4.6 GEOLOGY/SOILS

4.6.1 Setting

a. Topography and Geology.

Topography. The proposed MBSST corridor stretches the entire length of Santa Cruz County from the San Mateo County Line north of Davenport past the Pajaro River in Watsonville to connect to Monterey County's MBSST system, and into the town of Pajaro at the rail right-of-way southern terminus. The MBSST Network would primarily align with the Santa Cruz Branch Rail Line right-of-way, a 32-mile, continuous travel corridor, 31-miles of which is owned by the RTC. The rail right-of-way would serve both rail service and bike/pedestrian trail functions. The railroad corridor generally parallels the Pacific Ocean, except where it turns inland near Manresa State Beach and on to Watsonville.

The majority of the MBSST Network is located on lowlands seaward of the Santa Cruz Mountains and the coastal bluffs toward the northern extent of the County. The area of the corridor that turns inland toward Watsonville generally follows the flood plains of the Watsonville Slough and Pajaro River, as well as the low-lying coastal areas along Beach Street in the southern portion of the County. The lowlands along the coastline of the Pacific Ocean and Monterey Bay have been interpreted to be uplifted or emergent marine terraces of Quaternary age (Brabb, 1989). The higher terraces are progressively older and more dissected. These terraces are cut into the Santa Cruz Mountains, which consist of Tertiary-age sedimentary rocks that have been folded and faulted by movements along the San Andreas fault system.

The proposed MBSST Network corridor is located on the lowlands of the Santa Cruz Mountains, and consequently, there are varying slopes throughout the corridor. Slopes range from flat to gentle, moderate, and steep. In general, the project site slopes to the west, toward the Pacific Ocean. Elevations throughout the corridor range from sea level to approximately 30 to 40 feet above sea level. Additionally, the corridor is adjacent to steep hillsides throughout most of the northern reach.

Geology. The MBSST Network lies within the Coast Range geomorphic province of California. The Santa Cruz Mountains consist of Tertiary-age sedimentary rocks that have been folded and faulted by movements along the San Andreas Fault system.

The rocks underlying the corridor are predominantly of late Cenozoic marine origin with some continental deposits. The portion of the MBSST Network from north of Davenport to La Selva Beach rests on poorly-graded marine sands and gravels that range from 20 to 40 feet thick. Locally, this terrace has been cut by streams, exposing underlying Tertiary mudstones and siltstones in some locations and more recent alluvial fill deposits less than 100 feet thick in other locations. The underlying Tertiary rocks range up to 8,900 feet thick and are underlain by granitic basement rock. The portion of the site from La Selva Beach to Watsonville rests on continental deposits consisting of alluvial sand, silt, clay, and gravel and eolian sands. These deposits range from 50 to 200 feet thick (Geomatrix Consultants, 1997).

The MBSST Network project site is located within a seismically active region. The northwest-southeast structural grain of the Coast Ranges is controlled by a complex of active faults within the San Andreas fault system. Southwest of the San Andreas fault, the Coast Ranges, including the Santa Cruz Mountains, are underlain by a large, northwest-trending, fault-bounded elongated prism of granitic and metamorphic basement rocks. The granitic and metamorphic basement is Cretaceous in age or older, and is overlain by a sequence of dominantly marine sedimentary rocks of Paleocene to Pliocene age and non-marine sediments of Pleistocene and Holocene age. The older sedimentary rocks are moderately to strongly deformed, with steep-limbed folds and several generations of faults associated with uplift of the Santa Cruz Mountains.

The Santa Cruz Mountains are cut by several active faults, of which the San Andreas is the most important. Along the coast, the ongoing tectonic activity is most evident in the gradual uplift of the coastline, as indicated by the series of uplifted marine terraces that sculpt the coastline (City of Santa Cruz, 2011). In addition to the San Andreas fault, the Zayante-Vergeles and San Gregorio faults and the Monterey Bay – Tularcitos fault zone are associated with Holocene activity (movement in the last 11,000 years) and are considered to be active. Refer to Figure 4.6-1 for a map of faults in the region. The potential for seismicity present in Santa Cruz County is also pervasive through most of coastal California.

There are 42 different soil types within the MBSST Network right-of-way (ROW) and 20 different soil groups or series. Information regarding soils within the MBSST Network ROW was obtained from U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Data Mart. The MBSST Network traverses soils of the Aptos, Baywood, Bonnydoon, Clear Lake, Conejo, Danville, Elder, Elkhorn, Fluvaquentic Haploxerolls, Lompico-Felton, Mocho, Pfeiffer, Pinto, Pits-Dumps, Santa Lucia, Soquel, Tierra-Watsonville, and Watsonville series, as well as aquents [poorly to very poorly drained soils formed in human transported material or on excavated (cut) landscapes] and beaches.

c. Geologic Hazards along the MBSST Network.

Faulting and Seismically Induced Ground Shaking. The United States Geological Survey (USGS) defines active faults as those that have had surface displacement within Holocene time (approximately within the last 11,000 years). Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts. Active faults as defined by the State Geologist have been designated as Alquist-Priolo Fault Zones and require special regulation and study for projects proposed in these zones. Further discussion of the Alquist-Priolo Earthquake Fault Zoning Act is provided in the Regulatory Setting. Potentially active faults are those that have had surface displacement during Quaternary time (the last 1.6 million years). Inactive faults have not had surface displacement within the last 1.6 million years.

Historical earthquakes along the San Andreas fault and its branches have caused substantial seismic shaking in Santa Cruz County. The two largest historical earthquakes to affect the area were the moment magnitude (Mw) 7.9 San Francisco earthquake of April 18, 1906 and the Mw 6.9 Loma Prieta earthquake of October 17, 1989. Both earthquakes caused severe seismic shaking throughout Santa Cruz County. Regional faults in the MBSST Network are described below and shown in Figure 4.6-1.

Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Fault Map

Figure 4.6-1

San Andreas Fault Zone. The San Andreas Fault Zone is the dominant active fault in California. It is located approximately 10 miles northeast of the City of Santa Cruz and is less than 10 miles from the closest point on the MBSST Network, which lies between Segment 12 and Segment 20. The San Andreas Fault Zone is the primary surface boundary between the Pacific and the North American plates. The main trace of the fault trends northwest-southeast and extends over 800 miles from the Gulf of California through the Coast Ranges to Point Arena, where the fault passes offshore and merges with the Cascadia fault zone.

Zayante-Vergeles Fault. The Zayante Fault lies southwest of the San Andreas Fault and trends about 50 miles northwest from the Watsonville lowlands into the Santa Cruz Mountains. The southern extent of the Zayante Fault merges with the Vergeles Fault. It is at this junction that the fault is considered potentially active (California Geologic Survey, 2010). The nearest portion of the MBSST Network project to the potentially active region of the Zayante-Vergeles Fault is in the Watsonville reach. The easternmost portion of the Watsonville reach is approximately 2.75 miles southwest of the Zayante-Vergeles Fault.

San Gregorio Fault. The San Gregorio Fault cuts the ocean floor seaward of Monterey Bay and skirts the Santa Cruz County coastline before coming on land just south of Point Año Nuevo. The San Gregorio Fault is considered potentially active (California Geologic Survey, 2010.) The area where the San Gregorio Fault comes on land is considered an Alquist-Priolo Fault Zone and coincides with the two northernmost segments of the MBSST Network project.

Monterey Bay – Tularcitos Fault Zone. The Monterey Bay – Tularcitos Fault Zone is based on a postulated connection between the Tularcitos Fault, located on land near the Monterey Peninsula, and the offshore Monterey Bay Fault zone. The Monterey Bay Fault Zone is six to nine miles wide and about 25 miles long, located approximately 2.75 miles southwest of the central reach of the MBSST Network project. This fault zone is considered potentially active.

Faults generally produce damage in two ways: ground shaking and surface rupture. Ground shaking covers a wide area and is greatly influenced by the distance of the site to the seismic source, soil conditions, and depth to groundwater. Surface rupture is limited to very near the fault. As previously mentioned, the northernmost segment of the trail (segment 1) is within an Alquist-Priolo Fault Zone and therefore subject to surface rupture.

Earthquake-generated ground shaking is the greatest cause of widespread damage in an earthquake. California Geologic Survey (CGS) modeling efforts (probabilistic modeling) evaluate earthquake shaking potential in California for given areas by analyzing several factors, such as historical earthquakes, areas damaged, slip rates, and geologic materials (CGS, 2003). The interactive Probabilistic Seismic Hazard Assessment and Map produced by the California Geological Survey for the California/Nevada region (CGS, 2003) depicts peak ground acceleration (Pga), spectral acceleration (Sa) at short (0.2 second) and moderately long (1.0 second) periods. The probabilistic seismic hazards for each reach are shown in Table 4.6-1. Ground movements (10% probability of being exceeded in 50 years) are expressed as a fraction of the acceleration due to gravity (g). Ground movement accelerations were calculated based on firm rock conditions, soft rock conditions, and alluvium site conditions and are discussed below (CGS, 2003). The probabilistic seismic hazards shown for each reach are from one given location within each reach to provide an example of seismic hazards within the MBSST Network area. The approximate locations of each measurement are noted in the table next to the reach.

Table 4.6-1
Sample Probabilistic Seismic Hazards for the MBSST Network

Ground Motion	Firm Rock (g)[1]	Soft Rock (g)	Alluvium (g)
Northern Reach – Near Davenport			
Pga[2]	0.426	0.426	0.458
Sa 0.2 sec[3]	0.997	0.998	1.097
Sa 1.0 sec[4]	0.422	0.513	0.6
Central Reach – City of Santa Cruz			
Pga	0.472	0.472	0.485
Sa 0.2 sec	1.074	1.074	1.15
Sa 1.0 sec	0.477	0.571	0.648
Watsonville Reach – City of Watsonville			
Pga	0.598	0.598	0.598
Sa 0.2 sec	1.331	1.331	1.331
Sa 1.0 sec	0.58	0.656	0.757

Notes:
1. (g) Ground motion is expressed as a fraction of acceleration due to gravity.
2. Pga – Peak ground acceleration.
3. Spectral acceleration at 0.2 second time period.
4. Spectral acceleration at 1.0 second time period.
NEHRP Soil Corrections were used to calculate Soft rock and Alluvium.
Ground Motion values are interpolated from a grid (0.05 degree spacing) of calculated values.
Source: CGS, 2003.

The relationship between the peak ground acceleration and the Modified Mercalli Intensity (MMI), is shown in Table 4.6-2. The MMI is composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction. The MMI does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects. The definition of each scale of the MMI in terms of perceived shaking and potential damage are also shown in Table 4.6-2.

Table 4.6-2
Relationship between Peak Ground Acceleration and Modified Mercalli Intensity

MMI	Peak Ground Acceleration (g)	Perceived Shaking	Potential Damage
I	<0.0017	Not felt	None
II-III	0.0017 – 0.014	Weak	None
IV	0.014 – 0.039	Light	None
V	0.039 – 0.092	Moderate	Very light
VI	0.092 – 0.18	Strong	Light
VII	0.18 – 0.34	Very Strong	Moderate
VIII	0.34 – 0.65	Severe	Moderate to heavy
IX	0.65 – 1.24	Violent	Heavy
X+	>1.24	Extreme	Very heavy

Source: USGS, ShakeMap Scientific Background, 1999.

According to Table 4.6-2, peak ground acceleration for the sample locations along the MBSST Network would result in severe shaking and moderate to heavy damage. It should be noted that both lower and higher peak ground accelerations could be experienced in different areas of the trail, based on proximity to active faults.

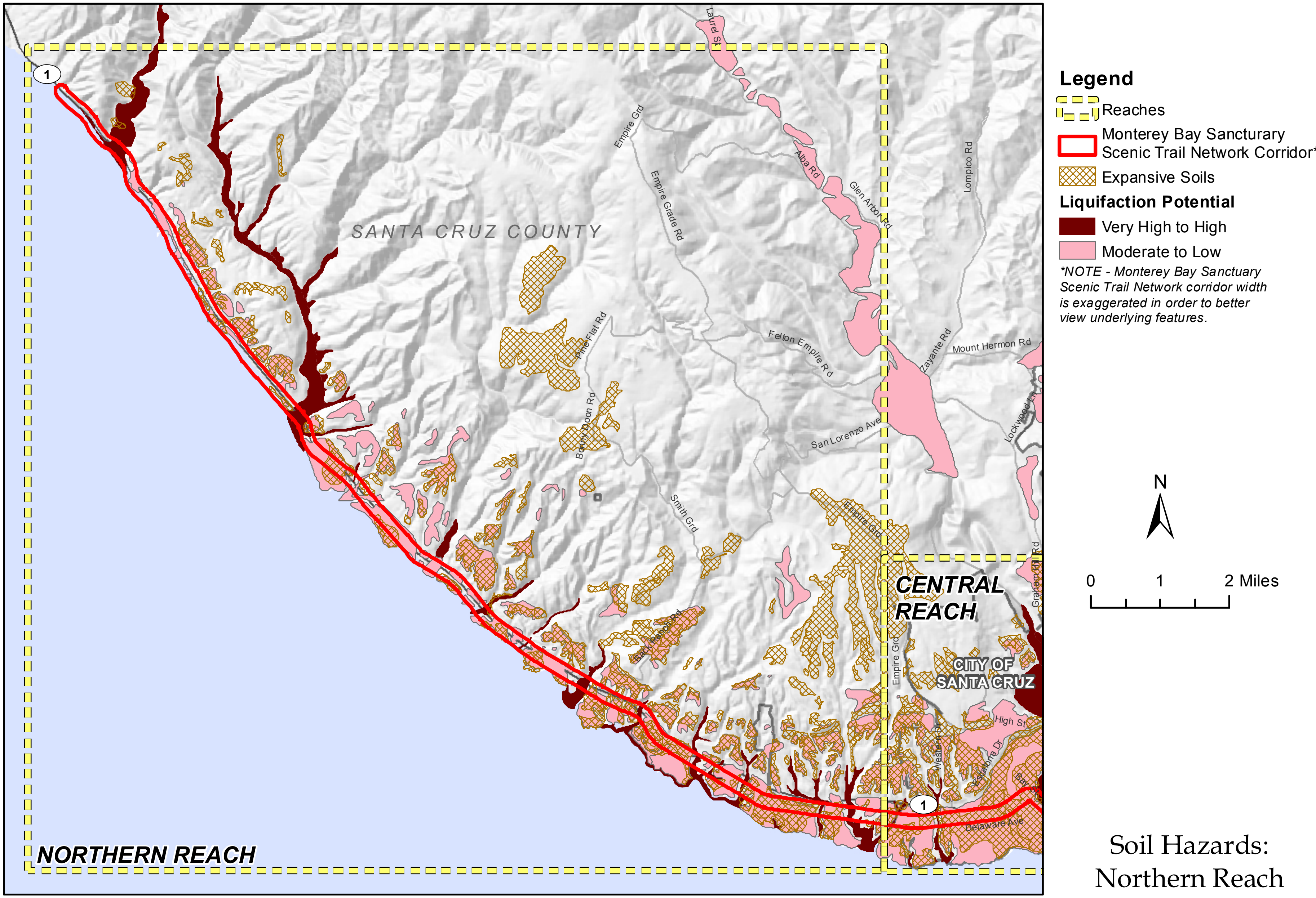
Liquefaction. Liquefaction is a temporary, but substantial, loss of shear strength in granular solids, such as sand, silt, and gravel, usually occurring during or after a major earthquake. This occurs when the shock waves from an earthquake of sufficient magnitude and duration compact and decrease the volume of the soil. If drainage cannot occur, this reduction in soil volume will increase the pressure exerted on the water contained in the soil, forcing it upward to the ground surface. This process can transform stable granular material into a fluid-like state. The potential for liquefaction to occur is greatest in areas with loose, granular, low-density soil, where the water table is within the upper 40 to 50 feet of the ground surface. Liquefaction can result in slope and/or foundation failure. According to the Santa Cruz County Liquefaction Hazard Areas map (2009) and shown in Figures 4.6-2a through 4.6-2c, most of the MBSST Network would be located in areas of low liquefaction potential. However, there are areas interspersed throughout the length of the trail that would be located in high liquefaction hazard areas, primarily within the City of Santa Cruz, the Pajaro Dunes area, and the City of Watsonville portions of the trail.

Subsidence and Settlement. Subsidence is the withdrawal of fluid (oil, natural gas, or water) from compressible sediments. As water is withdrawn and the water table lowered, the effective pressure in the drained sediments is increased. Compressible layers then compact under the over-pressure burden that is no longer compensated by hydrostatic pressure. The resulting land subsidence is most pronounced in uncompacted sediments.

Settlement is the downward movement of the land surface resulting from the compression of void space in underlying soils. Seismically induced settlement occurs in loose to medium dense unconsolidated soil. Loose to medium dense unconsolidated soil can compress (settle) when subject to seismic shaking. The settlement is exacerbated by increased loading, such as from the construction of structures on-site. This settlement can be mitigated prior to development through the removal and recompaction of loose soils. Generally, the same areas that are subject to seismic liquefaction are also subject to settlement because these soils tend to be loose. Thus, the areas shown in Figures 4.6-2a through 4.6-2c as having high liquefaction potential would also be expected to be subject to settlement.

Expansive Soils. Expansive soils are soils that are generally clayey, swell when wetted and shrink when dried. Wetting can occur in a number of ways (i.e., absorption from the air, rainfall, groundwater fluctuations, lawn watering, broken water or sewer lines, etc.). According to the Santa Cruz County Expansive Soils map (2009) and shown in Figures 4.6-2a through 4.6-2c, expansive soils are located at interspersed locations throughout the length of the proposed MBSST Network. Large areas of expansive soils can be found within the City of Santa Cruz, the Live Oak area, the City of Capitola, the Pajaro Dunes area, and the City of Watsonville.

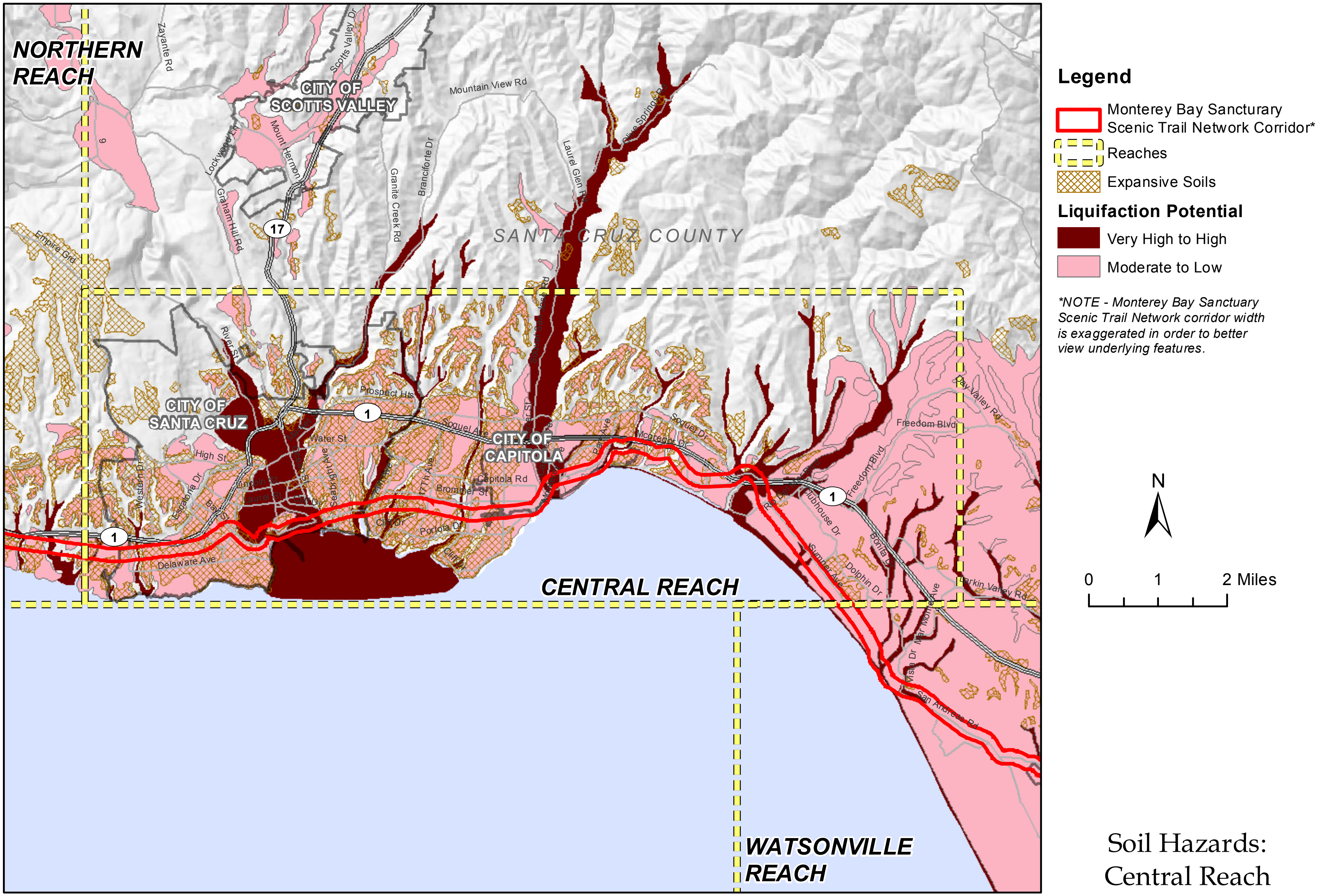
Erosion. Soil erosion is the removal of soil by water and wind. The rate of erosion is estimated from four soil properties: texture, organic matter content, soil structure, and permeability data. Other factors that influence erosion potential include the amount of rainfall and wind, the length and steepness of the slope, and the amount and type of vegetative cover.



Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Soil Hazards: Northern Reach

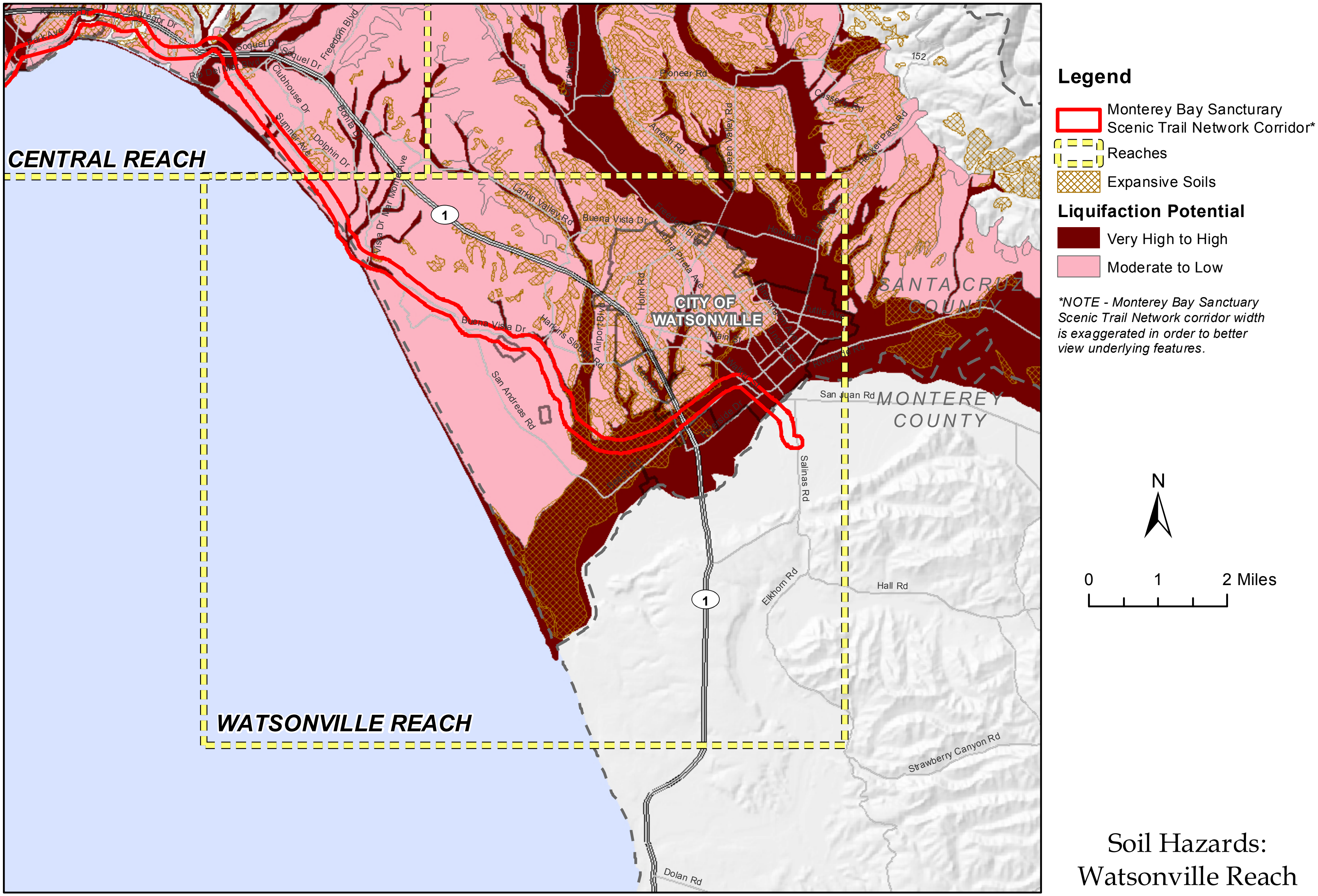
Figure 4.6-2a



Soil Hazards: Central Reach

Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Figure 4.6-2b



Soil Hazards: Watsonville Reach

Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Coastal erosion occurs along the coastline throughout the County. The segments of the trail that could be subject to coastal erosion are those that include the beach areas or are immediately adjacent to the beaches, such as near the Waddell Bluffs and Manresa State Beach (County of Santa Cruz, 2009). Figures 4.6-3a through 4.6-3c depict soils along each of the three reaches and their erosion potential, as well as the areas along the MBSST Network that are subject to coastal erosion.

Table 4.6-3 shows the soils present within the MBSST Network ROW and the erosion hazard potential. The erosion hazard potential is based on the NRCS rating for the hazard of erosion on roads and trails.

Table 4.6-3
Erosion Hazard Potential by Soil Unit

Map Unit	Soil Name	Slope	Percent of ROW	Erosion Hazard Potential*
100	Aptos Loam, warm	15-30%	<1%	Severe
103	Aquents, flooded	N/A	1%	Slight
104	Baywood loamy sand	0-2%	1%	Slight
106	Baywood loamy sand	15-30%	<1%	Severe
105	Baywood loamy sand	2-15%	2%	Severe
107	Baywood loamy sand	30-50%	12%	Severe
109	Beaches	N/A	2.7%	Very Severe
117	Bonnydoon loam	30-50%	4.8%	Severe
116	Bonnydoon loam	5-30%	<1%	Severe
118	Bonnydoon rock-outcrop complex	50-80%	5.2%	Severe
119	Clear Lake clay, moderately wet	N/A	8.2%	Slight
122	Conejo clay loam	0-2%	1.3%	Slight
120	Conejo loam	0-2%	1.9%	Slight
124	Danville loam	0-2%	<1%	Slight
125	Danville loam	2-9%	<1%	Moderate
129	Elder sandy loam	0-2%	1.5%	Slight
130	Elder sandy loam	2-9%	2.9%	Moderate
131	Elder sandy loam	9-15%	<1%	Severe
132	Elkhorn sandy loam	0-2%	<1%	Slight
135	Elkhorn sandy loam	15-30%	3.1%	Severe
133	Elkhorn sandy loam	2-9%	3.1%	Moderate
134	Elkhorn sandy loam	9-15%	13.7%	Moderate
136	Elkhorn-Pfeiffer complex	30-50%	2.5%	Severe
139	Fluvaquentic haploxerolls-aquic xerofluvents complex	0-15%	1.2%	Moderate
143	Lompico-Felton complex	30-50%	<1%	Severe
144	Lompico-Felton complex	50-75%	<1%	Severe
155	Mocho silt-loam	0 to 2 %	1.5%	Slight
160	Pfeiffer gravelly sandy loam	30-50%	<1%	Severe
161	Pinto loam	0-2%	<1%	Slight
162	Pinto loam	2-9%	<1%	Moderate
164	Pits-dumps complex		<1%	Not rated
167	Santa Lucia shaly clay loam	5-30%	<1%	Severe
169	Santa Lucia shaly clay loam	50-75%	<1%	Severe
170	Soquel loam	0-2%	<1%	Slight
171	Soquel loam	2-9%	<1%	Moderate
172	Soquel loam	9-15%	<1%	Moderate
174	Tierra-Watsonville complex	15-30%	1.6%	Severe
175	Tierra-Watsonville complex	30-50%	<1%	Severe
176	Watsonville loam	0-2%	1.7%	Slight

Table 4.6-3
Erosion Hazard Potential by Soil Unit

Map Unit	Soil Name	Slope	Percent of ROW	Erosion Hazard Potential*
177	Watsonville loam	2-15%	2.7%	Severe
178	Watsonville loam, thick surface	0-2%	11.3%	Slight
179	Watsonville loam, thick surface	2-15%	4.7%	Severe

Source: USDA, NRCS, Soil Data Mart, July 2010.

Landslides. "Landslide" is a general term for the dislodging and falling of rock and soil down a sloped surface. "Mudslide" is a general term used for a flow of very wet rock or soil. Landslides can occur from natural conditions such as heavy rainfall, hillside water table fluctuation, and seismic activity. According to the Santa Cruz County Flood and Landslide maps (2009), there are landslide hazards interspersed along portions of Highway 1 in the northern reach, the Wilder Ranch State Park area of the central reach, and several areas in the vicinity of the Watsonville reach. Figures 4.6-4a through 4.6-4c show areas along the trail with slopes greater than 30 percent, which may be subject to greater landslide potential.

d. Regulatory Setting.

Federal.

American Association of State Highway and Transportation Officials (AASHTO). AASHTO provides design guidelines and standards for the construction of bicycle and pedestrian pathways, including bridges.

State.

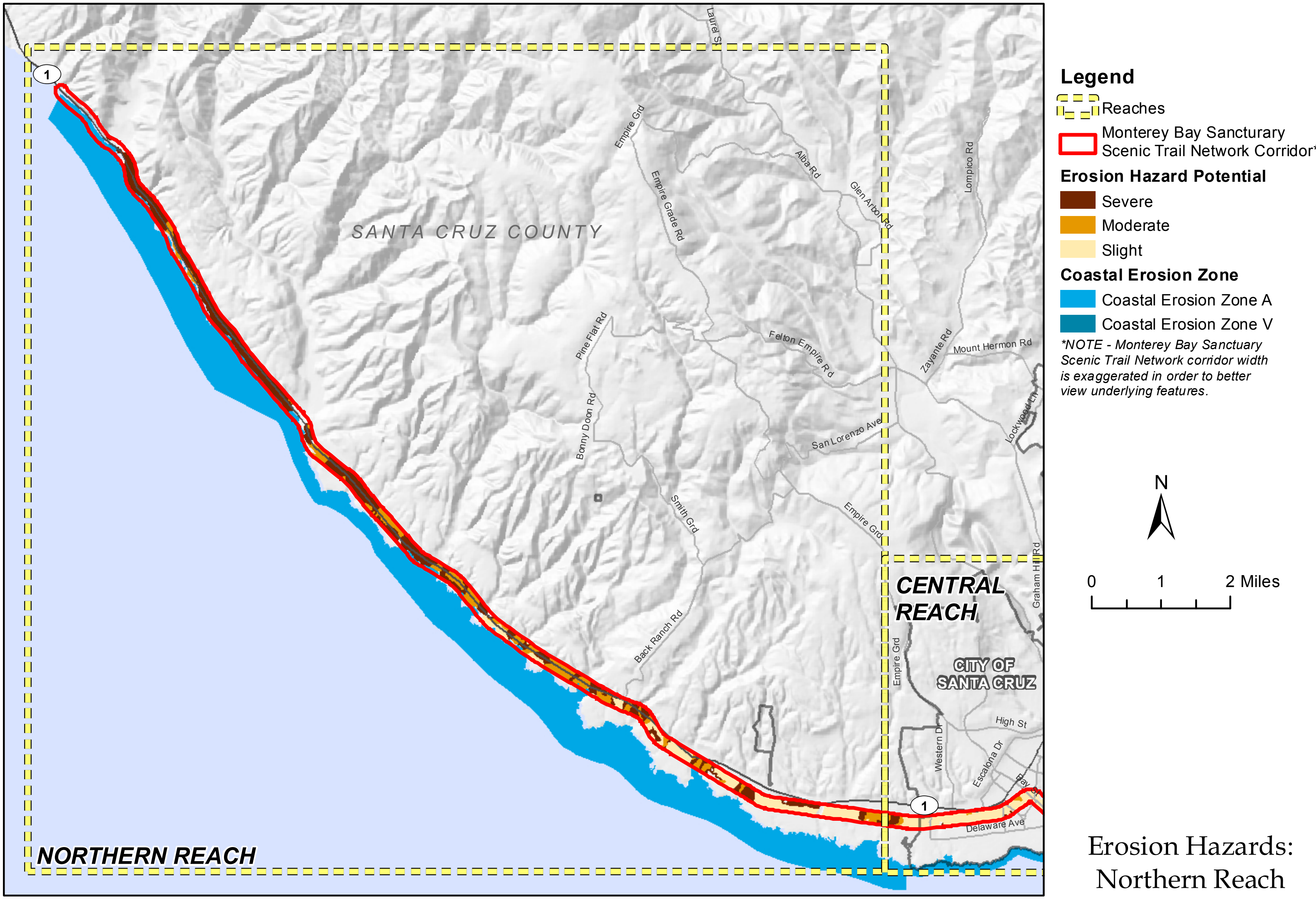
California Building Code (CBC). The California Building Code provides standards for building construction, including design guidelines and specifications to meet earthquake standards.

Caltrans Highway Design Manual. The Caltrans Highway Design Manual provides design guidelines and standards for the construction of bicycle and pedestrian pathways, including bridges.

Alquist-Priolo Earthquake Fault Zoning (AP) Act. The AP Act was passed into law in 1971 following the destructive San Fernando earthquake. The AP Act provides a mechanism for reducing losses from surface fault rupture on a statewide basis. The intent of the AP Act is to ensure public safety by prohibiting the siting of most structures for human occupancy across traces of active faults that constitute a potential hazard to structures from surface faulting or fault creep.

Santa Cruz County.

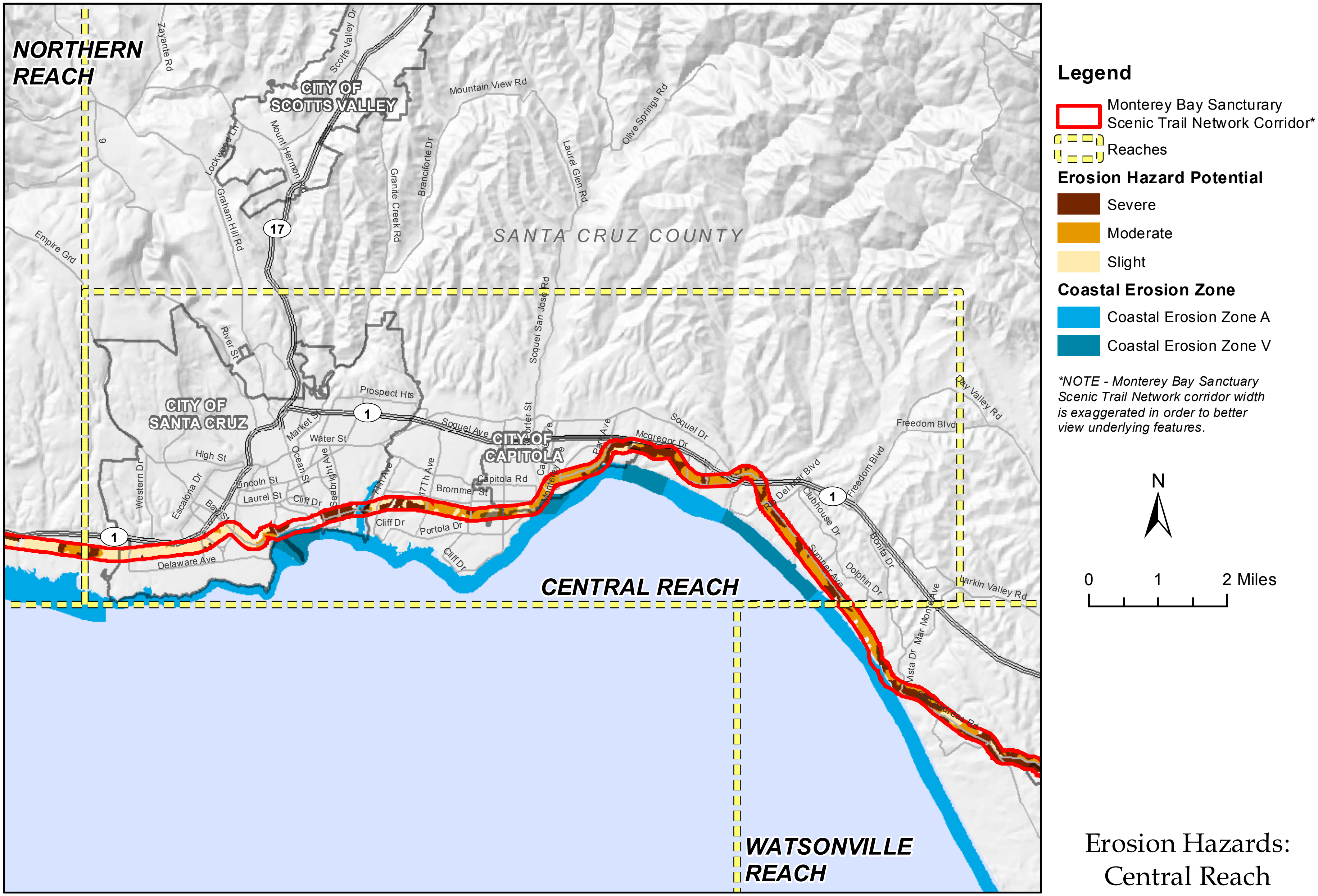
Santa Cruz County General Plan. The Santa Cruz County General Plan includes the following objectives and policies to minimize risks resulting from geologic and soil hazards:



Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Erosion Hazards: Northern Reach

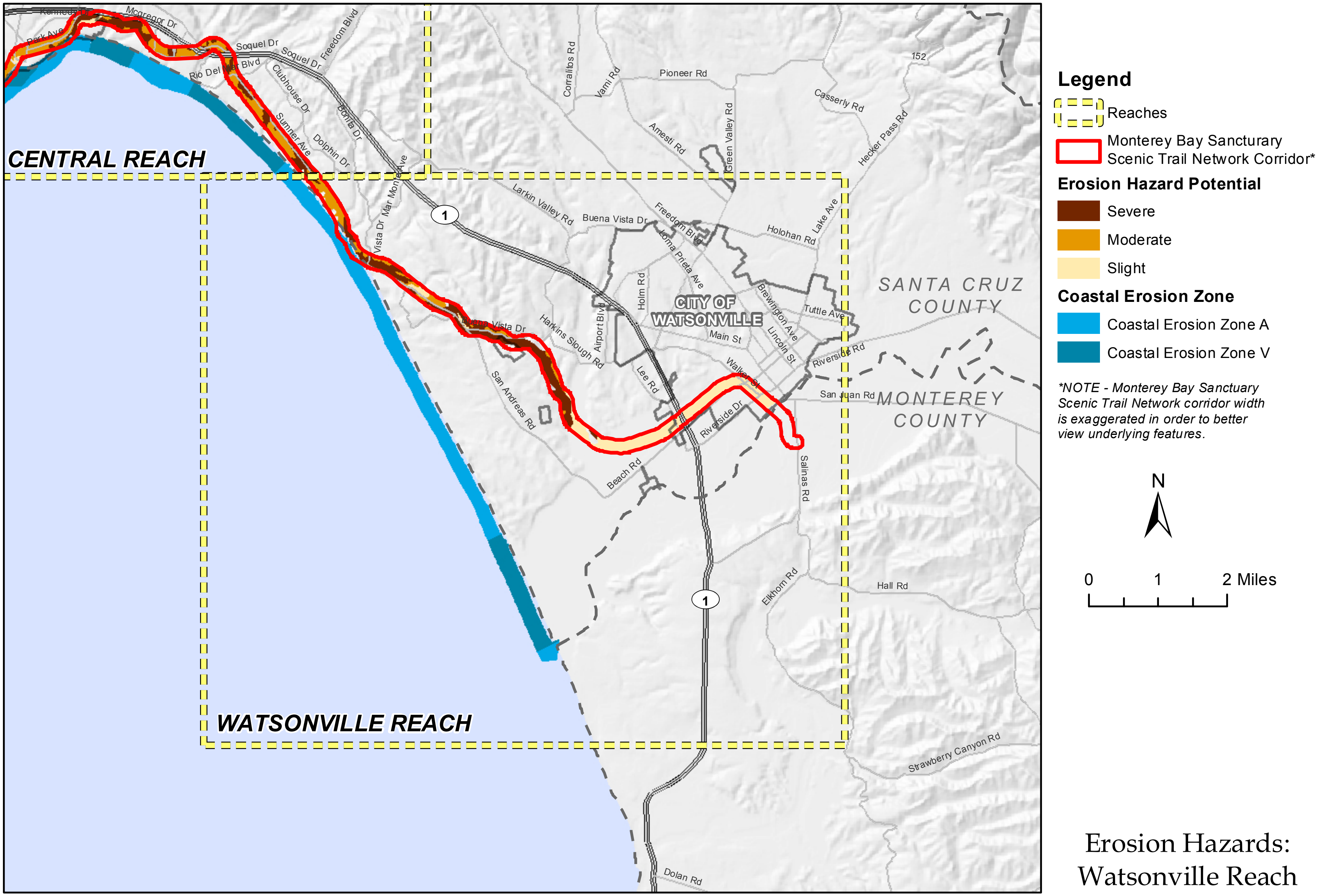
Figure 4.6-3a



Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Erosion Hazards: Central Reach

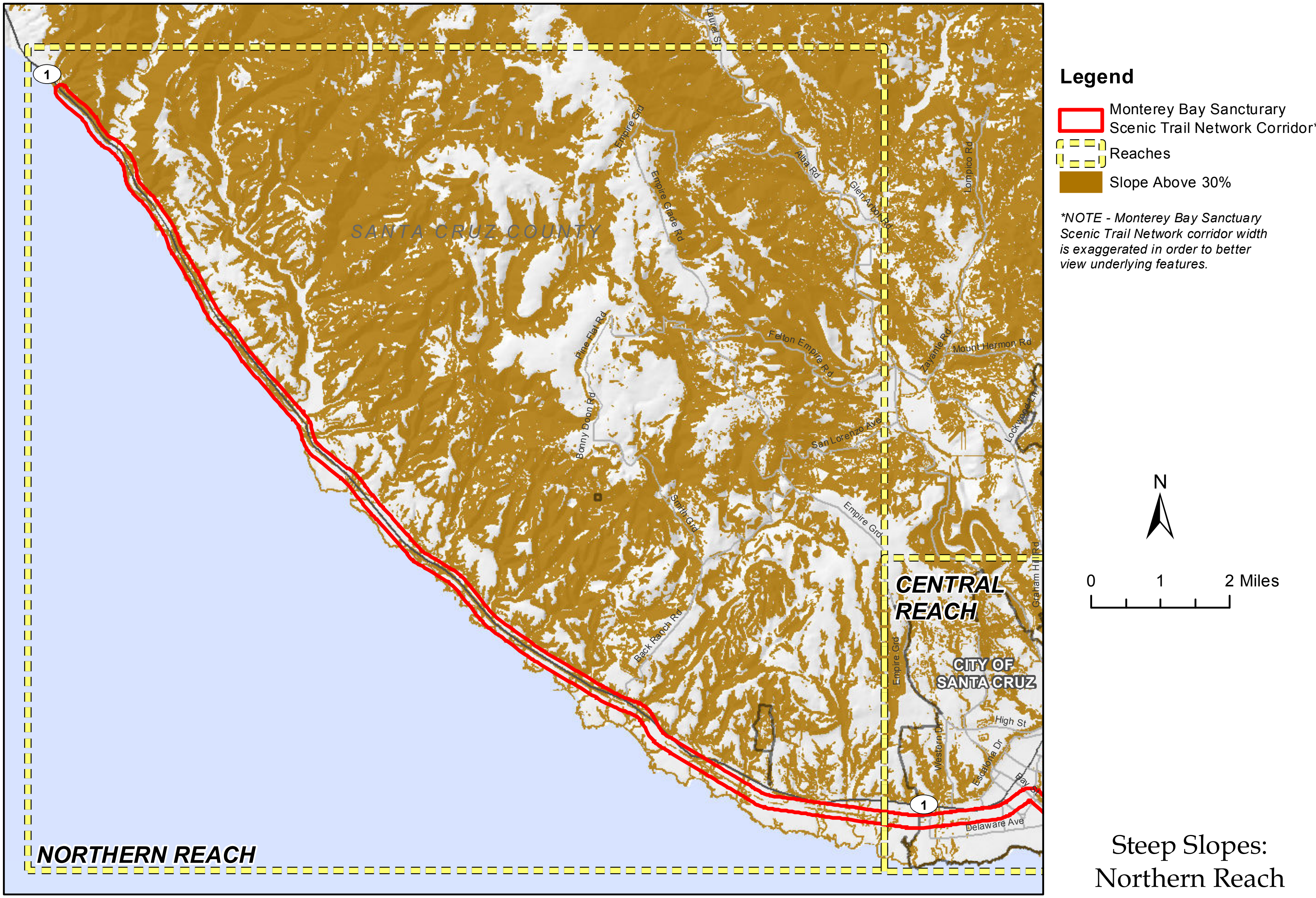
Figure 4.6-3b



Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Erosion Hazards: Watsonville Reach

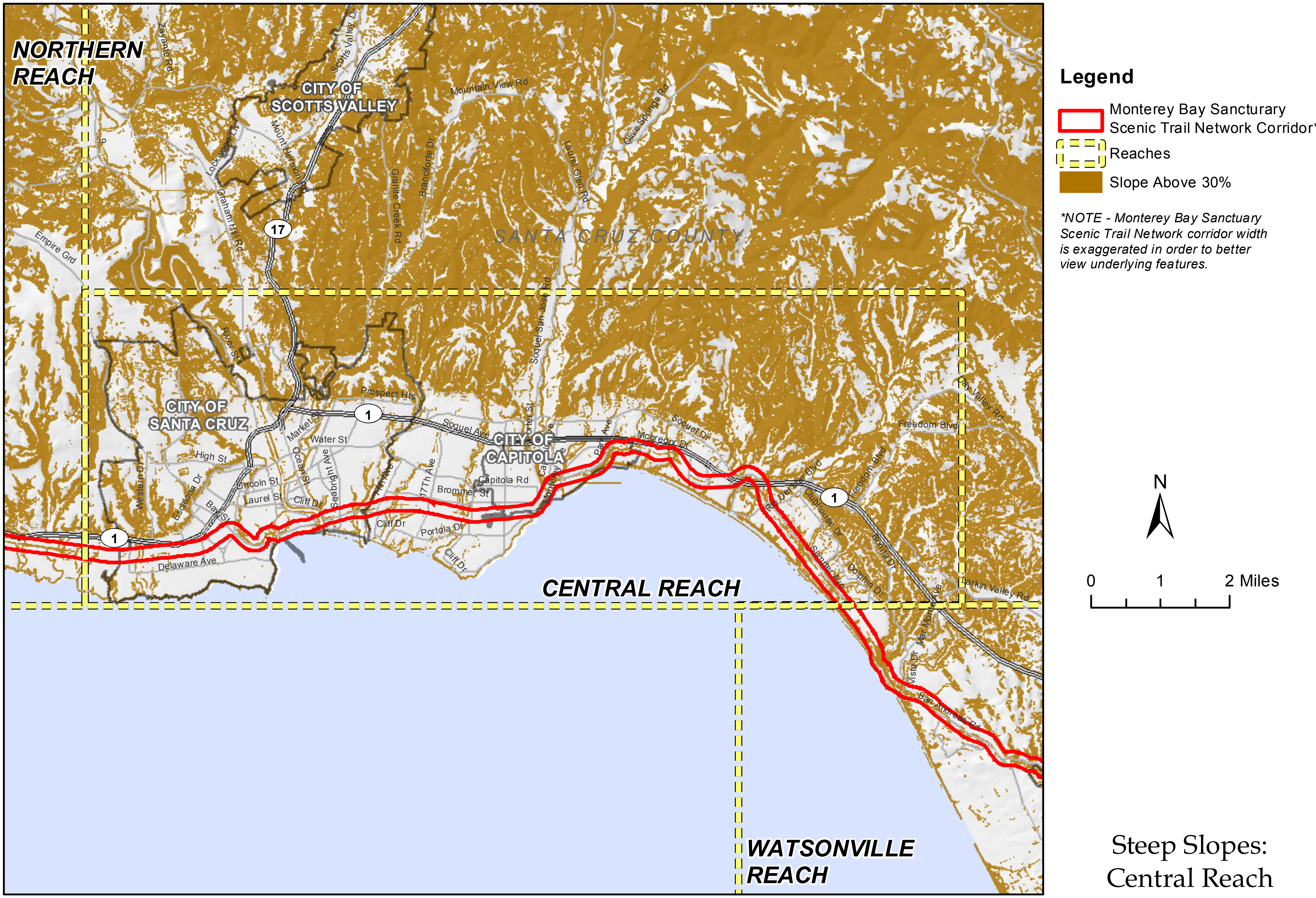
Figure 4.6-3c



Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Steep Slopes:
Northern Reach

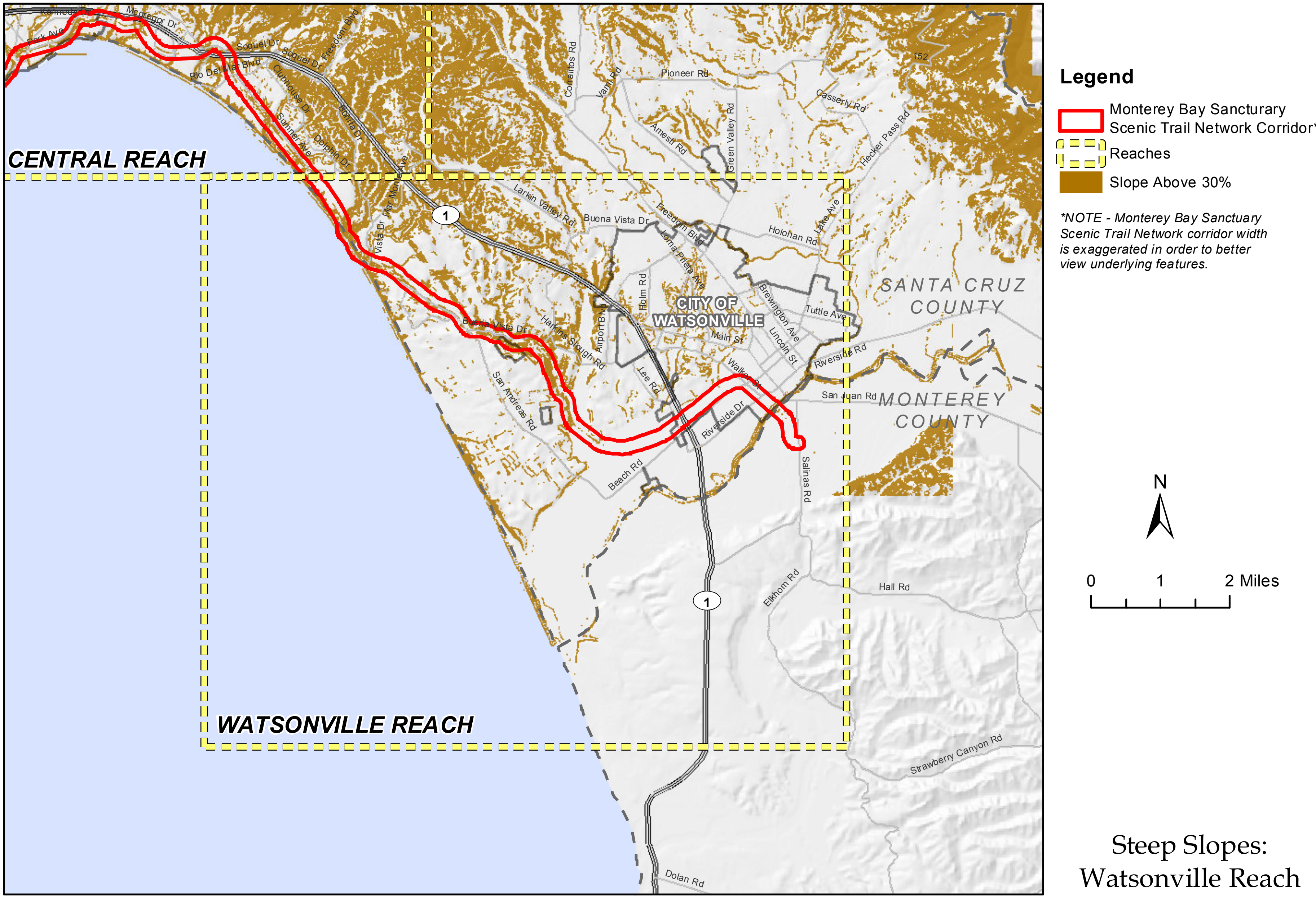
Figure 4.6-4a



Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Steep Slopes: Central Reach

Figure 4.6-4b



Base map source: RRM Design Group, 2012. Additional data provided by the County of Santa Cruz 2012.

Steep Slopes:
Watsonville Reach

Figure 4.6-4c

Policy 5.7.3 — *Erosion Control for Stream and Lagoon Protection. For all new and existing development and land disturbances, require the installation and maintenance of sediment basins, and/or other strict erosion control measures, as needed to prevent siltation of streams and coastal lagoons.*

Objective 6.1 — *Seismic Hazards. To reduce the potential for loss of life, injury, and property damage resulting from earthquakes by: regulating the siting and design of development in seismic hazard areas; encouraging open space, agricultural or low density land use in the fault zones; and increasing public information and awareness of seismic hazards.*

Policy 6.1.1 — *Geologic Review for Development in Designated Fault Zones. Require a review of geologic hazards for all discretionary development projects, including the creation of new lots, in designated fault zones. Fault zones designated for review include the Butano, Sargent, Zayante, and Corralitos complexes, as well as the State designated Seismic Review Zones. Required geologic review shall examine all potential seismic hazards, and may consist of a Geologic Hazards Assessment and a more complete investigation where required. Such assessment shall be prepared by County staff under supervision of the County Geologist, or a certified engineering geologist may conduct this review at the applicant's choice and expense.*

Policy 6.1.2 — *Geologic Reports for Development in Alquist-Priolo Zones. Require a preliminary geologic report or full engineering geology report for development on parcels within Alquist-Priolo State-designated seismic review zones.*

Policy 6.1.3 — *Engineering Geology Report for Public Facilities in Fault Zones. Require a full engineering geology report by a certified engineering geologist whenever a significant potential hazard is identified by a Geologic Hazards Assessment or Preliminary Geologic Report, and prior to the approval of any new public facility or critical structure within the designated fault zones.*

Policy 6.1.4 — *Site Investigation Regarding Liquefaction Hazard. Require site-specific investigation by a certified engineering geologist and/or civil engineer of all development proposals of more than four residential units in areas designated as having a high or very high liquefaction potential. Proposals of four units and under and non-residential projects shall be reviewed for liquefaction hazard through environmental review and/or geologic hazards assessment, and when a significant potential hazard exists a site-specific investigation shall be required.*

Policy 6.1.5 — *Location of New Development Away from Potentially Hazardous Areas. Require the location and/or clustering of development away from potentially hazardous areas where feasible and condition development permits based on the recommendations of the site's Hazard Assessment or other technical reports.*

Policy 6.1.8 — *Design Standards for new Public Facilities. Require all new public facilities and critical structures to be designed to withstand the expected ground shaking during the design earthquake on the San Andreas Fault.*

Policy 6.1.11	*Setbacks from Faults. Exclude from density calculations for land divisions, land within 50 feet of the edge of the area or fault induced offset and distortion of an active or potentially active fault trace. In addition, all new habitable structures on existing lots of record shall be set back a minimum of fifty (50) feet from the edge of the area of fault induced offset and distortion of an active or potentially active fault trace. This setback may be reduced to a minimum of twenty-five (25) feet based upon paleoseismic studies that include observation trenches. Reduction of the setback may only occur when both the consulting engineering geologist preparing the study and the County Geologist observe the trench and concur that the reduction is appropriate. Critical structures and facilities shall be set back a minimum of one hundred (100) feet from the edge of the area of fault induced offset and distortion of an active or potentially active fault traces. (Revised by Res. 81-99)*
Objective 6.2	*Slope Stability. To reduce safety hazards and property damage caused by landslides and other ground movements affecting land use activities in areas of unstable geologic formations, potentially unstable slopes and coastal bluff retreat.*
Policy 6.2.1	*Geologic Hazards Assessments for Development On and Near Slopes. Require a geologic hazards assessment of all development, including grading permits, that is potentially affected by slope instability, regardless of the slope gradient on which the development takes place. Such assessment shall be prepared by County staff under supervision of the County Geologist, or a certified engineering geologist may conduct this review at the applicant's choice and expense.*
Policy 6.2.2	*Engineering Geology Report. Require an engineering geology report by a certified engineering geologist and/or a soils engineering report when the hazards assessment identifies potentially unsafe geologic conditions in an area of proposed development.*
Policy 6.2.3	*Conditions for Development and Grading Permits. Condition development and grading permits based on the recommendations of the Hazard assessment and other technical reports.*
Policy 6.2.4	*Mitigation of Geologic Hazards and Density Considerations. Deny the location of a proposed development or permit for a grading project if it is found that geologic hazards cannot be mitigated to within acceptable risk levels; and approve development proposals only if the project's density reflects consideration of the degree of hazard on the site, as determined by technical information.*
Policy 6.2.10	*Site Development to Minimize Hazards. Require all developments to be sited and designed to avoid or minimize hazards as determined by the geologic hazards assessment or geologic and engineering investigations. (Revised by Res. 81-99)*

Policy 6.2.11 *Geologic Hazards Assessment in Coastal Hazard Areas. Require a geologic hazards assessment or full geologic report for all development activities within coastal hazard areas, including all development activity within 100-feet of a coastal bluff. Other technical reports may be required if significant potential hazards are identified by the hazards assessment. (Revised by Res. 81-99)*

Policy 6.2.12 *Setbacks from Coastal Bluffs. All development activities, including those which are cantilevered, and non habitable structures for which a building permit is required, shall be set back a minimum of 25 feet from the top edge of the bluff. A setback greater than 25 feet may be required based on conditions on and adjoining the site. The setback shall be sufficient to provide a stable building site over the 100-year lifetime of the structure, as determined through geologic and/or soil engineering reports. The determination of the minimum 100 year setback shall be based on the existing site conditions and shall not take into consideration the effect of any proposed shoreline or coastal bluff protection measures. (Revised by Res. 81-99)*

Objective 6.3 *Erosion. To control erosion and siltation originating from existing conditions, current land-use activities, and from new developments, to reduce damage to soil, water, and biotic resources.*

Policy 6.3.1 *Slope Restrictions. Prohibit structures in discretionary projects on slopes in excess of 30 percent. A single family dwelling on an existing lot of record may be excepted from the prohibition where siting on greater slopes would result in less land disturbance, or siting on lesser slopes is infeasible.*

Policy 6.3.2 *Grading Projects to Address Mitigation Measures. Deny any grading project where a potential danger to soil or water resources has been identified and adequate mitigation measures cannot be undertaken.*

Policy 6.3.3 *Abatement of Grading and Drainage Problems. Require, as a condition of development approval, abatement of any grading or drainage condition on the property which gives rise to existing or potential erosion problems.*

Policy 6.3.4 *Erosion Control Plan Approval Required for Development. Require approval of an erosion control plan for all development, as specified in the Erosion Control ordinance. Vegetation removal shall be minimized and limited to that amount indicated on the approved development plans, but shall be consistent with fire safety requirements.*

Policy 6.3.5 *Installation of Erosion Control Measures. Require the installation of erosion control measures consistent with the Erosion Control ordinance, by October 15, or the advent of significant rain, or project completion, whichever occurs first. Prior to October 15, require adequate erosion control to be provided to prevent erosion from early storms. For development activities, require protection of exposed soil from erosion between October 15 and April 15 and require vegetation and stabilization of disturbed areas prior to completion of the project. For agricultural activities, require that adequate measures are taken to prevent excessive sediment from leaving the property.*

<u>Policy 6.3.6</u> *Earthmoving in Least Disturbed or Water Supply Watersheds. Prohibit earthmoving operations in areas of very high or high erosion hazard potential and in Least-Disturbed or Water-Supply Watersheds between October 15 and April 15, unless preauthorized by the Planning Director. If such activities take place, measures to control erosion must be in place at the end of each day's work.*

<u>Policy 6.3.8</u> *On-Site Sediment Containment. Require containment of all sediment on the site during construction and require drainage improvements for the completed development that will provide runoff control, including onsite retention or detention where downstream drainage facilities have limited capacity. Runoff control systems or Best Management Practices shall be adequate to prevent any significant increasing in site runoff over pre-existing volumes and velocities and to maximize on-site collection of non-point source pollutants.*

<u>Policy 6.3.10</u> *Land Clearing Permit. Require a land clearing permit and an erosion control plan for clearing one or more acres, except when clearing is for existing agricultural uses. Require that any erosion control and land clearing activities be consistent with all General Plan and LCP Land Use Plan policies.*

<u>Policy 6.3.11</u> *Sensitive Habitat Consideration for Land Clearing Permits. Require a permit for any land clearing in a sensitive habitat area and for clearing more than one quarter acre in Water Supply Watershed, Least Disturbed Watershed, very high and high erosion hazard areas no matter what the parcel size. Require that any land clearing be consistent with all General Plan and LCP Land Use policies.*

Santa Cruz County Code. Chapter 16.10, Geologic Hazards, of the Santa Cruz County Code provides regulations guiding construction and development in areas with known geologic hazards, such as faulting, liquefaction, and coastal erosion.

<u>City of Santa Cruz</u>.

City of Santa Cruz General Plan 2030. The City of Santa Cruz General Plan 2030 includes the following goals, policies, and actions to minimize geologic hazards:

<u>Goal HZ6</u> *Protection from natural hazards.*

<u>Policy HZ6.1</u> *Reduce erosion hazards.*

<u>Action HZ6.1.1</u> *Minimize hazards posed by coastal cliff retreat.*

<u>Action HZ6.1.2</u> *For development adjacent to cliffs, require setbacks for buildings equal to 50 years of anticipated cliff retreat.*

<u>Policy HZ6.2</u> *Discourage development on unstable slopes.*

Action HZ6.2.1	*Require engineering geology reports when, in the opinion of the City's planning director, excavation and grading have the potential for exposure to slope instability or the potential to create unstable slope or soil conditions.*
Policy HZ6.3	*Reduce the potential for life loss, injury, and property and economic damage from earthquakes, liquefaction, and other seismic hazards.*
Action HZ6.3.1	*Adopt new State-approved California Building Codes (CBC) and require that all new construction conform with the latest edition of the CBC.*
Action HZ6.3.6	*Require site specific geologic investigations by qualified professionals for proposed development in potential liquefaction areas shown on the Liquefaction Hazard Map to assess potential liquefaction hazards, and require developments to incorporate the design and other mitigation measures recommended by the investigations.*

Santa Cruz City Code. The City of Santa Cruz Municipal Code provides regulations regarding geologic study requirements in Chapter 18.45, Excavation and Grading Regulations. Chapter 24.14, Environmental Resource Management, also provides regulations regarding slopes, erosion, and seismic hazards.

City of Capitola.

City of Capitola General Plan. The Capitola General Plan is currently being updated, and a Public Review Draft General Plan is anticipated for June 2013. The current General Plan was adopted in 1989. The Safety chapter of the existing Capitola General Plan contains the following policies related to geologic and seismic issues.

Goal	*Strive to protect the community from injury, loss of life, and property damage resulting from natural catastrophes and other hazardous conditions.*
Policy 11	*New development along the coastal bluffs shall be evaluated for seismic integrity.*
Impl. 11	*1. All development along the coastal bluffs and beach areas must demonstrate the geologic stability of a structure for a 50 year period, must not significantly contribute to the instability of the coastal bluffs or beach areas, and must be consistent with other policies of the Capitola General Plan and the Local Coastal Plan.* *2. Soils Report and seismic evaluation shall be required of all new construction within 200 feet of the edge of the coastal cliff line.*
Policy 13	*It shall be the policy of the City of Capitola to adequately plan for natural hazards in new development, reduce risks to life and property, and revise all plans and the Zoning Ordinance to be in conformance with all the policies of the Coastal Act relating to hazards and shoreline structures.*
Impl. 12	*1. Require geologic/engineering reports in areas of high seismic shaking for structures subject to public use or multi-residential as required by the UBC.*

2. Revise Zoning Ordinance to require geologic reports for all development proposed on coastal bluffs or beaches, including shoreline structures such as seawalls and including provisions of Policy VII-8.

<u>*Policy 15*</u> *A geologic/engineering report which indicated methods of achieving structural stability and mitigation measures to prevent erosion shall be submitted for any structure which is to be constructed on a slope in excess of 30 percent.*

<u>*Impl. 15*</u> *Revise Zoning Ordinance to require geologic/engineering report for structures to be built on slopes in excess of 30 percent.*

Capitola Municipal Code. Title 15 of the City of Capitola Municipal Code includes regulations for excavation and grading, which addresses hazardous conditions, erosion control, and requirements for inspection reports.

<u>City of Watsonville</u>.

City of Watsonville General Plan. An updated City of Watsonville General Plan was adopted by the City Council in January 2013, but was subsequently challenged in court and is on hold until resolution on the legal issues can be reached. Therefore, at this time, the 2005 General Plan remains in effect. The existing 2005 General Plan, adopted in 1994, identifies a policy and implementation measures for related to geologic and seismic issues, which are listed below.

<u>*Goal 13.1*</u> *Land Use Safety. Plan for and regulate the uses of land in order to provide a pattern of urban development that will minimize exposure to hazards from either natural or human-related causes.*

<u>*Policy 13.1.2*</u> *Soil Constraints. The City shall take all appropriate actions to ensure that current land use activities and new developments are mitigated to prevent soil failure and other soil-related dangers.*

<u>*Impl. 13.1.21*</u> *Risk Mitigation. The City shall identify and mitigate to an acceptable level of risk new development proposed in areas with geologic, seismic, flood, or other environmental constraints.*

<u>*Impl. 13.1.22*</u> *Soils Investigation. The City shall require a soils investigation report prior to new development on sites deemed to have a high potential for soil erosion, landslide, or other soil-related constraints.*

<u>*Impl. 13.1.24*</u> *Slope. The City shall not permit new development on soils that are subject to landslide. The City shall also strongly discourage development on slopes greater than 25 percent.*

<u>*Goal 13.2*</u> *Seismic and Other Geologic Hazards. Reduce the potential for loss of life, injury, and economic damage resulting from earthquakes and associated geologic hazards such as landslides and liquefaction.*

<u>*Policy 13.2.1*</u> *Seismic Hazards. The City shall use the development review process to ensure that potential geologic hazards are evaluated and mitigated prior to construction.*

<u>Impl. 13.2.11</u> *Geologic Review. The City may require a geo-technical report prepared by a registered professional prior to the issuance of a building permit.*

<u>Impl. 13.2.12</u> *Structural Design. The City shall place structural design conditions on new development to ensure that recommendations of geo-technical evaluation are implemented.*

Watsonville Municipal Code. Chapter 6 of the Watsonville Municipal Code provides design standards for erosion control, including the preparation of soils reports.

<u>Monterey County.</u> Segment 20 of the proposed MBSST Network project, which is 0.74 miles long, would be located in Monterey County. The purpose of this segment is to provide a regional connection to the Monterey County section of the Monterey Bay Sanctuary Scenic Trail. Implementation of this section would require cooperation and coordination with the Transportation Agency for Monterey County (TAMC) and the County of Monterey. Monterey County General Plan goals and policies, as well as Monterey County Municipal Code regulations, would apply to this segment.

4.5.2 Impact Analysis.

a. Methodology and Significance Thresholds. This evaluation is based on review of existing information that has been developed for the proposed MBSST Network Master Plan and other available regional sources, including the California Division of Mines and Geology (CDMG) and the USDA Soil Conservation Service Soil Surveys for Santa Cruz County. In accordance with Appendix G of the *State CEQA Guidelines,* impacts would be considered potentially significant if the proposed MBSST Network would:

1) *Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:*
    a. *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;*
    b. *Strong seismic ground shaking;*
    c. *Seismic-related ground failure, including liquefaction; and/or*
    d. *Landslides.*
2) *Result in substantial soil erosion or the loss of topsoil;*
3) *Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse; and/or*
4) *Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.*

It should be noted that compliance with the existing Santa Cruz County Environmental Health regulations, including required permitting, and the Regional Water Quality Control Board policies and regulations would eliminate impacts related to soils adequately supporting septic tanks, which are proposed in the Watsonville reach. As a result, the checklist item related to this conditions were excluded from the above list and further discussion can be found in the Initial Study (Appendix A of this document).

b. Project Impacts and Mitigation Measures.

Impact GEO-1 **Future seismic activity could result in fault rupture along the San Gregorio Fault, which lies under segments 1 and 2 of the MBSST Network. However, improvements along these segments would be limited to on-road improvements and would not include the construction of any structures. Impacts would be Class III, *less than significant*.**

The portion of the San Gregorio Fault that underlies segments 1 and 2 is an Alquist-Priolo Fault Zone, as shown in Figure 4.6-1. The Alquist-Priolo Earthquake Zoning Act was established to mitigate the hazard of surface rupture to structures for human occupancy. Construction in Alquist-Priolo Fault Zones is regulated by the State Geologist and requires special study for structures planned over active faults. Other than within segments 1 and 2, there are no other Alquist-Priolo fault zones or other known active faults located along the MBSST Network corridor.

Segments 1 and 2 of the trail would not include any structures that would be inhabited by people. Trail components in segments 1 and 2 would only involve improvements to existing on-street facilities along Highway 1, such as roadway striping and shoulder improvements. These segments of the trail also are not anticipated to include any paving or sidewalks. Because there are no structures proposed and this segment of the MBSST Network would only include improvements to existing roadway facilities, there would be no change to risks associated with surface rupture; therefore, impacts would be less than significant.

Mitigation Measures. No mitigation measures are required.

Significance After Mitigation. Impacts would be less than significant without mitigation.

Impact GEO-2 **Seismically induced ground shaking could destroy or damage MBSST Network structures, including bridges and a restroom facility, resulting in loss of property or risk to human health. All structures would be required to comply with California Building Code standards to address risk from seismic ground shaking. This would be a Class III, *less than significant* impact.**

There are several potentially active faults in the region that could generate ground-shaking along the MBSST Network. These faults include the San Andreas Fault, the Zayante – Vergeles Fault, the San Gregorio Fault, and the Monterey Bay – Tularcitos Fault, which are depicted in Figure 4.6-1. Ground shaking produced by earthquakes along these faults could result in potentially significant impacts to structures on the MBSST Network. As shown in Table 4.6-1, earthquakes in the MBSST Network vicinity could produce peak ground accelerations estimated between 0.4g and 1.3g, or possibly greater in some areas. According to Table 4.6-2, the perceived shaking from earthquakes that achieve these peak ground accelerations ranges from severe to extreme, and the potential damage ranges from moderate/heavy to very heavy. Any structures built along the trail, such as restroom facilities or bridges, would be at risk during a strong seismic event in the region.

Although nothing can ensure that structures do not fail under seismic stress, proper engineering can minimize the risk to life and property. As such, building standards have been developed for construction in areas subject to seismic ground shaking. The most recent California Building Code requirements ensure that new structures are engineered to withstand the expected ground acceleration at a given location. In addition, the bicycle and pedestrian bridges would be constructed in compliance with federal and state standards, including the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications, the AASHTO Guide Specifications for the Design of Pedestrian Bridges (which provides standards for bridges which are designed for and intended to carry primarily pedestrians, bicyclists, equestrian riders, and light maintenance vehicles, but not designed and intended to carry typical highway traffic), and the Caltrans LRFD. Each local jurisdiction also has policies and standards in place to regulate construction in areas subject to ground shaking. Compliance with all applicable provisions of federal, state, and local construction and design standards would reduce impacts to less than significant. Furthermore, the MBSST Network would not include any residences or structures that would be occupied by large numbers of people or for extended periods of time. The only structures that would temporarily be occupied by people would be a restroom facility in the Watsonville reach and the bicycle and pedestrian bridges throughout the MBSST Network. The limited number of people that would be in or on a MBSST Network structure at any given time would further reduce potential impacts resulting from seismic ground shaking.

<u>Mitigation Measures</u>. No mitigation measures are required.

<u>Significance After Mitigation.</u> Impacts would be less than significant without mitigation.

Impact GEO-3 **There are several areas within the MBSST Network that are at risk for seismic-related ground failure. Seismic activity could produce ground shaking sufficient to cause liquefaction, subsidence, or settlement in these areas. This is a Class II, *significant but mitigable* impact.**

Northern Reach. Figure 4.6-2a shows liquefaction potential in the northern reach. As shown therein, high liquefaction potential occurs near the various creek outlets, especially near the outlets of Waddell Creek and Scott Creek. There are also low to moderate liquefaction hazards throughout the other areas of the northern reach. Seismic subsidence and settlement also occur in the loose, alluvial soils that are typically associated with liquefaction hazards. Thus, the same areas may be subject to these hazards. The risk to structures, property, and people located in these areas would be potentially significant.

Central Reach. Figure 4.6-2b shows liquefaction potential in the central reach. As shown therein, high liquefaction potential occurs in the areas surrounding the San Lorenzo River and the various creek outlets. There are also low to moderate liquefaction hazards throughout the other areas of the central reach. Seismic subsidence and settlement also occur in the loose, alluvial soils that are typically associated with liquefaction hazards. Thus, the same areas may be subject to these hazards. The risk to structures, property, and people located in these areas would be potentially significant.

Watsonville Reach. Figure 4.6-2c shows liquefaction potential in the Watsonville reach. As shown therein, a large portion of the Watsonville reach is located in an area considered to have high liquefaction potential. This area extends from portion of the trail that in the Pajaro Dunes area to the City of Watsonville. There are also low to moderate liquefaction hazards throughout the remainder of the Watsonville reach. Seismic subsidence and settlement also occur in the loose, alluvial soils that are typically associated with liquefaction hazards. Thus, the same areas may be subject to these hazards. The risk to structures, property, and people located in these areas would be potentially significant.

In areas prone to liquefaction, current structural engineering methods for foundation design may not be sufficient to prevent a building's foundation from failing in a larger earthquake which results in stronger and longer ground shaking. However, as with ground shaking hazards, compliance with standard design and engineering practices in the California Building Code, AASHTO LRFD Bridge Design Specifications, AASHTO Guide Specifications for the Design of Pedestrian Bridges (which provides standards for bridges which are designed for and intended to carry primarily pedestrians, bicyclists, equestrian riders, and light maintenance vehicles, but not designed and intended to carry typical highway traffic), Caltrans LRFD, and Caltrans Highway Design Manual would reduce impacts to structures, bridges, paved multi-use paths, and trail furnishings located in liquefaction hazard zones. Each jurisdiction along the MBSST Network also has policies in place to regulate construction in areas with known soil hazards, such as liquefaction. Policies include preparation of soils report or geotechnical reports and compliance with recommendations contained therein. Furthermore, the only structures that would temporarily be occupied by people would be a restroom facility in the Watsonville reach and the bicycle and pedestrian bridges throughout the MBSST Network. The limited number of people that would be in or on a MBSST Network structure, paved multi-use path, or trail furnishing at any given time would further reduce potential impacts resulting from seismic related ground failure. Nonetheless, mitigation is required to reduce impacts associated with seismic-related ground failure to a less than significant level.

<u>Mitigation Measures.</u> The following mitigation measure is required.

GEO-3 **Geotechnical Study.** Prior to site development of each segment of the MBSST Network, a geotechnical study shall be prepared by a registered civil or geotechnical engineer and reviewed by the RTC and/or implementing entity. This report shall include an analysis of the liquefaction, subsidence, and settlement potential of the underlying materials. If the segment under study is confirmed to be in an area prone to seismically-induced liquefaction, subsidence, or settlement, appropriate techniques to minimize hazards shall be prescribed and implemented. Suitable measures to reduce ground-failure impacts could include, but are not limited to, the following:

- *Specialized design of foundations by a structural engineer*
- *Removal or treatment of liquefiable soils to reduce the potential for liquefaction*
- *In-situ densification of soils*
- *Replacement or recompaction of soils, or*
- *Other alterations to the ground characteristics.*

Significance After Mitigation. Implementation of the above mitigation measure would address anticipated impacts related to seismically-induced liquefaction to the extent of industry standards, and as such, would reduce impacts to a less than significant level.

Impact GEO-4 **Several isolated areas along the MBSST Network project are identified as potential landslide hazard areas. Impacts resulting from landslide hazards would be Class II, *significant but mitigable*.**

The terrain of the MBSST Network varies throughout the trail due to its length and its location near the foothills of the Santa Cruz Mountains. Figures 4.6-4a through 4.6-4c show numerous locations across all three reaches of the MBSST Network that have slopes greater than 30 percent. In addition, the Santa Cruz County Flood and Landslide Hazard Maps (2009) identify several areas along the MBSST Network corridor as having potential for landslides. These areas are discussed below.

Northern Reach. Throughout the northern reach, there are numerous hillsides adjacent to Highway 1 with slopes greater than 30 percent. There are also several small areas adjacent to Highway 1 that have been designated by the County of Santa Cruz as landslide hazard areas (Santa Cruz County Flood and Landslide Hazard Maps, 2009). These areas are located on the hillside of Highway 1 near Greyhound Rock, as well as several areas north of Scott Creek and north of Laguna Creek. MBSST Network facilities located in designated landslide hazard areas or areas with slopes greater than 30 percent could be susceptible to potential landslides, and mitigation would be required to reduce impacts to a less than significant level.

Central Reach. In the central reach, there are only a few small areas with slopes greater than 30 percent. This reach is mostly urbanized and there are fewer slopes. There is one small area in Wilder Ranch State Park that is a designated landslide hazard area (Santa Cruz County Flood and Landslide Hazard Maps, 2009). MBSST Network facilities located in designated landslide hazard areas or areas with slopes greater than 30 percent could be susceptible to potential landslides, and mitigation would be required to reduce impacts to a less than significant level.

Watsonville Reach. There are several areas in the Watsonville reach that have slopes greater than 30 percent. These areas are primarily in the La Selva Beach area and the Buena Vista Drive area. There are also several small areas in the Buena Vista Drive area that are designated as landslide hazard areas (Santa Cruz County Flood and Landslide Hazard Maps, 2009). MBSST Network facilities located in designated landslide hazard areas or areas with slopes greater than 30 percent could be susceptible to potential landslides, and mitigation would be required to reduce impacts to a less than significant level.

Mitigation Measures. The following mitigation measure is required.

GEO-4 **Hillside Stability Evaluation.** If any permanent structures (including structures, bridges, paved multi-use paths, and trail furnishings) within a segment are to be located within possible landslide hazard zones, then an evaluation of the adjacent hillside shall be performed by a registered engineering geologist or a registered professional civil or geotechnical engineer prior to approval of that segment. If a landslide potential is found to exist, then setbacks or retaining walls, where approved by a registered engineering geologist or registered professional civil or geotechnical engineer, shall be imposed. The setback distance or design of the retaining walls shall be determined by the results of the landslide evaluation study.

Significance After Mitigation. With implementation of the above mitigation, the potential impacts from landslide risks would be reduced to a less than significant level.

Impact GEO-5 **Several areas of the MBSST Network project could be subject to erosion hazards. Coastal erosion hazards are present in the areas of the MBSST Network that are directly adjacent to the coast. In addition, soils are present throughout the MBSST Network that have moderate to severe erosion hazard potential. However, design guidelines in the proposed MBSST Network Master Plan would ensure that impacts would be Class III, *less than significant*.**

Areas of coastal erosion are identified on the Santa Cruz County Coastal Erosion Map (2009). In addition, as indicated in Table 4.6-3, there are several soils within the MBSST Network that are considered to have moderate to severe erosion potential. Specific areas of erosion within each reach are discussed below.

Northern Reach. Figure 4.6-3a shows erosion hazards in the northern reach. As shown therein, coastal erosion hazards exist throughout segments 1, 2, and 3. There are also a few areas with coastal erosion hazards between Davenport and Wilder Ranch (segment 5). In addition, as shown in Figure 4.6-3a, soils with the potential for severe (non-coastal) erosion exist throughout most of the northern reach, especially in the northernmost segments. Soils with moderate erosion potential are prevalent in the southern portion of the northern reach.

Structural improvements along the northern portion of the northern reach (segments 1 and 2), where coastal erosion hazards are prevalent, would be limited, as the trail would consist of a Class III on-street/road shoulder bike route, much of which is currently in place. Erosion hazards along these segments would therefore be limited. However, beginning in segment 3, the proposed MBSST Network would include a new multi-use paved path adjacent to Highway 1. This path would be an approximately twelve foot wide paved surface with center lane striping in some areas. Structural improvements may include: various types of trail fencing; trail furnishings such as benches and seating areas, trash receptacles, bike racks, and picnic and shade shelters; landscaping; night lighting (in some areas); and signage. In addition, parking lot improvements to an existing dirt lot near the Davenport Overlook would be implemented along sub-segment 5.1. These facilities would be constructed in areas with a moderate to severe erosion hazard potential. Construction and operation of the proposed MBSST Network project in these areas could result in substantial soil erosion or loss of topsoil if adequate erosion control methods are not implemented.

Central Reach. Figure 4.6-3b shows erosion hazards in the central reach. As shown therein, few areas of the proposed MBSST Network project fall in the coastal erosion hazard zone through the central reach, with the exception of one small area near Arana Gulch in the City of Santa Cruz and one small area near Soquel Creek in the City of Capitola. However, soils with severe (non-coastal) erosion potential in the central reach exist east and west of Arana Gulch, as well as in the New Brighton State Beach area. Soils with moderate erosion potential are predominant throughout the eastern half of the central reach, including segments 10 through 12.

Improvements through the central reach would include a multi-use paved path with fencing, new pre-engineered and/or retrofitted bridges, railway and roadway crossings, trail furnishings, landscaping, and signage. These facilities would be constructed in areas with a moderate to severe erosion hazard potential, and some improvements would be implemented in areas within the coastal erosion hazard zone. Construction and operation of the proposed MBSST Network project in these areas could result in substantial soil erosion or loss of topsoil if adequate erosion control methods are not implemented.

Watsonville Reach. Figure 4.6-3c shows erosion hazards in the Watsonville reach. As shown therein, there is only one small area in the Watsonville reach near La Selva Beach that falls within the coastal erosion hazard zone. The MBSST Network turns inland after La Selva Beach, and coastal erosion hazards are no longer a concern. However, as shown in Figure 4.6-3c, there are two portions of the Watsonville reach that have soils with severe erosion potential, including the La Selva Beach area in segment 16 and the Buena Vista Drive area in segment 17. The southernmost portion of the trail, including segments 18 through 20, consists of soils with low erosion potential.

Improvements through the northern portion of the Watsonville reach would include a multi-use paved path with fencing, trail furnishings, landscaping, and signage. Within the City of Watsonville, improvements would be limited to on-street pedestrian and bicycle improvements. These facilities would be constructed in areas with a moderate to severe erosion hazard potential, and some improvements would be implemented in areas within the coastal erosion hazard zone. Construction and operation of the proposed MBSST Network project in these areas could result in substantial soil erosion or loss of topsoil if adequate erosion control methods are not implemented.

Mitigating Design Features. Chapter 5 of the proposed MBSST Network Master Plan identifies erosion control methods that would be implemented during construction and operation of the MBSST Network project, including engineering to prevent an increase of historic runoff onto other properties, channelization, culverts, improved bridge crossings, and minimization of siltation. The implementation of erosion control strategies would reduce impacts to on- and off-site erosion resulting from construction of the trail. Erosion impacts resulting from operation of the trail would be limited as trail improvements would be designed to prevent erosion and preserve the trail. Paved portions of the trail would prevent erosion impacts by protecting the soil from erosive elements, such as wind and water. Unpaved portions of the trail would be designed to avoid grades greater than two percent when possible and may require some hand tooled segments with drainage crossings.

In addition, each jurisdiction has policies in place designed to eliminate and prevent erosion. Policies include required measures for project design, runoff control, land clearing, and overall responsibility. Compliance with local regulatory policies and the drainage and erosion control methods and trail design standards included in the Master Plan would reduce impacts to a less than significant level.

Mitigation Measures. No mitigation measures are required.

Significance After Mitigation. Impacts would be less than significant without mitigation.

Impact GEO-6 **The proposed MBSST Network project could be subject to structural damage resulting from unstable soils, including soils with high liquefaction, subsidence, and settlement potential. Impacts would be Class II, *significant but mitigable.***

According to Santa Cruz County liquefaction hazard maps, there are several areas along the MBSST Network that have high liquefaction potential, including within the City of Santa Cruz, the Pajaro Dunes area, and the City of Watsonville portions of the trail. Figures 4.6-2a through 4.6-2c show the areas along the MBSST Network project that are subject to such hazards. Subsidence and settlement can also occur in the loose, alluvial soils associated with liquefaction. Thus, the same areas may be subject to these hazards. The same areas that are subject to seismic-related ground failure (as described in Impact GEO-3) would also be subject to non-seismically induced soil instability impacts. Refer to the discussion under Impact GEO-3 for a description of the location of these hazards along each reach.

In areas prone to liquefaction, compliance with standard design and engineering practices in the California Building Code, AASHTO LRFD Bridge Design Specifications, AASHTO Guide Specifications for the Design of Pedestrian Bridges (which provides standards for bridges which are designed for and intended to carry primarily pedestrians, bicyclists, equestrian riders, and light maintenance vehicles, but not designed and intended to carry typical highway traffic), Caltrans LRFD, and Caltrans Highway Design Manual would reduce impacts to structures, bridges, paved multi-use paths, and trail furnishings located in liquefaction hazard zones. Each jurisdiction along the MBSST Network also has policies in place to regulate construction in areas with known soil hazards, such as liquefaction, subsidence, or settlement. Policies include preparation of soils report or geotechnical reports and compliance with recommendations contained therein. Furthermore, the only structures that would temporarily be occupied by people would be a restroom facility in the Watsonville reach and the bicycle and pedestrian bridges throughout the MBSST Network. The limited number of people that would be in or on a MBSST Network structure, paved multi-use path, or trail furnishing at any given time would further reduce potential impacts resulting from soil instability. Nonetheless, mitigation would be required to reduce impacts associated with unstable soils to a less than significant level.

Mitigation Measure. Mitigation measure GEO-3 requires preparation of a geotechnical study prior to development of each segment. If the segment under study is confirmed to be in an area prone to seismically-induced liquefaction, subsidence, or settlement, then appropriate techniques to minimize hazards shall be prescribed and implemented. Refer to Impact GEO-3 for the complete mitigation measure.

Significance After Mitigation. Implementation of mitigation measure GEO-3 would address anticipated impacts related to soil instability to the extent of industry standards, and as such, would reduce impacts to a less than significant level.

Impact GEO-7 **The MBSST Network project is located in areas defined as having potential for the expansion or contraction of soils. This is a Class II, *significant but mitigable* impact.**

The County of Santa Cruz identifies several areas throughout the MBSST Network as having expansive soils. The areas within each reach that are subject to such hazards are discussed below.

Northern Reach. Figure 4.6-2a shows the areas within the MBSST Network that are subject to expansive soils. As shown therein, there are several small areas between Waddell Creek and Scott Creek and in the Davenport area that have expansive soils. The presence of expansive soils becomes more prevalent toward the lower segments of the northern reach. New trail features, such as paved multi-use paths, bridges, fences, or other trail furnishings located in these areas could be damaged as a result of soil expansion or contraction.

Central Reach. Figure 4.6-2b shows the areas within the central reach that are subject to expansive soils. These areas are primarily in the portions of the trail within the City of Santa Cruz, as well as in the City of Capitola. New trail features, such as paved multi-use paths, bridges, fences, or other trail furnishings could be damaged as a result of soil expansion or contraction.

Watsonville Reach. Figure 4.6-2c shows the areas within the Watsonville reach that are subject to expansive soils. Expansive soils in the Watsonville reach are concentrated in the Watsonville Slough area. New trail features, such as paved multi-use paths, restrooms, bridges, fences, or other trail furnishings could be damaged as a result of soil expansion or contraction.

Standard engineering practices in the California Building Code and the Caltrans Highway Design Manual would help reduce impacts to structures and pavement resulting from expansive soils. In addition, mitigation would be required to further reduce impacts resulting from expansive soils.

Mitigation Measures. The following mitigation measure is required.

GEO-7 **Study of Soil Expansion.** The geotechnical study required in mitigation measure GEO-3 shall include an evaluation of the potential for soil expansion of the underlying materials. If the segment under study is identified as being subject to expansive soil hazards, appropriate techniques to minimize hazards shall be prescribed and implemented. Suitable measures to reduce expansive soil hazards could include, but not be limited to: design of foundations by a structural engineer and/or or the replacement of soils beneath the segment.

Significance After Mitigation. With the implementation of the above mitigation measure, impacts related to soil expansion would be reduced to a less than significant level.

c. Cumulative Impacts. Buildout of Santa Cruz County will introduce new buildings and structures that would cumulatively increase the potential for exposure to seismic and soil-related hazards. The proposed MBSST Network and other facilities would incrementally contribute to this cumulative effect. However, seismic and soil-related hazards are site-specific and all new development would be subject to independent environmental review and regulations in place to minimize any potential health risks. Impacts associated with individual developments would be addressed on a case-by-case basis, depending upon the type and severity of geologic and soil hazards present. Assuming that all hazards are adequately addressed for each individual development proposal, no cumulative increase in the exposure to seismic and soil-related hazard would occur and therefore no significant cumulative impacts are anticipated.