D.5 Geology and Soils

This section presents a discussion of the geologic hazards, including seismic, liquefaction, and landslide hazards, that may affect the Proposed Project and alternatives. Section D.5.1 provides a description of the existing geologic setting, and the applicable ordinances and limitations are introduced in Section D.5.2. An analysis of the Proposed Project impacts is provided in Section D.5.3 along with proposed mitigation measures, and the geology and soils impacts related to alternatives are described in Section D.5.4. Section D.5.5 provides mitigation monitoring, compliance, and reporting information and Section D.5.6 lists the references cited in this section.

Public safety impacts due to gas migration resulting from possible faulting or seismic activity is discussed in Section D.6, Hazardous Materials, Public Health and Safety.

D.5.1 Environmental Setting for the Proposed Project

This section presents a discussion of the regional topography, geology, seismicity, soils, and mineral and paleontological resources in the project area. Baseline geologic information was collected from published and unpublished geologic, seismic, and geotechnical literature covering the Proposed Project site and the surrounding area. Regional and site-specific information was obtained from the United States Geological Survey (USGS) and California Department of Conservation (California Geological Survey) maps and other publications, including the Sacramento Natural Gas Storage (SNGS), LLC Proponent's Environmental Assessment (PEA) (SNGS, LLC 2007). The impacts of release of natural gas from the reservoir are addressed in Section D.6, Hazardous Materials, Public Health and Safety.

D.5.1.1 Regional Topographic and Geologic Setting

Topography

The area surrounding the Proposed Project is on nearly level to very gently sloping stream channels, levees, terraces, overflow basins, and small areas of floodplain, with fluvial erosion and deposition acting as the main geomorphic processes (United States Department of Agriculture, Forest Service (USFS) 1998). The Proposed Project area is a relatively flat alluvial plain with ground surface elevations ranging between approximately 20 and 40 feet above mean sea level (amsl). However, most of the area is relatively flat, at about 38 to 40 feet amsl (SNGS, LLC 2007).

Regional Geology

The Proposed Project area is located on a relatively flat alluvial plain within the Great Valley geomorphic province. The Great Valley is an alluvial plain approximately 50 miles wide and 400 miles long in the central part of California. The Great Valley is a trough in which sediments have been deposited continually since the Jurassic period. Its northern part is the Sacramento Valley, drained by the Sacramento River, and its southern part is the San Joaquin Valley, drained by the San Joaquin River (California Geological Survey 2002).

The Proposed Project is located at the southeastern end of the Sacramento Valley, an alluvial plain composed of a deep sequence of sediments derived from erosion of the Coast Ranges to the west and Sierra Nevada Mountains to the east, within the confines of a structural trough. The thickness of the alluvial deposits beneath the Proposed Project area is approximately 8,000 feet (Hackel 1966, Figure 1); however, a minimum of 60,000 feet of Mesozoic sediments consisting of siltstone, claystone, and sandstone of predominantly marine origin were laid down in the area west of the present margin of the Sacramento Valley (Hackel 1966, p. 217) and west of the Proposed Project area. The uppermost part of the alluvial plain is composed of Holocene basin deposits and Pleistocene age Riverbank Formation sediments, both alluvial in origin. These alluvial deposits are underlain by undifferentiated early Tertiary marine deposits, which overlie upper Cretaceous deposits of the Great Valley sequence. The sedimentary sequence rests on a basement complex composed of metamorphosed Paleozoic (at least 245 million years old) and Mesozoic (at least 66 million years old) sediments, volcanics, and granites extending west from the Sierra Nevada Mountains (SNGS, LLC 2007). See Table D.5-1 for descriptions of the geologic formations on the Proposed Project site.

Table D.5-1
General Descriptions and Characteristics of the Geologic Formations

Symbol	Unit	Age	Description
Qb	Basin deposits	Quaternary–Holocene	Alluvium (exposed mostly in the northwest and along the Sacramento River)
Qr	Riverbank Formation	Quaternary–Pleistocene	Alluvium (exposed over most of the project area)
Tmu	Marine deposits	Tertiary	Undifferentiated early Tertiary marine deposits beneath Sacramento Valley
Ku	Great Valley sequence	Upper Cretaceous	Includes the Winters Sand (formation); reservoir rock, gas-bearing sand unit
Jmx	Metamorphic rocks	Jurassic	Paleozoic–Mesozoic metamorphic sediments, volcanics, and granite rocks of the Sierra Nevada

Sources: SNGS, LLC 2007; Regional Geologic Map, Sacramento Quadrangle, 1987; Hackel 1966; Wagner et al. 1981; Helley and Harwood 1985.

Soils

Surface Conditions. The Proposed Project area is located in an urban setting but there is a substantial amount of unpaved land surface that is adjacent to streets and railroad rights-of-way. Areas subjected to past grading and/or disking activities make distinguishing between natural surfaces and those altered by human activity (fill material) difficult. Generally, fill material consists of sand, gravel, cobbles, etc., mostly of local origin. Near the surface and to a depth of 30 to 50 feet are deposits of silt and sand, commonly referred to as the upper sand unit, which represents the uppermost portion of the Riverbank Formation. Underlying the upper sand unit is a layer of sandy gravel between 60 and 80 feet below the ground surface (bgs), extending to an unknown depth. The cap rock and the gas-bearing formations (see Underground Field Conditions below) are in excess of 3,000 feet bgs (SNGS, LLC 2007).

Native soil types along the proposed pipeline alignment that do not contain roadways, structures, or other development belong to the San Joaquin sandy loam series. However, most of the locations where Proposed Project features would be constructed consist of previously disturbed land and are partially underlain by fill used to provide a base for foundations and roadways (SNGS, LLC 2007).

In their undisturbed native state, the San Joaquin soils have relatively high clay content, often occurring as layers of hardpan (indurated and/or cemented subsoils) within a few feet of the ground surface. Consequently, surface and near-surface San Joaquin soils may be expected to have a high shrink–swell potential that can swell (expand) when wetted and shrink (contract) as they dry. Such soil properties can threaten the stability of structures without adequately engineered foundations. Typically, clayey soils do not absorb water readily and generate moderately high to high rates of runoff, depending on the slope; the hazard of erosion varies from slight, where gently sloping, to high in steeper areas. However, the clayey surface texture of these soils renders them relatively non-susceptible to wind erosion and limits their susceptibility to water erosion (SNGS, LLC 2007). The Proposed Project area is not considered a source of topsoil, because areas where native San Joaquin and Hedge soils are exposed are minimal. At the proposed compressor station and wellhead site, native soil consists of Hedge loam, 0%–2% slopes. This soil is characterized by moderately slow permeability, slow runoff and slight erosion potential, and low expansion potential (SNGS, LLC 2007).

Underground Field Conditions. The subsurface conditions beneath the Proposed Project area have been summarized in the SNGS, LLC PEA (2007, 3.7-5). The Florin Gas Field was discovered by Union Oil Company of California in November 1977, and the field was explored and developed to produce commercial quantities of natural gas from the Winters Formation from a depth of approximately 3,750 feet bgs. The age of the Winters Formation (hereafter referred to as the Winters Sand) is about 70 million years old, placing it in the late Cretaceous period. Prior to this discovery, Hackel (1966) noted that most of the gas produced in the fields discovered in the central and west side of the Sacramento Valley comes from lenticular sands equivalent in part to the Forbes Formation. Gas delivery from this field began in 1980, continuing until 1987, from a total of five wells that were completed in the same formation through 1983. The last productive field well was abandoned in 1993 (SNGS, LLC 2007).

The Florin Gas Field consists of alternating layers of marine sand and shale deposited in ancient seas that occupied the Sacramento Valley between approximately 10 million and 80 million years ago. The sequence is at least 6,800 feet thick and dips to the west, a condition caused by the uplift of the Sierra Nevada Mountains and the down-dropping of the Sacramento Valley during this time. The constantly steepening older (lower) layers on the slope between the valley and the mountain range were cut off, or “capped,” by the continuing deposition of younger (upper) layers, creating a mechanism to trap natural gas. The Winters Sand is characterized as a 150-foot-thick porous sandstone unit forming the reservoir for the natural gas, which in turn is overlain (capped) by a 150- to 500-foot-thick shale unit. This shale unit above the Winters Sand forms a seal that prevents the natural gas from escaping (SNGS, LLC 2007). The gas field appears to be a convex lens-shaped sand mound controlled by thinning sand deposition to the east and northeast, with closure on all sides of the reservoir provided by the shale layer above the sandstone. There do not appear to be any mapped structural faults through the field that would contribute to leakage of natural gas through the capping shale unit.

Seismicity

Seismic Conditions. The Proposed Project is located along the eastern margin of the circum-Pacific earthquake zone, which is a result of the processes of plate tectonics and is the most seismically active area in the United States. A major feature of the circum-Pacific earthquake zone associated with this region of California is the San Andreas Fault System, which defines the boundary between the North American Plate to the east (on which the Proposed Project is located) and the Pacific Plate to the west. The San Andreas Fault System is generally expressed as a 40-mile-wide elongated zone of fracturing and rock deformation that creates the general northwest-to-southeast-trending valleys and ridges in the Coast Ranges, as well as the overall physiographic nature of California’s Central Valley. Another consequence of its proximity is the earthquake activity that is common throughout California.

A review of available published geologic and seismic hazards maps indicates that there are no known active faults identified in or adjacent to the City of Sacramento and the Proposed Project area. In addition, there has been no documented movement on faults mapped in Sacramento County during the past 150 years. However, the region has experienced numerous instances of ground shaking originating from faults in the San Andreas Fault System west of the county and the Sierra Nevada Fault System east of the county (SNGS, LLC 2007).

The closest known potentially active fault mapped by the California Geological Survey is the Dunnigan Hills Fault, located about 19 miles northwest of Sacramento, while the closest branches of the seismically active San Andreas Fault System (historical activity, i.e., within the last 200 years) are the Concord–Green Valley faults, 45 miles to the southwest (SNGS, LLC 2007). The main trace of the San Andreas Fault System is approximately 80 miles to the southwest. Other active faults within 100 miles of the Proposed Project area are listed in Table D.5-2. The Willows Fault, located approximately 15 miles north of the Proposed Project site as mapped by Helley and Harwood (1985), may also influence the area, but is thought to be incapable of producing a surface rupture. The project area may also support other older faults that are not considered active.

Table D.5-2
Active Faults within 100 Miles of the Proposed Project Area

Fault Name	Distance from Fault to Project Area (Miles)	Characteristic Earthquake (Mw) (Maximum at Fault Zone)[1]
West Valley Faults		
Dunnigan Hills	19	6.6[2]
Midland	22	Pre-Quaternary: no longer considered active[3]
Central Valley Faults		
Bear Mountain	22	6.0
New Melones	40	6.0
Stockton	47	5.0[4]
San Andreas Fault System		
Vaca–Kirby Hill	28	6.1[2]
Antioch	42	Pre-Quaternary: no longer considered active[5]
Greenville	43	6.6
Concord	45	6.2
Green Valley	42	6.2
Healdsburg/Rogers Creek	56	7.1
Hayward	66	6.9–7.1
Calaveras	66	7.5
San Andreas	80	7.9

Source: SNGS, LLC 2007.
1 Characteristic earthquake and moment magnitude.
2 Wesnouski 1986.
3 California Geological Survey 1994.
4 AGS, Inc. 2005.
5 California Geological Survey 1991.

The probable seismic shaking expected is anticipated to produce peak ground accelerations between 10% and 20% of the acceleration of gravity, 0.1 *g* and 0.2 *g*, respectively (SNGS, LLC 2007, 3.7-2). Earthquake intensities generally associated with this amount of ground shaking are typically between VI and VII on the Modified Mercalli Intensity Scale (MMI) (Table D.5-3). An expected characteristic earthquake on the entire San Andreas Fault System is moment magnitude (Mw) 7.9 and is probably the largest earthquake that would be felt in the Proposed Project area (SNGS, LLC 2007). However, given the distance between the San Andreas Fault and the Proposed Project area, the felt intensity would be expected to be between MMI IV and V (light to moderate shaking). A felt intensity between MMI VII and VIII (very strong to severe shaking) would be caused by a characteristic earthquake on the Dunnigan Hills Fault of Mw 6.6 because it is much closer to the project area (SNGS, LLC 2007).

Table D.5-3
The Modified Mercalli Scale of Earthquake Intensities

If most of these effects are observed:	Then the intensity is:
Effect on people: Earthquake shaking not felt but people may observe marginal effects of large, distant earthquakes without identifying these effects as earthquake-caused. Among them: trees, liquids, bodies of water sway slowly, or doors swing slowly.	I
Effect on people: Shaking felt by those at rest, especially if they are indoors, and by those on upper floors.	II
Effect on people: Felt by most people indoors. Some can estimate duration of shaking but many may not recognize shaking of building as caused by an earthquake; the shaking is like that caused by the passing of light trucks.	III
Other effects: Hanging objects swing. **Structural effects:** Windows or doors rattle. Wooden walls and frames creak.	IV
Effect on people: Felt by everyone indoors and by most people outdoors. Many now estimate not only the duration of shaking but also its direction and have no doubt as to its cause. Sleepers wakened. **Other effects:** Hanging objects swing. Standing autos rock. Crockery clashes, dishes rattle, or glasses clink. **Structural effects:** Doors close, open, or swing. Windows rattle.	V
Effect on people: Felt by everyone indoors and by most people outdoors. Many now estimate not only the duration of shaking but also its direction and have no doubt as to its cause. Sleepers wakened. **Other effects:** Hanging objects swing. Shutters or pictures move. Pendulum clocks stop, start, or change rate. Standing autos rock. Crockery clashes, dishes rattle, or glasses clink. Liquids disturbed, some spilled. Small unstable objects displaced or upset. **Structural effects:** Weak plaster and Masonry D* crack. Windows break. Doors close, open, or swing.	VI
Effect on people: Felt by everyone. Many are frightened and run outdoors. People walk unsteadily. **Other effects:** Small church or school bells ring. Pictures thrown off walls, knickknacks and books off shelves. Dishes or glasses broken. Furniture moved or overturned. Trees, bushes shaken visibly or heard to rustle. **Structural effects:** Masonry D* damaged; some cracks in Masonry C*. Weak chimneys break at roof line. Plaster, loose bricks, stones, tiles, cornices, unbraced parapets, and architectural ornaments fall. Concrete irrigation ditches damaged.	VII
Effect on people: Difficult to stand. Shaking noticed by auto drivers. **Other effects:** Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Furniture broken. Hanging objects quiver. **Structural effects:** Masonry D* heavily damaged; Masonry C* damaged, partially collapses in some cases; some damage to Masonry B*; none to Masonry A*. Stucco and some masonry walls fall. Chimneys, factory	VIII

Table D.5-3 (Continued)

If most of these effects are observed:	Then the intensity is:
stacks, monuments, towers, elevated tanks twist or fall. Frame houses move on foundation if not bolted down; loose panel walls thrown out. Decayed piling broken off.	
Effect on people: General fright. People thrown to ground. **Other effects:** Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes. Steering of autos affected. Branches broken from trees. **Structural effects:** Masonry D* destroyed; Masonry C* heavily damaged, sometimes with complete collapse; Masonry B* seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frames cracked. Reservoirs seriously damaged. Underground pipes broken.	IX
Effect on people: General panic. **Other effects:** Conspicuous cracks in ground. In areas of soft ground, sand is ejected through holes and piles up into small craters, and, in muddy areas, water fountains are formed. **Structural effects:** Mast masonry and frame structures destroyed along with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, and embankments. Railroads bent slightly.	X
Effect on people: General panic. **Other effects:** Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. **Structural effects:** General destruction of buildings. Underground pipelines completely out of service. Railroads bent greatly.	XI
Effect on people: General panic. **Other effects:** Same as for Intensity XI. **Structural effects:** Damage nearly total, the ultimate catastrophe. **Other effects:** Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.	XII

* Masonry A: Good workmanship and mortar, reinforced, designed to resist lateral forces.
Masonry B: Good workmanship and mortar, reinforced.
Masonry C: Good workmanship and mortar, unreinforced.
Masonry D: Poor workmanship and mortar and weak materials, like adobe.

D.5.1.2 Potential Geologic Hazards

Liquefaction

Sacramento is located in an area identified as having a low likelihood of intense seismic shaking and a future liquefaction occurrence within this area of about 2% (USGS 2005). However, as part of the construction permitting process, the City of Sacramento and the California Public Utilities Commission (CPUC) would require complete reports of soil conditions at the specific construction sites of the Proposed Project area to identify potentially unsuitable soil conditions, including liquefaction, settlement, subsidence, lateral spreading, and collapse.

Landslide

Due to the nearly level to very gently sloping alluvial plain of the Proposed Project area, landslide-related slope failure is not expected to represent a significant concern.

Subsidence

Subsidence is a lowering of the ground surface from historic levels. It is usually associated with excessive groundwater pumping, natural compaction of valley fill, oxidation of peat layers removal of petroleum or removal of natural gas from an existing reservoir. Terracon 2008 did not identify any instances of subsidence from the gas extraction in the Florin Gas Field. Based on data provided by the Yolo County Subsidence Network (2000), subsidence is in the order of a few hundredths of an inch per year.

Other Potential Hazards

The presence of expansive soil in the Proposed Project area increases the possibility of expansive soils occurring along the pipeline alignments and causing foundation-stability issues at the wellhead and compressor station sites.

No faults have been mapped within the Proposed Project area and it is not crossed by any Alquist–Priolo Earthquake Fault Zone. Because the project area is not in an Alquist–Priolo Earthquake Fault Zone, no associated provisions of the Alquist–Priolo Earthquake Fault Zoning Act related to fault rupture would apply. Those faults that are mapped outside the Proposed Project do not cross or trend toward the project area. Consequently, fault-line surface rupture is not considered a hazard, and the Proposed Project would have no impact regarding exposing people or structures to rupture of a known earthquake fault.

The project area is not a significant source of topsoil. Installation of the pipelines and construction of the wellheads and other project structures would result in earth-disturbing activities that could expose soil to erosion. However, since the project area is generally flat, there would be no hazards associated with erosion of slopes.

D.5.1.3 Groundwater

The Proposed Project is located in the northwest portion of South American Subbasin 5-21.65 of the Sacramento Valley Groundwater Basin, at the southern part of the Sacramento River Hydrologic Region, adjacent to the boundary with the San Joaquin River Hydrologic Region (State of California Department of Water Resources (DWR) 2003, Figure 33). The Sacramento River Hydrologic Region covers approximately 17.4 million acres (27,200 square miles) and extends south from the Modoc Plateau and Cascade Range at the Oregon border to the Sacramento–San Joaquin Delta. The South American Subbasin (5-21.65) encompasses an area of 248,000 acres (388 square miles) bounded on the east by the Sierra Nevada, on the west by the Sacramento River, on the north by the American River, and on the south by the Cosumnes and Mokelumne rivers. The Proposed Project is located southeast of the convergence of the

American River and the Sacramento River. These perennial rivers generally create a groundwater divide in the shallow subsurface (DWR 2004).

The South American Subbasin aquifer system in the vicinity of the Proposed Project area is composed of continental deposits of Late Tertiary to Quaternary age. These deposits include younger alluvium (consisting of flood basin deposits and Holocene stream channel deposits) and older alluvium. The cumulative thickness of these deposits increases from a few hundred feet near the Sierra Nevada foothills on the east to over 2,500 feet along the western margin of the subbasin. The maximum combined thickness of all the younger alluvial units is about 100 feet (DWR 2004).

The flood basins adjacent to the Sacramento River consist primarily of silts and clays, but may be locally interbedded with stream channel deposits of the Sacramento River. Stream channel deposits include sediments deposited in the channels of active streams as well as overbank deposits of those streams, terraces, and local dredger tailings. They occur along the Sacramento, American, and Cosumnes rivers and their major tributaries and consist primarily of unconsolidated silt, fine- to medium-grained sand, and gravel. Older alluvium deposits consist of loosely to moderately compacted sand, silt, and gravel deposited in alluvial fans during the Pliocene and Pleistocene. A number of formational names have been assigned to the older alluvium, including the Modesto and Riverbank formations (DWR 2004), Victor Formation and Laguna Formation (DWR 2004), Arroyo Seco Gravels, South Fork Gravels, and Fair Oaks Formation (DWR 2004). The older alluvial units are widely exposed between the Sierra Nevada foothills and overlying younger alluvial units near the axis of the Sacramento Valley. The thickness of the older alluvium ranges from approximately 100 to 650 feet (DWR 2004).

There are four water-bearing zones in the vicinity of the project area: two zones are interconnected at depths of approximately 80 to 150 feet bgs and two zones appear to be distinct confined aquifers at 155 to 190 feet bgs and 195 to 230 feet bgs, respectively (SNGS, LLC 2007). Groundwater flow is primarily south to southwest in the deeper aquifers; however, the shallow-aquifer flow follows landscape topography and flows westward. Local groundwater flow can also be influenced by local areas of recharge or withdrawal. Refer to Section D.7, Hydrology and Water Quality, for additional information on groundwater conditions.

In addition, the area is known to have perched groundwater tables and other shallow ground water. These may be encountered during construction.

D.5.1.4 Mineral Resources

City of Sacramento

The City of Sacramento portion of the Proposed Project area is located in an area classified MRZ-2, which indicates that the potential for mineral resources is high. This is inferred from the fact that this classification was placed on the project area due to its historical use as a natural gas production field.

D.5.1.5 Paleontology

The Riverbank Formation, which underlies the project area, is a fossil-bearing alluvial (river sediment) formation of Quaternary to Pleistocene age (less than 1.6 million years old). The fossil remains of horses, dogs, numerous smaller mammals, and invertebrates have been recovered from excavations of this formation throughout Sacramento County (SNGS, LLC 2007). The Riverbank Formation is considered paleontologically sensitive, with the closest recovery site to the Proposed Project area located in the vicinity of Rancho Cordova, about 6 miles east.

Determination of the “significance” of a fossil can only occur after a fossil has been found and identified by a qualified paleontologist. Until then, the actual significance is unknown. The most useful designation for paleontological resources in an environmental impact report (EIR) document is the “sensitivity” of a particular geologic unit. Sensitivity refers to the likelihood of finding significant fossils within a geologic unit. In California, fossils of land-dwelling vertebrates are considered significant.

The following levels of sensitivity recognize the important relationship between fossils and the geologic formations within which they are preserved.

- **High Sensitivity.** High sensitivity is assigned to geologic formations known to contain paleontological localities with rare, well-preserved, and/or critical fossil materials for stratigraphic or paleo-environmental interpretation and to fossils providing important information about the paleobiology and evolutionary history (phylogeny) of animal and plant groups. Generally speaking, highly sensitive formations are known to produce or have the potential to produce vertebrate fossil remains.
- **Moderate Sensitivity.** Moderate sensitivity is assigned to geologic formations known to contain paleontological localities with moderately preserved, common elsewhere, or stratigraphically long-ranging fossil material. The moderate-sensitivity category is also applied to geologic formations that are judged to have a strong but unproven potential for producing important fossil remains (e.g., pre-Holocene sedimentary rock units representing low to moderate energy of marine to non-marine deposition).

- **Low Sensitivity.** Low sensitivity is assigned to geologic formations that, based on their relatively youthful age and/or high-energy depositional history, are judged unlikely to produce important fossil remains. Typically, low-sensitivity formations may produce invertebrate fossil remains in low abundance.
- **Marginal Sensitivity.** Marginal sensitivity is assigned to geologic formations that are composed either of pyroclastic volcanic rocks or metasedimentary rocks, but which nevertheless have a limited probability for producing fossil remains from certain sedimentary lithologies at localized outcrops.
- **Zero Sensitivity.** Zero sensitivity is assigned to geologic formations that are entirely plutonic in origin (volcanic rocks formed beneath the earth's surface) and, therefore, have no potential for producing fossil remains.

As there are previously recorded vertebrate fossil sites in the Riverbank Formation in the local and regional vicinity of the City of Sacramento portion of the Proposed Project, there is a potential for uncovering additional similar fossil remains during earth-moving activities related to construction of the pipelines (SNGS, LLC 2007).

D.5.2 Applicable Regulations, Plans, and Standards

The evaluation and mitigation of potential geologic resources and geotechnical hazards is governed primarily by local jurisdictions. The conservation elements and seismic safety elements of city and county general plans contain policies for the protection of geologic features and avoidance of hazards. Relevant and potentially relevant statutes, regulations, and policies are discussed below.

D.5.2.1 State Regulations

California Environmental Quality Act

The California Environmental Quality Act (CEQA) (California Public Resources Code (PRC) Sections 21000–21177.1) was adopted in 1970 and applies to most public agency decisions to carry out, authorize, or approve projects that may have adverse environmental impacts. CEQA requires that agencies inform themselves about the environmental effects of their proposed actions, consider all relevant information, provide the public an opportunity to comment on the environmental issues, and avoid or reduce potential environmental harm whenever feasible. Relevant CEQA sections include those for protection of geologic and mineral resources, protection of soil from erosion, and protection of paleontological resources (certain fossils found in sedimentary rocks).

California Public Utilities Commission General Order 112-E

CPUC General Order 112-E establishes the following to safeguard life or limb, health, property, and public welfare and to ensure that adequate service will be maintained by gas utilities operating under the jurisdiction of the CPUC.

- Minimum requirements for the design, construction, quality of materials, locations, testing, operations, and maintenance of facilities used in the gathering, transmission, and distribution of gas
- Minimum requirements for similar equipment and procedures used in liquefied natural gas facilities.

These requirements are in addition to federal pipeline safety regulations, and are concerned with the safety of the general public and of employees. Specifically, they address the extent to which the general public's and employees' safety is affected by basic design, quality of materials and workmanship, and testing and maintenance of gas gathering, transmission, and distribution facilities as well as liquefied natural gas facilities. These requirements are intended to be adequate for safety under conditions normally encountered in the gas industry and all work performed within their scope must meet or exceed the safety standards set by them.

Department of Conservation, Division of Oil, Gas, and Geothermal Resources

Under Title 14, Division 2, Chapter 4, the Department of Conservation's Division of Oil, Gas, and Geothermal Resources (DOGGR) oversees the drilling, operation, maintenance, and plugging and abandonment of oil, natural gas, and geothermal wells. This regulatory program emphasizes responsible development of oil, natural gas, and geothermal resources in the state through sound engineering practices that protect the environment, prevent pollution, and ensure public safety.

Alquist–Priolo Earthquake Fault Zoning Act of 1972

The Alquist–Priolo Earthquake Fault Zoning Act of 1972 (formerly the Special Studies Zoning Act) regulates development and construction of buildings intended for human occupancy to avoid the hazard of surface fault rupture. While the act does not specifically regulate gas pipelines, it does help define areas where fault rupture is most likely to occur. The act groups faults into categories of active, potentially active, and inactive. Historical and Holocene-age faults are considered active, late-Quaternary- and Quaternary-age faults are considered potentially active, and pre-Quaternary-age faults are considered inactive. These classifications are qualified by the conditions that a fault must be shown to be "sufficiently active" and "well defined" by detailed site-specific geologic explorations in order to determine whether building setbacks should be established.

California Seismic Hazards Mapping Act : Seismic Ground Shaking Hazards

The California Seismic Hazards Mapping Act of 1990 (PRC Sections 2690–2699.6) is designed to protect the public from the effects of strong ground shaking, liquefaction, landslides, other ground failures, or other hazards caused by earthquakes. The act requires site-specific geotechnical investigations to identify the hazard and the formulation of mitigation measures before the permitting of most developments designed for human occupancy. Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California (California Geological Survey 1997), constitutes the guidelines for evaluating seismic hazards other than surface fault rupture and for recommending mitigation measures as required by PRC Section 2695(a). Because the project area has yet to be mapped, the provisions related to the California Seismic Hazards Mapping Act would not apply.

Erosion Regulations

State regulations pertaining to the management of erosion/sedimentation as they relate to water quality are described in Section D.7, Hydrology and Water Quality, of this EIR. The primary purpose of these regulations and standards is to protect surface waters from the effects of land development. Among other measures included in such regulations and standards are the requirements to reduce the potential for sedimentation caused by erosion.

California Building Code

The California Building Code (CBC) (2001) is based on the 1997 Uniform Building Code (UBC), with the addition of more extensive structural seismic provisions. The State of California provides minimum standards for structural design and site development for projects containing buildings for human occupancy through the CBC (2001). The CBC is based on the UBC, which is used widely throughout the United States, when adopted on a state-by-state or district-by-district basis, and has been modified for California conditions with numerous more detailed and/or more stringent regulations.

Chapter 16 of the CBC (2001) reduces impacts associated with exposure of people and structures to seismic hazards, and ensures that structures meet specific minimum seismic safety and structural design standards. Chapter 33 specifies the requirements to be fulfilled for site work, demolition, and construction, including the protection of adjacent properties from damage caused by such work. The CBC requires a site-specific geotechnical study to address seismic issues and identifies seismic factors that must be considered in structural design. Chapter 33 requires all development intended for human occupancy to adhere to regulations pertaining to grading activities, including drainage and erosion control and treatment of expansive soils.

D.5.2.2 Local Regulations

The City of Sacramento General Plan (Sacramento, City of 1988) contains policies regarding seismic and geologic issues as they relate to public health and safety and natural resources. The Building Division of the City's Development Services Department (DSD) regulates construction at the local level.

City of Sacramento General Plan Goals and Policies

The City of Sacramento General Plan (Sacramento, City of 1988) contains goals and policies to protect people and structures from geologic, soils, and seismic hazards that would apply to the project, as indicated below (SNGS, LLC 2007).

Goals and Policies for Seismic Safety

Goal A Protect lives and property from unacceptable risk of hazards due to seismic and geologic activity to the maximum extent feasible.

Policy 1 Prohibit construction of structures for permanent occupancy across faults, should any be designated.

Implementation of the project would not occur across any currently identified fault.

Policy 3 Continue to implement the Uniform Building Code requirements that recognize state and federal earthquake protection standards in the construction or repair of buildings.

The standards of the CBC as adopted by the City of Sacramento are required to be implemented by the project.

Development Services Department Grading and Erosion Control

The City of Sacramento Building Division of the DSD maintains policies and guidelines regarding grading, erosion control, stormwater drainage design, inspection, and permitting, with responsibility for several types of permits, including the following:

- Grading permits
- Construction permits
- U.S. Army Corps of Engineers Nationwide Permit 12 for utility line backfill and bedding.

Site-Specific Geotechnical Investigation

Prior to the commencement of any earthwork at a construction site that would require a building permit from the City of Sacramento, such as the Proposed Project, a complete geotechnical investigation must be prepared for that site. The city requires that a geotechnical engineering report produced by a California Registered Civil Engineer (Geotechnical) or Engineering Geologist be submitted to DSD for review. The report must address and make recommendations on the following topics, among others:

- Structural foundations
- Grading practices
- Erosion control
- Special problems discovered on site (e.g., shallow groundwater, expansive/unstable soils, or corrosive characteristics).

A grading permit must also be prepared prior to grading activities, as described in Section D.7, Hydrology and Water Quality. The applicant must submit, for review and approval, improvement and/or grading plans along with a site-specific erosion and sedimentation control plan.

D.5.3 Environmental Impacts and Mitigation Measures for the Proposed Project

D.5.3.1 Definition and Use of Significance Criteria

Geologic and soil conditions and paleontological resources were evaluated with respect to the impacts the project may have on the local geology, as well as the impact-specific geologic hazards may have on the SNGS Facility. The significance of these impacts was determined on the basis of CEQA statutes, guidelines, and appendices; thresholds of significance developed by local agencies; government codes and ordinances; and requirements stipulated by California Alquist–Priolo statutes. Significance criteria and methods of analysis were also based on standards set or expected by agencies for the evaluation of geologic hazards.

Impacts of the project on the geologic environment would be considered significant if:

- Unique geologic features or geologic features of unusual scientific value (including significant fossils) for study or interpretation would be disturbed or otherwise adversely affected by the Proposed Project components, including the gas pipelines and associated construction activities.

- Known mineral and/or energy resources would be rendered inaccessible by wellhead, compressor station, and pipeline construction.
- Geologic processes, such as landslides or erosion, could be triggered or accelerated by construction or disturbance of landforms.
- Substantial alteration of topography would be required or could occur beyond that which would result from natural erosion and deposition.

Impacts of geologic hazards on the project would also be considered significant if the following conditions existed:

- High potential for earthquake-induced ground shaking to cause liquefaction, settlement, lateral spreading, and/or surface cracking in project areas and probable attendant damage to pipelines or other project structures.
- Potential for failure of construction excavations or underground borings due to the presence of loose saturated sand or soft clay.
- Presence of corrosive soils, which would damage the underground portions of the pipelines or other structures.

D.5.3.2 Applicant Proposed Measures

Table D.5-4 presents the applicant proposed measures (APMs) proposed by SNGS, LLC to reduce project impacts related to geology, soils, and paleontology.

Table D.5-4
Applicant Proposed Measures for Geology and Soils

APM No.	Description
4	(a) The Proposed Project would be designed to meet the seismic safety standards of the California Building Code (CBC). Specific design measures may include but are not limited to special foundation design, additional bracing and support of upright facilities (e.g., tanks, exhaust stacks), and weighting the pipeline in areas of potential liquefaction. In addition, automated leak detection, isolation, and shutdown controls would limit the secondary effects of equipment damage. Project facilities and foundations would be designed to withstand changes in soil density. When the detailed engineering design of the project is completed, it would be submitted to the CPUC, Department of Transportation (DOT) Office of Pipeline Safety (which provides oversight of pipeline construction, operation, and safety) and the DOGGR (which provides oversight of design, installation, and operation of gas wells) for their review and approval. (b) The Proposed Project will be designed in accordance with the Natural Gas Pipeline Safety Act of 1968 and CPUC General Order 112-E and implement design specifications as identified in the geotechnical engineers report (Terracon 2008) to reduce primary and secondary risks associated with seismically induced ground shaking.

Table D.5-4 (Continued)

APM No.	Description
6	A paleontological resources discovery and management plan would be developed prior to construction and implemented as part of the Proposed Project to avoid potential impacts on these resources. The plan would contain the following elements: • Paleontological Mitigation Plan—Prior to the start of construction, a qualified paleontologist shall be retained to design a paleontological resource mitigation and monitoring program and to implement this program during earthmoving activities. The mitigation and monitoring program shall include the following: o Preconstruction coordination o Construction monitoring procedures that include the use of qualified paleontological resources monitors in sensitive areas o Procedures to be followed if a previously unidentified paleontological resource is discovered during construction that include halting all ground-disturbing activity in the vicinity of the discovery; notification of the City of Sacramento Community Development Department or the County of Sacramento, as appropriate; and specimen or data recovery as determined adequate by a qualified paleontologist and consistent with the Society of Vertebrate Paleontology guidelines o Sampling and data recovery procedures (if necessary) o Museum storage coordination for any specimens or data recovered o Report of findings. • Field Survey—Prior to the start of construction, the palaeontologist shall conduct a field survey of exposures of sensitive stratigraphic units within the construction area that will be disturbed. • Construction Personnel Education—Prior to the start of construction activities, construction personnel involved with earthmoving activities will be informed of the possibility of encountering fossils, the appearance of fossils, the types of fossils likely to be seen during construction activities, and proper notification procedures should fossils be encountered. This worker training will be prepared and presented by a qualified palaeontologist. • Paleontological Monitoring—The palaeontologist shall monitor earthmoving construction activities where this activity will disturb previously undisturbed sediment. Monitoring will not take place in areas underlain by artificial fill or in areas where exposed sediment will be buried but not otherwise disturbed.

D.5.3.3 Geology and Soils Impact Analysis

Impact G-1: Risk to People or Structures within a Known Alquist–Priolo Earthquake Fault Zone

The Proposed Project components do not lie within an Alquist–Priolo Earthquake Fault Zone; no fault traces have been mapped or identified within the Proposed Project area. The Green Valley Fault, the closest Alquist–Priolo Earthquake Fault Zone mapped fault, passes approximately 42 miles to the southwest of Proposed Project area. In addition, the buried pre-Quaternary Midland Fault and Willows Fault zones may pass about 22 miles west and 5 miles east of the project area, respectively, but their existence and locations are uncertain (SNGS, LLC 2007). Consequently, none of the known or suspected faults appear to cross the Proposed Project area.

The Proposed Project would not expose people or structures to potential substantial adverse effects due to rupture of a known Alquist–Priolo earthquake fault. Therefore, people and structures would not be at risk and no impact would occur.

Impact G-2: Exposure of People or Structures to Strong Seismic Ground Shaking

Wellhead Site, Compressor Station, and Pipeline Segments 1 and 2

The type and magnitude of seismic hazards affecting the site are dependent on the distance to causative faults, the intensity, and the magnitude of the seismic event. Estimations of the maximum credible earthquake, using the EQFAULT program, and of seismic ground motions, using the FRISKSP program, for the identified faults were performed (Terracon 2008). The results indicate that the expected peak ground acceleration for a 10% probability of exceedance in 50 years is about 0.19 *g* for the wellhead site. According to the PEA (SNGS, LLC 2007), the resulting vibration from seismic ground shaking could have the potential to cause damage to the project facilities, including the wellhead site, compressor station, and the pipelines (primary risks), and could cause ground failures, such as liquefaction or settlement, in loose alluvium and/or poorly compacted fill (secondary effects) only if such materials were present.

Damage to the wellhead site or pipelines could result in fire, which could present a hazard to nearby residential uses on Power Inn Road. However, the geotechnical evaluation of the wellhead site performed by Terracon identified specifications to be incorporated in the design requirements for these structures to reduce the primary and secondary risks associated with seismically induced ground shaking (Terracon 2008). Other design requirements that must be followed include those of the Natural Gas Pipeline Safety Act of 1968 (49 USC 1671–1686) and CPUC General Order 112-E or other accepted non-building structure standards to reduce the primary and secondary risks associated with seismically induced ground shaking. With implementation of APM 4 plus Mitigation Measure G-2, impacts to aboveground structures and facilities associated with the Proposed Project due to seismically induced ground shaking would be reduced to less than significant (Class II).

Natural Gas Field

The existing gas-bearing rock unit is capped by between 150 to 300 feet of impermeable shale and is overlain by layers of shale, sandstone, and alluvium totaling about 3,600 feet of material between the reservoir and the surface that would prevent seepage from the reservoir. Although strong seismic ground shaking could result in gas migration along an active fault line, no fault-related structures have been identified within the area of the project. The nearest active faulting, Dunnigan Hills Fault, is located approximately 19 miles to the northwest. In addition, experienced California Reservoir Engineers (Mannon 2008; Matthews, pers. comm., 2007; Scott 2008; Terracon 2008) indicate that the reservoir has demonstrated its ability to successfully contain natural gas for millions of years. Moreover, the observed abrupt lateral changes in subsurface lithology (sand/shale contact) have been attributed to stratigraphic variation as opposed to structural-fault-related causes. The Proposed Project would not expose people or structures to potential substantial adverse effects due to strong seismic ground shaking; thus, impacts would be less than significant (Class III). Section D.6, Hazardous Materials, Public Health and Safety, Impact HAZ-2a describes the potential for gas to migrate to the surface and groundwater from inactive faults or other anomalies in the cap rock. This is considered a significant and unavoidable impact.

Mitigation Measure for Impact G-2: Exposure of People or Structures to Strong Seismic Ground Shaking

G-2 **Seismic Design of Facilities.** The seismic design of the facilities will employ a lateral acceleration one-third greater than that required by the 2007 CBC. Therefore, the facilities will be designed to withstand ground shaking higher than anticipated by CBC.

Impact G-3: Seismically Induced Ground Failures, Including Liquefaction, Lateral Spreading, and Seismic Slope Instability

Liquefaction is the phenomenon whereby saturated soils develop high pore-water pressures during seismic shaking and lose their strength characteristics. This phenomenon generally occurs in areas of high seismicity, where groundwater is shallow and loose granular soils or hydraulic fill soils are present (Terracon 2008). Sacramento County is less affected by seismic events than other portions of California. Nevertheless, some property damage has occurred in the past as a result of major seismic events occurring in adjacent areas, especially the San Francisco Bay area and, to a less extent, the foothills of the Sierras.

The nearest known active fault to the Proposed Project area that has been mapped by the California Division of Mines and Geology is the Dunnigan Hills Fault, located approximately 19 miles to the northwest. During the past 150 years, no fault movement has been documented within Sacramento County. However, the region has undergone numerous instances of ground shaking caused by other major faults in the region. As a general rule, poorly consolidated, water-saturated fine sands and silts located within 50 feet of the surface are considered to be the most susceptible to liquefaction. According to the findings of the Terracon Geotechnical Engineering Report (2008), neither the wellhead site nor compressor station site is located within an area which the State of California has designated as a Seismic Hazard Zone for Liquefaction and/or Slope Instability (California Geological Survey 2002b). Based on the site-specific data collected and soils laboratory testing performed by Terracon, the potential for liquefaction is considered remote.[1] Since the potential for liquefaction is considered remote, the project components would not expose people or structures to potential substantial adverse effects due to seismic-related ground failure, including liquefaction. Therefore, impacts would be less than significant (Class III). Section D.6, Hazardous Materials, Public Health and Safety, addresses the potential health and safety impacts associated with a potential release of natural gas.

Impact G-4: Slope Instability, Including Landslides, Earth Flows, and Debris Flows

The topography of the entire project area is generally a flat floodplain with minimal topographic variation. Since there are no hillsides or slopes that could become unstable or over-steepened, land sliding is not considered a potential hazard. The Proposed Project would not expose people or structures to potential substantial adverse effects due to landslides; therefore, there would be no impact.

Impact G-5: Soils That Could Damage Foundations or Have High Erosion Potential

Wellhead Site, Compressor Station, and Pipeline Segments 1 and 2

The construction of the wellhead site, compressor station, and pipelines would result in earth-disturbing activities, but loss of topsoil due to erosion is not expected to be significant due to the flat topography. Some dust (airborne) and/or sediment can be expected during construction phases and conveyed via stormwater into local waterways. However, implementation of best management practices (BMPs) as part of a stormwater pollution prevention plan (SWPPP) can reduce or completely eliminate surface runoff, erosion, and loss of topsoil. Additional information regarding soil erosion can be found in Section D.7, Hydrology and Water Quality. With implementation of APMs 1, 2 and 14, the Proposed Project would not result in substantial soil erosion or the loss of topsoil; therefore, impacts would be less than significant (Class III).

Natural Gas Field

It is not anticipated that subsidence will be an issue relative to operation of the SNGS project based on documentation regarding historic use of the Florin Gas Field for natural gas extraction, as documented by Terracon 2008. Project activity is restricted to a 150-foot-thick sand layer approximately 3,750 feet bgs. This slight change of pressurizing and depressurizing the area would be expected to create negligible changes in surface elevation. Therefore, subsidence for this project is considered a less than significant impact (Class III) to structures in the area.

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[1] Based on the relative densities of soils encountered in soil borings, depth of historical groundwater (at least 60 feet bgs), and other research performed by Terracon (2008).

Impact G-6: Geologic Unit That Could Become Unstable

The topography of the Proposed Project area is generally a flat floodplain with minimal topographic variation. There are no hillsides or slopes at or near the Proposed Project area that could become unstable or over-steepened. In addition, the project components are not located on a geologic unit or soil that is unstable, or that could result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse; thus, there would be no impact.

Impact G-7: Expansive Soils

The results of the subsurface geotechnical soils investigation from data collected by advancing soil borings (Terracon 2008) indicates the presence of lean clays in the upper 5 feet and silty clays extending from approximately 26 feet to 41 feet bgs, the maximum depth explored in the compressor facility area. Similarly, lean clays were also observed in the upper 5 feet and clay was found to the total depth explored, approximately 31 feet bgs, in the area of the wellhead site. The potential for expansive soil may exist at each location, but can be mitigated, if present, by the application of proper engineering design to meet CBC and Natural Gas Pipeline Safety Act (49 USC 1671–1686) requirements.

With implementation of APM 4, the Proposed Project would not result in the creation of substantial risks to life or property due to the presence of expansive soils; therefore, impacts would be less than significant (Class III).

Impact G-8: Adequacy of Soils to Support Septic/Wastewater Systems

The project does not propose a septic or new wastewater system for any of the project components. The toilets at the wellhead site and compressor station would be connected to the existing wastewater system. Therefore, there would be no impact.

Impact G-9: Impact on Unique Geologic or Paleontological Resources

Based on the record search conducted at the University of California, Berkeley Museum of Paleontology (Burwasser 2007), there are no previously recorded fossil sites near the wellhead site, compressor station, or along the proposed pipeline alignments. Nonetheless, the alignments are in sediments of the Riverbank Formation, which is a paleontologically sensitive unit under the Society of Vertebrate Paleontology guidelines.

A paleontological resources discovery and management plan will be developed prior to construction and will be implemented as part of the project to avoid potential impacts on these resources (APM 6). Implementation of Mitigation Measure G-9 along with APM 6 will ensure that impacts to unique or paleontological resources will be less than significant (Class II).

Mitigation Measure for Impact G-9: Impact on Unique Geologic or Paleontological Resources

G-9 Procedures to Avoid Impacts to Paleontological Resources. Prior to the start of construction, a qualified paleontologist will conduct a field survey to identify sensitive stratigraphic units within the construction area that might be disturbed. If paleontological resources are discovered during construction-related earthmoving activities, all ground-disturbing activity in the vicinity of the discovery will be halted; the City of Sacramento Community Development Department or the County of Sacramento, as appropriate, will be notified; and specimen or data recovery, as determined adequate by a qualified paleontologist and consistent with the Society of Vertebrate Paleontology guidelines, will be completed before construction in the vicinity of the discovery resumes. These procedures ensure that the Proposed Project will have a less-than-significant impact on paleontological resources.

D.5.4 Project Alternatives

D.5.4.1 Gas Field Alternatives

Freeport Gas Field

Environmental Setting

The Freeport Gas Field alternative site is located approximately 5 miles southwest of the Florin Gas Field on agricultural land located on the suburban fringe of Elk Grove. The gas field is partially located underneath a wastewater treatment plant. This alternative site contains no known active faults and since it is located in generally level areas, it would have a low potential for landslides. Risk of liquefaction would be low to moderate. Little is known about the integrity of the former gas field, but it is inferred that it is stable since it once contained the gas reserve.

Environmental Impacts and Mitigation Measures

Similar to the Proposed Project, this alternative would involve constructing facilities including injection/withdrawal wells, compressor station, and connecting pipelines. This alternative would construct nearly 1 mile of pipeline travelling through a largely rural area in order to reach tie-ins. This project would have similar impacts to those associated with the Proposed Project (Impacts G-1 through G-9). As with the Proposed Project, Mitigation Measures G-2 and G-9 would be required to reduce impacts to less than significant levels. Safety-related issues are addressed in Section D.6.

Comparison to the Proposed Project

Geologic impacts resulting from the development and construction of the Freeport Gas Field alternative would be similar to those associated with the Proposed Project because the geologic conditions are similar.

Snodgrass Slough Gas Field

Environmental Setting

The Snodgrass Slough Gas Field alternative site is located approximately 20 miles southwest of the Florin Gas Field on agricultural land adjacent to Reclamation District 551 Borrow Canal, 3 miles east of the Sacramento River and California State Highway 160, and 4 miles north of the nearest population center, Walnut Grove. The alternative would be located in a largely agricultural area. It contains no known active faults, and since it is located in generally level area, it would have a low potential for landslides. Risk of liquefaction would be low to moderate. Little is known about the integrity of the former gas field, but it is inferred that it is stable since it once contained the gas reserve.

Environmental Impacts and Mitigation Measures

Similar to the Proposed Project, this alternative would involve constructing facilities including injection/withdrawal wells, compressor station, and connecting pipelines. This alternative would construct nearly 5 miles of pipeline travelling through a largely rural area in order to reach tie-ins. This project would have similar impacts as those associated with the Proposed Project (Impacts G-1 through G-9). As with the Proposed Project, Mitigation Measures G-2 and G-9 would be required to reduce impacts to less-than-significant levels.

Comparison to the Proposed Project

Geologic impacts resulting from the development and construction of the Snodgrass Slough Gas Field alternative would be similar to those associated with the Proposed Project because the geologic resources are similar.

Thornton Gas Field

Environmental Setting

The Thornton Gas Field alternative site is located approximately 20 miles south of the Florin Gas Field on agricultural land south of the Cosumnes River Preserve, 1.5 miles east of Interstate 5 and 1 mile north of the town of Thornton. It contains no known active faults, and since it is located in a generally level area, it would have a low potential for landslides. Risk of liquefaction would be low to moderate. Little is known about the integrity of the former gas field, but it is inferred that it is stable since it once contained the gas reserve.

Environmental Impacts and Mitigation Measures

Similar to the Proposed Project, this alternative would involve constructing facilities including injection/withdrawal wells, compressor station, and connecting pipeline(s). This alternative would construct nearly 7 miles of pipeline travelling through a largely rural area in order to reach tie-ins. This project would have similar impacts as those associated with the Proposed Project (Impacts G-1 through G-9). As with the Proposed Project, Mitigation Measures G-2 and G-9 would be required to reduce impacts to less than significant levels.

Comparison to the Proposed Project

Geologic impacts resulting from the development and construction of the Thornton Gas Field alternative would be similar to those associated with the Proposed Project since the geologic conditions are similar.

D.5.4.2 Project Design Alternatives

Alternative Wellhead Site to Compressor Station Pipeline Route 1

Environmental Setting

This alternative would use the same construction locations for the wellhead site, compressor station, and Sacramento Municipal Utilities District (SMUD) Line 700 tie-in (see Figure C-5). Only the pipeline route would differ from the Proposed Project. From the northwest corner of the wellhead site, this alternative would head due east to the Union Pacific Railroad (UPRR) tracks. This alternative would parallel Junipero Street and cross an active industrial use yard. It would then parallel the UPRR tracks northwest to Elder Creek Road. This route would be approximately 7,800 feet long. This alternative would be approximately 450 feet longer than the Proposed Project.

Environmental Impacts and Mitigation Measures

Generally, the geologic impacts for this project design alternative would be similar to those discussed for the Proposed Project (Impacts G-1 through G-9). As with the Proposed Project, Mitigation Measures G-2 and G-9 would be required to reduce impacts to less-than-significant levels.

Comparison to the Proposed Project

Geologic impacts resulting from the design of Alternative Wellhead Site to Compressor Station Pipeline Route 1 would be similar to those of the Proposed Project since it is passing through the same general area.

Alternative Wellhead Site to Compressor Station Pipeline Route 2

Environmental Setting

This alternative would use the same construction locations for the wellhead site, compressor station, and SMUD Line 700 tie-in (see Figure C-5). Only the pipeline route would differ from the Proposed Project. From the northwest corner of the wellhead site, this alignment would run approximately 600 feet north within the utility alignment to Berry Avenue, and then parallel the UPRR tracks northwest to Elder Creek Road. This alignment would be approximately 7,700 feet long. This alternative would be approximately 350 feet longer than the Proposed Project.

Environmental Impacts and Mitigation Measures

Generally, the geologic impacts for this project design alternative would be similar to those discussed for the Proposed Project (Impacts G-1 through G-9). As with the Proposed Project, Mitigation Measures G-2 and G-9 would be required to reduce impacts to less-than-significant levels.

Comparison to the Proposed Project

Geologic impacts resulting from the design of Alternative Wellhead Site to Compressor Station Pipeline Route 2 would be similar to those of the Proposed Project since it is passing through the same general area.

Alternative Wellhead Site to Compressor Station Pipeline Route 3

Environmental Setting

This alternative would use the same construction locations for the wellhead site, compressor station, and SMUD Line 700 tie-in (see Figure C-5). Only the pipeline route would differ from the Proposed Project. From the northwest corner of the wellhead site, this alignment would run north approximately 1,650 feet within an existing utility alignment and then approximately 650 feet north along Power Inn Road to Elder Creek Road. From that intersection, the pipeline would be installed within Elder Creek Road, for approximately 1,800 feet, to the intersection with the UPRR tracks. This alternative would be approximately 7,100 feet long. This alternative would be approximately 250 feet shorter in length than the Proposed Project pipeline.

Environmental Impacts and Mitigation Measures

Generally, the geologic impacts for this project design alternative would be similar to those discussed for the Proposed Project (Impacts G-1 through G-9). As with the Proposed Project, Mitigation Measures G-2 and G-9 would be required to reduce impacts to less-than-significant levels.

Comparison to the Proposed Project

Geologic impacts resulting from the design of Alternative Wellhead Site to Compressor Station Pipeline Route 3 would be similar to those of the Proposed Project since it is passing through the same general area.

D.5.4.3 Environmental Impacts of the No Project Alternative

Under the No Project Alternative, none of the facilities associated with the project or alternatives evaluated in this EIR would be developed; therefore, none of the impacts in this section would occur to geology and soils.

D.5.5 Mitigation Monitoring, Compliance, and Reporting

The Proposed Project is subject to the requirements and regulatory framework that governs the construction and operation of gas facilities. Incumbent upon the project applicant is the requirement for design, site preparation, construction, maintenance, and reporting procedures that will provide the maximum possible protection from adverse geotechnical conditions. Moreover, the Proposed Project should not cause substantial changes to or be subject to hazards from the existing geology, soils, and seismic conditions in the project area with implementation of Mitigation Measure G-2. The Proposed Project also includes APM 6 and Mitigation Measure G-9 to protect potential paleontological resources, thus, with implementation of the appropriate mitigation, the project as proposed at its current location would have no significant effect on those resources. See Table G-1 for the mitigation monitoring program relating to geology and soils.

D.5.6 References

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