4.0 ENVIRONMENTAL IMPACT ANALYSIS

E. GEOLOGY/SOILS

INTRODUCTION

This section analyzes geologic hazards in the Project Area regarding seismicity, volcanic events, carbon monoxide, erosion/loss of topsoil, and soil stability. In addition, this section analyzes the potential for soil hazards related to alternative wastewater disposal systems. Information in this section is based on geologic information contained in the Town of Mammoth Lakes General Plan Program EIR.

1. ENVIRONMENTAL SETTING

a. Regulatory Framework

(1) California's Alquist-Priolo Earthquake Fault Zoning Act

California's Alquist-Priolo Earthquake Fault Zoning Act (PRC Sec. 2621 et seq.), originally enacted in 1972 as the Alquist-Priolo Special Studies Zones Act and renamed in 1994, is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along known, active faults (earthquake fault zones). It also defines criteria for identifying active faults, giving legal weight to terms such as active, and establishes a process for reviewing building proposals in and adjacent to earthquake fault zones. Under the Alquist-Priolo Act, the California Geological Survey (previously known as the Division of Mines and Geology) maps the location of earthquake faults and establishes earthquake fault zones along faults that are "sufficiently active" and "well-defined." The resultant Alquist-Priolo maps are distributed to local governments who implement the provisions of the act to restrict construction along or across faults. A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the Act as referring to approximately the last 11,000 years). A fault is considered well-defined if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface, using standard professional techniques, criteria, and judgment.

(2) Seismic Hazards Mapping Act of 1990

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC Sec. 2690-2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong groundshaking, liquefaction, and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act: the California Geological Survey is charged with identifying and mapping areas at risk of strong groundshaking, liquefaction, landslides, and other corollary hazards, and cities and counties are required to regulate development within mapped Seismic Hazard Zones.

Under the Seismic Hazards Mapping Act, permit review is the primary mechanism for local regulation of development. Specifically, cities and counties are prohibited from issuing development permits for sites within Seismic Hazard Zones until appropriate site-specific geologic or geotechnical investigations have been carried out and measures to reduce potential damage have been incorporated into the development plans.

(3) California Building Standards Code

The State of California's minimum standards for structural design and construction are given in the California Building Standards Code (CBSC) (CCRs, Title 24). The CBSC is based on the Uniform Building Code (UBC), which is used widely throughout United States (generally adopted on a state-by state or district-by-district basis), and has been modified for California conditions with numerous, more detailed and/or more stringent regulations.

The CBSC requires that "classification of the soil at each building site... be determined when required by the building official" and that "the classification... be based on observation and any necessary test of the materials disclosed by borings or excavations." In addition, the CBSC states that "the soil classification and design-bearing capacity shall be shown on the (building) plans, unless the foundation conforms to specified requirements." The CBSC provides standards for various aspects of construction, including but not limited to excavation, grading, and earthwork construction; fill placement and embankment construction; construction on expansive soils; foundation investigations and liquefaction potential; and soil strength loss. In accordance with California law, project design and construction would be required to comply with provisions of the CBSC.

(4) Mammoth Lakes Municipal Code

The Town Municipal Code Section 12.08.076 requires that grading may be conducted under the following permits within the limits of each: 1) a letter of exemption, for minimal work; 2) a building permit, allowing grading within the footprint and as needed for the foundation excavations; and 3) a grading permit, for all other conditions. Municipal Code Section 12.08.080 requires engineered plans and a soils report to be submitted with an application for a grading permit.

Municipal Code Section 17.16.050 (Grading and Clearing) enforces the preservation of trees and other vegetation. Development includes public improvements required by parcel and tract maps, use permits, grading permits and encroachment permits. Grading is limited to that area required for construction of the structure, utilities, driveways and access to one primary entrance of the structure which is provided for resident and guest access. The code requires that existing trees and vegetation be preserved to the maximum extent possible. No live trees over six inches in diameter can be removed without prior approval of the planning director. Approval to remove a tree is based on the health of the tree(s), the necessity to remove the tree(s) because of building or driveway construction or snow removal/storage, potential hazard or solar access. Creation of views, lawns or similar amenities is not considered sufficient cause to remove native trees. Replacement planting for tree removal can be required to mitigate the removal of a tree. Required replacement shall not exceed a total trunk diameter equal to that removed and shall be limited to plantings in areas suitable for tree replacement.

Chapter 15 of the Town Municipal Code requires that all structures within the boundaries of the Town shall be designed to the requirements of Seismic Zone 4 as defined in the Uniform Building Code. One-third of the design snow load shall be added to the deadload for seismic design. In addition, a building permit is required for retaining walls exceeding four feet in height or retaining walls supporting any surcharge or special loads. Such walls are to be designed by a professional engineer licensed in the state.

(5) Town of Mammoth Lakes General Plan

The Town of Mammoth Lakes General Plan EIR includes policies that relate to minimizing hazards associated with erosion and sedimentation, as well as geologic and seismic hazards, which include the following:

<u>Erosion and Sedimentation</u>

Policy R.5.C: Prevent erosion, siltation, and flooding by requiring use of Best Management Practices (BMPs) during and after construction.

<u>Geologic and Seismic</u>

Policy S.3.H: Restrict development in areas with steep slopes.

Policy S.3.I: Require geotechnical evaluations and implement mitigation measures prior to development in areas of potential geologic and seismic hazards.

(6) Town Emergency Operations Plan

The Town maintains an Emergency Operations Plan (2001), which sets forth the responsibilities, functions, and operations of the Town government and its interrelationship with other agencies and jurisdictions which provide services during an emergency. The Emergency Operations Plan addresses earthquakes, volcanic activity, flooding, rapid snowmelt, fire, avalanches, landslides, transportation incidents, hazardous materials releases, medical emergencies, social unrest, terrorism, and war. The Plan meets the State's Standardized Emergency Management System (SEMS) and is updated regularly.

b. Existing Conditions

(1) Regional Geology

The Sierra Nevada is the largest continuous mountain range in the contiguous United States. The range is bounded on the east by a system of normal faults, which locally produced the escarpment separating the Sierra Nevada fault block from the Owens Valley. The Owens Valley, formed on the downfaulted east side of the Sierra Nevada boundary fault system, exhibits many examples of ongoing geologic processes including lava fields, cinder cones, fault scarps, hot springs, abandoned lake shorelines, volcanic calderas, and glacial deposits.

The Town of Mammoth Lakes is located near the southwest edge of the Long Valley Caldera, which overprints the Sierra Nevada boundary fault system. Persistent earthquake and volcanic activity over the past four million years have formed the eastern Sierra landscape in the vicinity of Long Valley Caldera and the Mono Basin. The high mountains around Mammoth constitute the caldera walls with the Glass Mountains forming the west and southwest walls and the Benton Range forming the east wall. Near the center of the caldera and off to the west is a system of hills that marks the remnants of the resurgent dome (dome-shaped uplift of the caldera floor caused by volcanic or seismic activity). Mammoth Mountain is a smaller dome on the rim of the caldera formed by repeated eruptions from vents on the southwest rim of the caldera 220,000 to 50,000 years ago. The caldera and other geologic features such as Devil's Postpile, Mammoth Rock, and Crystal Crag are evidence that the region around the Town is geologically young with an active recent history.

Although much attention has been focused on the Long Valley caldera resurgent dome and on associated volcanic hazards at Mammoth Mountain, little is known about the details of the most recent (latest Pleistocene to Holocene) eruptions in the greater Long Valley caldera complex, specifically in the Mono and Inyo Craters chain. In general, activity within the resurgent dome has not been linked with the formation and later eruptions of the Mono and Inyo Craters; however, there may be evidence to connect the two.

The eruptions that created the Long Valley Caldera were fed by a large magma chamber in the shallow crust, which culminated in the cataclysmic eruption of 150 cubic miles of rhyolite 760,000 years ago. This massive eruption resulted in the 6,000 to 10,000 foot subsidence of the magma chamber roof to form the present 20-mile long and 9-mile wide oval depression of the Long Valley Caldera. Despite recent activity in the resurgent dome east of Mammoth Mountain, the resurgent dome has experienced eruption only once every 100,000 to 200,000 years since the catastrophic caldera-forming event 760,000 years ago, and it last erupted roughly 50,000 years before present (B.P.). During the past 3,000 years the Mono-Inyo Craters have erupted at intervals of 700 to 250 years, the most recent eruptions being from Panum Crater and the Inyo Craters 500 to 600 years ago, and Paoha Island about 250 years ago. Evidence from both seismic soundings of the crust and studies of the fabric and composition of the lava indicate that these eruptions probably originated from small, discrete magma bodies rather than from a single, large magma chamber of the sort that produced the caldera-forming eruption 760,000 years ago.

During the past 3,000 years, glaciers have formed and melted several times in the eastern Sierra. The tillites preserved in the Town represent younger Pleistocene glacial deposits including the Tahoe till, the Tioga till, and related outwash deposits of gravel and sand swept away from the glacial margins by meltwater streams.

In 1982, the United States Geological Survey (USGS) under the Volcano Hazards Program began an intensive effort to monitor and study geologic unrest in the Long Valley caldera. The goal of this effort was to provide residents and civil authorities in the area reliable information on the nature of the potential hazards posed by this unrest and timely warning of an impending volcanic eruption, should it develop. Most, perhaps all, volcanic eruptions are preceded and accompanied by geophysical and geochemical changes in the volcanic system. Common precursory indicators of volcanic activity include increased seismicity, ground deformation, and variations in the nature and rate of gas emissions.

(2) Soils

The Town is underlain by a variety of rock types, including Pliocene to recent volcanic and pyroclastic deposits (12 million years old to less than 10,000 years old), Pleistocene glacial deposits (2.5 million to 10,000 years old), and Holocene alluvium (less than 10,000 years old). Soils are derived from these geologically recent deposits.

Soils in the Planning Area are characterized as Frigid and Cryic based on a four square mile survey, including the Town, by the USDA, Natural Resource Conservation Service in 2002. The soils are typically gravelly loams with low water capacity generally developed on glacial outwash south of Mary Lake Road and on glacial moraines to the north. Generally, soils are sensitive to disturbances by development and have a moderate to high erosion potential, depending on the steepness of the slopes.

Colluvial deposits located on the slopes of Mammoth Mountain and Mammoth Rock are generally loose unconsolidated material on slopes in excess of 30 percent. These deposits and the soils they support have moderate to high erosion and landslide potential.

(3) Topography

The land surface of the Town rises irregularly, but gently, toward the southwest from approximately 7,910 feet above mean sea level (amsl) near the intersection of Joaquin Road and Main Street to approximately 8,070 feet amsl near Camp High off Lake Mary Road. Topographic expression ranges from level to rolling alluvial plains at about 7,200 feet amsl in Long Valley, to approximately 11,600 feet amsl at Mammoth Mountain Summit, west of Mammoth Lakes. Slope gradients in the Town range from relatively flat terrain in Sherwin Meadow and Long Valley to slopes of 50 percent or greater on Mammoth Mountain. Slopes exceeding 30 percent are found in portions of Old Mammoth (particularly the Bluffs area), Mammoth Slopes, Westridge and the Mammoth Knolls.

(4) Volcanism

At least 30 volcanic events have occurred during the past 2,000 years in the Mono Lake Long Valley area, including at least ten eruptions in the Mono Inyo volcanic chain during the past 600 years. Actual volcanic eruptions in the vicinity of the Town have not occurred in historic times. The most recent eruption in the region occurred in 1890 beneath the southern portion of Mono Lake, approximately 35 miles north of the Town. Another eruption occurred in approximately 1,400 A.D. within four miles of the Town at the southernmost Inyo Crater. Both eruptions were phreatic in type (i.e., they produced steam, water, mud, and other gasses and materials, as a result of ground water being heated by magma). The Mono and Inyo Craters comprise a young volcanic chain with a violent history, and there is strong evidence that another eruption in the region is very likely in the thousands of years.

Recently, the occurrence of Richter magnitude 6 earthquakes in May of 1980 initiated a new phase of magmatic activity and heightened potential for volcanic eruptions. Since the early 1980s, persistent, frequent low magnitude (Richter magnitude less than 3.0) seismic activity has indicated that magma is moving at depth. Detailed surveys indicate that the central portion of the Long Valley Caldera has risen more than 30 inches since the late 1970s, possibly in response to the filling of a shallow magma chamber. In 1990, it was recognized that magmatic gasses were killing trees in certain portions of the caldera. The trees were killed by high carbon dioxide content in the soil gasses surrounding their roots. The most well known location of high carbon dioxide soil gas is at the north end of Horseshoe Lake where scientists estimate that between 50 and 150 tons of carbon dioxide is emitted daily.

(5) Seismicity

The Mono Lake Long Valley region is part of one of the most active seismic regions in the U.S. Low and moderate magnitude earthquakes occurring within the Long Valley Caldera are felt occasionally by residents of Mono and Inyo Counties. The two main sources of earthquakes in the Mono Lakes area are tectonic and those generated by the movement of magma or the formation of cracks through which magma can move.

Tectonic earthquakes occur from rapid displacement on faults as a result of regional geologic stresses. Earthquakes from magmatic activity rarely have Richter magnitudes greater than 5.0.

(6) Geotechnical Hazards

Several types of potential geologic hazards may occur in the vicinity of the Town that could affect existing and future land uses, including the proposed trail system components as part of the Project, within the Planning Area. These hazards are not all of equal severity and would not affect land uses in the Planning Area to the same extent. These potential hazards include slope instability, erosion, seismicity, and various volcanic events as discussed below.

(a) Slope Stability Hazards

Regional Hazards: Landslides, earthslips, mudflows, and soil creeps are expressions of soil conditions related to the instabilities created by steep slopes. These conditions are also related to shallow soil development, the presence of excess water, or the lack of shear strength in the soil or at the soil/rock interface. Each of these conditions has been observed in Mono County; however, it is usually reported simply as a landslide. Earthquake activity induces some landslides, but most slides result from the weight of rain saturated soil and rock exceeding the shear strength of the underlying material. Erosion of supporting material at the foot of constructed slopes is another major cause of sliding.

Local Hazards: The moraines[1] south, west, and north of the Town are considered unstable, partly because they contain irregular deposits of clay that lack the strength to stand in steep slopes. Moraines in the center of the Town and to the east are considered generally stable, unless they are underlain by shallow groundwater because of the relatively low topography in this area. The southwest portion of the Lodestar project area has the potential for shallow groundwater; however, no groundwater was encountered during test pits dug in this area in 1976. Slope stability problems are primarily limited to steeper slopes, particularly those with significant talus accumulations. The stability of moraines in the Planning Area is variable.

(b) Erosion Hazards

Erosion potential is variable throughout the Town. The highest erosion potential occurs in loose and/or shallow soils on steep slopes. The portions of the Town where loose, sandy soils occur are subject to erosion when the surface area is disturbed or vegetation is removed. Under existing conditions in the Town, erosion potential of overland flow from snowmelt and rainfall runoff is reduced by ground cover, fallen leaves and needles, or the root systems of living trees.

(c) Seismic Hazards

The Town could experience considerable seismic activity in the future due to a number of reasons that include the following: 1) a high degree of crustal faulting in the Mono Lake and Long Valley area, which may lead to the release of tectonic strain by frequent small or moderate earthquakes; 2) the present frequent moderate earthquakes and earthquake swarms along the Sierra Front fault, which indicate the potential for a

[1] *Moraines are the rocks and soil carried and deposited by a glacier. An "end moraine", either a ridge or low hill running perpendicular to the direction of ice movement, forms at the end of a glacier when the ice is melting.*

large earthquake; and 3) movement of magma beneath the caldera, which may be the cause of seismic events below the Long Valley Caldera.

The California Division of Mines and Geology has included the Town within seismic zone III in the Urban Geology Master Plan with an expected modified Mercali Rating of "IX" or "X" at maximum earthquake intensities. [The "IX" Mercali rating indicates that heavy damage to unreinforced structures would result and some structures would collapse. The "X" rating indicates that most masonry structures would be destroyed, some well built wooden structures would be destroyed, and public facilities would be damaged.]

<u>Regional Seismic Activity</u>: There are several active and potentially active fault zones within 60 miles of the Town. These zones include faults that are historically active (during the last 200 years), those that have been active in the Holocene (the last 10,000 years), and those that have been active at some time during the Quaternary Period (the last two million years). The Mono Lake, June Lake, and Hilton Creek faults form the northern extension of the Sierra Nevada Boundary fault system and are historically active. The southern extension of the Sierra Nevada Boundary fault system includes the main trace of the Sierra Nevada fault and the historically active Owens Valley fault. Holocene faults occur as branches within major active fault zones and as segments of other faults in Mono and Inyo Counties. The Bodie Hills, White Mountains, Death Valley Furnace Creek, and Saline Valley faults have been classified as Quaternary and display no recent offset.

<u>Local Seismic Activity</u>: Seismic activity in the vicinity of the Town is a result of continuing tectonic movement along the eastern front of the Sierra Nevada Mountain Range. Three historically active faults located in proximity to the Town have the greatest potential to create significant ground shaking in the Town. These faults include the Hilton Creek fault (1980 earthquake), the Owens valley fault (1972 earthquake) and the Chalfant Valley fractures (1986 earthquake). These three faults, as well as six other potentially active faults that have the potential for ground shaking within the Town, are described below. (See **Figure 4.E-1**, *Regional Fault Map*.)

Hilton Creek Fault - The main shocks (Richter magnitude greater than 6.0) of the Mammoth Lakes earthquakes of May 1980 are attributed to movement on the Hilton Creek fault. At its nearest point, the Hilton Creek fault (including the northern splays) is located approximately 10 miles east of the Town. This fault has the greatest potential for ground shaking in portions of the Planning Area because of its close proximity to the Town and historic seismic activity.

In 1998 and 1999 three earthquakes with Richter magnitudes greater than 5.0 occurred on an unnamed north northeast trending fault zone west of the Hilton Creek fault. The sequence of earthquakes and their associated aftershocks appeared to propagate in a southerly direction away from the Town.

Owens Valley Fault - The Owens Valley fault is a major component of the Sierra Nevada boundary fault system. It extends from Coso Junction on the south to near Bishop on the north, a length of 56 miles. At its closest point, the Owens Valley fault is approximately 48 miles south of the Town.

Chalfant Valley Fractures - The Chalfant Valley fractures, at their closest point, are approximately 36 miles east of the Town.

Other Faults - Of the 37 active or potentially active faults within approximately 62 miles of the Town, the three historically active faults that have the greatest potential to cause seismic hazards in the Town are described above. However, six other potentially active faults that may have the potential for ground shaking in the Town include the following:

- Hartley Springs Fault (approximately four miles northwest);
- Laurel Convict Fault (approximately four miles southeast);
- Long Valley Caldera Faults (approximately two miles northwest);
- Mono Craters Caldera Faults (approximately 13 miles northwest);
- Silver Lake Fault (approximately ten miles northwest); and
- Wheeler Crest Fault (approximately 20 miles southeast).

The Long Valley Caldera lies along the Sierra Nevada Boundary fault system, overprinting the geographic and geologic boundary between the Sierra Nevada Mountain Range and the Owens Valley. Some of the faults along the western boundary of the caldera may now be considered part of the Sierra Nevada Boundary fault system and serve to link the Hilton Creek fault system to the south with the northern continuation of the Sierra Nevada Boundary fault system, the Silver Lake fault system to the north. These faults pass under Mammoth Mountain, within two miles of the Town (see Figure 4.E-1).

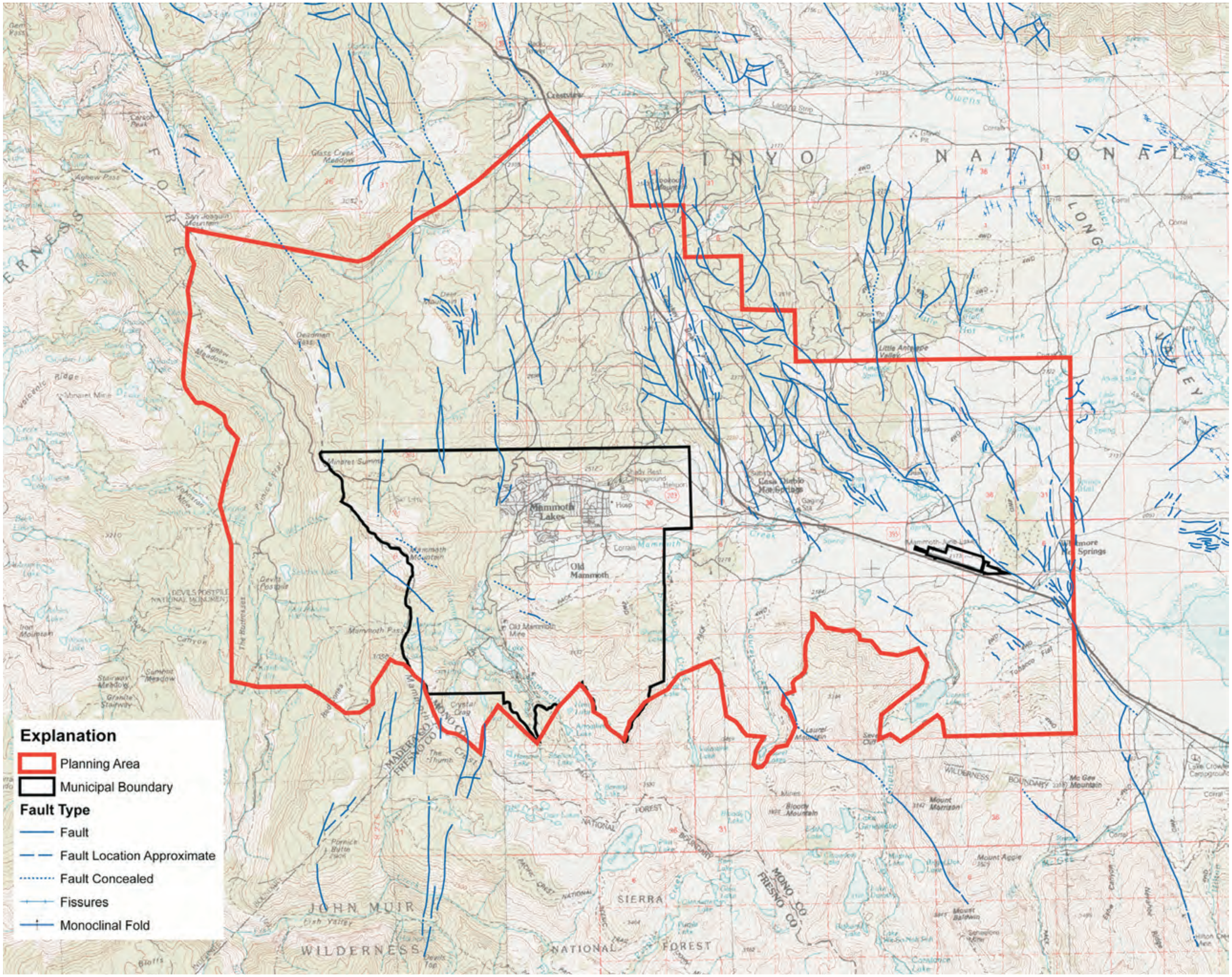
Other Geotechnical Hazards: Other geotechnical hazards may result from seismic activity. These related hazards include surface rupture, ground shaking, landslides, and liquefaction, as described below.

Surface Rupture - Damage due to surface rupturing is limited to the actual location of the fault line break, unlike damage from ground shaking, which can occur at great distances from the fault. The potential for surface rupture in the Town is considered to be moderate due to the presence of several active earthquake faults in the Planning Area. Further, there are several Alquist-Priolo Earthquake Fault Zones within the Planning Area.

Landslides - Landslides move under the force of gravity and are affected by the type of earth materials involved, the internal friction of the slide mass, and the slope over which the mass is moving. Triggering events for landslides include earthquakes, heavy precipitation, natural erosion, and earthwork/grading.

Liquefaction - Another response to severe ground shaking that can occur in loose soils is liquefaction. Liquefaction occurs in areas with shallow groundwater and where finer grained sands make up a significant part of the near surface (less than 30 feet amsl) soil section. Within Mammoth Lakes, areas of alluvium and moraine material with shallow groundwater have the potential for liquefaction.

According to the Lodestar EIR (1991) and General Plan EIR, some areas within the Town are composed of glacial outwash and till including the Westridge, Mammoth Slopes, Main Street Commercial, Old Mammoth Commercial, Minaret, Meridian, Snowcreek, Sierra Valley and Gateway Planning Districts. Areas subject to liquefaction because of fine-grained alluvium are in the low areas including Sherwin Meadows, areas to the north and south of the Old Mammoth District, and to a lesser extent, an area of shallow groundwater near the intersection of Meridian Boulevard and Minaret Road. Based on the character of surface and subsurface soil and depth to groundwater, there appears to be little potential for liquefaction in the Town.



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Regional Fault Map

Trails System Master Plan Project

Source: Town of Mammoth Lake General Plan EIR, 2008.

FIGURE

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(d) Volcanic Hazards

At least 30 volcanic events have occurred during the past 2,000 years in the Mono Lake-Long Valley area, including at least ten eruptions in the Mono-Inyo volcanic chain during the past 600 years. The Long Valley Caldera may be a center of volcanically-related seismic activity. Earthquake swarms and surface rupturing in the caldera are accompanied by uplift and deformation that have increased concerns about the possibility of renewed eruptive activity.

The possibility of such an occurrence in the Mono-Long Valley area has resulted in increased monitoring of seismic and non eruptive volcanic activity, and in increased efforts by local, state, and federal offices to prepare emergency response plans. The potential hazards from future eruptions of volcanoes in the area are being studied by the USGS and they have estimated the chances of an eruption in the Planning Area in any given year a small possibility. The Safety Element of the Mono County General Plan (1993) indicates a one in a 1,000 annual likelihood of volcanic eruption in the vicinity of the Town.

(e) Carbon Dioxide

Since 1980 scientists have monitored geologic unrest in the Long Valley Caldera. After a persistent swarm of earthquakes beneath Mammoth Mountain in 1989, geologists discovered large volumes of carbon dioxide gas likely derived from magma (molten rock). High concentrations of carbon dioxide in soil can kill the roots of trees. In addition, carbon dioxide gas is heavier than air and when it leaks from the soil it can collect in snow banks, depressions, and poorly ventilated enclosures, such as cabins and tents, posing a potential hazard to humans and animals.

2. ENVIRONMENTAL IMPACTS

a. Significance Thresholds

Appendix G of the CEQA Guidelines contains the Initial Study Environmental Checklist form used during preparation of the Project Initial Study, which is contained in Appendix A of this EIR. The Initial Study Environmental Checklist includes questions relating to geology and soils. The Initial Study Environmental Checklist questions relating to geology and soils have been utilized as the thresholds of significance in this section. Accordingly, a project may create a significant environmental impact if it causes one or more of the following to occur:

Threshold 1: Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

i) 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 (refer to Section 6, *Other CEQA Considerations*, and the Initial Study contained in Appendix A. No impact would occur in this regard.).

ii) Strong seismic ground shaking (refer to Impact Statement 4.E-1).

iii) Seismic-related ground failure, including liquefaction (refer to Impact Statement 4.E-1 and).

iv) Landslides (refer to Impact Statement 4.E-1).

Note : Volcano and carbon monoxide hazards are also addressed under this threshold (refer to Impact Statement 4.E-1);

Threshold 2: Result in substantial soil erosion or the loss of topsoil (refer to Impact Statement 4.E-2).

Threshold 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 (refer to Impact Statement 4.E-3).

Threshold 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 (refer to Section 6, *Other CEQA Considerations*, and the Initial Study contained in Appendix A. No impact would occur in this regard.).

Threshold 5: Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water (refer to Impact Statement 4.E-4).

b. Methodology

The analysis of geology and soils uses significance thresholds as set forth in the Town's General Plan EIR as well as Appendix G of the CEQA Guidelines. Significant impacts associated with geologic hazards are generally defined as those which directly or indirectly affect life, property or major public facilities (e.g., transportation and utility corridors). Compliance with applicable safety and building codes/regulations generally preclude the potential for adverse impacts; however, where applicable, recommended mitigation measures are provided to address potentially significant impacts. As indicated in the Initial Study prepared for the Project, no impacts related to surface fault rupture and expansive soils would occur with Project implementation and are not analyzed in this section.

c. Project Features

Chapter 6 in the TSMP contains Design Guidelines for the application of bicycle, pedestrian and trail facilities. These are not engineering specifications and are not intended to replace existing applicable mandatory regulations or advisory standards, nor the exercise of engineering judgment by licensed professionals. MUPs would be built to a standard high enough to allow heavy equipment to operate on the path without causing deterioration. During the design phase of each trail facility, appropriate surfacing would be selected. Asphalt and concrete are the most common surface treatments for MUPs, however, alternative surface materials such as decomposed granite may be appropriate in some circumstances. When selecting alternative surfaces, durability and snow removal needs (grooming and clearing) would be considered on a project-by-project basis.

The Design Guidelines also address soft-surface trail facilities design considerations. These design considerations are carried over into the Soft-Surface Trails Concept (SSTC) document. The USFS relies on a number of trail construction related documents that include the *Trail Construction and Maintenance Notebook* (2007 Edition) and the *Forest Service Trails Management Handbook* (FSH 2309.18) for guidelines on building almost any type of trail, including soft-surface trails. These USFS documents would be referred to during the construction of trails within the SHARP area. Soft-surface trails recommended in the SSTC and/or the SHARP area would be designed in consideration of a number of factors that include: the intended trail user, type of soil, and average and maximum grades, amongst others. Trails would be designed to follow natural land contours and topography to the maximum extent feasible. Surface water control features to control erosion such grade reversals, knicks, rolling grade dips, and water bars would be incorporated into soft-surface trail designs. Trail surfaces and routing would be determined based on a project-by-project basis. Best Routing Location (BRL) Principals are included in the TSMP Design Guidelines and the SSTC (similar trail design standards are provided in the USFS trail construction documents). Examples of the BRL Principals include:

- Avoid hazardous areas such as unstable slopes, cliff edges, faults, crevasses, embankments and undercut streams, and avalanche prone zones (in the winter).
- Avoid trail routing that encourages shortcutting. Use natural topography or features to screen short cuts.
- Avoid routing trails too close to other trail systems to minimize trail proliferation and user conflict.

Soft surface trail facilities constructed in accordance with the TSMP Design Guidelines and/or USFS standards would not only be designed meet the needs of the intended users, but would be constructed with appropriate surfacing or tread so that the trail would not deteriorate over time or be eroded away by water and use. Standards and specifications for design and materials to be used in all trails facilities will be developed and adopted in a "Standards Manual." These specifications would be reviewed for consistency with applicable Codes and engineering standards, to ensure durability and suitability of trails surfaces.

Chapter 7, *Operations and Maintenance*, in the TSMP provides a summary of existing and recommended maintenance policies and procedures within the Town. Under current maintenance policies, trail facilities are inspected, cleared and repaired on a routine basis during both summer and winter conditions. Existing maintenance activities are identified on a weekly, monthly, seasonal, and long-term (at least every 5 years) basis. The proposed maintenance policies in the TSMP include: developing a coordinated year-around (interdepartmental) maintenance plan; and providing and prioritizing snow removal and grooming activities on paved MUPs and sidewalks during winter conditions to maintain year around use.

d. Analysis of Project Impacts

The analysis of Project impacts regarding geology and soils below applies to all future trail components associated with the Project, including the Priority Projects. Many of the future trail components associated with the Project (including the Priority Projects) would be subject to similar geology and soils impacts throughout the Project Area. However, the analysis, where appropriate, analyzes impacts that could occur due to varying geologic characteristics (i.e., topography, steep slopes, etc.) and the developed (or undeveloped) nature of certain areas within the Project Area.

(1) Seismic Hazards

4.E-1 Project implementation would result in less than significant seismic-related ground shaking and liquefaction impacts, as well as volcanic and carbon monoxide impacts, based on the Project's compliance with applicable regulatory requirements. Potentially significant landsliding impacts would be reduced to a less than significant level with implementation of the prescribed mitigation measures.

Seismic Ground-Shaking. The Project Area is located in a seismically active area, as is the case throughout the Town of Mammoth Lakes. Major faults and fault zones characterize the region. Generally, trail projects do not involve the construction of habitable structures that would expose people or structures to substantial adverse effects associated with seismic hazards. Thus, the focus of this analysis is on built facilities and/or structures to be developed as part of the Project. Built structures and/or facilities would be constructed in accordance with the requirements of the CBSC and the Town's Municipal Code Sections 12.08.076 and 12.08.080, as applicable, local building codes for to address local snow-loading, seismic and wind conditions, and with construction standards and specifications set forth by the US Forest Service for projects on National Forest lands. As indicated above, Section 12.08.080 requires engineered plans and a soils report to be submitted with an application for a grading permit. Site development plans, as appropriate, would be reviewed by the Town to determine conformance with specific recommended geotechnical procedures. Field inspection would be conducted by the Town during earthwork and construction operations. The observation of cuts, fills, backfills, foundation excavations, and the preparation of pavement subgrades would take place during these phases of site development. Although trail system-related facilities and structures (i.e., bridges and trail crossings) would be limited and vary on a project-by-project basis, such facilities would be designed in accordance with the ground motion parameters that have been calculated for the project site to withstand seismic ground shaking from the maximum credible earthquake anticipated to occur at the particular project site, as necessary per applicable regulatory requirements. Further, it is anticipated that most, if not all, structures to be implemented as part of the Project would not involve the construction of habitable structures that would expose people or structures to substantial adverse effects associated with seismic hazards. Thus, despite the seismically active area, impacts associated with seismic ground shaking would be less than significant.

Liquefaction. According to the Town of Mammoth Lakes General Plan EIR, areas subject to liquefaction because of fine-grained alluvium are in the low areas including Sherwin Meadows, areas to the north and south of the Old Mammoth District, and to a lesser extent, an area of shallow groundwater near the intersection of Meridian Boulevard and Minaret Road. However, based on the character of surface and subsurface soil and depth to groundwater, there generally appears to be little potential for liquefaction in the Town. Regardless, the Project's proposed trail system components would be built in accordance with the applicable seismic requirements of the CBSC and Town of Mammoth Lakes Municipal Code requirements, as described above. Further, it is anticipated that most, if not all, structures to be implemented as part of the Project would not involve the construction of habitable structures that would expose people or structures to substantial adverse effects associated with seismic hazards. Thus, despite the seismically active area, less than significant impacts regarding liquefaction would occur with Project implementation.

Landslides. The Project includes trail system components that traverse nearly all parts of Mammoth's landscape and topography, including with the UGB, and outside of the UGB within the Planning Area that includes moderate to steep topography. Many of the proposed trail system components would be located within the UGB over existing informal trails, adjacent to existing roadways, or in otherwise developed areas, on relatively level to gently sloping surfaces. Construction in these areas would involve removal of existing grasses or vegetation (including tree removal) if necessary, minor grading, and/or smoothing of the trail surface and importation of a surface material (i.e., asphalt, concrete, decomposed granite, etc.) to provide a usable trail surface. In such instances, construction activities would not involve substantial quantities of earthwork. The minimal amount of earthwork combined with the relatively level to gently sloping topography within the UGB would preclude the potential for significant landsliding impacts. In addition, according to the Town's General Plan EIR, there is no record of landslide activity in the Town.

Outside of the UGB, including within the SHARP area, proposed trail system components may be developed in areas of moderate to steep topography. According to the USFS's *Trail Construction and Maintenance Notebook (2007 Edition)*, the steepness of the hillside determines how difficult a trail is to build. The steeper the hillside, the more excavation will be needed to cut in a stable backslope. Trail grade also has a direct bearing on how much design, construction, and maintenance work will be needed to establish solid tread and keep it solid. Grades range from 1 percent for wheelchair access to 50 percent or greater for scramble routes. Most high-use trails would be constructed with an average trail grade in the 5- to 10-percent range. Trails of greater difficulty can be built at grades approaching 15 percent when solid rock is available. Trails steeper than 20 percent typically require steps or hardened surfaces to maintain original trail route.

As indicated in the "Project Features" section above, soft-surface trail facilities would be designed in accordance with the Design Guidelines provided in the TSMP and/or USFS trail construction guidance documents, and with the Standards Manual when adopted. The determination of trail routes on a project-by-project basis would set a priority for taking advantage of existing non-formal trail alignments where feasible, avoiding landslide related hazards, and minimizing the need for grading, excavation and vegetation clearance. In addition, existing and proposed maintenance policies in the TSMP and per the USFS trail construction guidance documents would serve to ensure that soft-surface trails are maintained in a manner to provide on-going erosion control and to address any unstable soil conditions. Based on these considerations, the potential for landslides to occur with implementation of the majority of the proposed trail system components appears low.

Nonetheless, landsliding hazards cannot be completely disregarded in steep areas without a project specific review of soil conditions. For purposes of this analysis, steep slopes are considered to be slopes greater than or equal to 20 percent. In steeper areas where excavation is required, trail segments could be constructed on a cut and fill section or retaining walls could be used. The combination of these construction techniques, steep slopes and unstable soils, could result in potentially significant landsliding impacts. Thus, to minimize the potential for landsliding impacts on slopes greater than 20 percent to the extent feasible, Mitigation Measures 4.E-1.A and 4.E-1.B have been prescribed. Implementation of the prescribed mitigation measures would reduce potentially significant landsliding impacts to a less than significant level.

<u>Volcanic and Carbon Monoxide Hazards</u>. Geotechnical hazards in the Planning Area related to volcanic activity are possible based on geologic history. Potential impacts to the Town include inundation by ash deposition, lava, or lahars, or complete destruction from a catastrophic eruption. A comprehensive daily monitoring program of activity along known faults helps scientists to assess the volcanic hazards in the Long Valley area and to recognize the early signs of possible eruptions. The USGS, in cooperation with the California Office of Emergency Services and local jurisdictions in eastern California, has established procedures to promptly alert the public to a possible eruption. In addition, the Town adopted an Emergency Operations Plan in 2001, which is updated regularly. The Project, in and of itself, would not change the population in the Town in the near- or long-term. Thus, the Project would not put more people within the

Town at risk to volcanic hazards compared to existing conditions. Accordingly, with the plans in place stated above, impacts regarding volcanic hazards are concluded to be less than significant.

With regards to carbon monoxide, since carbon dioxide derived from molten rock is heavier than air, when it leaks from the soil it can collect in snow banks, depressions, and poorly ventilated enclosures, such as cabins and tents. The areas in which carbon dioxide occur are outside the UGB and are within USFS jurisdiction. The occurrences are seasonal and USFS monitors the areas. Should trail facilities be located in areas where carbon monoxide hazards are present and conditions present safety hazards to trail users, such trail facilities would be marked and closed off as needed by the USFS. With these USFS management activities in place, impacts regarding carbon monoxide are concluded to be less than significant.

(2) Soil Erosion/Loss of Topsoil

4.E-2 *Project implementation could result in substantial soil erosion or loss of topsoil impacts. Potentially significant impacts would be reduced to a less than significant level with implementation of the prescribed mitigation measure.*

As stated in the Existing Conditions discussion, soils throughout the Project Area are sensitive to disturbance and exhibit moderate to high erosion potential depending on the grade of the slope. Construction of individual trail system components could therefore, expose earth surfaces to wind and rain action. If slopes and exposed surfaces are not protected by vegetation or some other form of protection, uncemented soils could experience erosion during strong winds or heavy precipitation. In turn, erosion would generate potential impacts to nearby streams and watercourses or the storm drain system due to sedimentation. (Please refer to Section 4.H, *Hydrology and Water Quality*, for a discussion regarding water quality impacts.)

Development of future trail system components would comply with the applicable provisions of Municipal Code Section 12.08, *Land Clearing, Earthwork and Drainage Facilities*, which includes Sections 12.08.090, *Drainage and Erosion Design Standards*, and 12.08.080, *Engineered Grading Permit Requirements*. In addition, projects would be required to comply with the Lahontan Regional Water Quality Control Board (LRWQCB) *Guidelines for Erosion Control in the Mammoth Area*. These regulatory requirements serve to implement construction techniques that minimize soil erosion and slope instability. In addition, best management practices (BMPs), which would reduce and/or eliminate erosion potential, would be incorporated into trail system component projects, as applicable. Trail system components would be subject to compliance with the requirements (as applicable) set forth in the National Pollutant Discharge Elimination System (NPDES) Storm Water General Construction Permit for construction activities (as applicable) and water quality regulations set by the LRWQCB. These regulatory requirements, as well as BMPs, are discussed in detail within Section 4.H, *Hydrology and Water Quality*. Compliance with applicable requirements would ensure that short-term construction impacts associated with soil erosion are less than significant.

Once in operation, hard surface trails (i.e., concrete or asphalt), such as MUPs and bike lanes within the Town, are not expected to be subject to substantial erosion impacts given that they would be inspected and repaired on a routine schedule, as necessary, pursuant to the existing and proposed maintenance activities as part of the TSMP. The greatest potential for long-term erosion impacts would occur on soft-surface trails, as discussed below.

As indicated in the "Project Features" section above, trail facilities would be designed in accordance with the Design Guidelines provided in the TSMP and/or USFS trail construction guidance documents that include the

Trail Construction and Maintenance Notebook (2007 Edition) and the *Forest Service Trails Management Handbook (FSH 2309.18)*. Development of trails on a project-by-project basis in compliance with these policies and guidelines would help determine the trail route and surface that would be least susceptible erosion hazards. Trails would be designed to follow natural land contours and topography to the maximum extent feasible. Surface water control features to control erosion such grade reversals, knicks, rolling grade dips, and water bars would be incorporated into soft-surface trail designs. In addition, existing and proposed maintenance policies in the TSMP and per the USFS trail construction guidance documents would serve to ensure that soft-surface trails are maintained in a manner to provide on-going erosion control. Implementation of the above referenced design and maintenance considerations would ensure that impacts regarding substantial soil erosion or loss of topsoil erosion associated with recreational use on trails are less than significant.

During winter conditions, snowmobile use on motorized trails can cause significant impacts on the stability of trails during periods when inadequate snowpack allows tires to contact the ground surface. Vehicle contact in these conditions can create rapid erosion impacts in a short-period of time during continued use of the trail. This trail use pattern requires vehicles to cross areas that are, alternatively, covered in a minor amount of snow and/or saturated by snowmelt. Further, snow coverage of the established trail alignment can be difficult to follow, resulting in vehicles crossing over the trail boundaries. Erosion and loss of topsoil impacts attributed to over snow vehicles during these circumstances are especially severe during early and late winter conditions when the snowpack is at its lowest levels. Impacts from snowmobiles under these conditions are considered to be potentially significant due to the potential for their operation to erode soil materials and introduce them into downstream receiving waters. However, to minimize the potential for erosion impacts from snowmobiles to the extent feasible, Mitigation Measures 4.H-4, 4.H-9, 4.H-10, 4.H-11, 4.H-12, 4.H-14, 4.H-15, 4.H-16, and 4.H-17 in Section 4.H, *Hydrology and Water Quality*, of this EIR that serve to minimize erosion effects throughout the operational life of the proposed facilities through design features and erosion control BMPs. Furthermore, implementation of the TSMP itself would not, by itself increase trail use by non-motorized users to a substantial degree, nor would expand the network of trails or other areas open to motorized users. This fact, together with implementation of the prescribed mitigation measures would reduce potentially significant erosion impacts attributable to snowmobiles to a less than significant level.

(3) Soil Stability

4.E-3 *While the geologic units and soils within the Town are generally considered to be adequate and would support the Project, there would be potentially significant impacts regarding landslides. Potentially significant impacts regarding landslides would be reduced to a less than significant level with implementation of the prescribed mitigation measures.*

Impacts associated with landslides and liquefaction are analyzed above in *Impact Statement 4.E-1*. As analyzed therein, potentially significant impacts regarding landslides would be reduced to a less than significant level with implementation of Mitigation Measures 4.E-1.A to 4.E-1.C. Also, less than significant impacts regarding liquefaction would occur with Project implementation.

Lateral spreading involves displacement of large blocks of ground down gentle slopes or towards stream channels. Lateral spreading is typically a type of displacement of major concern associated with liquefaction. As described above, liquefaction impacts are considered to less than significant. In addition, the Town does not have any know history of significant lateral spreading occurrences. Thus, the potential for lateral spreading is considered to be low and as such, impacts are considered to be less than significant.

Subsidence is a localized mass movement that involves the gradual downward settling or sinking of the ground, resulting from the extraction of mineral resources, subsurface oil, groundwater, or other subsurface liquids, such as natural gas. The Project Area does not include areas of known subsidence associated with oil or ground water withdrawal, peat oxidation or hydro-compaction. Furthermore, the Project does not include the extraction of oil or groundwater from aquifers. As such, no impacts regarding subsidence would occur with Project implementation. Based on the above, impacts associated with unstable geology and soils would be less than significant.

(4) Soils and Alternative Waste Water Disposal Systems

4.E-4 *Project implementation would result in less than significant impacts regarding septic and other wastewater disposal systems based on the Project's compliance with applicable regulatory requirements.*

Implementation of the Project could involve new restroom facilities at various locations throughout the Town. Some of the restroom facilities may have access to water and/or sewer infrastructure to accommodate wastewater disposal needs. However, there may be instances where due to the remote location of a proposed restroom facility it may not be feasible to connect with existing infrastructure for wastewater disposal. In these circumstances, septic and/or or other wastewater disposal systems may be considered by the Town and/or USFS. Development of such systems may not be supported by certain soils types and could directly or indirectly result in water quality impacts. However, any proposed septic or alternative waste disposal system would be required to comply with the standards and regulatory requirements stipulated by the current regulatory standards, including those set by the Town of Mammoth Lakes, Mono County Environmental Health Department, and LRWQCB, at the time of the proposed restroom facility. The regulatory requirements are anticipated to include a site specific review of the proposed restroom facility to determine whether soils would be capable of adequately supporting the proposed wastewater system. Compliance with the applicable regulatory requirements would ensure that impacts in this regard are less than significant.

3. MITIGATION MEASURES

The following mitigation measures address the potentially significant impacts regarding geology and soils from the Project.

a. Seismic Hazards

Seismic Ground Shaking and Liquefaction

No mitigation measures are necessary.

Landslides

Mitigation Measure 4.E-1.A Trail development on slopes greater than 20 percent shall be avoided where feasible alternative alignments exist.

Mitigation Measure 4.E-1.B Prior to trail development on slopes 20 percent or greater, a soils and geotechnical study shall be conducted to determine the potential for landsliding and soil instability and to ensure that design measures are incorporated to avoid landslide and soils instability hazards.

Mitigation Measure 4.E-1.C Trails development on slopes greater than 20 percent shall be regularly monitored at least annually and evaluated by the Town and/or USFS to ensure that unstable soil conditions do not develop. Should unstable soil conditions develop, the trail shall be temporarily closed until conditions are improved.

b. Soil Erosion/Loss of Topsoil

Refer to Mitigation Measures 4.H-4, 4.H-9, 4.H-10, 4.H-11, 4.H-12, 4.H-14, 4.H-15, 4.H-16, and 4.H-17 in Section 4.H, *Hydrology and Water Quality*, of this EIR.

c. Soil Stability

Landslides**.** Refer to Mitigation Measure Mitigation Measures 4.E-1.A to 4.E-1.C. No additional mitigation measures are necessary.

Liquefaction, Lateral Spreading and Subsidence. No mitigation measures are necessary.

d. Soils and Alternative Waste Water Disposal Systems

No mitigation measures are necessary.

4. CUMULATIVE IMPACTS

4.E-5 *The Project combined with cumulative projects may result in cumulative geology and soils impacts. However, project-by-project analysis of geology and soils impacts, compliance with applicable regulatory requirements and implementation of the prescribed mitigation measures would ensure that potentially significant cumulative impacts regarding geology and soils are reduced to a less than significant level.*

The Project would not result in significant unavoidable impacts related to geology and soils with implementation of applicable mitigation measures. Geology and soils impacts are site-specific and each trail system component project would subject to, at minimum, uniform site development and construction standards relative to seismic and other geologic conditions that are prevalent within the Town and/or region. Impacts related to erosion could be cumulative in nature, if future development were to contribute to increased soil loss. However, provided that: such development, as well as all future contemplated trail system components as part of the Project, adheres to standards and polices in the Mammoth Lakes General

Plan, Mono County Environmental Health Department, and the LRWQCB *Guidelines for Erosion Control in the Mammoth Area*, and; the prescribed mitigation measures are implemented for the Project, as applicable, cumulative erosion impacts would be less than significant. Further, because the development of each cumulative project site would have to be consistent with Town of Mammoth Lakes design and construction requirements and the CBSC, as each pertains to protection against known geologic hazards, and given the known geologic conditions, impacts of cumulative development would be less than significant.

5. LEVEL OF SIGNIFICANCE AFTER MITIGATION

Implementation of the mitigation measures included in this EIR would reduce all potentially significant impacts regarding geology and soils to a less than significant level. No significant and unavoidable impacts would occur with Project implementation.