3.11 GEOLOGY, SOILS, AND MINERALS

This section describes the existing geologic setting and soil conditions in the study area as well as any potential impacts that would occur with either the No Build or Build Alternative. The section evaluates existing fault lines, seismic hazards, landslide susceptibility, and liquefaction susceptibility. The analysis also discloses locations of oil and gas fields, mineral resource sites, and bedrock conditions that are relevant for any potential excavation activities.

3.11.1 REGULATORY REQUIREMENTS

There are no federal statutes or regulatory provisions related to geology and soils considerations on non-federal lands. However, a number of state and local regulations apply to geologic hazards and engineering best practices.

State

Alquist-Priolo Earthquake Zoning Act (Public Resources Code § 2621 et seq.):

The Alquist-Priolo Earthquake Zoning Act regulates development and construction in designated corridors along active faults (earthquake fault zones) where there is elevated risk of surface fault rupture. Earthquake fault zone maps are prepared by the State Geologist to indicate areas with potential surface fault rupture hazards. Before a project can be permitted or developed, cities and counties must conduct a site-specific geologic investigation to determine if the project would cross an active fault. The Alquist-Priolo Act prohibits the location of most types of structures for human occupancy across the active traces of faults in earthquake fault zones.

Seismic Hazards Mapping Act (Public Resources Code § 2690-2699.6):

The Seismic Hazard Mapping Act was adopted in 1990 following the Loma Prieta earthquake to reduce threats to public health and safety and to minimize property damage caused by earthquakes. The act directed the California Department of Conservation to identify and map areas prone to the earthquake hazards of liquefaction, earthquake-induced landslides, and amplified ground shaking. The act further required most new development projects for human occupancy with designated zones to undergo site-specific geotechnical investigations to identify potential seismic hazards and formulate/implement mitigation measures.

Surface Mining and Reclamation Act (Public Resources Code § 2710 et seq.)

The Surface Mining and Reclamation Act established a program to regulate surface mining activities to assure that adverse environmental impacts are minimized and mined lands are reclaimed to a usable condition. The law sets uniform requirements for areas that are known to contain mineral deposits important to meet the future needs of the area.

Local

Monterey County General Plan

The Monterey County General Plan Safety Element contains policies for seismic and geologic hazards. The overall goal of these policies is to minimize the potential for loss of life and property resulting from geologic and seismic hazards. The policies include enforcement of state policies, site-specific geologic studies as it relates to new development, land use designations, and required involvement of a California licensed civil engineer or landscape architect when necessary.

San Luis Obispo County General Plan

The San Luis Obispo County General Plan Safety Element contains policies for seismic and geologic hazards. The overall goal of these policies is to minimize the potential for loss of life and property resulting from geologic and seismic hazards. The General Plan includes policies, standards, and a corresponding implementation program that relates to fault rupture hazards, groundshaking, liquefaction and seismic settlement, slope instability and landslides, and coastal bluff erosion.

3.11.2 METHODS OF EVALUATION

To assess potential impacts related to geology, soils, and minerals, aerial mapping was used to obtain information for the existing Coast Corridor rail alignment and the proposed physical improvement areas. Proposed physical improvements were mostly evaluated as having high, medium, or low potential geologic impacts based on the number of geologic constraints identified.

Active faults, ground shaking, liquefaction, slope stability, and soil type are evaluated in the analysis. The data used for the aerial mapping incorporated the permanent and temporary footprints for each proposed physical improvement and the existing alignment to determine the findings. **Table 3.11-1** summarizes potential geological and soils-related effects. **Table 3.11-2** summarizes specific geologic and soils related issues for each of the proposed physical improvements**.** The permanent and temporary footprint areas are defined as follows:

- Impact Type Definitions:
  - Permanent: Areas where affected resources will not be restored back to their original conditions (i.e. new track locations).
  - Temporary: Areas that will be disturbed during construction and then returned to their original conditions post construction (i.e. staging areas, ingress/egress).
- Track/Signal Upgrades:
  - Existing railroad right of way (upgrades will be constructed via existing tracks – No Impacts are assumed)
- Sidings:
  - Permanent = Existing railroad right of way
  - Temporary = 50 feet on either side of existing right of way
- Curve Realignments:
  - Permanent =100 foot wide corridor
  - Temporary = 200 feet on either side of 100 foot corridor for a total width of 500ft
- Second Mainline:
  - Permanent = Existing railroad right of way
  - Temporary = 100ft on either side of existing railroad right of way
- Stations
  - Soledad Station: 1.9 Acres – permanent impact area is based on conceptual station plans from the *Soledad Downtown Specific Plan* (2012).
  - King City Station: 3.4 Acres – permanent impact area is based on conceptual station plans from the *King City First Street Corridor Master Plan* (2013).

Faults

The permanent and temporary impact footprints were measured to identify any Alquist-Priolo and Quaternary faults that cross the existing alignment as well as the areas with proposed physical improvements. The data was measured in the amount of feet of the proposed improvements that are within a fault zone; the results are expressed as a percentage within **Table 3.11-2**.

Ground Shaking

The permanent and temporary impact footprints were measured to show the level of ground motion that may affect the areas with proposed physical improvements. The data was categorized has low, medium, and high horizontal ground accelerations using California potential shaking ranges. Low is classified as 0.0 – 0.83g, medium is 0.83 – 1.66g, and high is 1.66 – 2.50g.

Liquefaction

The permanent and temporary footprints of proposed physical improvements were measured to show the relative susceptibility for liquefaction (accounting for the age and type of soil/sediment, relative density of the mater, and the depth of the water table). The data was ranked to show whether the area was very low, low, moderate, high, and very high susceptibility to liquefaction.

Slope Stability

The permanent and temporary footprints of proposed physical improvements were measured to show areas that may be susceptible to landsliding. The data was ranked to show whether the area was very low, low, moderate, high, and very high susceptibility to liquefaction.

Shrink-Swell Potential

The permanent and temporary footprints of proposed physical improvements were measured to show areas of soils that would be considered expansive by the Uniform Building Code (1994). The data was ranked as low, moderate, or high susceptibility to shrink-swell.

Corrosive Soils

The permanent and temporary footprints of proposed physical improvements were measured to show areas of soils that are considered corrosive to uncoated steel and concrete. The data was ranked as low, moderate, or high susceptibility to corrosion.

Soil Erosion

The permanent and temporary footprints of the proposed physical improvements were reviewed in light of existing slope and vegetation coverage to determine whether construction activities would have high, medium, or little/low potential to result in soil erosion.

Mineral Resources

The presence of important mineral resources, such as oil/gas fields and geothermal wells are evaluated in the analysis. The aerial mapping data incorporated the permanent and temporary footprints for each proposed physical improvement and the existing alignment relative to known oil and gas fields. The number of such fields crossed by the proposed improvements is noted.

3.11.3 AFFECTED ENVIRONMENT

Geologic Setting

California's central coast has a dynamic and varied landscape made up of coastal mountain ranges, gently sloping hills, and valley flats. Overtime, tectonic plate activity and instances of high-pressure and heat (metamorphism) changed the composition and structure of underlying materials. As a result, Monterey and San Luis Obispo Counties are geologically complex and seismically active.

The Coast Corridor is situated in the Coastal Ranges Geomorphic Province with the Pacific Ocean to the west and the Great Valley Geomorphic Province to the east, with the distant Sierra Nevada Mountain Range Geomorphic Province further east.[1] The California coastal mountain ranges were formed by vertical uplift as the Pacific tectonic plate and the North American tectonic plate converged and compressed. Over tens of millions of years, these mountain ranges eroded and deposited nutrient-rich soil on the California central valley flats. The earth's climate changed over time, shifting between glacial maximums and interglacial periods, and resulted in sea level fluctuations. When the seas advanced, marine layers were deposited and formed the rich soils found in the Salinas Valley, which continue today to lend themselves to intensive agricultural uses.

In the northern portion of the study area within Monterey County, most of the underlying geologic units are quaternary alluvium and marine deposits from the Pliocene to Holocene epoch, between the present time and 1.6 million years ago (mya). The quaternary alluvium deposits are generally young and made up of unconsolidated sand, silt, and clay-bearing material. [2]

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[1] California Geological Survey, 2006

[2] County of Monterey, 2006, pp. 4.4-1-2, 25

San Luis Obispo County is primarily underlain with quaternary alluvium and marine deposits and Franciscan Complex. The underlying Franciscan Complex formed when subsurface soils underwent high-pressure and heat as the Pacific and North American plates interacted. These geological deposits are much older than quaternary alluvium; they were formed between the Jurassic to Cretaceous epochs (between 65 and 200 mya).

Seismic Hazards

Faults

Tectonic plate activity in Central California has resulted in a variety of active fault zones. A fault is a fracture on the earth's surface where two blocks of the earth's crust slide past each other. In most of California, large faults form in response to stress caused by relative displacement between the North American and Pacific tectonic plates. Over time, the displacement stresses build up enough strain that the two blocks slip past each other to alleviate the tension, causing an earthquake. Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake.

Several faults are located within the Coast Corridor rail alignment, as shown in **Figure 3.11-1** and **Figure 3.11-2**. [3]

The California Geological Survey and the United States Geological Survey (USGS) classify *active* faults if they have ruptured in the last 11,000 years (or within the Holocene epoch). All other faults are considered *inactive*.[4]

The Rinconada quaternary fault is the most prevalent active fault within the Coast Corridor alignment. The Rinconada fault zone is a strike-slip fault that is part of the San Andreas Fault system and extends west of King City southeast for approximately 74 miles to Santa Margarita.[5] The Rinconada fault is parallel to the Coast Corridor throughout most of Monterey County. Near Paso Robles, the existing rail alignment travels turns towards the southwest direction and traverses the fault line through Templeton, Atascadero, and Santa Margarita. According to the Monterey County General Plan EIR, the Rinconada fault has a low-rated slip potential and is not expected to produce large earthquakes. No major earthquake has occurred along this fault within the past 100 years.

[3] This graphic depicts only terrestrial portions of the illustrated fault lines within Monterey County.

[4] County of Monterey, 2006, p. 4.4-.

[5] Rosenberg and Bryant, 2003

Small portions of the Cambria and Oceanic faults traverse the existing rail alignment near the City of San Luis Obispo. The Cambria fault trends northwest and is approximately 39 miles long. The Oceanic Fault Zone trends north-northwest for 62 miles.[6]

Ground Shaking

Ground or seismic shaking is the motion of the earth's surface resulting from an earthquake generated by a sudden slip at a fault line. An earthquake with moderate to high magnitude can generate considerable ground shaking. The degree of shaking is dependent on the magnitude of the earthquake, distance to the epicenter, duration of strong ground motion, and local geological conditions (soil type, topography, etc). The most common damage from ground shaking is structural damage to buildings.

Both Monterey County and San Luis Obispo Counties are located in a seismically active region subject to earthquakes and potentially strong ground shaking from nearby faults and generally unconsolidated alluvial areas. The most recent large earthquake in the region was the 2003 San Simeon earthquake, which registered a magnitude of 6.5. This event resulted in two fatalities from a building collapse in downtown Paso Robles. The 1989 Loma Prieta earthquake resulted in moderate to light ground shaking in the northern Salinas Valley. Although most of Monterey and San Luis Obispo Counties are subject to strong ground shaking, the vast majority of the existing Coast Corridor alignment and proposed improvements have a low potential for ground shaking, as further discussed below. One portion of Section #1 of the existing alignment within Monterey County, south of Salinas, has moderate ground shaking potential.

Liquefaction

Liquefaction is the process in which water-saturated sediment temporarily loses strength and acts as a fluid. During liquefaction, the soil undergoes temporary loss of strength causing the soil to behave as a fluid for short periods of time. To be susceptible to liquefaction, a soil is typically cohesionless, with a grain size distribution of a specified range (generally sand and silt), loose to medium dense, below the groundwater table, and subjected to a sufficient magnitude and duration of ground shaking. Liquefaction-related damage could include loss of support beneath foundations and other rail improvements. **Figure 3.11-3** and **Figure 3.11-4** summarizes liquefaction potential of the Coast Corridor.

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[6] County of San Luis Obispo, 1999,pp. 57-60

According to the Monterey County General Plan EIR, ground shaking that causes liquefaction is most prevalent in alluvial basins in Monterey County. The portions of Coast Corridor within Monterey County are most subject to liquefaction near the Salinas River and floodplain.

In San Luis Obispo County, areas that are underlain by young, poorly consolidated, saturated granular alluvial sediments are most susceptible to liquefaction. Areas adjacent to rivers and creeks are also considered vulnerable. Liquefaction potential along the Coast Corridor ranges from very low to very high, but most of the existing alignment and proposed improvements have moderate potential.

Slope Stability

Slope failure can occur as either rapid movement of large masses of soil (landslide) or slow, continuous (creep). The primary factors influencing the stability of a slope are the nature of the underlying soil or bedrock, the geometry of the slope (height and steepness), rainfall, and the presence of previous landslide deposits. Landslides typically occur in areas of steep slopes where underlying earth materials are relatively weak and particularly where high rainfall occurs and/or high groundwater levels are present. Water can act as a lubricant to decrease resisting forces. Ground shaking due to earthquakes can also cause landslides. The Coast Corridor alignment is located along largely flat areas where landslide hazard risk is generally low, with the exception of several high-risk area as discussed below.

Soils

Shrink-Swell Potential

Expansive soils can undergo significant volume change (shrink or swell) due to variations in moisture content. Earth materials susceptible to these volumetric changes include soils and rock formations containing clays. Changes in soil moisture content can result for rainfall, irrigation, utility leakage, surface drainage, perched groundwater, drought, or other factors.

During shrink-swell cycles, the volume of the soil changes and can cause damage to infrastructure. Expansive soils vary in severity along the existing Coast Corridor alignment and where there are proposed physical improvements. In Monterey County, expansive soils are most severe in the northern portions of the existing alignment. Most of the proposed physical improvements have low or moderate amounts of expansive soil.

In San Luis Obispo County, the shrink-swell potential for soils is much lower than in Monterey County. Along the existing Coast Corridor alignment, the presence of expansive soils is mostly moderate to low.

Corrosive Soils

A corrosive substance is one that will destroy or irreversibly damage another surface or substance with which it comes into contact. Corrosive soils are a potential hazard to concrete and metal foundations, utilities, and other buried or ground-level improvements.

Soil Erosion

Soil erosion is a natural process that can be caused by wind, water, waves, or corrosion. Erosion can lead to soil loss, degraded water quality, and other effects.

In agricultural areas of the Salinas Valley, erosion is common when flooding is prevalent. As a result, sediment is picked up and deposited in another location. Wind is another common source of erosion in the Salinas Valley, especially in areas with sandy deposits.[7] Most of the existing Coast Corridor alignment has soil prone to moderate erosion.

Mineral Resources

Geological resources in California include oil and gas fields, geothermal fields, and a wide range of mineral resources. Given the value of these resources, CEQA requires consideration of whether a project would eliminate or otherwise reduce access to such resources. According to the Monterey County General Plan EIR, there are oil wells scattered throughout Monterey County, but the vast majority are clustered in the San Ardo oil and gas field, the sixth largest oil field in the state of California. The existing Coast Corridor rail alignment passes through a portion of the San Ardo field.

3.11.4 ENVIRONMENTAL CONSEQUENCES

No Build Alternative

The No Build Alternative represents the continuation of existing operations and physical components, and assumes the perpetuation of existing freight and passenger service. The only proposed physical improvement would be the implementation of PTC along the corridor, including modification to signaling and

[7] County of Monterey, 2006,pp. 4.4-21-23

communications equipment. These PTC related changes are not expected to incur heightened risk associated with geology or soils-related effects. As such, existing passenger and freight operations (along with potential additional freight operations) would continue to be susceptible to the geologic hazards present within the study area.

Build Alternative

The Build Alternative would construct physical improvements in areas with high geological impact potential. **Table 3.11-1** summarizes potential geological and soils-related effects. **Table 3.11-2** summarizes specific geologic and soils related issues for each of the proposed physical improvements.

Table 3.11-1 Types of Potential Impacts from Geologic and Soil Conditions

Geologic Condition	Potential Impact
Ground Shaking/Liquefaction	Ground shaking and liquefaction effects from an earthquake could pose safety hazards to workers and public from possible derailment, collapse of infrastructure, or damage to facilities.
Active Fault Crossing	Active fault crossings could pose potential risk to workers and public due to interruption of service or derailment due to surface rupture along faults.
Slope Stability	Landslide potential could pose potential risk to workers and public due to failure of natural and/or construction cut slopes or retention structures.
Soil Conditions	Expansive soil, corrosive soil, and soil erosion could damage infrastructure and cause premature deterioration of underground structures.
Oil & Gas Fields	Potential migration of oil & gas fields could release toxic gases into subsurface materials.
Mineral Resources	Potential project costs and delays due to potential impacts on existing mineral resource areas and facilities, including remediation.

Source: Circlepoint, 2014.

Table 3.11-2 Summary of Potential Geologic and Soil Impacts

Build Alternative Components	Active Fault Crossing (% of length)	Ground Shaking Potential (H/M/L)	Liquefaction Potential (H/M/L)	Landslide Potential/ Slope Stability (H/M/L)	Soil Shrink-Swell Potential (H/M/L)	Soil Corrosivity Potential (H/M/L)		Soil Erosion Hazard Potential (H/M/L)	Oil & Gas Fields (# crossed)
						Steel	Concrete		
Salinas Powered Switch	0%	Low	High	Low	Moderate	High	Low	Low	0
Upgrades to Existing Alignment Section #1	0%	Low/ Moderate	High	Low	High (56%) Moderate (12%) Low (32%)	High	Low	Very Low	0
Spence Siding Extension	0%	Low	Moderate	Low	Moderate/ High	High	Low	Low	0
Upgrades to Existing Alignment Section #2	0%	Low	Moderate	Moderate	High (28%) Moderate (28%) Low (37%) N/A (5%)	High	Low/ Moderate	High (8%) Moderate (2%) Low (90%)	0
Gonzales Powered Switch	0%	Low	Moderate	Moderate	Moderate	High	Low	Low	0

Build Alternative Components	Active Fault Crossing (% of length)	Ground Shaking Potential (H/M/L)	Liquefaction Potential (H/M/L)	Landslide Potential/ Slope Stability (H/M/L)	Soil Shrink-Swell Potential (H/M/L)	Soil Corrosivity Potential (H/M/L)		Soil Erosion Hazard Potential (H/M/L)	Oil & Gas Fields (# crossed)
						Steel	Concrete		
Soledad Powered Switch	0%	Low	Moderate	Low	High	High	Low	Low	0
Soledad New Passenger Station	0%	Low	Moderate	Low	High	High	Low	Low	0
Harlem/Metz Curve Realignments	0%	Low	High	Moderate	Low	High	Low	Low/ Moderate	0
Chalone Creek New Siding	0%	Low	High	Moderate	Low/ Moderate	High	Low	Low	0
Upgrades to Existing Alignment Section #3	0%	Low	High	Moderate	High (36%) Moderate (22%) Low (32%) N/A (11%)	High	Low	High (11%) Moderate (23%) Low (66%)	0
Coburn Curve Realignments	0%	Low	High	Moderate	Moderate/ High	High	Low	Low	0
King City Siding Extension	0%	Low	Moderate	Low	Moderate	High	Low	Low	0

Build Alternative Components	Active Fault Crossing (% of length)	Ground Shaking Potential (H/M/L)	Liquefaction Potential (H/M/L)	Landslide Potential/ Slope Stability (H/M/L)	Soil Shrink-Swell Potential (H/M/L)	Soil Corrosivity Potential (H/M/L)		Soil Erosion Hazard Potential (H/M/L)	Oil & Gas Fields (# crossed)
						Steel	Concrete		
King City New Passenger Station	0%	Low	Moderate	Low	Moderate	High	Low	Low	
King City Powered Switch	0%	Low	Moderate	Low	Moderate	High	Low	Low	
Upgrades to Existing Alignment Section #4	0%	Low	Moderate	Low	Moderate (44%) Low (31%) N/A (26%)	High	Low	High (26%) Moderate (4%) Low (71%)	0
MP 165 Curve Realignment	0%	Low	Moderate	Low	High	High	Low/ Moderate	Low/ Moderate	0
San Lucas New Siding	0%	Low	Moderate	Low	Low/High	High	Moderate	Low/ Moderate	0

Build Alternative Components	Active Fault Crossing (% of length)	Ground Shaking Potential (H/M/L)	Liquefaction Potential (H/M/L)	Landslide Potential/ Slope Stability (H/M/L)	Soil Shrink-Swell Potential (H/M/L)	Soil Corrosivity Potential (H/M/L)		Soil Erosion Hazard Potential (H/M/L)	Oil & Gas Fields (# crossed)
						Steel	Concrete		
Upgrades to Existing Alignment Section #5	0%	Low	High	High	High (13%) Moderate (51%) Low (32%) N/A (4%)	High	Low	Very High (6%) High (11%) Moderate (5%) Low (78%)	2
MP 172 Track Realignment	0%	Low	Moderate	Low	Moderate	High	Low/ Moderate	Low/ Moderate	0
San Ardo Powered Switch	0%	Low	Moderate	Low	Moderate	High	Low	Low	0
Getty/Bradley Curve Realignments	0%	Low	Moderate	High	Low/ Moderate	High	Low	Low/ Moderate	0
Bradley Siding Extension	0%	Low	High	Moderate	High	High	Low/ Moderate	Low	0
Bradley Powered Switch	0%	Low	High	Moderate	High	High	Low/ Moderate	Low	0

Build Alternative Components	Active Fault Crossing (% of length)	Ground Shaking Potential (H/M/L)	Liquefaction Potential (H/M/L)	Landslide Potential/ Slope Stability (H/M/L)	Soil Shrink-Swell Potential (H/M/L)	Soil Corrosivity Potential (H/M/L)		Soil Erosion Hazard Potential (H/M/L)	Oil & Gas Fields (# crossed)
						Steel	Concrete		
Upgrades to Existing Alignment Section #6	0%	Low	High	Low	High (14%) Low (96%)	High	Low	Low	0
Upgrades to Existing Alignment Section #7	0%	Low	Moderate (95%) Very High (5%)	Low	Low	Moderate	Low	Low	0
McKay/ Wellsona Curve Realignments	0%	Low	Moderate/Very High	Low	Low	Moderate	Low/ Moderate	Low/ Moderate	0
McKay East Powered Switches	0%	Low	Moderate	Low	Low	Moderate	Low	Low	0
Wellsona New Siding	0%	Low	Moderate/ Very High	Low	Low	Moderate	Low	Low/ Moderate	0
Upgrades to Existing Alignment Section #8	0.21%	Low	Very Low (47%) Moderate (23%) Very High (30%)	Low	Moderate (41%) Low (59%)	Moderate /High	Low/ Moderate	Low/ Moderate	0

Build Alternative Components	Active Fault Crossing (% of length)	Ground Shaking Potential (H/M/L)	Liquefaction Potential (H/M/L)	Landslide Potential/ Slope Stability (H/M/L)	Soil Shrink-Swell Potential (H/M/L)	Soil Corrosivity Potential (H/M/L)		Soil Erosion Hazard Potential (H/M/L)	Oil & Gas Fields (# crossed)
						Steel	Concrete		
Wellsona/ Paso Robles Curve Realignments	0%	Low	Moderate	Low	Low	Moderate / High	Low/ Moderate	Low	0
Templeton Siding Extension	2.02%	Low	Moderate/ High	Low	Low/ Moderate	Moderate /High	Low	Low	0
Templeton/ Henry Curve Realignments	0%	Low	Moderate	Low	Low	Moderate	Low/ Moderate	Moderate	1
Upgrades to Existing Alignment Section #9	0.84%	Low	Very Low (27%) Moderate (72%) Very High (1%)	Low (68%) Moderate (16%) High (16%)	High (6%) Moderate (38%) Low (56%)	Moderate	Low	Low	0
Henry/Santa Margarita Curve Realignment	18.31%	Low	Very Low/ Moderate	Low	Low/ Moderate	Moderate	Low/ Moderate	Low	0
Santa Margarita Powered Switch	0%	Low	Moderate	Low	Low	Moderate	Low/ Moderate	Low	0

Build Alternative Components	Active Fault Crossing (% of length)	Ground Shaking Potential (H/M/L)	Liquefaction Potential (H/M/L)	Landslide Potential/ Slope Stability (H/M/L)	Soil Shrink-Swell Potential (H/M/L)	Soil Corrosivity Potential (H/M/L)		Soil Erosion Hazard Potential (H/M/L)	Oil & Gas Fields (# crossed)
						Steel	Concrete		
Cuesta Second Main Track	0%	Low	Very Low/ Moderate	Low/High	Low/ Moderate	Moderate / High	Moderate/ High	Moderate/ High	0
Upgrades to Existing Alignment Section #10	0.58%	Low	Very Low (83%) Moderate (17%)	Low (15%) High (80%) Very High (4%)	High (30%) Moderate (62%) Low (8%)	High	Low/ Moderate	Low/ Moderate	0

Source: ICF, 2013

Seismic Hazards

As shown in **Table 3.11-2,** geologic conditions in the study area generally present low to moderate constraints on development. Overall, the study area has a low potential for ground shaking as few active faults cross the existing and proposed alignment areas; however, about 18 percent of the proposed Henry/Santa Margarita curve realignment area traverses the Rinconada Fault. As a result, the improvement would require special designs to minimize potential damage to the tracks and other infrastructure as a result of potential surface fault rupture. That said, the Rinconada fault has a low-rated slip potential and is not expected to produce large earthquakes, as discussed in **Subsection 3.11.3.**

Liquefaction potential is generally moderate to high for most of the study area. The Coburn curve realignment, Harlem/Metz curve realignment, Bradley siding extension, and the new siding at Chalone Creek are most notable in Monterey County with high liquefaction potential. Similarly, the proposed McKay/Wellsona curve realignment, Templeton siding extension, and new siding at Wellsona are proposed in areas of high liquefaction potential in San Luis Obispo County.

Portions of the existing alignment and proposed physical improvements within Monterey County have mostly low potential for landslides due to generally flat topography, as shown in **Figure 3.11-5**. However, several portions of the alignment run immediately adjacent to or near relatively steep slopes. Such areas include the Harlem/Metz and Coburn curve realignments, Chalone Creek new siding, and upgrades to existing alignment #3. These components thus have moderate potential for landslides. Further south, the Getty/Bradley curve realignments and the Bradley siding extension have moderate to high potential for landslides. In San Luis Obispo County, the existing railroad alignment is within an area of generally low landslide potential.

Overall, the proposed physical improvements with the most noteworthy geologic risks are the Getty/Bradley curve realignments, Harlem Metz curve realignments, Bradley siding extension, and the new siding at Chalone Creek, which face moderate to high risks for both liquefaction and landslide potential.

Soils

As shown in **Table 3.11-2,** soil conditions in the study area generally present moderate constraints on development. Most of the proposed improvements within Monterey County have moderate to high shrink-swell potential. Particularly, the Spence siding extension, Coburn curve realignment, MP 165 curve realignment, Bradley siding, San Lucas siding, and the proposed Soledad station have several acres of high potential shrink-swell soil potential. In San Luis Obispo County, shrink-swell soil potential in improvement areas and existing areas is generally low to moderate.

Most of the soils in areas of the proposed physical improvements in Monterey County are highly corrosive to steel and low to concrete with low potential for soil erosion. Most of the soils in San Luis Obispo County are moderately corrosive to steel and concrete with low to moderate soil erosion potential.

Mineral Resources

The proposed Templeton/Henry curve realignment would cross over one oil and gas field that is no longer in use. There are no geothermal wells within any of the proposed improvement areas.

3.11.5 AVOIDANCE, MINIMIZATION, AND MITIGATION STRATEGIES

The individual improvements comprising the Build Alternative should be designed to minimize impacts related to geology and soils along the Corridor. The following strategies have been identified at this preliminary stage to avoid, minimize, and/or mitigate any potentially significant impacts.

Ground Shaking

Ground shaking hazards cannot be mitigated completely and thus can be unpredictable. The following minimization strategies should be implemented to reduce potential adverse effects from ground shaking in areas where substantial risk is present:

MIN-GEO-1. Infrastructure can be designed to withstand strong ground motion. Designs typically include additional ductility in the structure. The design needed to reduce ground shaking would be determined upon for structures during subsequent stages of development, when detailed design plans are created.

MIN-GEO-2. Liquefaction potential can be reduced through site-specific methods such as soil densification or structural design.

Fault Crossings

MIN-GEO-3. Techniques to monitor track alignment as routine maintenance and the installation of ground motion warning systems could be used to reduce the effects of fault crossings.

Slope Stability/Landslides

A-GEO-4. Geotechnical studies during subsequent site-specific evaluation would assist in determining the potential for failure of natural and constructed slopes and identifying temporary and permanent slope reinforcement and protection measures where appropriate.

Soil Hazards

A-GEO-5. As one or more components of the Build Alternative are selected for further design, a site-specific subsurface evaluation shall be performed by a qualified geologist to evaluate the extent of soils susceptible to shrink-swell present along the alignment. Where expansive soil conditions are found and would be detrimental to proposed improvements, measures recommended by the geologist would be implemented in project design.

MIN-GEO-6. A subsurface evaluation would be performed prior to design and construction to evaluate the potential for corrosive soil and identify recommendations to minimize or avoid any potential effects related to the presence of such soils (including but not limited to corrosion of rails or ties).

Hazards Related to Oil and Gas Fields

Hazards related to potential migration of hazardous gases due to the presence of oil fields, gas fields, or other subsurface sources can be mitigated by following strict federal and state Occupational Safety & Health Administration (OSHA/CalOSHA) regulatory requirements for excavations, and consultation with the California Department of Conservation (Division of Oil and Gas) and the California Department of Toxic and Substances Control regarding known areas of concern. Mitigation strategies would include

A-GEO-7. Use safe and explosion-proof equipment during construction and testing for gases regularly.

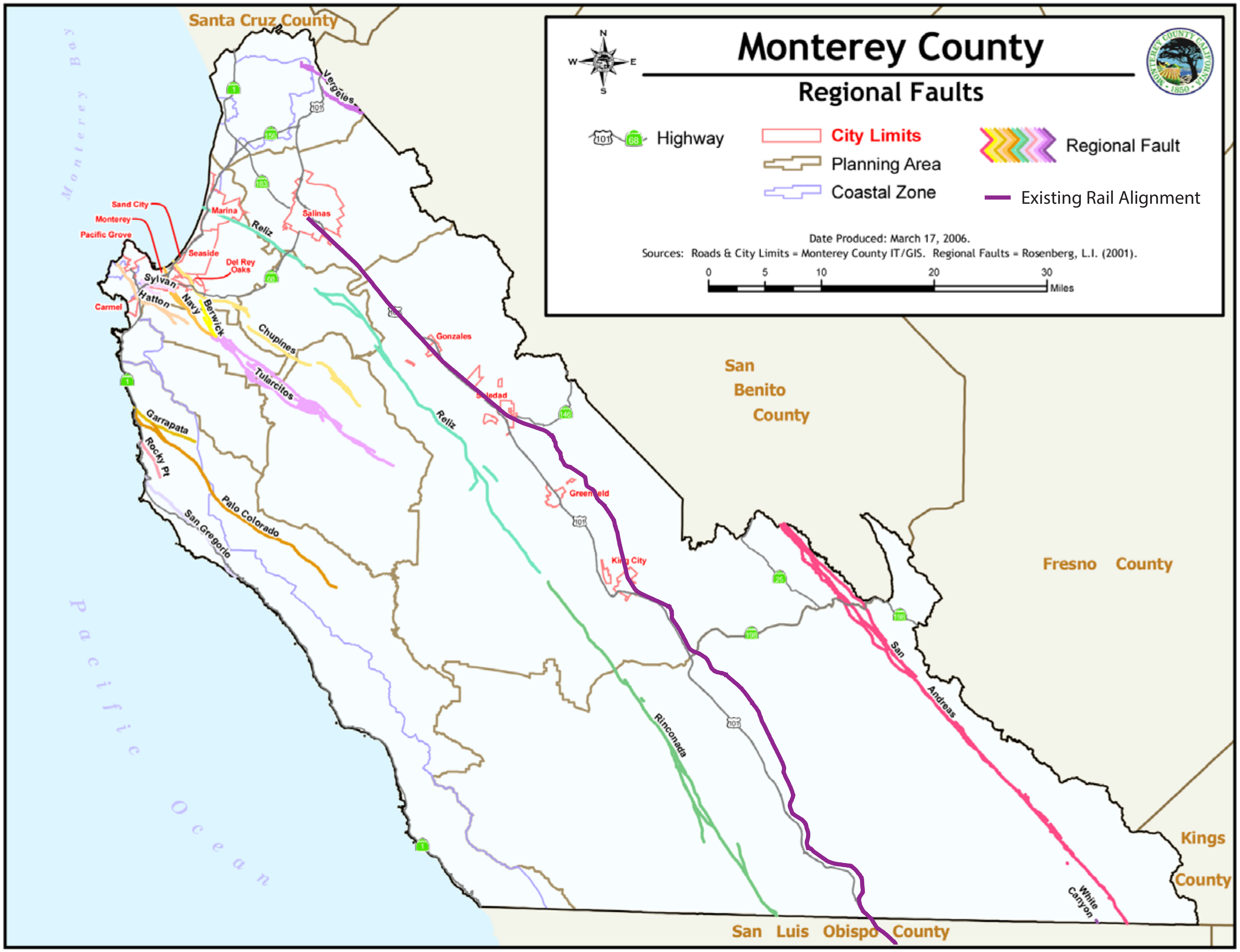
A-GEO-8. Active monitoring systems and alarms would be required in underground construction areas and facilities where subsurface gases are present.

Mineral Resources

A-GEO-9. Important mineral sites will be identified as early as possible during detailed project-level reviews and avoided where possible.

3.11.6 SUBSEQUENT ANALYSIS

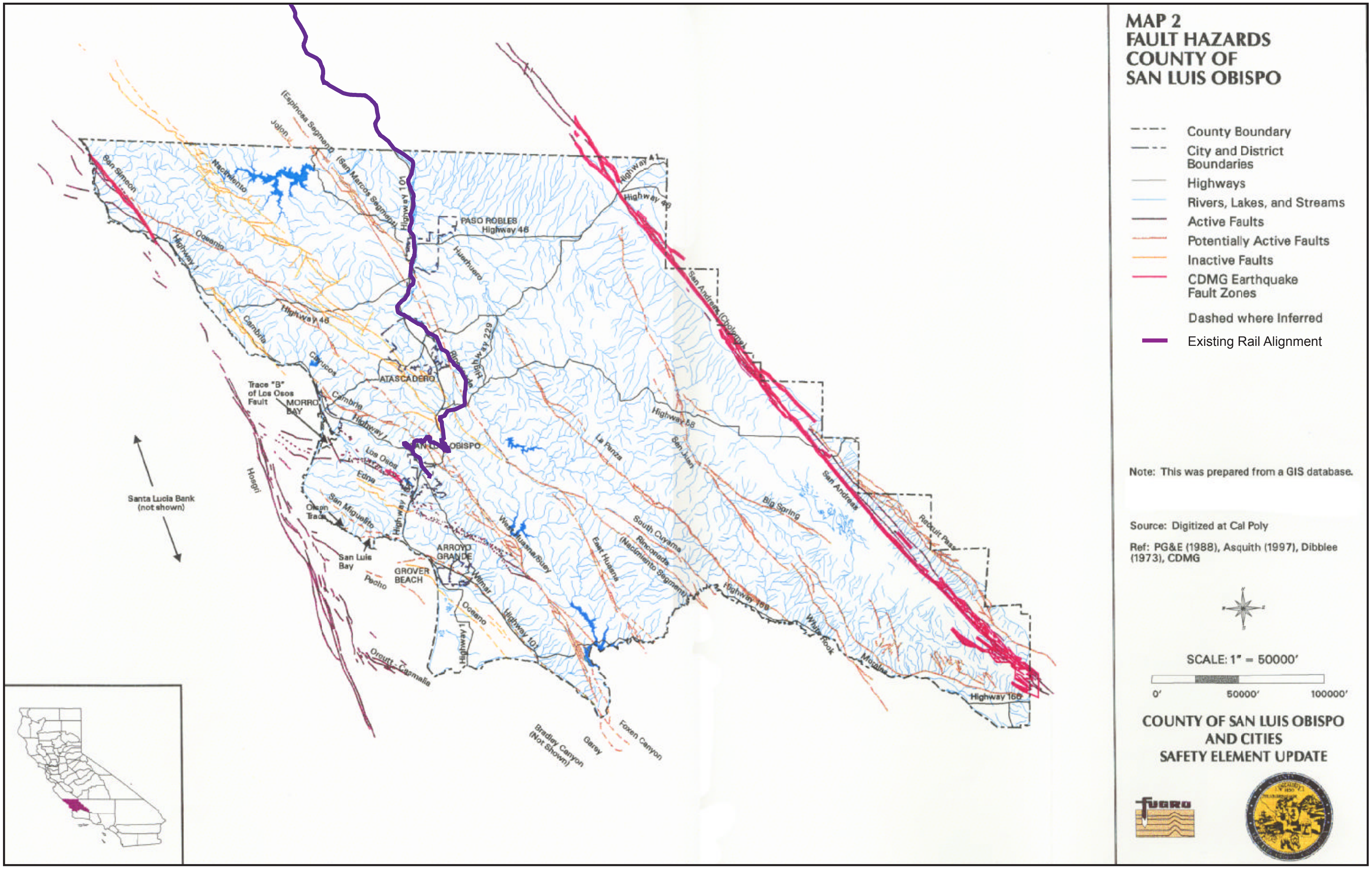
Prior to implementing specific elements of the Build Alternative, component-specific geology, soils and minerals evaluations should be conducted. These evaluations would be used to determine if additional mitigations strategies from those discussed above in **Subsection 3.11.5** would be applicable.



Active Fault Zones in Monterey County

Figure 3.11-1

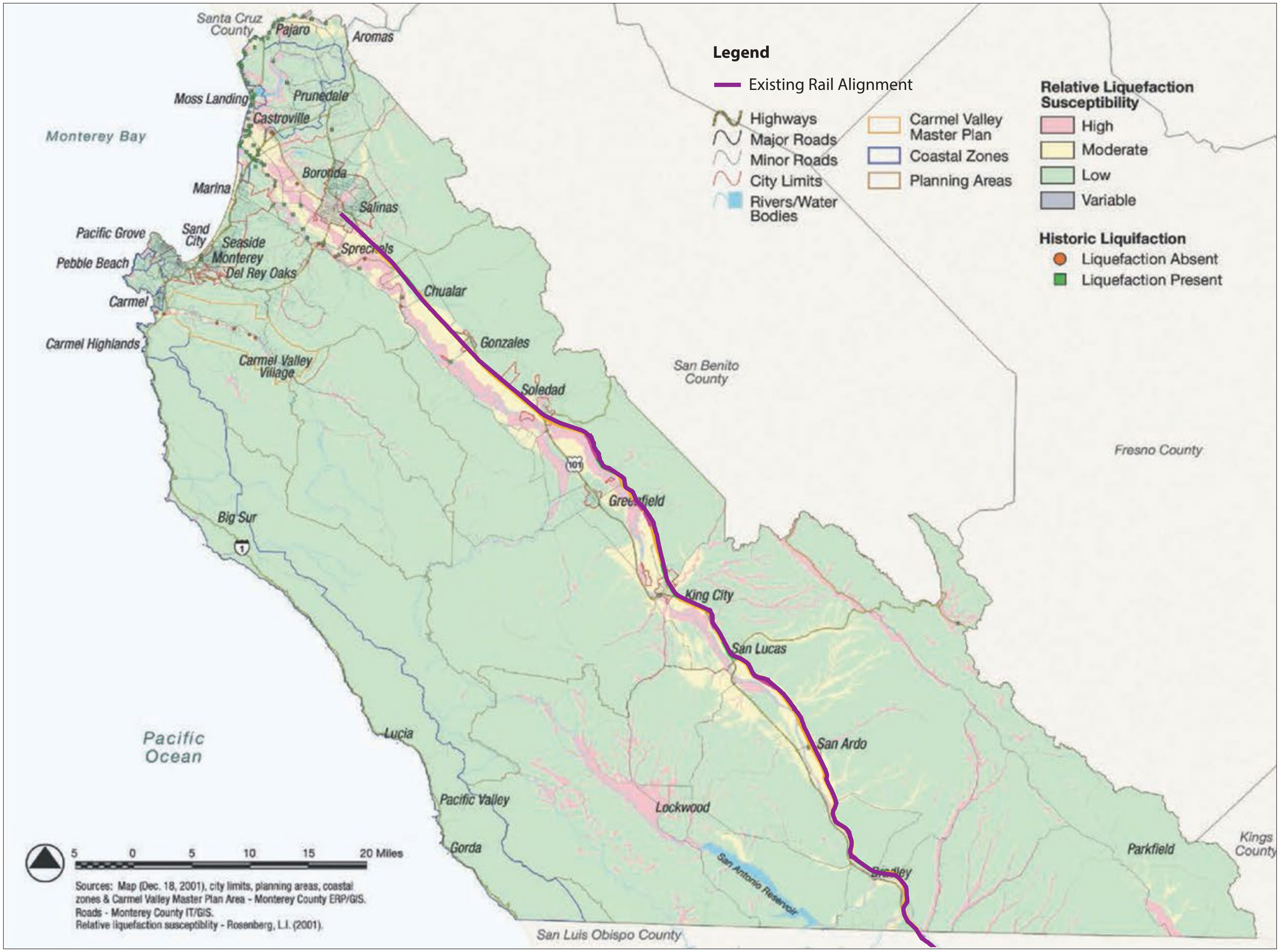
Source: Monterey County, 2004



Active Fault Zones in San Luis Obispo County

Figure 3.11-2

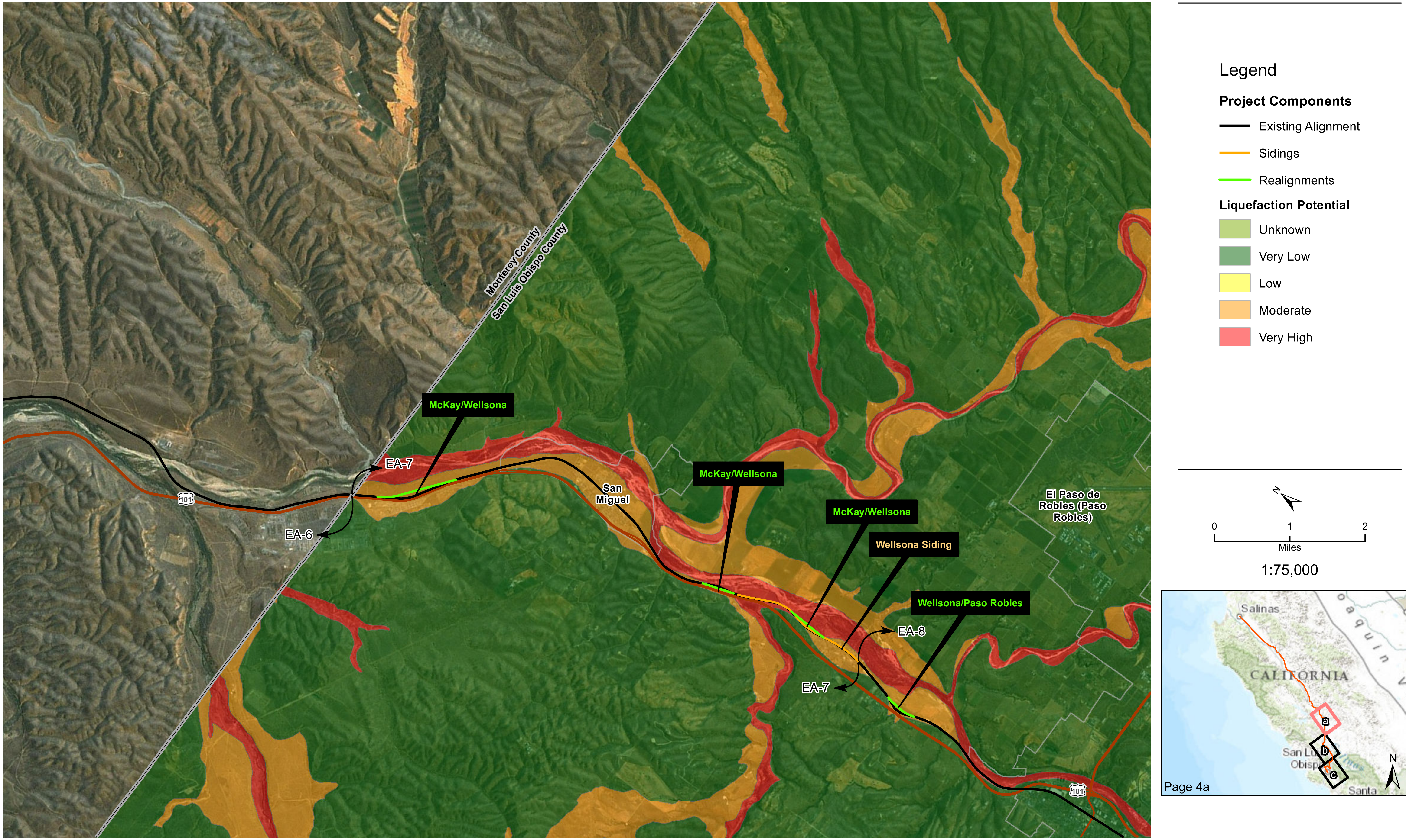
Source: USGS, 2013



Monterey County Liquefaction Potential

Figure 3.11-3

Source: Monterey County, 2004



San Luis Obispo Liquefaction Potential

Figure 3.11-4a

Source: ICF International, 2013

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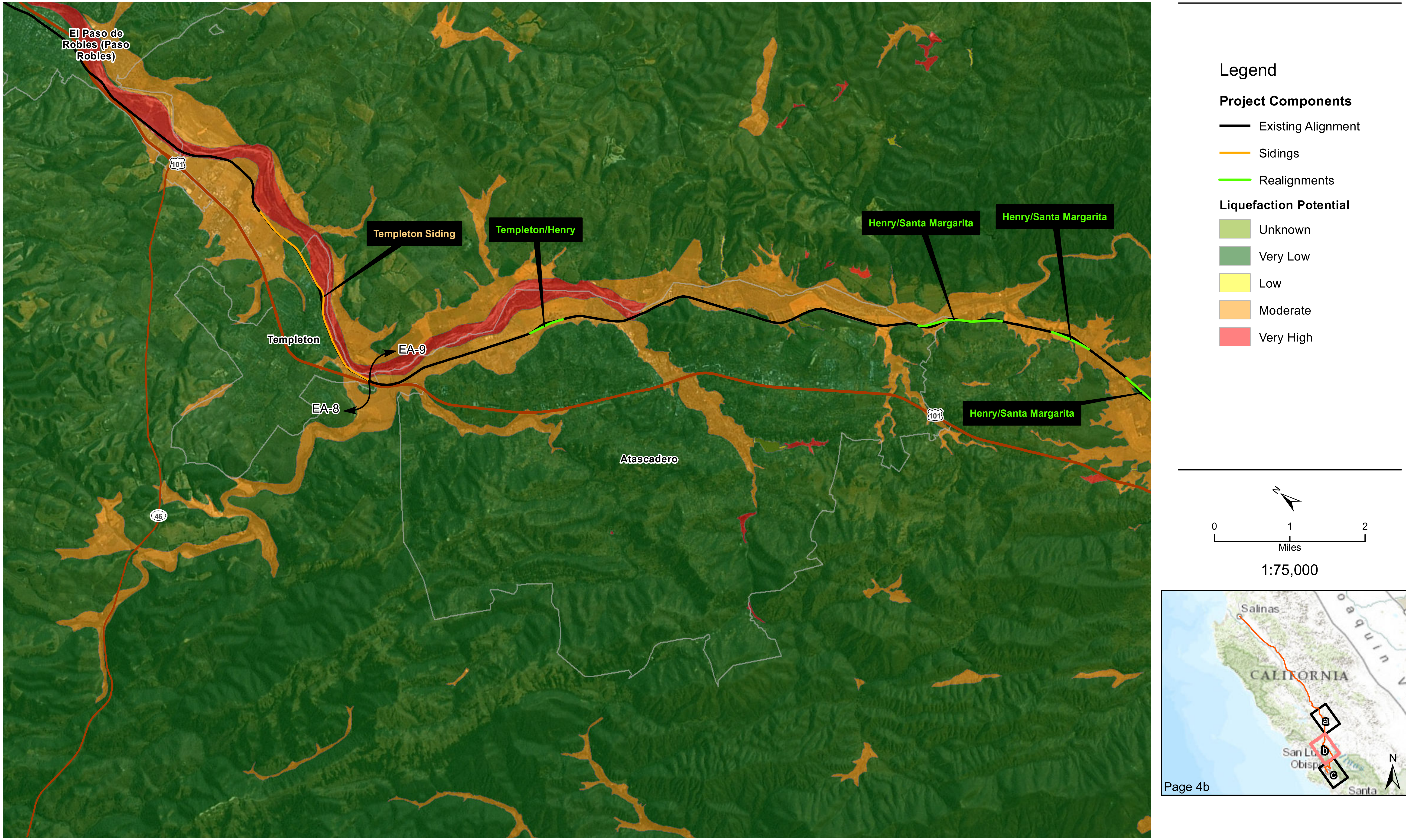
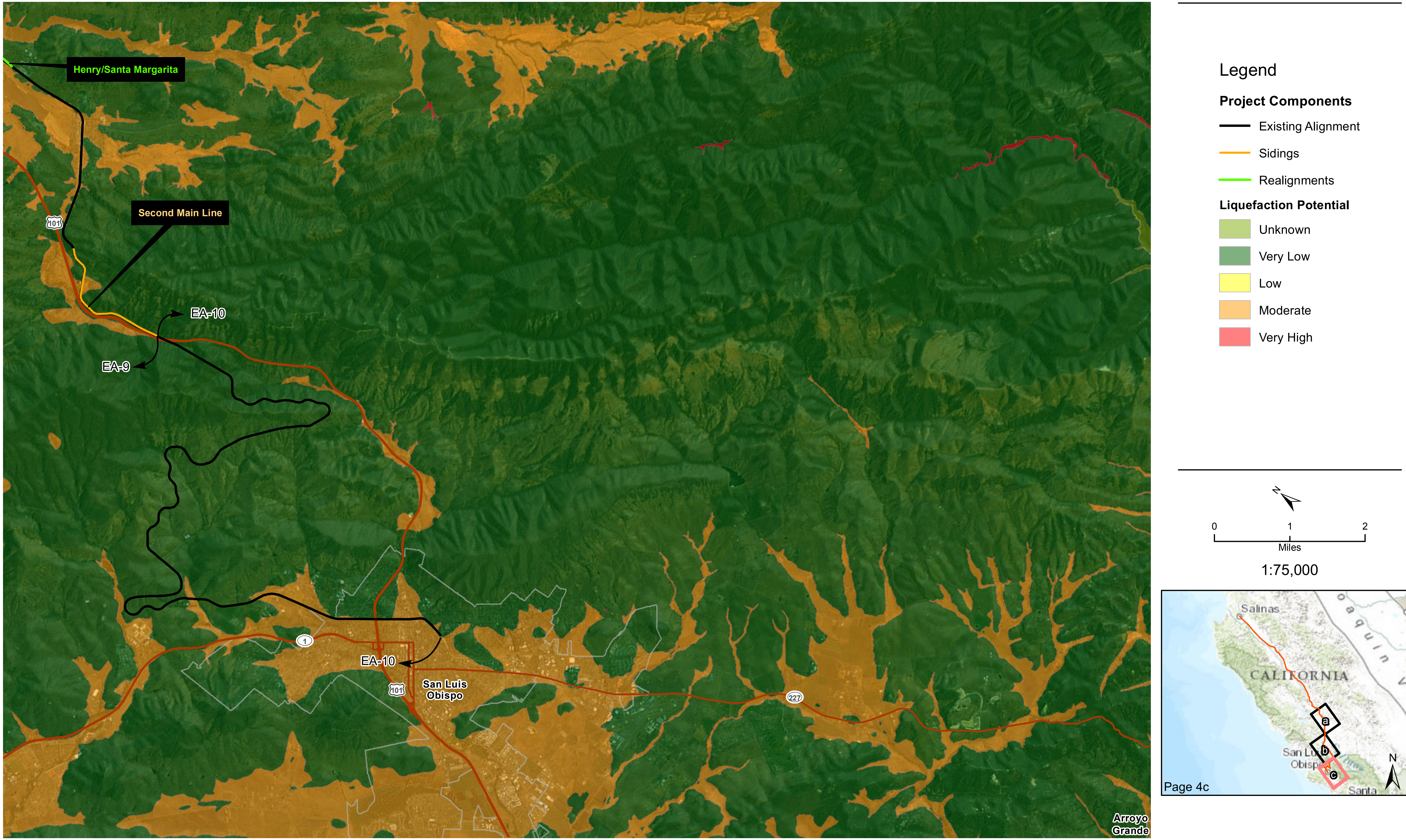


San Luis Obispo Liquefaction Potential

Figure 3.11-4b

Source: ICF International, 2013



San Luis Obispo Liquefaction Potential

Figure 3.11-4c

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Monterey County Landslide Potential

Figure **3.11-5**

Source: Monterey County, 2004

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