near the flanks of the adjoining hills. The alluvium also becomes thinner at the western end of the East Subbasin where the SCR flows into the Piru Subbasin through the Blue Cut.

Terrace Deposits

Terrace deposits consist of isolated remnants of older alluvial deposits of the SCR. Tectonic uplift caused the river to incise, leaving topographically-higher benches exposed above the regional groundwater table. These units consist of weakly cemented reddish-brown gravels, sands, and silts up to 200 feet thick. Locally occurring zones of perched water are found in these deposits; however, they are not viable for groundwater development.

Saugus Formation

The Pliocene to Pleistocene age Saugus Formation is present throughout the main portion of the SCV and extends to the surrounding foothills. The Saugus Formation contains lenticular and interfingered beds of poorly to well-consolidated sandstone, conglomerate, and siltstone. In the vicinity of the proposed project area, the Saugus Formation is generally located between 200 and 6,000 feet below ground surface (bgs) (Davis and Namson 2004).

Non-Freshwater-Bearing Formations

Underlying the freshwater-bearing sediments in the SCV are a series of consolidated, older, cemented sedimentary and crystalline rocks of Tertiary age or older. These formations, such as the Pico and Modelo Formations, contain alternating layers of permeable sand and impermeable shale.

Pico Formation

The Saugus Formation is unconformably underlain by the Pico Formation, which resulted largely from shallow marine turbidity flow deposition during the early to middle Pliocene. The clastic, weakly lithified rocks of this formation are characterized generally by light buff-colored sandy silt, grading up section toward a coarser sandy texture near the top of the formation. This indicates a shallowing environment throughout the Pliocene. Porosity and permeability are generally expected to decrease with depth. The subsurface geology is defined by the Pico Anticline, which folds the units roughly parallel to the valley orientation in a northwest-southeast direction (CH2M HILL 2012). In the vicinity of the proposed project area, the Pico Formation is generally located between 6,000 and 9,000 feet bgs (Davis and Namson 2004).

Modelo Formation

The Pliocene Pico Formation is unconformably underlain by the Miocene Modelo Formation. The depth to the top of the Modelo formation generally follows the same pattern as the overlying Pico Formation. In some locations, the Pico Formation is underlain by an undivided occurrence of Modelo rocks with upper Miocene/lower Pliocene Towsley Formation, and in others with an interceding stratum of upper Miocene/lower Pliocene Repetto Formation. All of these formations result from deep marine deposition during the Miocene and earliest Pliocene (16.5 to 4.5 million years ago). In the vicinity of the proposed project area, the Modelo Formation generally begins at 9,000 feet bgs (Davis and Namson 2004). The Modelo Formation is comprised of interbedded sand and shale layers and has multiple well-defined sandstone members. The Modelo Formation is known to be an important oil-producing formation in the region; however, none of the wells near the potential DWI site were producing wells. This could indicate that there is not a trapping mechanism for oil and gas to accumulate in this area. Geophysical logs in the area do show vertical confinement. However, the dip angle of the formation may have directed buoyant oil and gas to the perimeter of the basin where it accumulated at local traps as evidenced by the oilfields in the area (CH2M HILL 2012).

14.2.3.2 Piru Subbasin

Extensive investigation of the hydrogeology in Ventura County has been performed by a variety of investigators. The following paragraphs contain a summary of the descriptions from CH2M-HGL (CH2M-HGL 2006), unless otherwise cited.

The Piru Subbasin consists of an alluvial trough bounded by the Topatopa Mountains and the San Cayetano Fault to the north and the Oak Ridge and Santa Susanna Mountains and the Oak Ridge Fault to the south. The subbasin narrows at both the western end at the Fillmore Fish Hatchery (Piru Narrows) and eastern end at Blue Cut. Lithologic units, from the stratigraphic top to the stratigraphic bottom, include recent and older alluvium, terrace deposits, and the San Pedro Formation. These units are underlain by non-freshwater-bearing formations.

Freshwater-Bearing Formations

Alluvium

Recent and older alluvial deposits are found across the extent of the Piru Subbasin. The recent alluvial deposits consist of interbedded sands, gravels, silts, and clays deposited by the SCR, Piru Creek, Hopper Creek, and smaller tributaries. Deposits found along the SCR consist primarily of coarse sand and gravel. Lower permeability materials are found with distance from the stream channels. These finer grained deposits represent inter-stream and inter-fan areas and create local zones of perched groundwater.

Older alluvial materials underlie recent alluvium over most of the basin. These deposits consist of finer-grained materials deposited by the ancestral SCR and its tributaries. The older alluvium is underlain by the San Pedro Formation across all but the eastern portion of the basin near the Blue Cut. In this area, recent and older alluvium directly overlie the non-water bearing Pico Formation. As previously discussed, the recent alluvium is thin at the eastern margin of the Piru Subbasin at the Blue Cut, down to about 5 feet (CH2M-HGL 2008) to a maximum of 30 feet (Geomatrix 2007). Over most of the basin, the thickness of the recent and older alluvium ranges from 60 to 80 feet.

San Pedro Formation

The Pliocene to Pleistocene age San Pedro Formation underlies the alluvium and consists predominantly of lenticular deposits of sands and gravels with local lenses of clay. Deposits of the San Pedro Formation are terrestrial and analogous to the Upper Saugus Formation in the East Subbasin. The San Pedro Formation has a reported thickness of up to 8,000 feet in the Piru Subbasin (United Water Conservation District [United Water] 1996). Geophysical logging of one oil well in the Piru Subbasin indicated that the San Pedro Formation extends to depths of up to 8,800 feet bgs (Mann 1959).

Non-Freshwater-Bearing Formations

Underlying the freshwater-bearing sediments in the Piru Subbasin is a series of consolidated, older, cemented, and sedimentary rocks of late Cretaceous and Tertiary age. These formations are considered non-freshwater bearing and contain alternating layers of permeable sand and impermeable shale.

14.2.3.3 Fillmore Subbasin

Extensive investigation of the hydrogeology in Ventura County has been performed by a variety of investigators. The following paragraphs contain a summary of the descriptions from United Water Conservation District (United Water) (United Water 1996 and 2009) and CH2M-HGL (CH2M-HGL 2006), unless otherwise cited.

The Fillmore Subbasin consists of an east-west oriented synclinal trough. The basin can be divided into a larger southern and eastern part that is adjacent to the Piru Subbasin, a smaller north central upland area referred to as the Sespe Upland, and the Pole Creek Fan Area, an alluvial fan area that underlies the City of Fillmore. Lithologic units, from the stratigraphic top to the stratigraphic bottom, include recent and older alluvium, terrace deposits, the San Pedro Formation, underlain by non-freshwater bearing formations and Precambrian basement rock. The alluvium and San Pedro Formation are continuous between the Fillmore and Piru Subbasins.

Freshwater-Bearing Formations

Alluvium

Recent and older alluvial deposits are found across the extent of the Fillmore Subbasin. These deposits consist of interbedded sands, gravels, silts, and clays deposited by the SCR and smaller tributaries. Deposits found along the SCR consist primarily of coarse sand and gravel. Lower permeability materials are found with distance from the stream channels. The recent alluvium consists of sand and gravel deposits of the SCR that extend to depths of 60 to 80 feet bgs at the eastern end of the subbasin near the Fillmore Fish Hatchery (United States Geologic Survey [USGS] 2003). The sediments within the alluvium lack cementation and are coarse grained, resulting in highly permeable material. The horizontal conductivity (Kh) of these deposits ranges from 30 to 190 ft/day, based on a numerical model initially developed as part of the Regional Aquifer System Analysis study by the USGS and then later modified and maintained by United Water (referred to as the United Water model) (CH2M-HGL 2006).

San Pedro Formation

The Pliocene to Pleistocene age San Pedro Formation consists predominantly of lenticular deposits of sands and gravels with local lenses of clay. Deposits of the San Pedro Formation are terrestrial and analogous to the Upper Saugus Formation in the East Subbasin. The San Pedro Formation has a reported thickness of up to 8,430 feet along the main axis of the syncline, decreasing to 5,000 to 6,000 feet at the western end of the subbasin. Specific capacities of wells screened within the upper few hundred feet of the San Pedro Formation are reported to exceed 100 gpm/ft (up to 200 gpm/ft) (Mann 1959). The horizontal conductivity of the upper San Pedro Formation in the United Water model ranges from 10 to 115 ft/day.

Non-Freshwater-Bearing Formations

Underlying the freshwater-bearing sediments in the Fillmore Subbasin is a series of consolidated, older, cemented, and sedimentary rocks of late Cretaceous and Tertiary age. These formations are considered non-freshwater bearing and contain alternating layers of permeable sand and impermeable shale.

14.2.4 Faults and Seismicity

The proposed project site is located within the seismically-active Southern California region where numerous active and potentially active faults exist. Seismic hazards in the proposed project area are described in Section 2.2.3.1, including summarizing the displacement on active faults shown on Figure 2-5, listing the historical earthquakes in the area (Table 2-2), and listing the maximum probable magnitude of future earthquakes for active nearby faults (Table 2-3).

14.2.4.1 Earthquake Terminology and Concept

Earthquake Magnitude

When an earthquake occurs along a fault, its size can be determined by measuring the energy released during the event. A network of seismographs records the amplitude and frequency of the seismic waves that an earthquake generates. The Richter Magnitude (M) of an earthquake represents the highest amplitude measured by the seismograph and mathematically corrected for what would have been recorded at a distance of 100 kilometers from the epicenter. Richter magnitudes vary logarithmically with each whole number step representing a ten-fold increase in the amplitude of the recorded seismic waves and 32 times the amount of energy released. While Richter Magnitude was historically the primary measure of earthquake magnitude, seismologists now use Moment Magnitude as the preferred way to express the size of an earthquake. The Moment Magnitude scale (Mw) is related to the physical characteristics of a fault, including the rigidity of the rock, the size of the area that slipped, and the size of displacement along the fault. Although the formulae of the scales are different, they both contain a similar continuum of magnitude values, except that Mw can reliably measure larger earthquakes and do so from greater distances.

14.2.5 Seismic Hazards

14.2.5.1 Surface Fault Rupture

Surface fault rupture occurs when regional earthquake movements change the ground's surface configuration. These changes in ground surface can damage manmade structures and natural drainages. Fault ruptures primarily occur along pre-existing faults. Faults are considered to pose a hazard if they have moved within the past 11,000 years (Ventura 2011).

Many active faults surround the proposed project area. The San Gabriel Fault, located less than a mile northwest of the SWRP, is noted as having Holocene fault displacement occurring sometime within the last 11,000 years. The Santa Susana Fault, the San Fernando Fault, and the San Andreas Fault have all experienced historic displacement occurring sometime within the last 200 years (California Department of Conservation [CDC] 2007).

The strongest recent seismic event in the region was the January 1994 Northridge earthquake. The earthquake's epicenter was located approximately 13 miles southwest of the SCV in the Northridge community of Los Angeles County.

14.2.5.2 Induced Seismicity

Induced seismicity is earthquake activity resulting from human activity that causes a rate of energy release, or seismicity, which would be expected beyond the normal level of historical seismic activity. For example, if there is already a certain level of seismic activity before human activities begin, one would expect that this historical seismic activity would continue at the same rate in the future. However, if human activity causes a concurrent increase in seismic activity, this increase in seismic activity would be considered induced. An indication of induced seismic activity would be if seismic activity returns to background levels after a concurrent human activity stops (U.S. Department of Energy [USDOE] 2013).

14.2.5.3 Ground Shaking

Ground shaking is the physical movement of the land surface due to seismic waves caused by earthquakes. Seismic waves can result in damage to manmade structures, cause landslides, and induce liquefaction failure. Shaking is strongest at sites with softer surface materials and thick, unconsolidated alluvial sediments. The damage potential to structures from ground shaking also depends on the orientation of the fault, the magnitude of the earthquake, and the epicenter location (Ventura 2011).

The Santa Clara River Valley is one of the locations determined to have the highest potential for amplification of ground shaking in Ventura County (Ventura 2011).

The ground shaking potential is calculated as the level of ground motion that has a 2 percent chance of being exceeded in 50 years, which is the same as the level of ground-shaking with about a 2,475 year average repeat time (return period). The shaking potential in the proposed project area ranges from very high to extremely high. As the proposed pipeline alignments progress from the City of Santa Clarita either west or south, shaking hazard decreases due to increasing distance from active faults (CGS 2008).

The Modified Mercalli (MM) intensity scale (Table 14-2) is commonly used to express earthquake effects due to ground shaking because it expresses ground shaking relative to actual physical effects observed by people during a seismic event. MM intensity scale values range from I (earthquake not felt) through a scale of increasing intensities to XII (nearly total damage). Earthquakes on the various active and potentially active fault systems near the proposed project sites can produce a wide range of ground shaking intensities. Geologists and engineers attempt to predict earthquake ground acceleration at sites to improve the structural design of buildings so that the building can withstand the earthquake motion and not collapse. A probabilistic seismic hazard assessment describes seismic hazard from earthquakes that geologists and seismologists agree could occur. 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. Ground acceleration is measured in gravity (g), where 1 g corresponds to the vertical acceleration force due to gravity. The CGS Probabilistic Seismic Hazard Assessment for California determined that a ground acceleration of 0.384 g has a 10 percent probability of being exceeded in the proposed project area within 50 years (1 in 475 chance annually) (CGS 2011). The USGS working group

Table 14-2. Modified Mercalli Intensity Scale

Intensity Value	Intensity Description	Average Peak Ground Acceleration[a]
I	Not felt except by a very few persons under especially favorable circumstances.	< 0.0017 g
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.	0.0017-0.014 g
III	Felt 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 similar to a passing truck. Duration estimated.	0.0017-0.014 g
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.	0.014-0.039g
V (Light)	Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; and unstable objects overturned. Disturbances of trees and poles may be noticed. Pendulum clocks may stop.	0.035-0.092 g
VI (Moderate)	Felt by all, many frightened and run outdoors. Some heavy furniture moved; fallen plaster or damaged chimneys. Damage slight.	0.092-0.18 g
VII (Strong)	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; and considerable in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motor cars.	0.18-0.34 g
VIII (Very Strong)	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; and great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, and walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.	0.34-0.65 g
IX (Violent)	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.65-1.24 g
X (Very Violent)	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; and ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.	> 1.24 g
XI (Very Violent)	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	> 1.24 g
XII (Very Violent)	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.	> 1.24 g

[a] Value is expressed as a fraction of the acceleration due to gravity (g), which is 9.8 meters per second squared. 1.0 g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

Sources: ABAG 2003, CGS 2002.

on earthquake probabilities estimates a 67 percent probability that a magnitude 6.7 or larger earthquake could strike Southern California in the next 30 years (Southern California Earthquake Center [SCEC] 2013).

A common measure of ground motion at any particular site during an earthquake is the peak ground acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal acceleration obtained from a seismograph. PGA is expressed as the percentage of the acceleration due to gravity, which is approximately 9.8 meters per second squared. Unlike measures of magnitude, which provide a single measure of earthquake energy, PGA varies from place to place, and is dependent on the distance from the epicenter and the character of the underlying geology (e.g., hard bedrock, soft sediments, or artificial fills).

14.2.5.4 Seismically Induced Landslides

Landslides are defined as the movement of rock, debris, or earth masses down a slope. Landslides are a form of mass wasting, which refers to any down slope movement of soil and rock under the direct influence of gravity. Types of landslides include rock falls, topples, slides, spreads, and debris flows. Causes of landslides include rainfall, earthquakes, volcanic activity, groundwater changes, and alteration of a slope by man-made construction activities – or a combination thereof (USGS 2010).

14.2.6 Geologic Hazards

14.2.6.1 Settlement and Subsidence

Settlement occurs when a load from a structure or placement of new fill material is applied, causing distortion in the underlying materials. This settlement occurs quickly and is typically complete after placement of the final load. Soils tend to settle at different rates and by varying amounts depending on the load weight or changes in properties over an area, which is referred to as differential settlement.

Subsidence is a form of settlement that can be caused by natural (tectonic movement) or through human extraction activities such as the removal of groundwater, oil, or gas. The extraction activities reduce the pore pressure, increase void spaces, and allow the underlying soils to compact. Areas such as the San Joaquin Valley have experienced significant subsidence as a result of over-drafting of groundwater for agricultural purposes. Subsidence as a result of extraction activities is generally higher in areas where alluvial sediments are relatively thick.

14.3 REGULATORY BACKGROUND

14.3.1 EPA Underground Injection Control Program

DWI is regulated by the EPA's UIC Program under 40 CFR, Parts 144 through 148. The Safe Drinking Water Act (SDWA) establishes requirements and provisions for the UIC Program. Specifically, the SDWA requires the EPA to develop federal requirements for UIC programs and other safeguards to protect public health by preventing injection wells from contaminating USDW (EPA 2013).

The regulatory requirements for Class I non-hazardous waste injection wells are primarily based on the goal of protecting usable groundwater. The operator must protect USDW during construction, operations, and after injection activities have ceased (CH2M 2009). Every Class I injection well operates under a permit, which is valid for up to 10 years. Owners and operators of Class I injection wells must meet specific requirements to obtain a permit. These requirements address siting, construction, operation, monitoring and testing, reporting, record keeping, and well closure/abandonment (EPA 2013).

As part of the EPA permitting process, existing wells and exploratory borings within an Area of Review (AOR) must be investigated to ensure that the proposed injection would not cause the existing wells or borings to become a conduit for migration of relatively poor quality, naturally occurring liquids in the injection zone into a potential drinking water source. The AOR must cover at least a 0.25-mile radius, but, in practice, the EPA's minimum radius is 0.5 mile. The required radius for the AOR may increase depending on factors such as injection flow rate, formation properties, and initial pressure of the formation where the injection will occur (Robin [EPA] pers. comm., 2012).

14.3.2 Occupational Safety and Health Administration Regulations

Excavation and trenching are among the most hazardous construction activities. The Occupational Safety and Health Administration's (OSHA's) Excavation and Trenching standard, Title 29 of the Code of Federal Regulations (CFR), Part 1926.650, covers requirements for excavation and trenching operations. OSHA requires that all excavations in which employees could potentially be exposed to cave-ins must be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area.

14.3.3 Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zone Act), signed into law in December of 1972, requires the delineation of zones along active faults in California. The purpose of the Alquist-Priolo Fault Zoning Act is to regulate development on or near active fault traces to reduce the hazards of potential fault rupture and to limit the construction of structures for human occupancy across these traces. Cities and counties must regulate certain development projects within the zones by, among other things, withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement (Hart 2007). The proposed project is not subject to this act because it is not within an earthquake fault zone and it does not involve structures for human occupancy. Nevertheless, this act is included in the regulatory framework because it requires the State of California to identify and disseminate information about the location of earthquake fault zones, which is considered relevant to the environmental setting.

14.3.4 Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was passed in 1990 following the Loma Prieta earthquake to reduce threats to public health and safety and to minimize property damage caused by earthquakes. The act directs the Department of Conservation to identify and map areas prone to the earthquake hazards of liquefaction, earthquake-induced landslides, and amplified groundshaking. The act requires that site-specific geotechnical investigations be performed before permitting structures intended for human occupancy located within potential hazard zones to identify potential seismic hazards and formulate mitigation measures. According to the seismic hazard zones map for the Tustin Quadrangle where the VWRP is located, the proposed project site is located in a zone of required investigation due to liquefaction potential (DOC 2001). Special Publication 117 is designed to assist in the evaluation and mitigation of earthquake-related hazards for projects within zones designated for investigation (CDC 2008).

14.3.5 California Building Code

The California Building Code (CBC) has been codified in the California Code of Regulations (CCR) at Title 24, Part 2. The CBC is administered by the California Building Standards Commission, which is responsible for coordinating all building standards. State law provides that, to be enforceable, all building standards must be centralized in Title 24. The purpose of the CBC is to establish minimum standards for construction to safeguard the public health, safety, and general welfare. The CBC accomplishes this purpose through standards that regulate and control the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within its jurisdiction. The 2010 CBC is based on the 2009 International Building Code published by the International Code Conference. In addition, the CBC contains necessary California amendments that are based on reference standards obtained from various technical committees and organizations such as the American Society of Civil Engineers (ASCE), the American Institute of Steel Construction, and the American Concrete Institute. ASCE Minimum Design Standards 7-05 provides requirements for general structural design and includes means for determining earthquake loads as well as other loads (flood, snow, wind, etc.) for inclusion into building codes. The provisions of the CBC apply to the construction, alteration, movement, replacement, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California.

The CBC's earthquake design requirements take into account the occupancy category of the structure, site class, soil classifications, and various seismic coefficients that are used to determine a Seismic Design Category (SDC) for a project. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site and ranges from SDC A (very small seismic vulnerability) to SDC E (very high seismic vulnerability and near a major fault). Design specifications are then determined according to the SDC.

14.3.6 County of Los Angeles General Plan

The County of Los Angeles General Plan Safety Element, adopted in 1990, provides county-wide long range emergency response plans. The purpose of the General Plan is to reduce losses of life by avoidance of hazardous sites. The Safety Element addresses earthquake, landslide, flood, and fire hazards and potential hazardous materials incidents related to these hazards. The Safety Element includes polices and goals related to geologic and seismic hazards. Los Angeles County is in the process of updating the General Plan, and it is anticipated that the plan will be adopted in 2013.

14.3.7 Santa Clarita Valley Area Plan

The Santa Clarita Valley Area Plan Update was adopted by the County of Los Angeles Board of Supervisors on November 27, 2012. The Safety Element of the Area Plan provides goals for protecting public health and safety of the SCV. The Safety Element describes natural and man-made hazards that may affect existing and future residents. The goals and policies of the Area Plan include specific seismic design requirements to limit structural damage from earthquakes and policies related to preventing subsidence in order to mitigate potential hazards from soil instability, floods, and landslides (Los Angeles County 2011).

14.3.8 City of Santa Clarita General Plan

The Safety Element of the City of Santa Clarita General Plan, adopted in 2011, discusses the goals and policies for protecting residents from natural and man-made hazards. The Safety Element describes natural and man-made hazards that may affect existing and future residents, and provides guidelines for protecting public health and safety. The Safety Element identifies present conditions and public concerns, and establishes policies and standards designed to minimize risks from hazards to acceptable levels (Santa Clarita 2011).

14.3.9 County of Ventura General Plan

The County of Ventura General Plan, amended in 2011, provides long-term development guidelines for future growth in Ventura County. The General Plan is organized into four chapters: Resources, Hazards, Land Use, and Public Facilities and Services. The Hazards chapter describes goals, policies, and programs related to existing and potential hazards and significant physical constraints to development including fault rupture, ground shaking, liquefaction, tsunami, expansive soils, flood hazard, and inundation from dam failure (Ventura County 2011).

14.3.10 Piru Area Plan

The Piru Area Plan, adopted in 1988 and last amended in 2011, serves as the Land Use Plan for the Piru Area of Interest. The Plan also governs the distribution, general location, and extent of permissible use of land for housing, business, industry, open space, agriculture, and community facilities. The Resources section contains specific goals, policies, and programs that pertain to the geological resources of the area. The Hazards section contains goals and policies addressing seismic and geologic hazards.

14.4 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

14.4.1 Thresholds of Significance

The criteria used to determine the significance of impacts related to geology, soils, and seismicity are based on Appendix G of the CEQA Guidelines. The proposed project would result in a significant impact if it would result in any of the following:

- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, and potentially result in onsite or offsite subsidence.
- Degrade a source of potential drinking water.
- Adversely impact a mineral rights holder's ability to extract minerals.
- Expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death due to DWI induced seismicity.

The Initial Study (Appendix 8-A) concludes that the proposed project would not result in potentially significant impacts for certain Appendix G significance criteria. As a result, those issues are not evaluated further in this EIR.

14.4.2 Impact Analysis

14.4.2.1 Subsidence

Impact 14-1: The proposed project could be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, and potentially result in onsite or offsite subsidence.

Alternative 1 – MF/RO With Brine Disposal via Pipeline

MF/RO and UV Disinfection Facilities

The microfiltration/reverse osmosis (MF/RO) facilities at the VWRP and the potential ultraviolet (UV) disinfection facilities at the VWRP and/or SWRP are described in Section 6.7.1. The MF/RO and potential UV disinfection facilities would not involve water or mineral extraction and would not be located on unstable soils. Impact would be less than significant.

RO Product Water Conveyance System to SWRP

The RO product water conveyance system facilities are described in Section 6.7.1. The RO product water conveyance system would not involve water or mineral extraction and would not located on unstable soils. Impact would be less than significant.

Brine Disposal System (Pipeline to JOS)

The brine disposal system facilities are described in Section 6.7.1. The brine disposal system would not involve water or mineral extraction and would not be located on unstable soils. Impact would be less than significant.

Impact Summary

The construction and operation of Alternative 1 would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, and would not result in onsite or offsite subsidence. The construction and operational impact would be less than significant.

Mitigation Measures: None Required.

Significance Level After Mitigation: Less Than Significant Impact.

Alternative 2 – MF/RO With Brine Disposal via DWI

MF/RO and UV Disinfection Facilities

The MF/RO facilities at the VWRP and the potential UV disinfection facilities at the VWRP and/or SWRP would be the same as described for Alternative 1. Impact would be less than significant.

RO Product Water Conveyance System to SWRP

The RO product water conveyance system facilities would be the same as described for Alternative 1. Impact would be less than significant.

Brine Disposal System (DWI)

The brine disposal system facilities are described in Section 6.7.1. The brine disposal system would not involve water or mineral extraction. Rather, the DWI system would inject brine into deep formations. Impact would be less than significant.

Impact Summary

The construction and operation of Alternative 2 would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, and would not result in onsite or offsite subsidence. The construction and operational impact would be less than significant.

Mitigation Measures: None Required.

Significance Level After Mitigation: Less Than Significant Impact.

Alternative 3 – MF/RO With Brine Disposal via Trucking

MF/RO and UV Disinfection Facilities

The MF/RO facilities at the VWRP and the UV disinfection facilities at the VWRP and SWRP would be the same as described for Alternative 1. Impact would be less than significant.

RO Product Water Conveyance System to SWRP

The RO product water conveyance system facilities would be the same as described for Alternative 1. Impact would be less than significant.

Brine Disposal System (Trucking)

The brine disposal system facilities are described in Section 6.7.1. The brine disposal system would not involve water or mineral extraction. Impact would be less than significant.

Impact Summary

The construction and operation of Alternative 3 would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, and would not result in onsite or offsite subsidence. The construction and operational impact would be less than significant.

Mitigation Measures: None Required.

Significance Level After Mitigation: Less Than Significant Impact.

Alternative 4 – Phased AWRM

Phase I

UV Disinfection Facilities

The UV disinfection facilities at the VWRP and SWRP would be the same as described for Alternative 1. No impact would occur.

Salt Management Facilities

The salt management facilities are described in Section 6.7.1. The salt management facilities include the East and West Piru well fields that would consist of 11 wells with a maximum extraction capacity of approximately 30 million gallons per day (mgd). Unconstrained operation of the well fields would have the potential to induce subsidence. However, groundwater extraction has occurred within the Piru Subbasin for over 100 years. During this period, water levels have fluctuated depending on the overlying demands, seasonal variability, and the annual hydrologic cycle. Subsidence could occur if soils not previously dewatered became dewatered, allowing the water-bearing spaces to collapse. Implementation of Mitigation Measure HYDRO-1 would limit pumping to historic groundwater depths unless further studies are performed. Thus, the proposed project would not dewater water-bearing formations that have not already been dewatered historically for periods of time unless studies beforehand. As a result, Mitigation Measure HYDRO-1 would prevent the operations of the wells from inducing subsidence in the Piru Subbasin. Implementation of Mitigation Measure HYDRO-1 would reduce the impact to a less than significant level.

Supplemental Water System

The supplemental water system facilities are described in Section 6.7.1. The supplemental water system would include use of existing wells or the construction of new wells in the East Subbasin. The proposed project would not result in increased use of these wells, but would operate them for different purposes at certain times. Operation of these wells for the proposed project would result in groundwater level drawdown similar to that which would occur without the project. Therefore, the potential for inducing subsidence as a result of the proposed project would be low. Impact would be less than significant.

Impact Summary – Phase I

The operation of the East and West Piru well fields for Phase I of Alternative 4 would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, but would potentially result in onsite or offsite subsidence. Implementation of Mitigation Measure HYDRO-1 would mitigate the impact to a less than significant level. The construction impact would be less than significant.

Mitigation Measures: Implement HYDRO-1 (see Section 16).

Significance Level After Mitigation: Less Than Significant Impact.

Phase II

MF/RO Facilities

The MF/RO facilities at the VWRP would be similar to those described for Alternative 1 but, under this alternative, would be smaller in size. No impact would occur.

RO Product Water Conveyance System to Ventura County

The RO product water conveyance system facilities are described in Section 6.7.1. The RO product water conveyance system facilities would not involve water or mineral extraction and would not be located on unstable soils. No impact would occur.

Brine Disposal System

The brine disposal system facilities are described in Section 6.7.1. The brine disposal system would rely on a pipeline, DWI, or trucking – each of which was previously analyzed for Alternatives 1, 2 and 3, respectively, but there would be lower peak flow to manage so the diameter of the pipeline, number of injection wells, and peak number of truck trips would be smaller. None of these brine disposal system options would involve water or mineral extraction and would not be located on unstable soils. No impact would occur.

Impact Summary – Phases I and II

The operation of the East and West Piru well fields for Phase I of Alternative 4 would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, but would potentially result in onsite or offsite subsidence. Implementation of Mitigation Measure HYDRO-1 would mitigate the impact to a less than significant level. The construction impact would be less than significant.

The construction and operation of Phase II of Alternative 4 would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, and would not result in onsite or offsite subsidence. No construction or operational impact would occur.

Mitigation Measures: Implement HYDRO-1 (See Section 16).

Significance Level After Mitigation: Less Than Significant Impact.

14.4.2.2 Degradation of Potential Drinking Water

Impact 14-2: The proposed project could degrade a source of potential drinking water.

Impact 14-2 is only applicable to DWI, which is a component of Alternative 2 and potentially a component of Phase II of Alternative 4. Alternatives 1, 3, and Phase I of Alternative 4 do not include any components that have a potential to degrade drinking water. Therefore, no additional discussion is warranted for Alternatives 1, 3, and Phase I of Alternative 4. Below is a discussion of the DWI included in Alternative 2 and potentially included in Phase II of Alternative 4.

Alternative 2 and Phase II of Alternative 4

Brine Disposal System (DWI)

The brine disposal system facilities are described in Section 6.7.1. An overview of DWI is provided in Section 14.1.2. If injection is located near inadequately abandoned existing wells or borings, such wells or borings have the potential to provide a conduit for relatively poor quality, naturally-occurring liquids in the injection zone to leak upward into USDW due to elevated pressures from the injection operation. Most existing wells and borings are filled with drilling mud that initially provides a significant impediment to fluid movement in the boring or well. There are mixed opinions about the integrity of this drilling mud over time. One group believes that the mud continues to serve as an effective impediment to flow. Another group, which includes the EPA and the California Division of Oil, Gas, and Geothermal Recovery (DOGGR) takes a more conservative approach and assumes the integrity of the drilling mud diminishes over time and only views cement plugs as an effective long-term flow barrier. The EPA's UIC Program is designed to protect potentially drinkable groundwater (e.g., USDW), and an AOR evaluation must be performed to address the possibility of leakage through an existing well or boring.

In assessing whether to issue a permit, the EPA considers the suitability of the geology and also requires investigation of existing wells and borings within an AOR. Suitable geology includes a thick, relatively permeable layer to inject into (injection zone) with one or more relatively impermeable layers above (confinement zones) to prevent upward migration into the USDW. The AOR evaluation process is intended to provide assurance that the proposed injection would not cause any existing well or boring to become a conduit for flow migration into a potential drinking water source. The AOR must cover the expected Zone of Endangering Influence from the proposed injection and is calculated using several parameters including flow rate, permeability and formation pressure. In practice, the EPA requires an AOR radius of 0.5-mile, but the radius can increase to several miles if the formation pressure is close to the pressure of the USDW (Robin pers. comm., 2012).

Existing wells and borings within the AOR must be investigated to ensure that they were abandoned per EPA requirements. If the well is determined to have been inadequately abandoned, the EPA requires that corrective action be taken in accordance with 40 CFR, Part 144.55 prior to injection (CH2M HILL 2012).

In accordance with 40 CFR, Part 261 (Hazardous Waste Identification), injected brine would be considered a hazardous material if its components are either specifically listed or if it exhibits any of the four regulated characteristics: ignitability, corrosivity, reactivity, or toxicity. Wastewater derived brine is not specifically listed as hazardous. Of the four regulated characteristics, only the toxicity characteristic could potentially apply to the proposed project's brine. When compared to these 39 specified toxic chemicals above the regulatory level listed in 40 CFR, Part 261, the estimated brine concentrations would be lower; thus, the brine would not be considered toxic. Therefore, the brine would not be regulated as hazardous waste, and an injection well would be classified by EPA as a Class I non-hazardous well. Furthermore, the brine would have similar or lower salt content (total dissolved solids) as existing formation water.

There is the possibility that there are undocumented wells in the proposed project area. Prior to 1916, the California State Mining Bureau maintained records; however, these archives are deemed to be incomplete. Since 1916, improved recordkeeping practices have been in place such that the DOGGR well records from 1916 onward are considered to be reliable and complete.

Prior to 1916, well construction technology only enabled drilling to 1,000 feet (Hesson [DOGGR] pers. comm., 2013). These depths are considered shallow and would not penetrate the confining layer at the bottom of the USDW, thereby creating a potential pathway for leakage. In contrast, the potential SCVSD injection would be 9,000 to 12,000 feet below ground surface. Therefore, no undocumented wells having the potential to result in brine movement from the injection zone to a USDW are expected.

The primary purpose of EPA's UIC Program is to prevent impact to potentially drinkable groundwater. The SCVSD would be required to obtain and comply with a UIC permit. No impact would occur.

Impact Summary – Alternative 2 and Phase II of Alternative 4

The construction and operation of DWI for Alternative 2 would not degrade a source of potential drinking water. No construction or operational impact would occur.

The construction and operation of DWI potentially for Phase II of Alternative 4 would not degrade a source of potential drinking water. No construction or operational impact would occur.

Mitigation Measures: None Required.

Significance Level After Mitigation: No Impact.

14.4.2.3 Impact to Mineral Extraction

Impact 14-3: The proposed project could adversely impact a mineral rights holder's ability to extract minerals.

Impact 14-3 is only applicable to DWI, which is a component of Alternative 2 and potentially a component of Phase II of Alternative 4. Alternatives 1, 3, and Phase I of Alternative 4 do not include any components that could adversely impact a mineral rights holder's ability to extract minerals. Therefore, no additional discussion is warranted for Alternatives 1, 3, and Phase I of Alternative 4. Below is a discussion of the DWI included in Alternative 2 and potentially included in Phase II of Alternative 4.

Alternative 2 and Phase II of Alternative 4

Brine Disposal System (DWI)

The brine disposal system facilities are described in Section 6.7.1. An overview of DWI is provided in Section 14.1.2. Depending on the location of brine injection relative to deposits of oil and natural gas, the brine injection could have a positive or negative impact on the ability to extract such resources. For example, if the proposed DWI site was located into the middle of an existing oil extraction operation, the extracted oil may have a higher percentage of water, thus diminishing its quality. If the proposed DWI site was located in an area where oil extractors would want to inject their brine waste, the injection would cause the oil operator to inject at higher pressures and reduce their capacity to inject. However, if the proposed DWI site was at the periphery of an oil extraction operation, the injection could establish favorable pressure gradients that help oil extractors. In fact, the process of injection near the periphery of an oil extraction area is known as enhanced oil recovery and the deliberate injection of brine at strategic locations is used by the oil industry to improve oil extraction.

Recognizing these concerns and the fact that old oil fields currently labeled as abandoned could become active again if the demand for oil rises, the proposed DWI site would be located in a non-oil bearing area. Given the extensive amount of exploratory boring in the Santa Clarita region, it is highly unlikely that an area identified as non-oil bearing would later be found to be oil bearing. No impact would occur.

Impact Summary – Alternative 2 and Phase II of Alternative 4

The construction and operation of DWI for Alternative 2 would not adversely impact a mineral rights holder's ability to extract minerals. No construction or operational impact would occur.

The construction and operation of DWI potentially for Phase II of Alternative 4 would not adversely impact a mineral rights holder's ability to extract minerals. No construction or operational impact would occur.

Mitigation Measures: None Required.

Significance Level After Mitigation: No Impact.

14.4.2.4 Deep Well Injection Induced Seismicity

Impact 14-4: Deep injection of brine could expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death due to DWI induced seismicity.

Impact 14-4 is only applicable to DWI, which is a component of Alternative 2 and potentially Phase II of Alternative 4. Alternatives 1, 3, and Phase I of Alternative 4 do not include any components that could expose people or structures to potential substantial adverse effects including the risk of loss, injury or death due to DWI-induced seismicity. Therefore, no additional discussion is warranted for Alternatives 1, 3, and Phase I of Alternative 4. Below is a discussion of the DWI included in Alternative 2 and potentially included in Phase II of Alternative 4.

Alternative 2 and Phase II of Alternative 4

Brine Disposal System (DWI)

The brine disposal system facilities are described in Section 6.7.1. An overview of DWI is provided in Section 14.1.2. In a small percentage of cases, injection and extraction operations are suspected to have caused seismic events. In 2012, the National Academy of Sciences completed a report on induced seismicity at the request of the federal government. This report examines the scale, scope, and consequences related to energy technologies that involve fluid injection or withdrawal from Earth's subsurface (National Academy of Sciences 2012). The reason why some operations result in seismic events, while the great majority of operations do not, is not well understood. In general, the main factors for an induced seismic event are thought to be the presence of existing faults and an injection/extraction operation that causes a substantial increase or decrease in subsurface pressure and stresses at a fault. The change in stress is thought to allow movement along a nearby fault resulting in an earthquake.

For the past 40 years, scientists have studied seismic events triggered by fluid injection and extraction. The first documented case was the Rocky Mountain Arsenal earthquakes near Denver, Colorado in the 1960s. Fluid injection was found to have caused earthquakes ranging in magnitude from 4.5 to 4.8 (National Academy of Sciences 2012). More recently, fluid injection in Youngstown, Ohio, was the suspected cause of a series of earthquakes ranging in magnitude from 2.5 to 4.0 (Schneider 2012).

The Santa Clarita area, like much of California, is seismically active and contains a number of faults including the active San Gabriel Fault about 1.5 miles from the proposed injection location. While naturally occurring earthquakes can be expected in this region even without an injection system in operation, injection of brine at the proposed project location has the potential to induce seismic activity.

As of 2010, over 16,000 Class I injection wells had been operated in California including nearly 600 that were actively operating in the DOGGR region that includes Santa Clarita (DOGGR 2011). Only nine injection sites have reported induced seismic events in California and none in the DOGGR region that includes Santa Clarita (National Academy of Sciences 2012). As a result, the probability of an injection-induced seismic event is believed to be very small. If DWI is implemented, the SCVSD would develop a seismic monitoring plan prior to commencing injection that would identify the monitoring frequency during well startup and operations as well as a flow ramp-up schedule during startup. Impact would be less than significant.

Impact Summary – Alternative 2 and Phase II of Alternative 4

The construction and operation of DWI for Alternative 2 would not expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death due to DWI induced seismicity. The construction and operational impact would be less than significant.

The construction and operation of DWI potentially for Phase II of Alternative 4 would not expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death due to DWI induced seismicity. The construction and operational impact would be less than significant.

Mitigation Measures: None Required.

Significance Level After Mitigation: Less Than Significant Impact.