4.8 Geology, Soils, and Mineral Resources

This section describes geological conditions at the Proposed Project site that could pose a significant threat to human health, structures, or the environment. The existing conditions and pertinent federal, State, and local agency laws, regulations, plans, and policies related to geology are described. The impacts and mitigation measures section defines the criteria of significance for geology, soils and mineral resources, and identifies potential impacts and mitigation measures, as warranted.

Scoping Issues Addressed

During the Proposed Project's scoping period, two comments were made at the public scoping meeting held on June 27, 2013 that were related to geology, soils and mineral resources. One commenter inquired as to whether the existing quarry could produce more than 700,000 tons of aggregate material per year. It was confirmed for the commenter that the quarry could produce more aggregate per year, but that it is not permitted to do so, and that the Proposed Project does not include any plans to increase the existing quarry's annual production rate. A second commenter inquired as to the location of the nearest aggregate quarry to the Proposed Project site. It was confirmed for the commenter that the closest aggregate quarry to the Proposed Project is the Rocky Canyon Quarry, located near Atascadero. No other scoping comments affecting this analysis were received on the Proposed Project's NOP, as summarized in Table ES-1 and Appendix A.

4.8.1 Existing Conditions

The following section provides an overview of existing geological conditions at the Proposed Project site based on a review of readily available geotechnical and geological literature, a previous geotechnical investigation report, and geologic maps.

Project Location and Setting

The Proposed Project site is located east of the Santa Margarita Valley along the Central Coast Mountain Range. The Salinas River, located parallel to the north and east boundaries of the Proposed Project site, generally flows northwest. The topography is relatively flat in the Lower Area of the quarry and very steep in the Upper Area of the quarry (Figure 2.4-1). Elevations range from about 940 feet above mean sea level (AMSL) to 1,350 feet AMSL across the Proposed Project (United States Geological Survey [USGS], 1965).

The regional geology and degree of seismic activity in the County has been divided into four structurally and physiographically distinct areas known as seismotectonic domains. The Proposed Project is located within the Salinian domain, which consists of northwest-trending ranges of low mountains and intervening valleys characterized by granitic and crystalline metamorphic basement rocks. The main geologic hazards associated with the Salinian domain are intense groundshaking, liquefaction in low lying areas, and seismically induced landslides along hillsides with moderate to steep slopes (County of San Luis Obispo, 2010).

Site Soils and Bedrock Geology

Soils data were reviewed from the United States Department of Agriculture, Natural Resources Conservation Service (USDA NRCS), *GeoSpatial Data Gateway* (2013) to identify and evaluate existing soil conditions at the Proposed Project site.

The following soils classifications have been identified across the Proposed Project site:

- Cieneba coarse sandy loam, 30 to 75 percent slopes
- Cieneba-Andregg complex, 30 to 75 percent slopes
- Hanford and Greenfield soils, 2 to 9 percent slopes
- Metz loamy sand, 0 to 5 percent slopes
- Pits
- Xerofluvents-Riverwash association
- Pico fine sandy loam, 0 to 2 percent slope

The bedrock formations underlying the Proposed Project site have been identified as Cretaceous granite rocks. Fresh bedrock exposed in the existing excavation pit consists of medium-grained granite that is strong but moderately fractured. The strong granite bedrock is overlain by about 50 feet of weathered granite and then approximately six to 25 feet of decomposed granite. A series of thin west-northwest-striking faults, about two to three inches wide, crosscut the excavation pit. A large north-northwest-striking, moderately west-dipping, fault cuts across the north end of excavation pit and there are several large near-vertical, northeast-striking, faults in the upper benches of the west quarry wall. These larger faults are generally about two to three feet wide, and are filled with clay and strongly altered fault breccia and gouge (Golder Associates, 2012).

Seismic Hazards

Seismic hazards include surface fault rupture, seismic shaking, and seismically induced ground failures, such as liquefaction and landslides.

Surface Fault Rupture

Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. Surface rupture is generally expected to occur along active fault traces that have exhibited signs of recent geological movement (i.e., within the past 11,000 years). Alquist-Priolo Earthquake Fault Zones mapped by the California Geological Survey (CGS) delineate areas around active faults with potential surface fault rupture hazards that would require specific geological investigations prior to approval of certain kinds of development within the delineated area. The Earthquake Fault Zones boundaries generally have about a ¼-mile buffer around the surface traces of active faults (CGS, 2008). The Proposed Project site is not located within or adjacent to an Earthquake Fault Zone. The nearest Earthquake Fault Zone is located along the Los Osos Fault, approximately 12 miles southwest of the Proposed Project. The San Andreas Fault Zone is located about 26 miles northeast of the Proposed Project. The Rinconada Fault is a potentially active fault with evidence of geologic movement between 11,000 and 2 million years ago located approximately one mile west of the Proposed Project.

Strong Seismic Shaking

Seismic ground shaking generally refers to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. The magnitude of a seismic event is a measure of the energy released by an earthquake; it is assessed by seismographs that measure the amplitude of seismic waves. The intensity of an earthquake is a subjective measure of the perceptible effects of a seismic event at a given point. The Modified Mercalli Intensity scale (MMI) is the most commonly used scale to measure the subjective effects of earthquake intensity in values ranging from I to XII. Intensity can also be quantitatively mea-

sured using strong motion seismographs that record the peak ground acceleration (PGA) in terms of percent of acceleration force of gravity (%g). An earthquake that generates an upward PGA of 100%g or more would overcome the downward force of gravity and throw loose objects into the air. Descriptions of the MMI scale and PGA equivalents are summarized in Table 4.8-1.

Based on USGS Probability Seismic Hazard Analysis mapping (2008), there is a 10 percent probability of exceedance that a 7.8 moment magnitude earthquake along the San Andreas Fault within the next 50 years would generate a PGA of 24%g at the Proposed Project site (Golder Associates, 2012). This conservative estimate of the maximum PGA would be equivalent to a MMI value of III (Table 4.8-1), which means there would be no potential damage expected from ground shaking.

Table 4.8-1. Modified Mercalli Scale[1]

MMI Scale	PGA (%g)	Potential Damage	Description of Ground Motion Intensity
I	<0.17	None	Not felt except by a very few under especially favorable circumstances.
II	0.17-1.4	None	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	0.17-1.4	None	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	1.4-3.9	None	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	3.9-9.2	Very light	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	9.2-18	Light	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	18-34	Moderate	Everybody runs outdoors. Damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.
VIII	34-65	Moderate/heavy	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.
IX	65-124	Heavy	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.
X	>124	Very heavy	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	>124	Very heavy	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.
XII	>124	Very heavy	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted.

1 - Data summarized from CGS (2002).

Seismically Induced Ground Failure

Seismically induced ground failure includes liquefaction and landslides. Liquefaction is the temporary transformation of loose, saturated, granular sediments to a fluid-like state as a result of seismic ground shaking. In the process, the soil undergoes transient loss of strength, which commonly causes ground displacement such as lateral spreading and settlement. Areas most likely to be vulnerable to liquefaction are underlain by younger alluvium where groundwater and granular sediments are present, such as low lying lands adjacent to rivers, creeks, beaches, and estuaries. Seismically induced landslides occur as the rapid movement of large masses of soil on unstable slopes.

The CGS has developed Seismic Hazard Zone Maps that delineate areas susceptible to liquefaction and seismically induced landslides that require additional investigation to determine the extent and magnitude of potential ground failure prior to development. Seismic Hazard Maps have not been prepared in the vicinity of the Proposed Project, because the area is not highly susceptible to liquefaction and seismically induced landslides, as described below.

Soils in the Upper Area of the quarry have a low liquefaction potential and soils in the Lower Area of the quarry have a moderate liquefaction potential (County of San Luis Obispo, 2013). The Proposed Project site is located in an area with low landslide potential (County of San Luis Obispo, 2013).

Geologic Hazards

Geologic hazards include soil erosion, landslides, subsidence, and expansive soils.

Soil Erosion

Erosion is the detachment and movement of soil material by natural processes, such as wind and water. The rate of soil erosion, which is dependent on the local landscape, climate, and soil properties, can be accelerated by human activities such as construction grading and excavation. In the Proposed Project vicinity, erosion from stormwater runoff is the dominant natural erosion process. The susceptibility of specific soils to water erosion is described by the K factor derived for the Universal Soil Loss Equation (Wischmeier and Smith, 1978).

Soils with a low susceptibility to water erosion have K factors less than 0.25, and soils with a moderate susceptibility to water erosion have K factors between 0.25 and 0.4 (Institute of Water Research, Michigan State University, 2002). Based on K factors estimated by the USDA NRCS (2013), up to about 70 percent of the soils on the Proposed Project site could have a potentially moderate susceptibility to water erosion with K factors as high as 0.37. Soils with a potentially high susceptibility to water erosion (K factors greater than 0.4) were not identified at the Proposed Project site.

Landslides

The primary factors influencing the stability of a slope are the nature of the underlying soil or bedrock, the geometry of the slope (height and steepness), and rainfall. The Proposed Project site is located in an area with low landslide potential (County of San Luis Obispo, 2013). However, the slope stability at the Proposed Project site is primarily a function of the slope cuts for quarry excavation activities. There is no evidence of large-scale, deep seated slope failure involving rock mass in the existing excavation pit due to the relatively high strength and competency of the fresh granitic rocks and generally favorable structural conditions (Golder Associates, 2012).

Subsidence

Subsidence is the settlement of organic soils and/or saturated mineral soils of low density following drainage. Soils on the Proposed Project site are not expected to be susceptible to subsidence (USDA NRCS, 2013).

Expansive Soils

Expansive soils are characterized by the potential for shrinking and swelling as the moisture content of the soil decreases and increases, respectively. Shrink-swell potential is influenced by the amount and type of clay minerals present and can be measured as a percent change of the soil volume (referred to as the "linear extensibility"). Soils on the Proposed Project site have low expansion potential with estimated linear extensibility values ranging from 0 to 2.9 percent (USDA NRCS, 2013).

Mineral Resources

In compliance with the SMARA, the CGS has designated mineral resources in areas within California subject to irreversible land uses that would preclude mineral extraction. Land has been classified by the State Geologist into Mineral Resource Zones ("MRZs") based on geologic and economic factors. The MRZs include classifications for construction materials, industrial and chemical mineral materials, metallic and rare minerals, and non-fluid mineral fuels. The mapping of MRZs is intended to help identify and preserve significant mineral deposits for future use. The MRZs are defined as follows:

- MRZ-1: Areas where adequate information indicates that no significant mineral deposits are present, or it is judged that little likelihood exists for their presence;
- MRZ-2: Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood exists for their presence;
- MRZ-3: Areas containing known or inferred mineral deposits of which the significance is undetermined based on available data; and
- MRZ-4: Areas where available information is inadequate for assignment to any other MRZ zone.

The Upper Area of the existing quarry is classified as MRZ-2 for PCC grade aggregate while the Lower Area is classified as MRZ-3. The CGS considers PCC to be an "indispensable, high grade construction aggregate which is costly to transport" (Miller, et al., 1989). The Proposed Project site is also designated by the as an Extraction Resource Area (EX1). The EX1 designation is used by the County to identify areas classified as either MRZ-2 or MRZ-3, and to enforce the SMARA regulations. Under the County's Land Use Ordinance (Title 22, Section 22.14.050), existing resource extraction operations and undeveloped geologic resources in areas with EX1 designations are protected for resource extraction, such as the Proposed Project.

4.8.2 San Luis Obispo County Plans and Policies

General Plan

The Safety Element of the County's General Plan includes policies for geologic and seismic hazards (County of San Luis Obispo, 1999). Most of the geologic and seismic hazard policies are intended to protect habitable structures or mitigate landslide hazards in areas of known landslide activity. These policies are not relevant to the Proposed Project, because it does not include structural developments and is not located in an active landslide area. The following standard associated with landslide hazards is directly relevant to the Proposed Project.

- *Standard S-59: Development proposals will be required to mitigate the impacts that their projects contribute to landslides and slope instability hazards on neighboring property, and appurtenant structures, utilities, and roads; such as emergency ingress and egress to the property, and loss of water, power or other lifeline facilities.*

The County's COSE includes policies for mineral resource protection. Many of the mineral resource policies are intended to identify and protect new mineral resources. These policies are not relevant to the Proposed Project because the mineral resources in the expansion area have previously been mapped for resource extraction (County of San Luis Obispo, 2010). The following standard associated with mineral resources is directly relevant to the Proposed Project.

- *Standard MN-3.4.1: Require that applications for proposed extraction operations include plans for preserving the long-term productivity of the site and other affected lands, as well as ensuring on-site and off-site restoration of affected lands. Identify riparian corridors, other sensitive habitats, and important agricultural soils prior to development, and restore and enhance them as a condition of the required land use permit.*

4.8.3 Regulatory Setting

The California Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to regulate development near known active faults due to hazards associated with surface fault ruptures. Earthquake Fault Zones delineated by the CGS indicate areas with potential surface fault-rupture hazards where specific geological investigations are required prior to development. Since there are no mapped active faults crossing the Proposed Project site, this regulation does not apply.

The California Seismic Hazard 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. Under the U.S. Department of Conservation, the Act directs the CGS to identify and map areas prone to the liquefaction or earthquake-induced landslides. The Act requires site-specific geotechnical investigations to identify potential seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy within the Zones of Required Investigation. Since the Proposed Project area has not been mapped under this program, none of the provisions of the Act would apply.

The California Surface Mining and Reclamation Act was passed in 1975 to assure that adverse environmental impacts from surface mining are minimized and mined lands are reclaimed to a usable condition. The SMARA regulations have been adopted by the County under the County's Land Use Ordinance (Title 22, Section 22.36). A Conditional Use Permit and Reclamation Plan (including amendments, as needed) must be approved by the County's Department of Planning and Building for all surface mining activities. Associated Reclamation Plans must incorporate adequate measures to mitigate potentially significant adverse environmental impacts and restore a proposed mining site to a natural appearing or otherwise usable condition compatible with adjacent land uses.

4.8.4 Environmental Impact Methodology

Significance Criteria

The following significance criteria for geologic hazards and mineral resources are premised on Appendix G of the State CEQA Guidelines. These criteria identify environmental issues to be considered when determining whether a project could have significant effect on the environment. The Proposed Project would have a significant impact related to geological conditions if it would:

- Expose people, buildings, or infrastructure to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;
  - Strong seismic shaking;
  - Seismically induced ground failure;
- Be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on- or off-site soil erosion, landslides, subsidence, liquefaction or collapse;
- Be located on expansive soil, creating substantial risks to life or property;
- Result in the loss of availability of a known mineral resource that would be of local or state-wide value.

Approach to Impact Analysis

Impacts of the Proposed Project related to the expansion of the mining area and site-wide reclamation are discussed in EIR Section 4.8.5. The significance of impacts is evaluated with respect to the significance criteria, which have been established as thresholds above which an impact would be considered significant.

Impacts are categorized per the significance classification system provided in EIR Section 4.1 (Environmental Analysis, Introduction, Impact Significance Classification Scheme).

4.8.5 Project Impacts and Mitigation Measures

Impact GEO-1:	**Expose people, buildings, or infrastructure to potential substantial adverse effects, including the risk of loss, injury, or death involving surface fault rupture, strong seismic shaking, or seismically induced ground shaking**

Excavation and Reclamation

The Proposed Project is not located within a CGS Earthquake Fault Zone or Seismic Hazard Zone, and therefore is not susceptible to surface fault rupture or direct impacts related to seismic shaking (the potential for liquefaction and/or landslides, potential indirect hazards related to seismicity, is discussed below under Impact GEO-2). The maximum intensity of ground shaking estimated at the Proposed Project is a III on the MMI scale, which is relatively low and would not likely cause structural damage. Based on the existing geologic conditions and the existing and proposed post-reclamation land uses, seismic hazards related to the excavation and reclamation phases of the Proposed Project would be less than significant (Class III).

Impact GEO-2:	**Be located on a geologic unit or soil that is significantly unstable or that would become unstable as a result of the Project implementation, or potentially result in on- or off-site soil erosion, landslides, subsidence, liquefaction or collapse**

Soils on the Proposed Project site have low to moderate erosion and liquefaction potentials, low landslide potential, and no apparent potential for subsidence or collapse. However, proposed quarry excavation and reclamation activities could alter the ground stability and result an increased risk of soil erosion, liquefaction, and/or landslides. Soil erosion is addressed in EIR Section 4.15 (Water Quality and Supply).

As required by SMARA, the Proposed RPA updates the 1981 Reclamation Plan and describes concurrent mining and reclamation activities over approximately the next 64 years at the Proposed Project site. The Proposed RPA establishes performances standards that would mitigate potential landslide and liquefaction hazards that could potentially result from the Proposed Project. Therefore, impacts would be less than significant (Class III)

Excavation and Reclamation

The Upper Area is underlain by granitic bedrock and groundwater occurs only in bedrock fractures, and, in some areas, is perched on the soil bedrock interface. Due to the lack of substantial zones of saturated fine-grained sediment, the Upper Area would not be expected to be subject to liquefaction. Alterations to site drainage patterns in the Lower Area could increase the liquefaction potential. However, any changes to topography in the Lower Area would be relatively modest and the proposed open space uses during and after the final reclamation phase would not be particularly susceptible to liquefaction hazards. Therefore, potential impacts related to liquefaction would be less than significant (Class III).

The Proposed RPA requires slope configurations during excavation to minimize landslide potentials for final reclamation. SMARA does not specify a minimum factor of safety (FOS)[1] for slope stability for final reclaimed slopes. However, Section 3502(b)(3) of SMARA indicates that final reclaimed slopes shall be flatter than the critical gradient, which implies that static FOS should be greater than 1.0. Based on the Applicant's Geotechnical Report and slope design recommendations, applying a minimum FOS of 1.5 under static conditions for global slope stability is considered appropriate given the existing site conditions of the Proposed Project site and is consistent with SMARA (Golder Associates, 2012).

The Proposed RPA incorporates both site-wide and vector-specific slope design recommendations from the applicant's geotechnical report to implement a global stability FOS of at least 1.5 in the design of final slopes configurations at the Proposed Project site. The final excavation pit would be excavated about 250 feet deep with 50-foot high benches. Final catch bench widths would be designed according to the Ritchie criteria to minimize the risk of rock falls. For 50-foot high benches, this would result in a design catch width bench of 25 feet around the perimeter of the excavation pit. Final grading would use drilling and blasting techniques in areas where hard rock persists and dozers in areas where weathered granite is exposed to ensure that the final slope configurations are achieved in the specific sectors shown in Table 4.8-2 (Golder Associates, 2012).

Table 4.8-2. Final Slope Configurations

Sector	Granite Type	Bench Configuration	Bench Height (ft)	Catch Bench Width (ft)	Bench Face Angle (°)	Design Inter-Ramp Slope Angle (°)
All	Weathered	Single	Varies	10 (minimum)	1.25(H):1(V)	Varies with height
Northwest and West	Fresh	Single	50	25	70	49
North, Northeast, and East	Fresh	Single	50	25	60	43

Based on the findings of the Applicant's Geotechnical Report, these performance standards would ensure that the final landform after excavation is stable under static and seismic loading conditions, and suit-

[1] The "factor of safety" = (resisting forces/driving forces), in other words the forces that tend to keep materials in place on a slope (e.g., cohesion, friction) divided by forces that tend to move materials downslope (e.g., gravity). When these forces are exactly equal, the FOS equals 1.0. When the FOS is less than 1.0, the slope is unstable.

able for open space uses. However, this geotechnical analysis is based on fracture patterns observed in current quarry wall exposures and data derived from a limited number of drilled cores. Phased mining over the life of the Project may expose previously unidentified fractures with adverse orientations that could affect slope stability. This is a potentially significant impact. Implementation of Mitigation Measure GEO-1 would reduce this potential impact to less than significant (Class II).

Mitigation Measure for Impact GEO-2

GEO-1 **Annual Inspection of Hard Rock Slopes Stability.** The Applicant shall ensure that a qualified engineering geologist or geotechnical engineer experienced in evaluating the stability of hard rock slopes shall inspect the quarry slopes annually. These inspections shall summarize the rock types observed, provide detailed rock mass descriptions and measured discontinuity orientations, observed seepage conditions, and compare the observed conditions relative to that described in the Geotechnical Investigation and Design Recommendations Report (Golder, 2012). If the conditions vary from those characterized in the Golder Report, the engineering geologist or geotechnical engineer shall evaluate whether the changes have an adverse impact on slope stability, and if so, provide recommendations to mitigate any slope stability concerns. The findings of each annual inspection shall be submitted to the County Planning and Building Department for review within 30 days of the date of each inspection.

Impact GEO-3: Be located on expansive soil creating substantial risks to life or property

Excavation

Excavation would not include structural development and all top soils and overburdened would be removed to expose the granite resources. As a result, potentially expansive soils (if present) would have no impact on excavation of the proposed expansion area (No Impact).

Reclamation

Existing soils on the Proposed Project site, which will be reused for reclamation, have a low expansion potential. Since reclaimed soils have a low expansion potential and no structural developments would be included for the Proposed Project, expansive soils would have no impact on reclamation of the Proposed RPA Area (No Impact).

Impact GEO-4: Result in the loss of availability of a known mineral resource that would be of local or State-wide value

Excavation

The expansion area is classified as MRZ-2 for PCC grade aggregate and the entire Proposed Project site is designated by the County as EX1, which indicates that the intended land use is protected for resource extraction. Since expansion of excavation activities would increase the extraction of mineral resources, the Proposed Project would have a beneficial impact (Class IV).

Reclamation

Following the completion of mining operations, the Proposed RPA area would be reclaimed to open space uses and not preclude future extraction activities on the property or within the surrounding area. Therefore, reclamation would have no impact on the availability of potential mineral resources (No Impact).