3.7.3.7 Irreversible and Irretrievable Commitment of Resources

Because paleontological resources are nonrenewable, any impacts would render the resource disturbance irreversible and the integrity of the resource irretrievable.

3.7.3.8 Significance of the Effects under the Alternatives

None of the alternatives would be expected to result in the loss or destruction of scientifically important or valuable paleontological resources within the CESA or 3 Bars Project treatment areas. Thus, none of the direct, indirect, or cumulative impacts from the alternatives would create a significant impact within the CESA or 3 Bars Project area.

3.7.4 Mitigation

No mitigation measures for paleontological resources are recommended. According to Instructional Memorandum 2009-011 *Guidelines for Assessment and Mitigation of Potential Impacts to Paleontological Resources* (USDOI BLM 2008e), "If the proposed project will not disturb potentially fossil-yielding bedrock or alluvium, no additional work is necessary… Examples of such projects include noxious weed spraying, mechanical brush treatment, geophysical exploration, or surface disturbing activities such as road construction when the fossil resource is expected to be buried well below project compression or excavation depth or when surface fossil resources would be left undamaged."

3.8 Soil Resources

3.8.1 Regulatory Framework

There are no federal or state laws or regulations specific to soil. State and federal agencies, however, have identified best management practices (BMPs) to limit the effects of soil erosion on the aquatic environment, including water quality. The USEPA guidelines define BMPs as "methods, measures, or practices to prevent or reduce water pollution, including but not limited to, structural and non-structural controls, operation and maintenance procedures, and scheduling and distribution of activities. Usually BMPs are applied as a system of practices rather than a single practice. Best management practices are selected on the basis of site-specific conditions that reflect natural background conditions and political, social, economic, and technical feasibility."

The BLM Nevada Northeastern Great Basin Resource Advisory Council, as chartered by the USDOI to promote healthy rangelands, has developed Standards and Guidelines for grazing administration on about 16.2 million acres of public lands in Nevada. Included in the Standards and Guidelines is Standard 1 – Upland Sites. This Standard states that "upland soils exhibit infiltration and permeability rates that are appropriate to soil type, climate and land form." Indicators include canopy and ground cover, including litter, live vegetation and rock, appropriate to the potential of the site. Livestock grazing management and wild horse and burro population levels are appropriate when in combination with other multiple uses they maintain or promote upland vegetation and other organisms and provide for infiltration and permeability rates, soil moisture storage, and soil stability appropriate to the ecological site with management units (USDOI 2007b).

3.8.1.1 Nevada Best Management Practices

The use of BMPs in Nevada is addressed in the *Handbook of Best Management Practices* (Nevada Division of Environmental Protection and Nevada Division of Conservation Districts 1994). Nevada Administrative Code

445A.306 defines "Best Practices" as "measures, methods of operation, or practice that are reasonably designed to prevent, eliminate, or reduce water pollution from diffuse sources and that are consistent with the best practices in the particular field under the conditions applicable. This term is intended to be equivalent to the term 'best management practices' as used in federal statutes and regulations."

3.8.2 Affected Environment

3.8.2.1 Study Methods and Study Area

Information on major land resource areas and soil characteristics was obtained from the *Land Resource Regions and Major Land Resource Areas (MLRAs) of the United States, the Caribbean, and the Pacific Basin* (USDA 2006), while information on soil characteristics was obtained from the Soil Survey Geographic Database (USDA Natural Resources Conservation Service 2012). The Mount Hope Project EIS, and references cited therein, was also consulted (USDOI BLM 2012c).

The study area for direct and indirect effects to soil resources is the 3 Bars Project area. The cumulative effects study area for soil resources is the Hydrologic Unit Code 10 watersheds wholly or partially within the project area (**Figure 3-1)**.

3.8.2.2 Soils Characteristics on the Project Area

3.8.2.2.1 Soil Orders

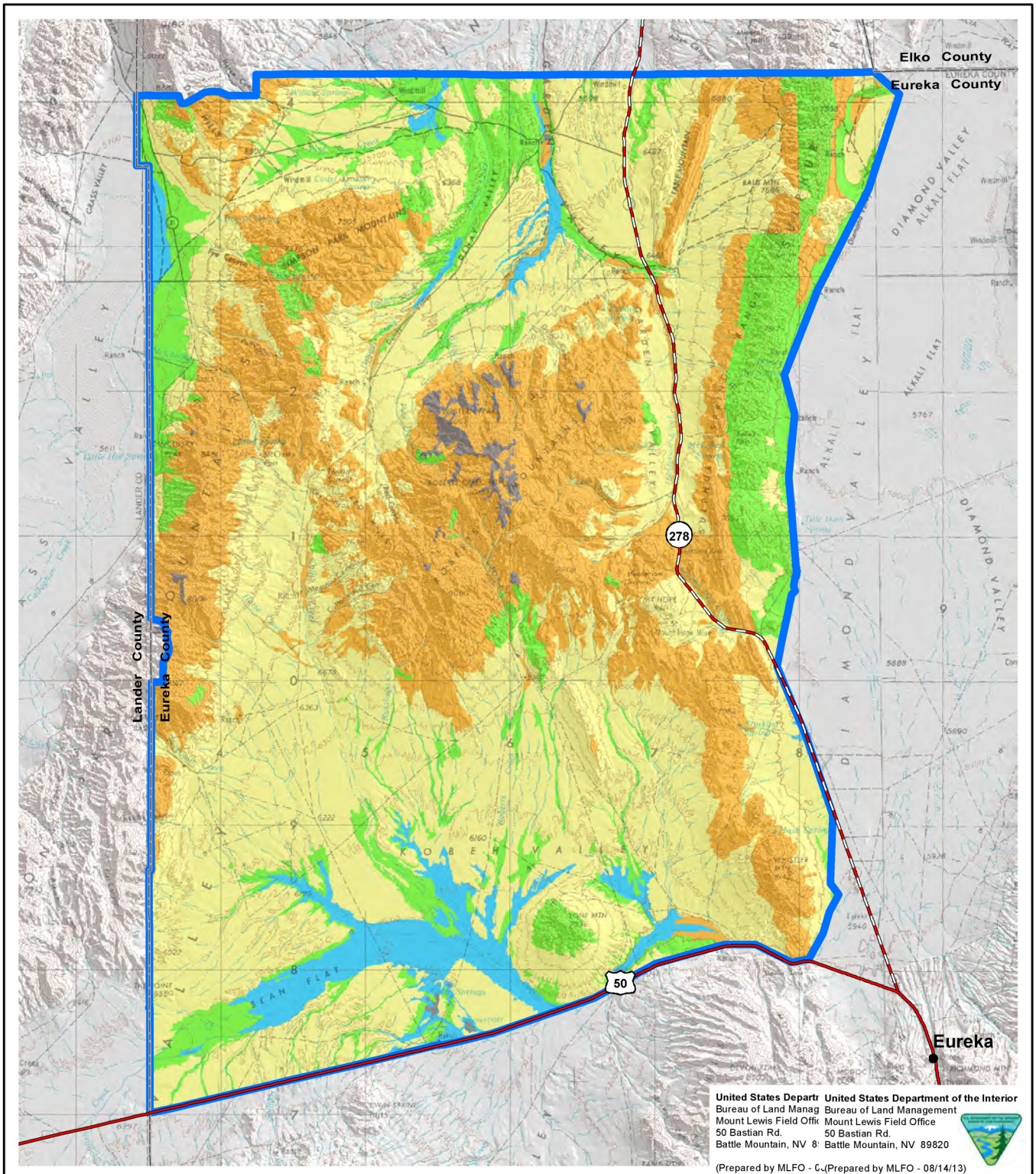
Soil resources in the project area formed in major land resource area 28B, the Central Nevada Basin and Range. The dominant soil orders in this major land resource area are Aridisols, Entisols, Inceptisols, and Mollisols (**Figure 3-12**). Aridisols form in an arid or semi-arid climate and are well developed soils that have a very low concentration of organic matter. In contrast, Mollisols are fertile soils with high organic matter and a nutrient-enriched, thick surface. Entisols are considered recent soils that lack soil development because erosion or deposition rates occur faster than the rate of soil development. Inceptisols are generally young mineral soils, but have had more time to develop profile characteristics than Entisols. The soils in this major land resource area generally are well drained, loamy or loamy-skeletal, and range from shallow to very deep (USDA Natural Resources Conservation Service 2006).

3.8.2.2.2 Soil Physical Properties

Soil physical characteristics, such as the susceptibility to erosion and the potential for revegetation, are important to consider when planning for vegetation treatment activities and stabilization of disturbed areas. These hazards or limitations for use are a function of many physical and chemical characteristics of each soil, in combination with the climate and vegetation. **Table 3-10** summarizes some important soil characteristics to be considered when evaluating the effects of vegetation treatment activities.

3.8.2.2.3 Soil Compaction

Soil compaction occurs when soil particles are pressed together and the pore spaces between them are reduced and bulk density is increased. Moist, fine textured soils are most susceptible to severe compaction. Approximately 19 percent of the soils in the project area are compaction prone (**Figure 3-13**).



Legend

Soil Order

- Aridisols
- Entisols
- Inceptisols
- Mollisols
- Not Rated
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-12

Soil Order

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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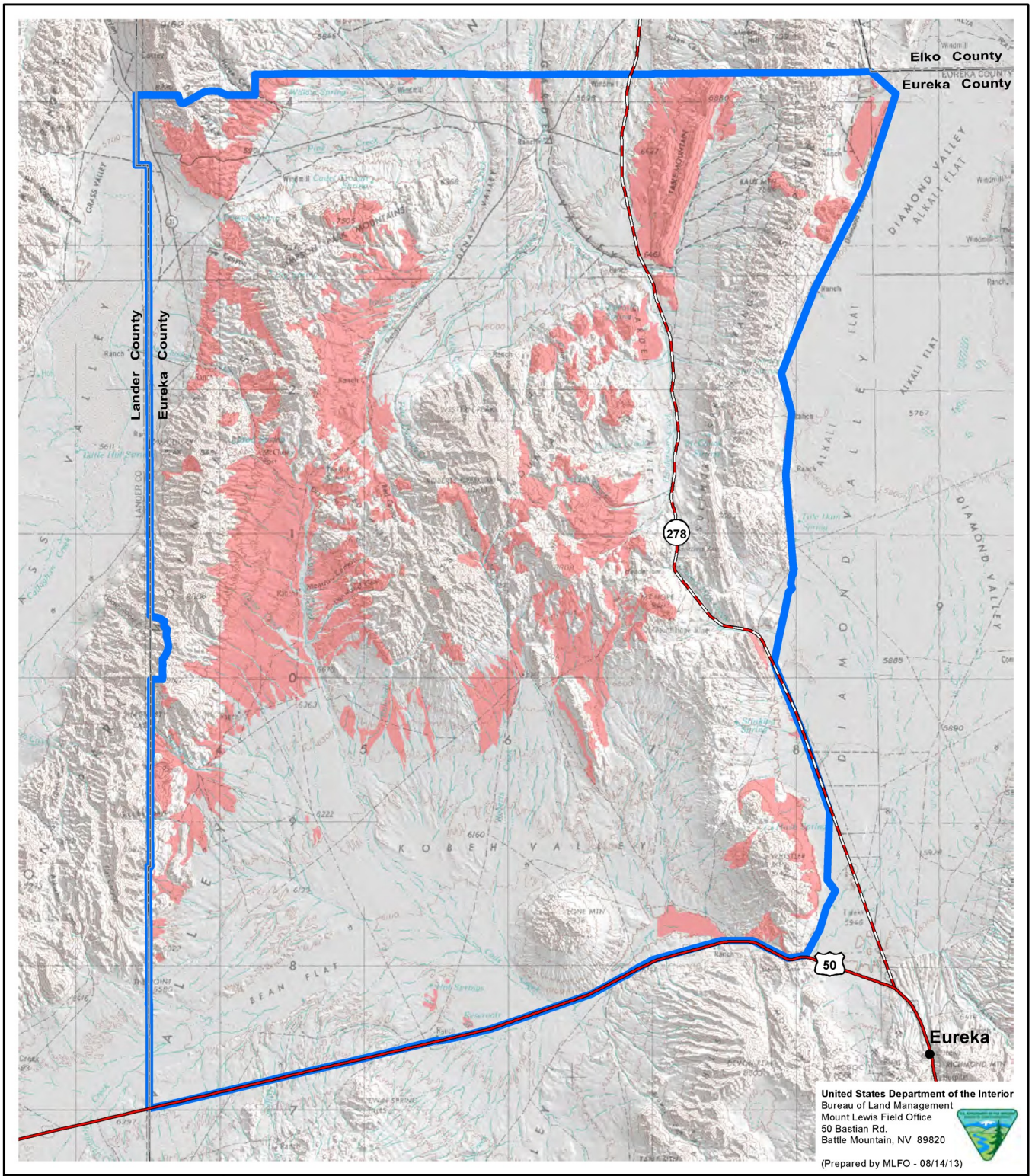

Legend

Compaction Prone Soils

3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-13

Compaction Prone Soils

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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3.8.2.2.4 Soil Erodibility Hazard

Water erosion is the detachment and movement of soil by water. Natural erosion rates depend on inherent soil properties, slope, soil cover, and climate.

Soil erodibility hazard potential has been assessed for both water driven and wind driven causes of erosion on each soil unit within the project area. Erodibility ratings are based on analyzing the dominant conditions of the surface layer of each soil within a soil unit. Water driven causes have been qualified based on the USDA Natural Resources Conservation Service K factor. The erosion K factor indicates the susceptibility of a soil to sheet and rill erosion by water, based primarily on the percentage of silt, sand, organic matter, and rock fragments within the soil unit and on soil structure and saturated hydraulic conductivity. Values of K range from 0.02 to 0.64. Soils with higher K values are more erodible than soils with lower K values. A small percentage of the soils within the project area (approximately 15 percent) have a "severe" soil erodibility hazard rating for water-caused erosion. These soils are on steep slopes (**Figure 3-14, Table 3-10**).

TABLE 3-10

Project Area Soil Limitations

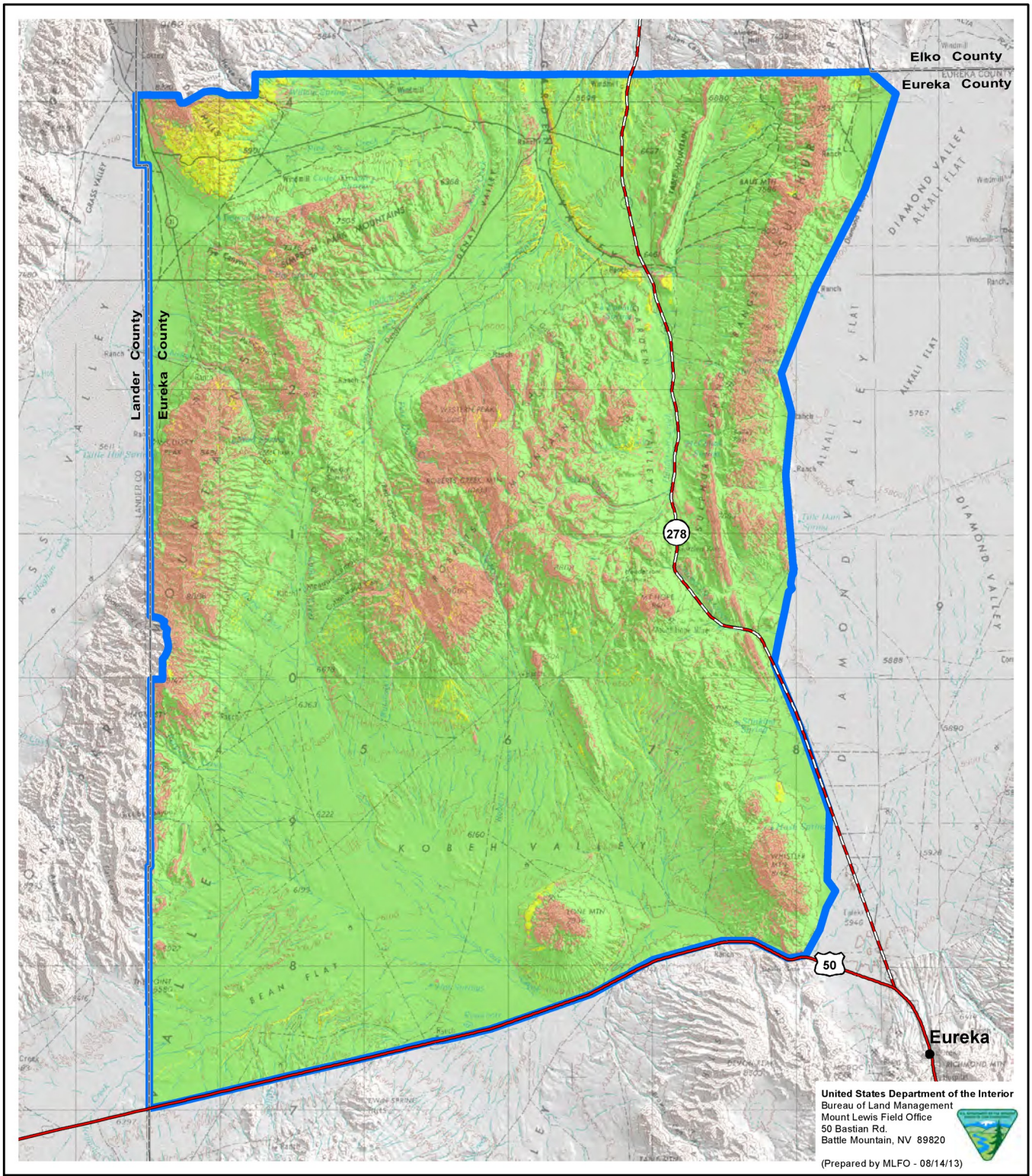
Limitation	Acres	Percent of Project Area
Compaction Prone	141,484	19
Low Revegetation Potential	51,321	7
Wind Erodible	1,043	<1
Water Erodible	109,139	15
Shallow to Bedrock	490,311	65
Droughty	156,905	21

Source: USDA Natural Resources Conservation Service (2012).

Wind erosion is the physical wearing of the earth's surface by wind. Wind erosion removes and redistributes soil. Small blowout areas may be associated with adjacent areas of deposition at the base of plants or behind obstacles, such as rocks, shrubs, fence rows, and roadbanks (Soil Quality Institute 2001). Wind driven erodibility interpretations are based on USDA Natural Resources Conservation Service wind erodibility group ratings. Wind erodibility group ratings range from 1 to 8 with values of 1 and 2 considered "severe," and thus considered a limitation within the project area. The wind erodibility group value is closely correlated to the texture of the surface layer, the size and durability of surface clods, rock fragments, and organic matter, and the calcareous reaction potential of the soil. Soil moisture and frozen soil layers also influence wind erodibility group ratings. Wind erodible soils are not prevalent in the project area. A small percentage of the soils within the 3 Bars Project area (less than 1 percent) have a "severe" soil erodibility hazard rating for wind-caused erosion (**Figure 3-15**). These soils are in the southeastern portion of the project area.

3.8.2.2.5 Soil Productivity and Quality

Site productivity is primarily a measure of vegetation success. Productivity varies with vegetation community, but more importantly, with land management objectives as they relate to the establishment of desirable or productive vegetation types. In contrast, soil quality is an inherent soil resource characteristic involving aeration, permeability, texture, salinity and alkalinity, microbial populations, fertility, and other physical and chemical characteristics that are



Legend

Soil Erosion Potential from Water

- Severe Water Erosion
- Moderate Water Erosion
- Low Water Erosion
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-14

Soil Erosion Potential from Water

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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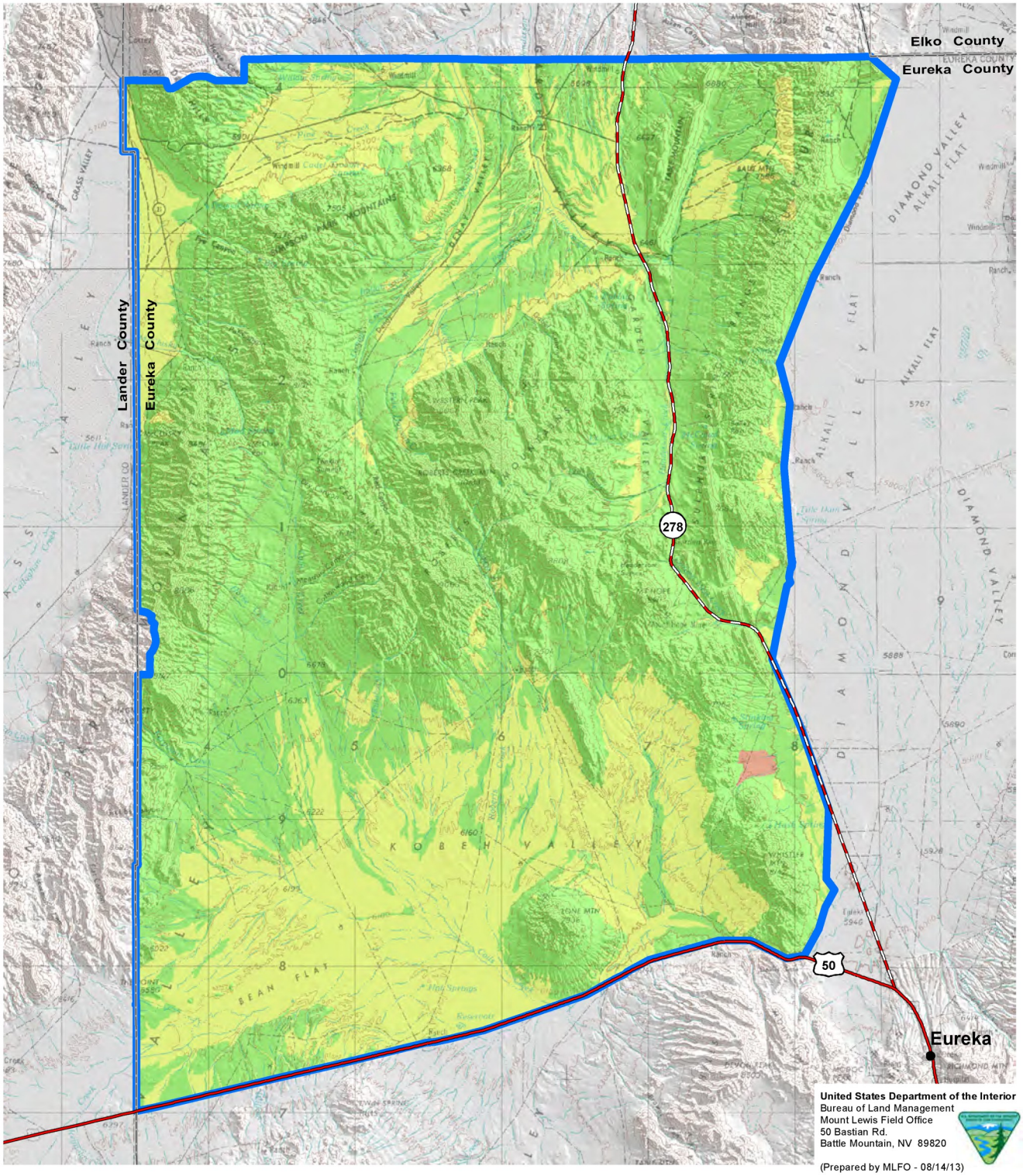

Legend

Soil Erosion Potential from Wind

- Severe Wind Erosion
- Moderate Wind Erosion
- Low Wind Erosion
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-15

Soil Erosion Potential from Wind

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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accepted as beneficial to overall plant growth and establishment. Topsoil thickness and organic matter content influences water and nutrient holding capacity and improves soil structure and soil quality. Topsoils in the project area have organic matter contents that range from 0 to 5 percent, as shown in **Table 3-11** and **Figure 3-16**.

3.8.2.2.6 Soil Textures

Surface soil textures in the project area range from silty clay to loamy very fine sand. Rock fragments such as gravel, cobbles, and stones are common in surface soils within the project area. The soils in the mountainous central part of the project area are typically very stony to very gravelly loams found on 8 to 50 percent slopes intermixed with rocky outcrops. These soils are shallow to moderately deep over lithic and paralithic bedrock and derive from residuum and colluvium from mixed igneous, metamorphic, and volcanic rocks. Soils found in the hilly terrain surrounding Mount Hope are on slopes ranging from 4 to 30 percent and derive from volcanic rocks and limestone. **Table 3-12** and **Figure 3-17** provide information on the surface soil textures within the project area.

3.8.2.2.7 Low Revegetation Potential

Soils with low revegetation potential have chemical characteristics such as high salts, sodium, or pH that may limit plant growth. Saline soils affect plant uptake of water and sodic soils (soils with high levels of sodium) often have drainage limitations. In addition, the success of stabilization and restoration efforts in these areas may be limited unless additional treatments and practices are employed to offset the adverse physical and chemical characteristics of the soils. Approximately 7 percent of soils in the project area are characterized as having low revegetation potential (**Figure 3-18**).

3.8.2.3 Vegetation Treatment Soil Suitability

3.8.2.3.1 Fire Damage Susceptibility

Wildfire is a naturally occurring event that has helped maintain ecosystem function in wildlands. Wildland fire can be caused by natural ignition, such as a lightning strike, or by man-caused ignition, and is used for a resource benefit. Buildup of excess fuel loads can result in high severity fires that damage the soils in the burn area. Prescribed burning is a restoration practice that is primarily designed to help return the natural fire cycle to the landscape.

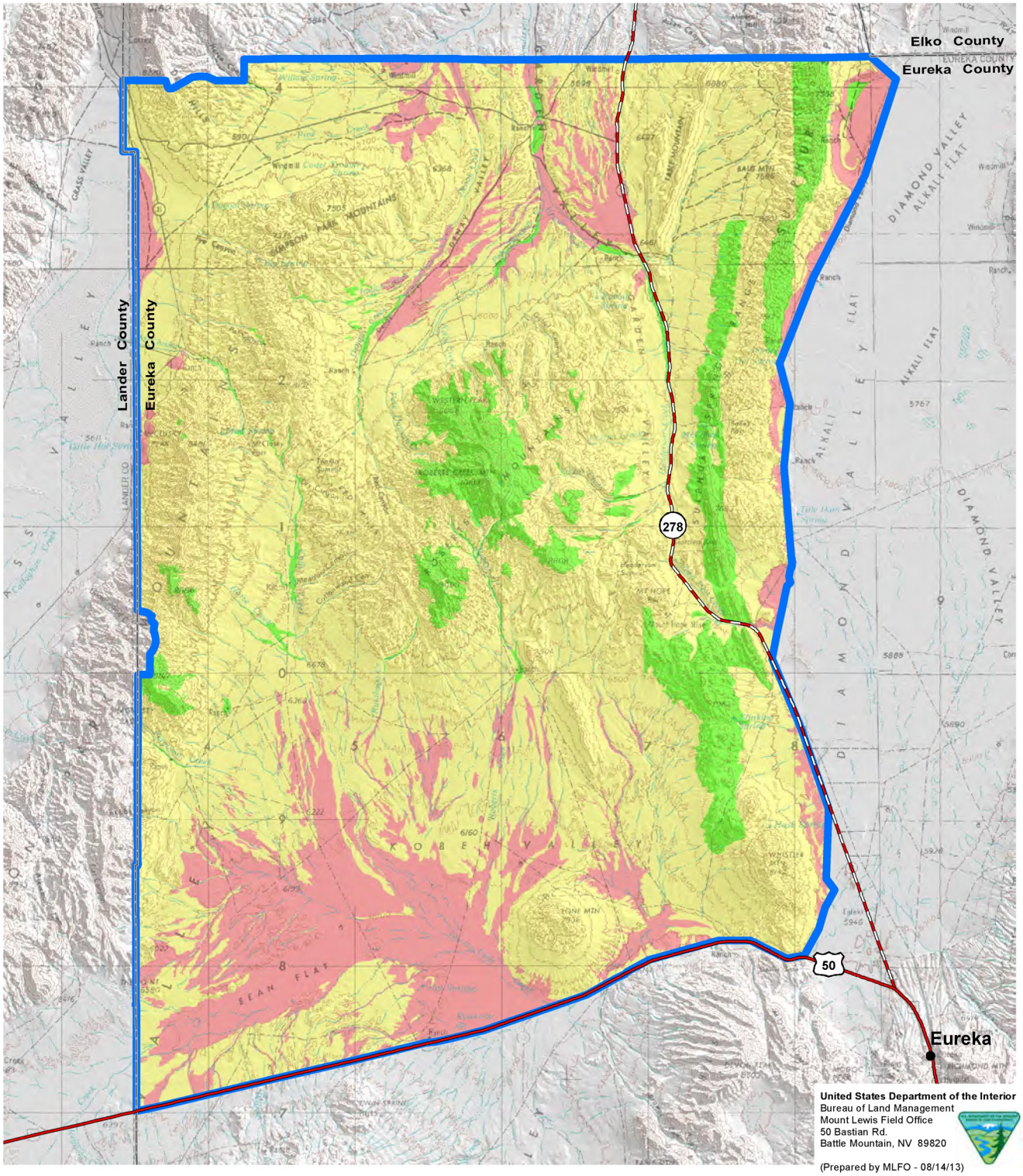
TABLE 3-11

Project Area Topsoil Organic Matter Content

Percent Organic Matter	Acres	Percent of Project Area
<1	121,740	16
1-1.9	396,013	53
2-3.9	213,342	28
>4	18,714	2

Source: USDA Natural Resources Conservation Service (2012).

Vulnerability to fire damage ratings are used to assess the risks that a fire will create a water repellant (hydrophobic) soil layer, volatilize essential soil nutrients, destroy soil biological activity, and cause soil and water erosion on a burned site. Vulnerability to fire damage ratings are directly related to burn severity (e.g., a low to moderate severity burn will not result in water repellant layer formation). **Table 3-13** and **Figure 3-19** provide vulnerability to fire damage ratings for the 3 Bars Project area (USDA Natural Resources Conservation Service 2012). Sandy soils are



Legend

Organic Matter within Surface Soils

- < 1%
- 1 - 3%
- 3 - 5%
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-16

Organic Matter within Surface Soils

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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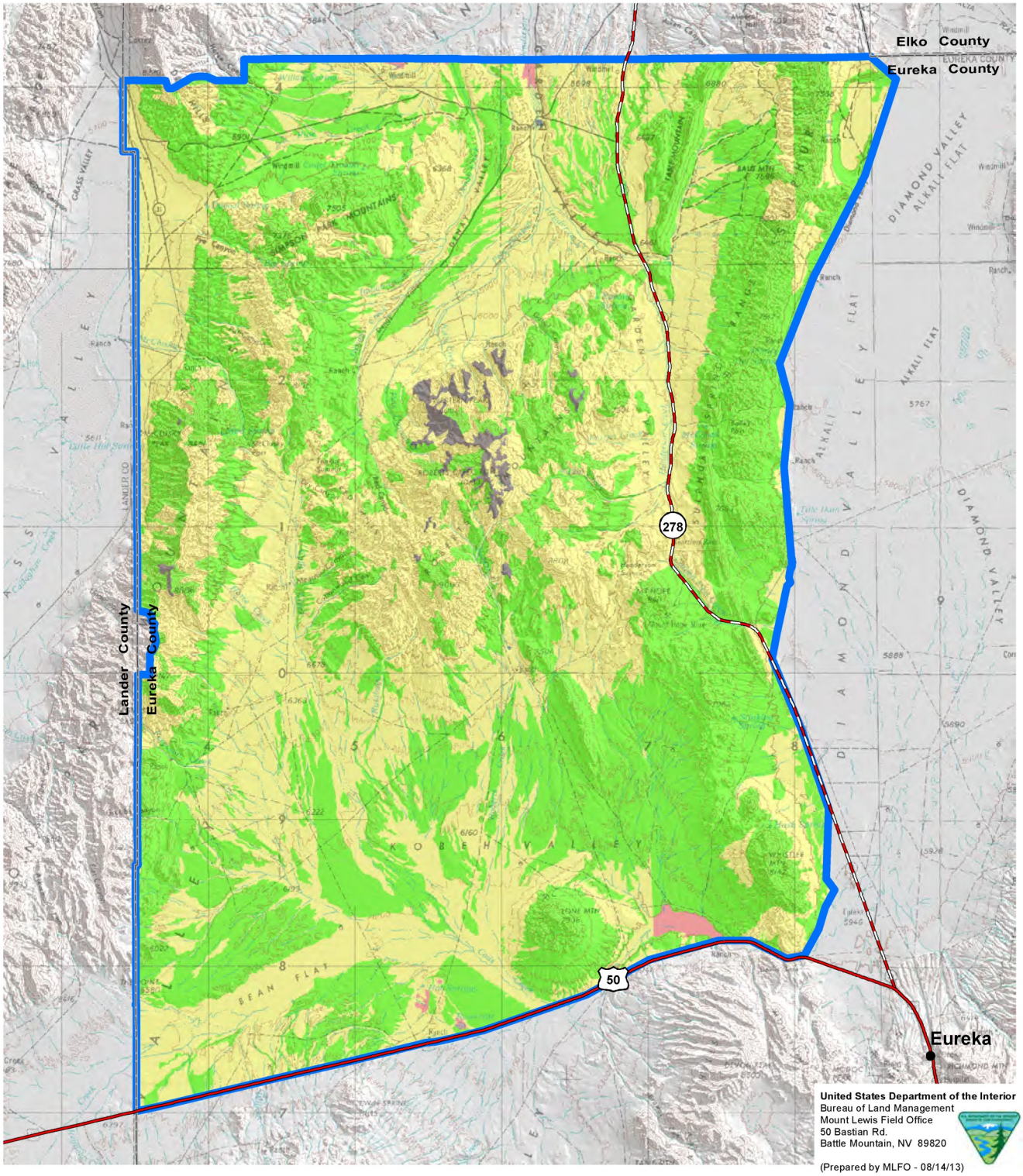

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Soil Surface Texture

- Fine Texture
- Medium Texture
- Coarse Texture
- Not Rated
- 3 Bars Project Area

Source: USDA NRCS 2012.

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Figure 3-17

Soil Surface Texture

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

1:400,000

N

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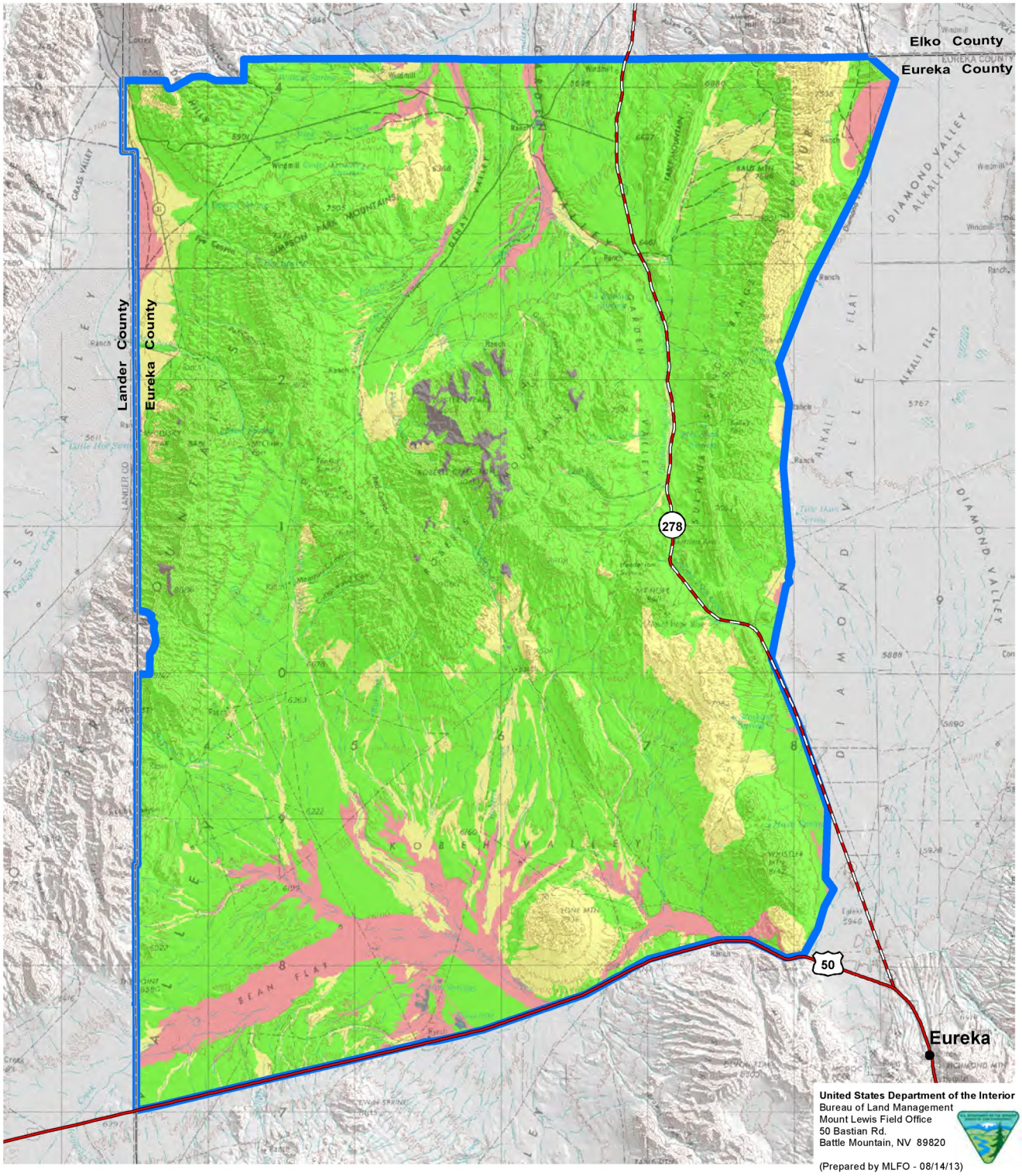

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Revegetation Potential

- Low Potential
- Moderate Potential
- High Potential
- Not Rated
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-18

Revegetation Potential

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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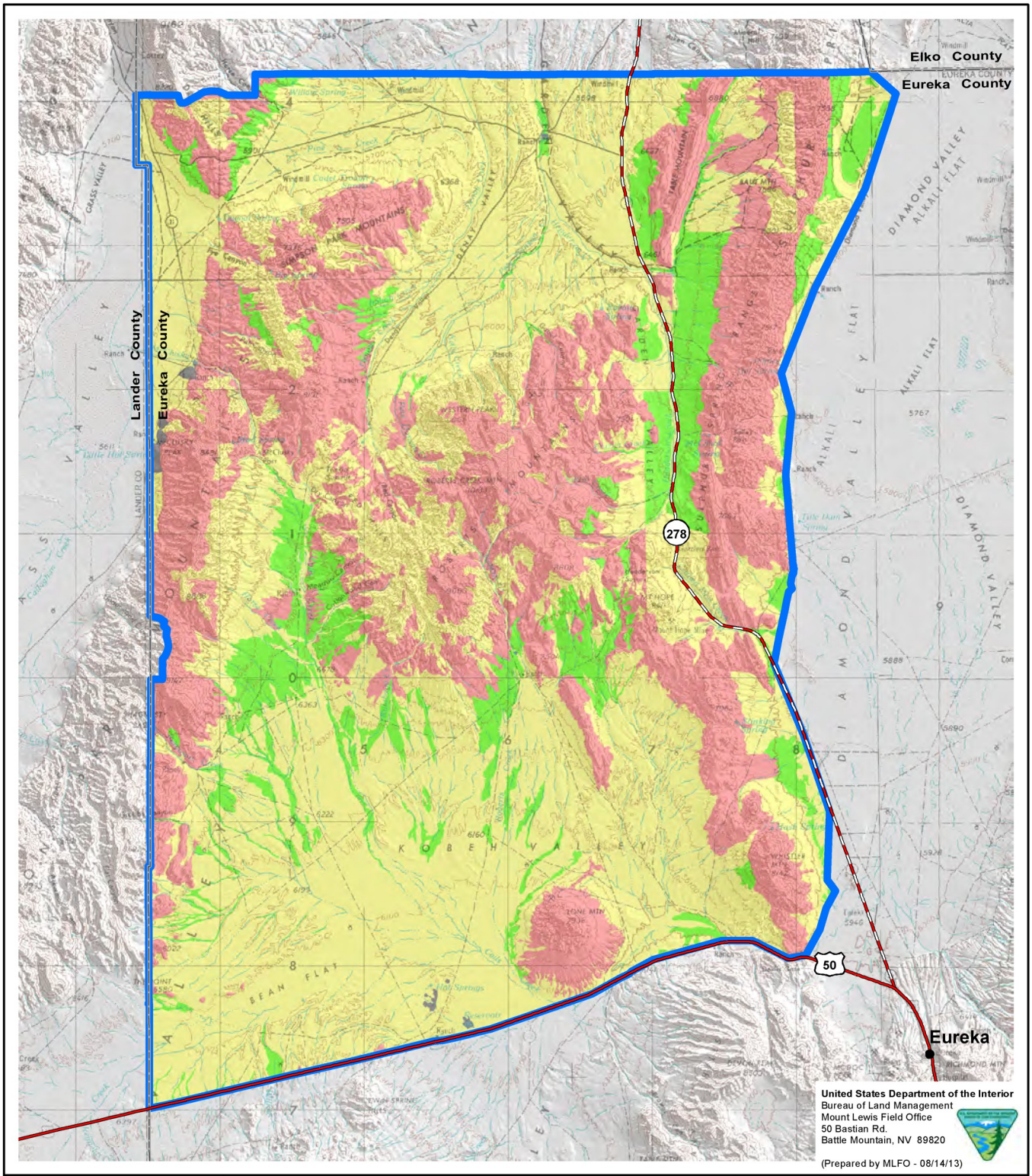

Legend

Fire Damage Susceptibility

- Highly Susceptible
- Moderately Susceptible
- Slightly Susceptible
- Not Rated
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-19

Fire Damage Susceptibility

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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more susceptible to formation of a water repellant layer than are fine textured soils. High rock fragment content increases the rate of heat transfer into the soil. Steep slopes increase the vulnerability to water erosion.

Vulnerability to formation of hydrophobic (water repellant) layers varies by vegetation type. For example, pinyon-juniper vegetation types are more susceptible to hydrophobicity than other shrubland or grassland vegetation types. Hot, dry south slopes are more susceptible to fire damage than cool northern slopes.

The vulnerability to fire damage rating should be used in conjunction with the rangeland seeding rating or the opportunity for restoration rating depending upon whether seeding or natural regeneration will be utilized on the site.

TABLE 3-12

Soil Textures in the Project Area

Surface Texture	Acres	Surface Texture	Acres
Cobbly Loam	46,483	Silt Loam	66,405
Extremely Cobbly Loam	3	Silty Clay	317
Extremely Stony Loam	10,389	Silty Clay Loam	2,298
Fine Sandy Loam	19,655	Stony Loam	40,686
Gravelly Fine Sandy Loam	13,842	Very Cobbly Clay Loam	255
Gravelly Loam	119,273	Very Cobbly Loam	94
Gravelly Sandy Loam	15,949	Very Fine Sandy Loam	4,451
Gravelly Silt Loam	183	Very Gravelly Loam	75,154
Loam	138,274	Very Stony Loam	87,785
Loamy Very Fine Sand	1,043	No Data	5,307
Sandy Loam	101,965	**Total**	**749,810**

Source: USDA Natural Resources Conservation Service (2012).

TABLE 3-13

Soil Suitabilities for Vegetation Treatment (acres)

Suitability or Susceptibility	Fire Damage Susceptibility	Shredder Susceptibility	Chaining Susceptibility	Site Degradation Susceptibility
Poorly Suited/Highly Susceptible	78,786	109,545	201,250	112,900
Moderately Suited/ Susceptible	444,257	210,470	121,653	426,103
Well Suited/Slightly Susceptible	225,446	428,474	425,586	209,487
Not Rated	1,321	1,321	1,321	1,321

Source: USDA Natural Resources Conservation Service (2012).

3.8.2.3.2 Shredder Susceptibility

Shredder mechanical treatment is commonly practiced, sometimes in combination with seeding, for rangeland restoration. This type of treatment is often implemented in sagebrush, mountain shrub, and pinyon-juniper vegetation types to reduce the size and composition of dense brush and trees up to 15 to 18 inches diameter at breast height. The treatment objective of creating a mulch layer can include reducing hazardous fuel loads, increasing forage for

livestock and wildlife, increasing infiltration, and reducing runoff and erosion (USDA Natural Resources Conservation Service 2012).

Shredder mechanical treatment suitability ratings represent the relative physical limitations of soil factors upon use of shredder implements suitable for treatment of rangeland sites. This rating should be used in conjunction with the rangeland seeding rating or the opportunity for restoration rating depending upon whether seeding or natural regeneration will be utilized on the site. **Table 3-13** and **Figure 3-20** show shredder suitability ratings for the 3 Bars Project area.

3.8.2.3.3 Chaining Susceptibility

Chaining is commonly practiced, sometimes in combination with seeding, for rangeland restoration. Chaining is implemented to reduce the composition of pinyon-juniper trees or sagebrush. Chaining also helps bury seed prior to chaining or between double-chainings.

The chaining suitability ratings represent the relative physical limitations of soil factors upon use of implements suitable for chaining rangeland sites. **Table 3-13** and **Figure 3-21** show chaining suitability ratings for the 3 Bars Project area. Steep slopes limit the ability to safely perform the chaining operation along the contour. Stones and rock outcrops potentially hinder the operation of the equipment. High water table affects the timing of chaining by limiting access to the site (USDA Natural Resources Conservation Service 2012).

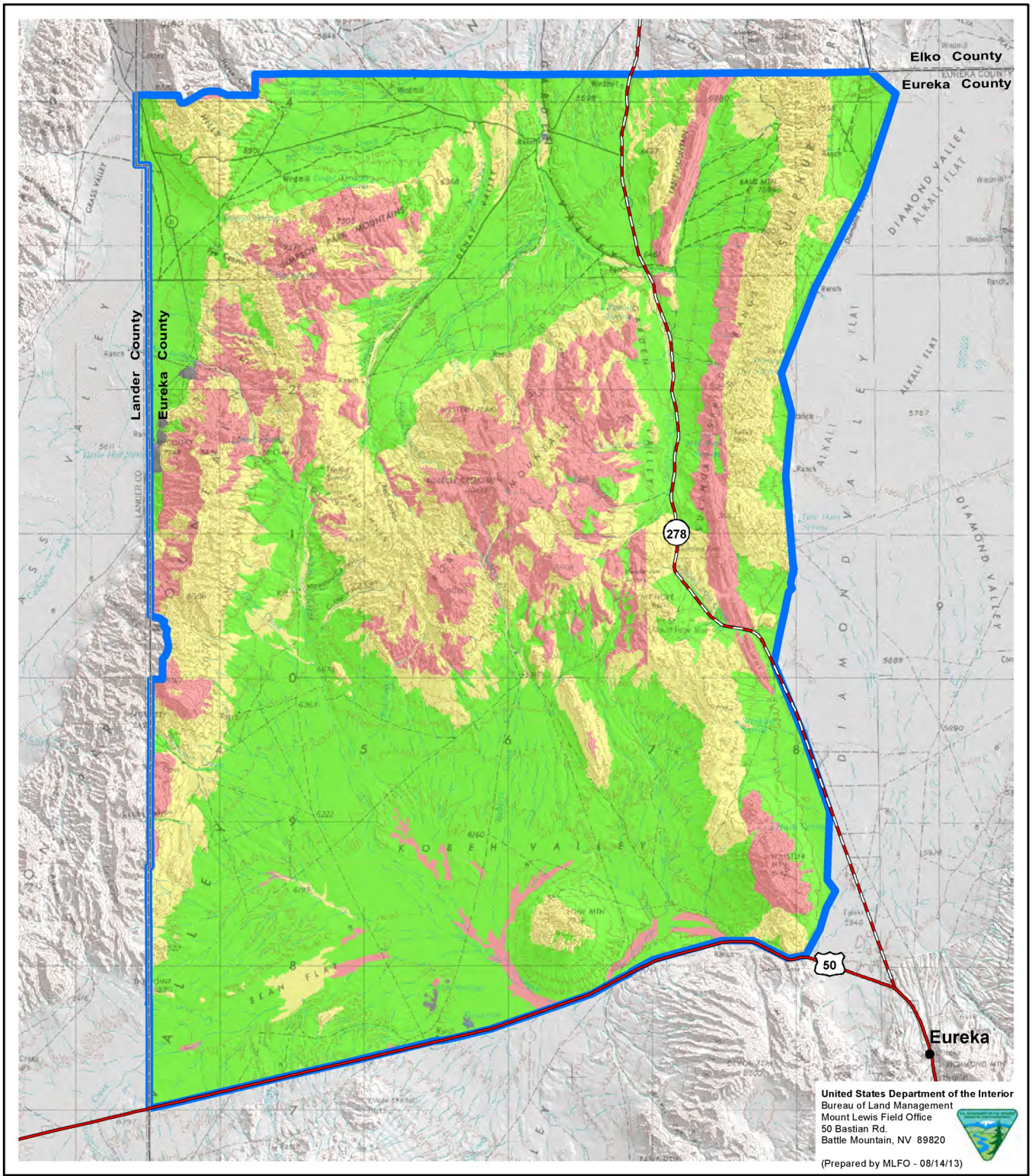
3.8.2.3.4 Site Degradation Susceptibility

Vulnerability to degradation is a function of resistance to degradation. Resistance to degradation of a rangeland or woodland site is a measure of its ability to function without change throughout a disturbance. The magnitude of decline in the capacity to function determines the degree of resistance to change. Resistance to degradation thus could be described as an area's buffering capacity (USDA Natural Resources Conservation Service 2012).

The vulnerability to site degradation suitability ratings represent the relative risk of water and wind erosion, salinization, sodification, organic matter, and nutrient depletion and/or redistribution, and loss of adequate rooting depth necessary to maintain desired plant communities. This rating should be used with the objective to protect vulnerable sites from the type of degradation that would result in accelerated erosion, reduction in water and air quality, invasion by annual grasses or noxious weeds, and other large scale potential natural plant community conversions. When degradation of soil and natural plant community characteristics goes beyond the threshold for the ecological site, the ecological site characteristics cannot be restored without artificial restoration efforts. **Table 3-13** and **Figure 3-22** show the site degradation susceptibility ratings for the 3 Bars Project area (USDA Natural Resources Conservation Service 2012).

3.8.3 Environmental Consequences

One of the goals of the 3 Bars Project is to improve soil quality and productivity and reduce soil erosion, especially in riparian zones. Restoration treatments would potentially affect soils by altering their physical, chemical, and/or biological properties. Physical changes could include the loss of soil through erosion or changes in soil structure, porosity, or organic matter content. Fire and other treatments would potentially alter nutrient availability and soil pH.



Legend

Mechanical Treatment Suitability (Shredder)

- Poorly Suited
- Moderately Suited
- Well Suited
- Not Rated
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-20

Mechanical Treatment Suitability (Shredder)

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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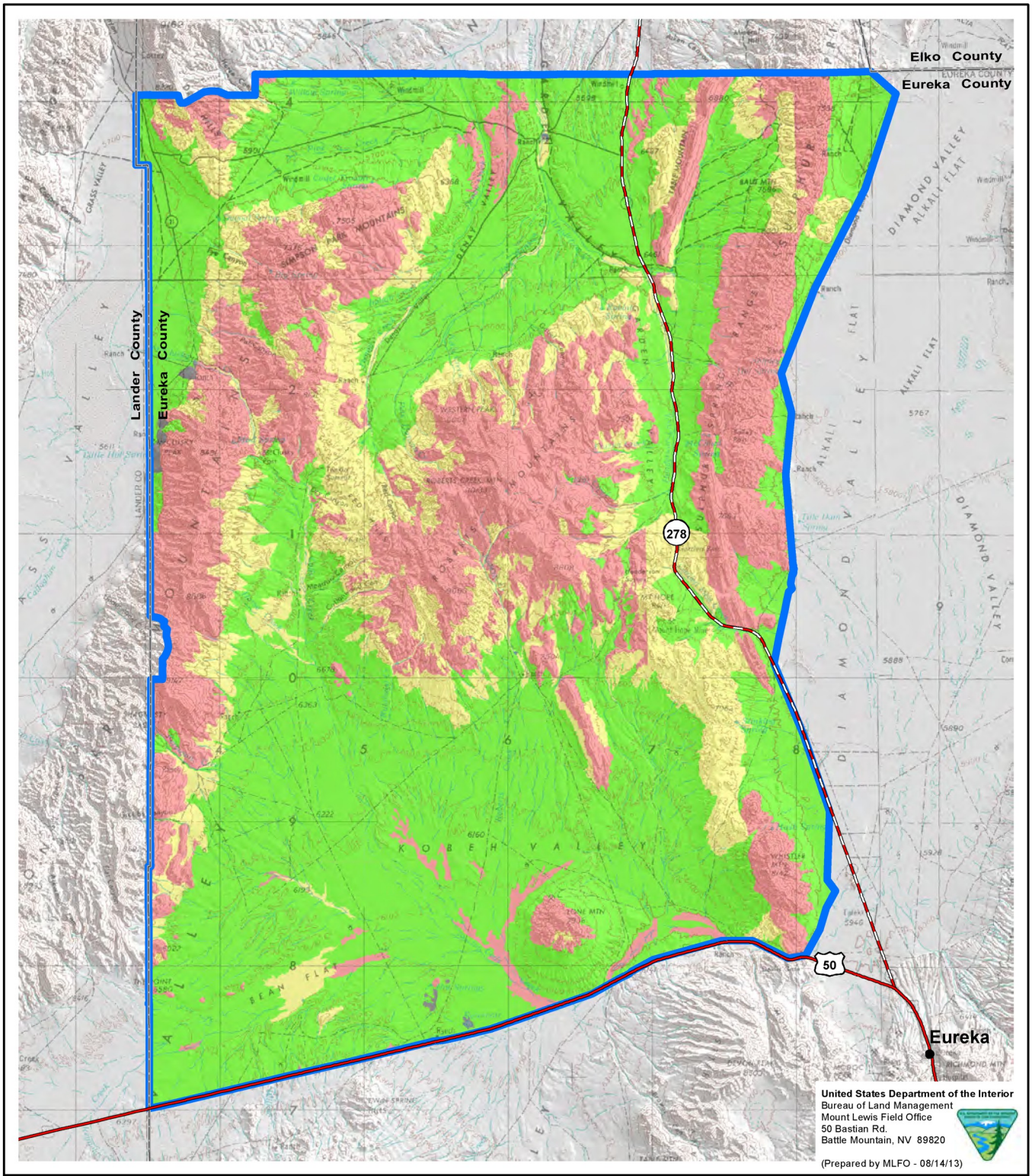

Legend

Mechanical Treatment Suitability (Chaining)

- Poorly Suited
- Moderately Suited
- Well Suited
- Not Rated
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-21

Mechanical Treatment Suitability (Chaining)

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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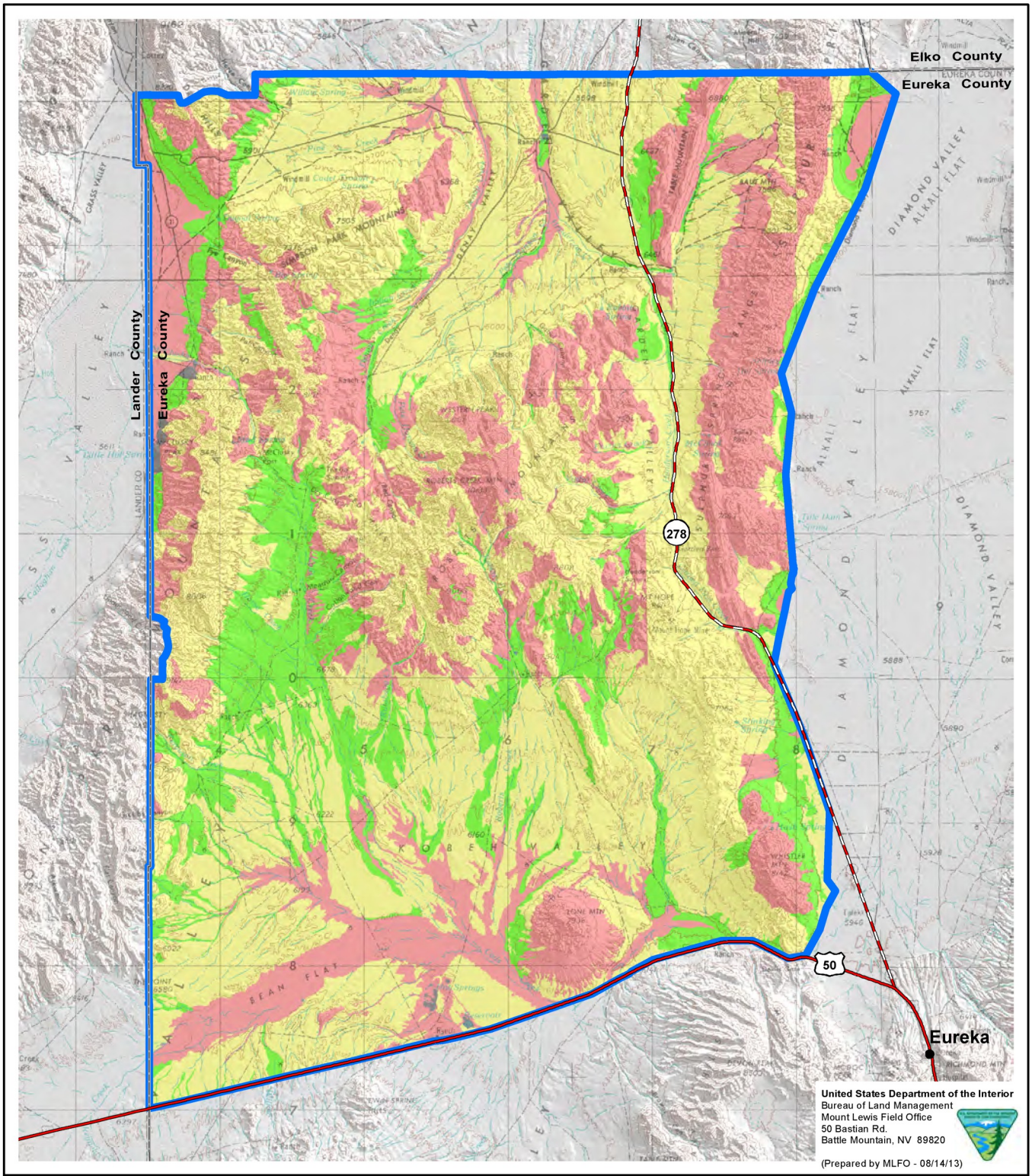

Legend

Site Degradation Susceptibility

- Highly Susceptible
- Moderately Susceptible
- Slightly Susceptible
- Not Rated
- 3 Bars Project Area

Source: USDA NRCS 2012.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-22

Site Degradation Susceptibility

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

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Some vegetation treatments might also alter the abundance and types of soil organisms that contribute to overall soil quality, including mycorrhizae (USDOI BLM 2007c:4-11). These consequences are expected to be short-term. Over the long term, treatments that remove noxious weeds and other invasive non-native vegetation, reduce fuels, and restore native plants should enhance soil quality on the 3 Bars Project area.

3.8.3.1 Key Issues of Concern Considered during Evaluation of the Environmental Consequences

Issues identified during public scoping include soil stability, wind and water erosion hazards, and effects of multiple treatments on soil resources.

3.8.3.2 Significance Criteria

Impacts to soil would be considered significant if BLM actions resulted in:

- Accelerated erosion that would likely exceed annual soil loss tolerances.
- Loss of topsoil, soil quality, or productivity that would limit revegetation success.
- Accelerated erosion from watershed slopes, leading to increased sedimentation or turbidity in streams or ponds, or to other instabilities along stream corridors.

3.8.3.3 Direct and Indirect Effects

3.8.3.3.1 Direct and Indirect Effects Common to All Action Alternatives

Adverse Effects

Restoration treatments could result in increased rates of erosion and reduced water infiltration, leading to reduced soil productivity. Erosion results when unstable soils are displaced under the forces of gravity, wind, or water. Although erosion is a natural process, it can increase markedly when vegetation is cleared (Bonneville Power Administration 2000). Unnaturally high erosion rates could occur as a result of soil disturbance during the restoration treatment, or from the resultant vegetation removal and associated decrease in soil stability. The effects of loss of plant cover and organic matter on soil erosion would be greatest for treatments in areas with soils having severe water and wind erosion hazards as shown in **Figures 3-14** and **3-15**.

Soils that are highly prone to water erosion would likely undergo accelerated erosion for a period during and after treatments. These areas are indicated on **Figure 3-14**. Erosion risk would be greatest for treatment areas on steep slopes, or where soils have clay, poor structural aggregation, or low organic content, and includes most riparian treatment areas. Treatments on these soils, particularly during wet periods, would encourage adverse impacts from soil erosion and sedimentation.

Removal of vegetation on public lands would influence the amount of water infiltrating into the soil in some areas. Removal of vegetation could increase surface runoff, reducing the amount of water that might infiltrate into the soil. However, vegetation removal would also eliminate the loss of water to the soil from water being captured by the plant canopy or lost through evapotranspiration.

Soil compaction associated with some vegetation treatment methods could reduce infiltration and soil productivity by eliminating pore spaces used for water storage and air exchange. Where highly compactable soils occur, noticeable compaction impacts would likely occur from vehicle traffic and equipment operations. These areas are indicated on **Figure 3-13**. Compaction could impede infiltration and accelerate runoff and erosion. Soil compaction may also result from manual construction of fences and spring exclosures, although disturbance areas would be small. Soil compaction risk would be greatest during wet or muddy conditions, such as during spring runoff, during rainstorms, and for a day or so after storm events.

Vegetation treatments can alter the chemistry of the soil. Treatment methods that reduce organic matter cover can reduce the productivity of soils by reducing carbon and other nutrient inputs, and by reducing the moisture-holding capacity. Erosion can result in the transport of organic matter and nutrients off site. Soils with little organic matter to begin with (e.g., most Aridisols) are more susceptible to losses of organic matter. Removing nitrogen-fixing plants, such as legumes, can reduce soil nitrogen, and removing logs and other plant material can deprive soils of nutrients provided by decaying material. Removing vegetation can also reduce evapotranspiration, allowing more water to leach soluble nutrients from the soil (USDOI BLM 2007c:4-12).

Laborers and vehicles accessing the site could disturb topsoil and/or surface organic matter; however, the extent of this disturbance should be limited. Coarse-textured soils and steep slopes would be the most fragile, and extensive areas of disturbance could result in increased erosion rates. There is the potential for some contamination of the soil from petroleum products used in hand-held power equipment or from transport vehicles, but these effects would be localized.

Beneficial Impacts

Although treatments would have short-term effects on soil condition and productivity, it is predicted that disturbance effects resulting from restoration activities would be less severe than wildfire effects and erosion that would result from lack of restoration. In particular, efforts to restore stream functionality, reduce noxious weeds and other invasive non-native vegetation spread, and reduce wildfire risk would benefit soils. The time necessary to accomplish these beneficial results would vary between treatments and from site to site, but would likely be on the order of years to decades after treatment. Based on soil characteristics, site revegetation potential is moderate to high for 3 Bars Project treatment sites (**Figure 3-18)**.

Vegetation treatments that reduce or eliminate noxious weeds and other invasive non-native vegetation could be beneficial to soil quality. Beneficial impacts to soil stability and quality would ultimately result from revegetation treatments, due to the overall improvement in nutrient cycling, structural aggregation, reduction of erosion and sedimentation, accumulation of topsoil and organic matter, and enhanced infiltration.

If these treatments were to result in increased native plant cover on sites degraded by noxious weeds and other invasive non-native vegetation, soil quality would begin to rebound. Sites with a large component of noxious weeds and other invasive non-native vegetation may be at a higher risk for erosion than sites that support native vegetation. Invasive plants can increase the potential for wind or water erosion by altering fire frequency or producing chemicals that directly affect soil quality or organisms. These negative effects include increased sediment deposition and erosion, and alterations in soil nutrient cycling. In areas where pinyon-juniper has invaded, studies show that when tree dominance is reduced and herbaceous cover is increased, runoff and soil erosion decrease on sites with relatively fine-textured soils. Leaving tree debris on the ground after mechanical treatments can intercept runoff and increase

infiltration, increase soil moisture by reducing evapotranspiration and evaporative loss of soil water, and promote nutrient cycling (Tausch et al. 2009).

Restoration treatments would benefit soil quality and productivity by reducing the risk of wildfire. Wildfires generally occur when soils are driest, resulting in hot soil temperatures, loss of nutrients, consumption of soil organic matter, and reduction of soil aggregation, infiltration, and aeration (Erickson and White 2008). Catastrophic, stand-replacing wildfires in pinyon-juniper woodlands can cause the loss of 75 to 100 percent of the soil organic matter (Neary et al. 1999). Given the ability of an unplanned, uncontrolled, severe wildfire to cover a large geographic area, the detrimental effects of wildfire on soil quality have the potential to be high. Thus, vegetation management that reduces this risk would be beneficial to soil resources on public lands. Lower intensity prescribed fires would help avoid these conditions. This would be especially important on moderate and steep slopes, where uncontrolled catastrophic wildfires fires could cause severe erosion impacts.

Removal of noxious weeds and other invasive non-native vegetation should improve soil function and increase both soil biodiversity and soil moisture. Many noxious weeds and other invasive non-native vegetation have relatively sparse canopies, which allow for greater evaporation from the exposed soil than dense vegetative cover. Sites infested with noxious weeds and other invasive non-native vegetation often experience more extreme soil temperatures that can alter soil moisture regimes. Removal of noxious weeds and other invasive non-native vegetation and reestablishment of native vegetation should slow runoff and evaporation and moderate soil temperatures (USDOI BLM 2007c:4-23).

3.8.3.3.2 Direct and Indirect Effects under Alternative A (Preferred Alternative)

Accelerated erosion and sediment yields could occur under Alternative A, primarily from pinyon-juniper and sagebrush treatments. About 4,000 of the acres treated annually would occur in areas that are susceptible to wind or water erosion, or would be compaction prone, while about 10,000 of the acres treated annually could occur in areas that are susceptible to damage from fire treatments.

Over time, the risks of water and wind erosion should be reduced from current levels. Soil fertility would improve over time for most treatments. Treatment activities that move pinyon-juniper woodlands and rangelands toward historical ranges of variability would provide favorable conditions for soil functions and processes that contribute to long-term soil productivity at a broad scale (USDOI BLM 2007c:4-18).

Riparian Treatments

The following discussion focuses on the effects of riparian treatments on soil. A discussion of stream processes, and how proposed stream engineering treatments would affect stream morphology and functionality, including processes related to soil erosion and deposition, is in Section 3.10.3 under Wetland, Floodplain, and Riparian Zones.

Adverse Effects

Locally, riparian conditions could be adversely affected if treatments resulted in accelerated soil erosion or deposition occurred near water bodies. These effects would occur along streams or other riparian zones if soils on nearby slopes were exposed and subjected to greater transport capacities from raindrop splash or overland flow.

Treatment work at several streams, ponds, and springs, including projects associated with the Black Spring Unit, Garden Spring Unit, Henderson above Vinini Confluence Unit, and Frazier Creek Unit groups, would involve using

heavy equipment to reconstruct streams and improve riparian habitat. Because of the spatial scale of construction-related disturbance associated with channel modification projects, the risk of unanticipated impacts can be very high. This is particularly true when projects do not meet restoration objectives, are not constructed as planned, or are designed with inadequate knowledge of watershed processes, disturbance regimes, or altered watershed conditions. Poorly designed channel modification projects can result in unexpected channel erosion in adjacent reaches, aggradation or degradation of the channel bed, or other impacts to habitat and processes due to changes in channel slope, bed elevation, and sediment transport capacity. Furthermore, the dynamic nature of hydraulic forces, and the uncertainties inherent in design and analysis, may result in inadvertent impacts from channel modification even when properly designed (Saldi-Caromile et al. 2004).

The use of heavy equipment can result in soil compaction, particularly in areas of moist soils. Compaction by vehicles and other heavy equipment can reduce the porosity of soils, thus limiting water infiltration and increasing surface water runoff and erosion. Soil disturbance during stream restoration could increase erosion and degrade riparian habitat, especially when the treatment is performed on hillslopes. Erosion can be a problem on slopes greater than 20 percent. About 21 percent of riparian treatment acreage has moderate to high soil water erosion potential, 8 percent has moderate to high wind erosion potential, and 27 percent is compaction prone.

The treatment areas most prone to compaction and severe water erosion include the McClusky Creek and Indian Creek Headwaters North units. The McClusky Creek Unit in particular has a combination of severe water erosion risk and compaction-prone soils. For those streams identified for Lahontan cutthroat trout habitat improvement, streams most prone to severe water erosion would include portions of streams within the Vinini Creek and Roberts Creek units. Compaction prone soils exist at the upper Henderson Creek, Vinini Creek, and Willow Creek units. The Vinini Creek and Willow Creek units in particular have a combination of severe water erosion risk and compaction-prone soils. Wind erosion hazard is also a moderate risk for adverse impacts in the Lower Henderson Creek Unit. Treatment by mechanical methods during dry months can minimize the effects of erosion on riparian zones.

In general, prescribed fires would have fewer impacts on soil than wildfires, as they are low severity and can be controlled to occur in one particular area. In addition, if the BLM does conduct prescribed fire treatments near riparian zones, fire treatments would be limited to no more than a few acres annually. However, nearly 90 percent of riparian treatment acreage has high risk for fire damage to soils and this risk would be considered when planning treatments. Prescribed fires could consume or degrade peat soil, change the vegetation composition and structure of an area, and increase soil erosion. When the various potential impacts to soils (water erosion hazard, compactability, fire damage, and other site degradation factors) are reviewed in combination, the areas where riparian treatments have the most potential for adverse impacts occur along Roberts Creek, Vinini Creek, Willow Creek, McClusky Creek, and Henderson Creek.

Beneficial Effects

Stream restoration efforts would help reconnect the streams with their floodplains, help the systems dissipate energy associated with high water flow, filter sediment, capture bedload, aid floodplain development, improve floodwater retention and groundwater recharge, restore desirable soil moisture regimes, and provide suitable conditions for riparian plants to develop root masses that stabilize streambanks against erosion. Stream bioengineering and stabilization efforts using manual and mechanical methods would reduce soil erosion and episodes of bank failure.

The BLM would remove pinyon-juniper that is encroaching into riparian zones. Pinyon-juniper is not a riparian species and does not hold soil as well as native riparian species. Pinyon-juniper would be cut into logs or mulched.

Vegetation that is uprooted, shredded, mowed, or otherwise altered and scattered on the surface would improve soil cover and organic matter. Scattered vegetative debris could temporarily provide greater soil stability than before treatment. Noelle (2012) observed that slash did not affect runoff but sediment yield was significantly reduced in pinyon-juniper stands where slash was used to slow runoff on steep slopes.

Stream degradation in the 3 Bars Project area can be attributed to historic livestock, wild horse, and wild ungulate soil disturbance in addition to other natural and human-caused factors, and this disturbance has led to soil erosion (USDOI BLM 1999a, 2004b, 2007f, 2008f, 2009e). To reduce these impacts, the BLM could use fencing to temporarily exclude livestock, wild horses, and wild ungulates from treatment areas to reduce soil disturbance in treatment areas and allow native vegetation to recover.

Aspen Treatments

Adverse Effects

Mechanical and prescribed fire treatments could lead to soil erosion, as 57 percent of aspen management acreage has moderate to high soil water erosion potential and 14 percent is compaction prone; none of the aspen management treatments areas have potential for wind erosion. Nearly all potential treatment acres have moderate to high fire damage susceptibility, so fire should be used sparingly in aspen treatment areas.

Beneficial Effects

The BLM would remove pinyon-juniper trees to slow pinyon-juniper encroachment into aspen stands, and to create fire and fuel breaks. Only about 10 acres of pinyon-juniper would be treated annually near aspen stands. Creation of fire and fuel breaks would slow or stop the spread of a wildfire, to the benefit of soil, as discussed earlier.

Pinyon-juniper Treatments

Adverse Effects

Pinyon-juniper treatment areas are generally on moderate to steep hillslopes that are prone to erosion. Where trees are in dense stands, removal of these trees could lead to water and wind erosion as vegetative ground cover is mostly absent from these stands. These effects of vegetation loss would lessen as forbs and grasses improve ground cover, and soil loss could also be mitigated by leaving downed wood and slash on the ground as mulch.

Manual treatments using chainsaws would have few effects on soil as there would be little soil disturbance. The effects of mechanical treatments on soil would depend on the following: 1) the amount of soil exposed during the treatment; 2) the effect of ground disturbance on soil properties; and 3) the site conditions, especially slope and patterns of precipitation.

Mechanical treatments would affect soils by removing vegetation and by disturbing or removing topsoil. Because plant and litter cover protect the soil, and roots hold the soil in place, removal of plant materials exposes soil. Exposed soils are vulnerable to increased water and wind erosion and reduced water holding capacity. Overall, 37 percent of pinyon-juniper management acreage has moderate to high water erosion potential, 16 percent has moderate to high wind erosion potential, and 32 percent is compaction prone. Of those areas where mechanical treatments could occur, about 18 and 38 percent of the treatment acreage are poorly suited for shredding and chaining, respectively.

Although most of the mechanical treatments would not directly disturb the soil, the use of heavy equipment on treatment sites could result in increased soil compaction, and heavy equipment can shear and rut wet soils. Compaction by vehicles and other heavy machinery can reduce soil pores and limit water infiltration, soil aeration, and root penetration. Approximately 21 percent of treatment acres are prone to soil compaction.

Mechanical treatments could disrupt biological soil crusts. Crusts are sensitive to compaction by vehicles and other heavy equipment. The removal or destruction of biological soil crusts could adversely affect soil quality by increasing susceptibility to erosion, reducing nitrogen inputs, reducing infiltration, and potentially encouraging weed establishment (USDOI BLM 2007c:4-15).

The BLM would use manual and mechanical treatments to thin pinyon-juniper and create fire breaks on up to 1,400 acres on the Lone Mountain area. Most trees would be thinned using chainsaws, while fire breaks would be created using manual and mechanical methods, such as shredding. These methods have minimal impact on the soil layer, and soils on Lone Mountain are not prone to compaction. Approximately 60 acres have water erosion hazard, and 400 acres have moderate wind erosion hazard.

The BLM would thin and remove pinyon-juniper and create fire breaks in several drainages on Roberts Mountains. Treatment units include the Atlas, Birch, Frazier, Gable, Henderson, Upper Pete Hanson, Upper Roberts, and Vinini units. Approximately one-third of the proposed treatment acres are on soils that are susceptible to compacting, and the resulting adverse impacts to erosion, runoff, sedimentation, and degraded soil quality, would be of concern for this treatment group. In addition, approximately 17 percent of acres have severe water erosion hazard. Nearly 80 percent of acres have moderate or high fire damage susceptibility, while 43 and 26 percent are poorly suited for chaining and shredding, respectively. Thus, mechanical treatments may be preferable to fire treatments if there is concern about soil damage and loss.

On the 3 Bars Ranch, Cottonwood/Meadow Canyon, Dry Canyon, Lower Pete Hanson, Tonkin North, Tonkin South, whistler, and Sulphur Spring Wildfire Management units, soil compaction risk occurs on about 15 percent of the treatment areas, and the resulting accelerated erosion, runoff, sedimentation, and degraded soil quality would be a minor adverse impact within this treatment group. Approximately 21 percent of the treatment areas have severe water erosion hazard due to slopes and inherent soil conditions. About 70 percent of the areas have moderate or high fire damage susceptibility, while 45 and 18 percent of the areas are poorly suited for chaining and shredding, respectively. Thus, shredding treatments may be preferable to prescribed fire and chaining treatments if there is concern about soil damage and loss. Approximately 30 percent of the Sulphur Spring Wildfire Management Unit is at risk for water erosion, while 90 percent of the unit has moderate or high fire damage susceptibility.

Potential adverse impacts from wildland fires in pinyon-juniper treatment areas include greater vulnerability to accelerated erosion, loss of organic matter, temporarily reduced microbial populations, and the potential formation of water-repellent surface layers (Ice et al. 2004). Barger (2012) found that prescribed fire in pinyon-juniper stands led to a 11- to 32-fold increase in wind erosion compared to shredded and control sites. He recommended that shredding should be preferred over prescribed fire where possible.

Biological soil crusts could be destroyed in areas that are burned; however, lightly scorched biological crusts may still function to reduce erosion. Extensive and severe wildfires often destroy biological crusts and leave the bare soil unprotected, whereas small, less intense prescribed burns may leave some biological soil crusts intact and functioning. Over 80 percent of pinyon-juniper treatment areas are prone to fire damage that can create a water repellant soil layer, volatilize essential soil nutrients, destroy soil biological activity, and cause soil and water erosion on a burned site.

Conducting prescribed burns when soils are not extremely dry, or during cooler times of the year, could reduce fire effects to soils and biological soil crusts.

Beneficial Effects

Restoration treatments that move woodlands toward historical ranges of variability would provide favorable conditions for soil functions and processes that contribute to long-term soil productivity at a broad scale (USDOI BLM 2007c:4-18). Erosion and sedimentation processes in pinyon-juniper stands would be reduced long term by vegetation treatments. In a review by Wilcox and Davenport (1995), they found that as pinyon-juniper increases in density, the understory cover decreases. Hastings et al. (2003) observed accelerated erosion in areas where pinyon-juniper was encroaching into native woodlands and displacing native vegetation. Pierson et al. (2007) noted that juniper-dominated hillslopes had significantly lower ground cover and produced rapid runoff from rainfall events that was up to 15 times greater than on sites that were not dominated by juniper. They noted that cutting juniper stimulated herbaceous recovery, improved infiltration capacity, and protected the soil surface from rainfall events. Lossing (2012) observed that interception by pinyon-juniper reduced the amount of rainfall reaching the soil beneath the tree canopy by 44 percent. Mechanical treatments that ultimately result in improved plant cover and diversity can improve habitat for soil organisms and reduce the risk of soil erosion. Soil organic matter contents, nutrient cycling, topsoil formation, and greater structural aggregation would increase following treatments. Soil fertility, aeration, and infiltration should improve over time. The length of time for these effects to occur is likely to be on the order of years to decades, but improving trends may become noticeable after a few years (USDOI BLM 2007c:4-18).

Crushing, chipping, and shredding of vegetation can result in all or most of the organic material remaining on site. The application of large quantities of fresh, woody organic material to the soil surface can provide protection to the soil in the form of mulch. It is well documented that mulch results in attenuated soil temperatures, improved water infiltration, increased soil moisture retention, and reduced sediment yield. Chaining is a common and relatively inexpensive mechanical method of converting woodlands to a mix of herbaceous and shrubby vegetation. It is effective in adding litter to the soil surface (Grahame and Sisk 2002).

Several beneficial effects to soils would result from prescribed fires. These include increases in plant nutrient availability, and long-term enhancement of organic matter and microbial populations under desirable plant communities.

Sagebrush Treatments

Adverse Effects

In areas where mechanical treatments could occur, water and wind erosion is of concern at several treatment units. Overall, about 24 percent of sagebrush treatment acreage has moderate to high soil erosion potential, 75 percent has moderate to high wind erosion potential, and 39 percent is compaction prone. Only about 10 percent of the treatment units are poorly suited for chaining or shredding of vegetation.

At Alpha, Coils Creek, Kobeh East, Nichols, Roberts Mountain Pasture, and South Simpson units, approximately 60 percent of sagebrush treatment areas for this group have wind erosion hazards, and thinning of the shrub overstory could increase the risk of soil loss from this process. Approximately 2,100 acres in the South Simpson Unit are compaction prone. These units are moderately to well-suited for shredding and chaining of vegetation.

Approximately 48 percent of the Table Mountain Unit has compaction prone soils, most (84 percent) of West Simpson Park is susceptible to severe water erosion, and the Rocky Hills Unit has moderate risk of wind erosion (63 percent of potential treatment area). About 63 percent of the Whistler Sage Unit also has moderate wind erosion risk. About 78 percent of the West Simpson Unit is poorly suited for vegetation shredding. Use of equipment in these areas could contribute to soil loss and reduced water infiltration, and some soils may not be well suited for use of shredding and chaining equipment.

Fire could be used on sagebrush treatment areas to treat mountain big sagebrush on a few acres in the Three Corners Unit, and to remove non-native vegetation on Table Mountain, Rocky Hills, Whistler Sage, and West Simpson Park units. The Three Corners Unit is moderately susceptible to fire damage, while about half of the acreage on the Rocky Hills and West Simpson Park units is moderately to highly susceptible to fire damage.

Disking would be used to control non-native vegetation, while drill and broadcast seeding would be used to revegetate treatment sites. These methods could improve soil porosity and aerate the root zone in clayey or compacted soils, but may degrade soil structure and reduce permeability to air and water on more fragile soil surfaces. This could promote soil erosion. Similar impacts could occur from harrowing and dragging, but generally would be less severe because of the shallower nature of these techniques. Treatments would likely destroy any existing biological soil crusts in the treatment area, which could reduce infiltration, accelerate erosion, and degrade soil microbiological properties (USDOI BLM 2007c:4-15).

The BLM could use livestock, in combination with mechanical treatments, to control cheatgrass and other invasive non-native vegetation. The action of animal hooves could cause some disturbance, shearing, and compaction of soil, increasing its susceptibility to both water and wind erosion. Severe compaction often reduces the availability of water and air to plant roots, sometimes reducing plant vitality. Domestic animals could damage biological soil crusts at treatment sites through physical disruption, resulting in reduced species richness and lichen/moss cover (Belnap et al. 2001). Biological soil crusts, however, are not likely to be well developed in areas dominated by non-native vegetation.

Beneficial Effects

Treatments that thin the sagebrush canopy and promote the development of understory vegetation would help to stabilize soils and reduce the risk of wind and water erosion.

Sites with a large component of noxious weeds and other invasive non-native vegetation may be at a higher risk for erosion than sites that support native vegetation. Units with a large component of cheatgrass (fine fuels) may experience faster moving wildfires, which would adversely affect soils. Reestablishment of native vegetation on treatment sites would stabilize the fire cycle and lend to improved soil stability and productivity.

3.8.3.3.3 Direct and Indirect Effects under Alternative B (No Fire Use Alternative)

Adverse effects to soil would generally be the same as described for Alternative A. Excluding prescribed fire and wildland fire for resource benefit would avoid the increases in runoff and erosion common to burned areas. Reduced soil infiltration, due to resinous sealing after intense burning, and loss of soil microorganisms would not occur as a result of prescribed burns.

The BLM would primarily be limited to mechanical methods and using livestock to control non-native vegetation over large areas. These methods could result in more soil disturbance and soil compaction than the use of fire. The

Table Mountain and West Simpson Park units are on rugged terrain, and use of mechanical equipment to control cheatgrass would be difficult and erosion potential from treatments would be great, especially on the West Simpson Park Unit. The BLM would not be able to conduct prescribed burns to open up woodland stands to promote understory development and improve infiltration. The BLM also would not be able to use fire to create fuel breaks, remove hazardous fuels in Phase II and III pinyon-juniper stands, and prepare areas with cheatgrass for seeding, potentially resulting in an increase in wildfire and reduction in sagebrush restoration success. Thus, many of the beneficial, long-term effects of treatments on soils discussed under Alternative A would not be realized under Alternative B.

3.8.3.3.4 Direct and Indirect Effects under Alternative C (Minimal Land Disturbance Alternative)

The BLM anticipates treating about one-fourth as many acres under Alternative C as under Alternative A. Because the BLM would be unable to use mechanical methods, and prescribed fire and wildland fire for resource benefit, adverse impacts and benefits to soil would be similar to those described under Effects Common to All Alternatives. The risk of localized compaction and short-term accelerated erosion would be less under Alternative C than the other alternatives, as there would be little ground disturbance under Alternative C. By not being able to use mechanical methods, there would be less risk of soil compaction and erosion from these treatments, and less risk for soil disturbance that could lead to noxious weeds and other invasive non-native vegetation infestations. However, the BLM would not be able to use mechanical equipment to thin and remove pinyon-juniper and sagebrush and create mulch to promote understory development, improve soil fertility, reduce soil erosion, and increase infiltration. The BLM also would also not be able to use equipment to reduce hazardous fuels, create fire and fuel breaks, and pile and slash burn to remove downed wood and slash, increasing the risk of wildfire and its impacts on soil. Thus, many of the beneficial, long-term effects of treatments on soils discussed under Alternatives A and B would not be realized under Alternative C.

3.8.3.3.5 Direct and Indirect Effects under Alternative D (No Action Alternative)

There would be no direct effects to soil resources from this alternative as no treatments would be authorized under this alternative. The BLM, however, would not create fire and fuel breaks; thin and remove pinyon-juniper to promote healthy, diverse stands; slow the spread of noxious weeds and other invasive non-native vegetation, especially cheatgrass; restore fire as an integral part of the ecosystem; or reduce the risk of a large-scale wildfire. Thus, long-term loss of soil and soil productivity due to erosion, stream channel instability, pinyon-juniper encroachment, and wildfire would be greatest under Alternative D.

3.8.3.4 Cumulative Effects

The CESA for soil resources is approximately 1,841,700 million acres and includes those watersheds at the Hydrologic Unit Code 10 level that are all or partially within the 3 Bars Project area (**Figure 3-1**). Approximately 92 percent of the area is administered by the BLM, 6 percent is privately owned, and 2 percent is administered by the Forest Service. Past and present actions that have influenced soil resources in the 3 Bars ecosystem are discussed in Section 3.2.2.3.3.

3.8.3.4.1 Cumulative Effects under Alternative A (Preferred Alternative)

Historic overgrazing, introduction of cheatgrass, large wildfires, and other natural and human-caused factors have contributed to the deviation of the plant communities from the Potential Natural Communities across the 3-Bars

ecosystem. The Potential Natural Community is the plant community that would become established if all successional sequences were completed without interference by humans under current environmental conditions. Potential Natural Communities can include naturalized non-native species. This has led to a decrease in the functionality of ecological processes, thus reducing the resilience and resistance of these ecosystems to disturbance. The treatments proposed in the 3-Bars ecosystem are designed to help these ecosystems recover their functionality and return to their Potential Natural Community.

The BLM would continue wild horse management activities including Appropriate Management Level reviews and adjustments, adjustments to Herd Management Area boundaries, wild horse gathers and fertility treatments to control wild horse populations, fence removal, enhancement of existing water sources and development of new water sources, and implementation of range improvement projects. These activities would better distribute wild horses across the range and reduce localized adverse effects to soils. The measures that the BLM would take to minimize livestock impacts to treatment areas are discussed in more detail in Section 3.17.4, and in **Appendix C**.

Land development, utility and infrastructure development, mineral development, and oil, gas, and hydrothermal geothermal exploration and development could affect about 10,000 acres in the reasonably foreseeable future, including about 8,335 acres of surface disturbance associated with the Mount Hope Project. Although disturbance areas would be reclaimed using soil removed from the site and stockpiled for later use, soil productivity may be less after reclamation. Land sales in Diamond Valley and Kobeh Valley associated with the Mount Hope Project, agriculture, ranching, and other land development interests, and for rights-of-ways for power and telephone lines, could lead to loss of soil if land sales lead to a use of that land, such as undeveloped land being converted to a housing development. Impacts to soil resources would be similar to those described under direct and indirect effects, and would include compaction, removal, stockpiling, denudation, and alteration of runoff. Although many past actions were not subject to reclamation, many current and reasonably foreseeable activities would be subject to reclamation, especially those regulated by federal, state, or local agencies.

The BLM would continue to conduct ground- and aerial-based herbicide application treatments to control noxious weeds and other invasive non-native vegetation. Although initial vegetation treatments using herbicides could indirectly lead to minor short-term soil erosion from the lack of rooting weedy plants, in the long term those treatments would allow for deeper-rooting native plants to stabilize soils, enhance soil fertility, and reduce the risk of wildfire. Five herbicides are typically used on the 3 Bars Project area are 2,4-D, glyphosate, imazapyr, metsulfuron methyl, and picloram. For the 3 Bars Project, it is likely that the BLM would also use imazapic to treat cheatgrass. Based on an assessment of risks to soil from the use of herbicides, there is potential for glyphosate and metsulfuron methyl to be transported by wind and water in areas with moderate to high risk of wind or water erosion. There should be few risks to soil organisms and soil productivity from use of these herbicides, as most break down quickly (USDOI BLM 2007c:4-18).

Hazardous fuels reduction, habitat improvement, and invasive species control projects would occur on approximately 142,000 acres (127,000 for the 3 Bars Project and 15,000 for other hazardous fuels projects in the CESA), or about 8 percent of the CESA during the life of the project. Loss of vegetation and soil disturbance associated with the use of treatment equipment could cause some short-term loss of soil functions, process, and productivity on nearly all treated land. However, these treatments would help to reduce the risk of wildfire within the CESA, a major contributor to loss of soil function and processes. In addition, the BLM would conduct stream bioengineering and plantings along about 31 miles of stream to restore surface water systems to Proper Functioning Condition to improve riparian habitat and reduce soil erosion.

Although 3 Bars Project treatments would have short-term adverse effects on soil resources, soil functions and processes on 127,000 acres should improve long term as discussed under the direct and indirect effects of the alternatives. These benefits, along with those associated with hazardous fuels and habitat improvement projects elsewhere in the CESA (about 15,000 acres), would be greater under Alternative A than the other alternatives and would help to offset adverse effects to soils occurring elsewhere in the CESA from reasonably foreseeable future actions.

3.8.3.4.2 Cumulative Effects under Alternative B (No Fire Use Alternative)

Under Alternative B, effects from non-3 Bars Project reasonably foreseeable future actions on soil would be similar to those described under Alternative A. The BLM anticipates treating about half as many acres under Alternative B as under Alternative A, and less effort would be spent by the BLM on treatments to reduce wildfire risk and loss of soil from erosion, including use of fire to restore natural fire regimes.

Adverse effects to soil would generally be the same as described for Alternative A. However, by not using prescribed fire and wildland fire for resource benefits, there would be no risk to soil from fire treatments, including soil erosion, hydrophobicity, and loss of soil productivity, or increase in spread of noxious weeds and other invasive non-native vegetation.

The BLM would be limited to all mechanical methods and using livestock to control non-native vegetation on several thousand acres annually. These methods could result in more soil disturbance than the use of fire. By relying on manual, mechanical, and biological control methods, the BLM would be unable to use reduce hazardous fuels over large acreages, including dense stands of Phase II and III pinyon-juniper, and remove large amounts of downed woody material from treatment areas. Thus, the risk of wildfire and its effects on soil would be greater under this alternative than under Alternative A.

Although 3 Bars Project treatments would have short-term adverse effects on soil resources, soil productivity on 63,500 acres should improve long term, as discussed under the direct and indirect effects of the alternatives. Although these actions would benefit soils on the project area, and would help to offset adverse effects to soils occurring elsewhere in the CESA from reasonably foreseeable future actions, benefits to soils would not be as great as those that would occur under Alternative A.

3.8.3.4.3 Cumulative Effects under Alternative C (Minimal Land Disturbance Alternative)

Under Alternative C, effects from non-3 Bars Project reasonably foreseeable future actions on soil would be similar to those described under Alternative A. Under Alternative C, the BLM would treat about 3,200 acres annually within the 3 Bars Project area, and about another 1,500 acres annually in the remainder of the CESA. Because of the limited number of acres treated, and lack of use of mechanical equipment and fire for 3 Bars Project treatments, short-term effects associated with the use of mechanical equipment and fire, including soil compaction, erosion, and disturbance, would not occur within the project area.

By not being able to use mechanical methods and fire, however, the BLM would have less ability to reduce hazardous fuels, create fire and fuel breaks, thin and remove pinyon-juniper and sagebrush to promote understory development, enhance stream habitat and channel stability and functions in the riparian zone, shred vegetation to create mulch to help reduce soil water erosion and improve water infiltration, and remove downed wood in the 3 Bars Project area. Thus, there would be more soil erosion, less improvement in soil productivity, less infiltration, and a greater risk of wildfire and its impacts on soil within the CESA than would occur under the other action alternatives. Actions taken

under this alternative would help to offset adverse effects to soils occurring elsewhere in the CESA from reasonably foreseeable future actions, but not to the extent that would occur under the other action alternatives.

3.8.3.4.4 Cumulative Effects under Alternative D (No Action Alternative)

Under Alternative D, effects from non-3 Bars Project reasonably foreseeable future actions on soil would be similar to those described under Alternative A. There would be no cumulative impacts to soil resources from this alternative as no treatments would be authorized under this alternative. The BLM could conduct stream bioengineering treatments; create fire and fuel breaks; thin and remove pinyon-juniper to promote healthy, diverse stands; slow the spread of noxious weeds and other invasive non-native vegetation, especially cheatgrass; restore fire as an integral part of the ecosystem; and reduce the risk of a large-scale wildfire, but on a very limited acreage. Thus, loss of soil and soil productivity due to erosion, stream channel instability, spread of noxious weeds and other invasive and non-native vegetation, pinyon-juniper encroachment, and wildfire would continue on the 3 Bars Project area and would likely be greatest under this alternative. Treatments under Alternative D would do little to offset adverse effects to soils occurring from other reasonably foreseeable future actions within the CESA.

3.8.3.5 Unavoidable Adverse Effects

Regardless of the method used to remove vegetation, restoration treatments could potentially result in adverse short-term impacts through increased erosion and reduced water infiltration, leading to loss of soil and reduced soil productivity. The degree of these effects would vary by treatment method (greater risk with mechanical and fire treatments), treatment type (greater risk with stream restoration in riparian zones) and soil risk category (greater risk in areas prone to water or wind erosion, or soil compaction), and if downed vegetation is left on the ground as mulch. To reduce this level of variability as much as possible, achievement of objectives would be evaluated for past projects and an adaptive response to less than favorable results would be applied to future treatments.

Vegetation treatments could disturb biological soil crusts, potentially reducing soil quality and ecosystem productivity. The extent of impacts to biological soil crusts would be dependent on the intensity and kind of disturbance and the amount of area covered. The duration of the effects would vary, but recovery of biological soil crusts typically takes much longer than the recovery of vascular vegetation (USDOI BLM 2007b:4-243).

3.8.3.6 Relationship between Local Short-term Uses and Maintenance and Enhancement of Long-term Productivity

Although treatments would have short-term effects on soil condition and productivity, it is predicted that the soil disturbance associated with restoration activities would have less impact and be less severe than soil erosion caused by wildfire and encroachment by noxious weeds and other invasive non-native vegetation. Furthermore, monitoring and evaluation, integrated with an adaptive management approach, would allow the BLM to adjust treatments to reduce soil disturbance to levels to match management objectives.

Studies in woodland and rangeland environments indicate that landscapes that resemble conditions within historical ranges of variability provide favorable conditions for soil functions and processes that contribute to long-term sustainability of soil productivity. Restoration activities that move landscapes toward historical ranges of variability would provide favorable conditions for soil functions and processes, and contribute to long-term soil productivity levels at the broad scale (USDOI BLM 2007b:4-247).

3.8.3.7 Irreversible and Irretrievable Commitment of Resources

Disturbance activities associated with proposed treatments could result in soil erosion and loss of soil and soil productivity. This loss of soil and soil productivity would be irretrievable in the disturbance area, although the soil could be available for use at some other location. This commitment of resources could extend over many years, depending on treatment methods and site-specific conditions, until soil quality attributes improved either through amendments or natural processes. However, a benefit of increasing the amount of acres treated would be to slow the loss of soil and soil productivity due to noxious weeds and other invasive non-native vegetation and wildfire and to restore soil structure and function on degraded sites as part of a larger goal to restore native ecosystem processes. As a result of these actions, soil productivity in disturbed areas should reestablish over time (USDOI BLM 2007b:4-251).

3.8.3.8 Significance of the Effects under the Alternatives

Under all alternatives, there would be a short-term (greater than 5 years) increase in soil erosion from 3 Bars Project and other CESA habitat improvement and hazardous fuels reduction treatments, primarily those where the soil is disturbed by mechanical or fire treatments, or by large-scale removal of non-native vegetation using herbicides. This increase in erosion could lead to increased sedimentation or turbidity in streams or ponds. These impacts from soil erosion would accrue with soil erosion and loss of soil associated with other land disturbance activities in the CESA. These losses of soil due to erosion and its impacts to water quality in streams and ponds in the CESA would be offset by long-term benefits from: 1) stream restoration projects that promote stream stability and riparian vegetation development; 2) improvements in vegetation in areas where thinning pinyon-juniper and sagebrush promotes understory development; 3) removal and control on noxious weeds and invasive non-native vegetation and revegetation of treatment sites with native vegetation; and 4) hazardous fuels treatments that reduce the risk of a catastrophic wildfire, including prescribed burning and use of wildland fire for resource benefits, and the creation of fire and fuel breaks.

It is possible that prescribed fire and wildland fire for resource benefits treatments could result in erosion that could exceed annual soil loss tolerances, and in the loss of topsoil, soil quality, or productivity that could limit revegetation success. Based on monitoring done by the BLM at fire treatment sites, loss of soil is low when sites are revegetated and noxious weeds and invasive non-native vegetation is removed from treatment sites (USDOI BLM 2007c:4-18). There is also the potential that large-scale non-native control treatments using mechanical equipment could result in loss of vegetation and soil over large areas. However, the BLM would use SOPs to minimize this risk, including disking on contour, avoiding treatments on steep slopes, and restricting livestock access to treatment sites. Based on monitoring, loss of soil would be greater in areas burned by wildfire, as these areas can be large, are often in remote areas, and can be difficult to revegetate (Erickson and White 2008). Thus, BLM treatments that reduce the risk of wildfire should help to slow soil loss and loss of soil quality and productivity in the project area.

There should be an overall improvement in soil quality and productivity from treatments under all alternatives. Although the risks and benefits to soil from 3 Bars Project treatments would be greatest under Alternative A, proper adaptive management should greatly reduce these risks by identifying and addressing treatment issues as they arise. 3 Bars Project treatments would not result in a long-term (greater than 5 years) significant increase in soil erosion, water quality degradation from soil erosion, loss of topsoil, or loss of soil quality or productivity in the 3 Bars Project area or CESA.

3.8.4 Mitigation

Soil resources would benefit from mitigation and monitoring measures identified in Section 3.17.4 (Livestock Grazing Mitigation). No mitigation or monitoring measures are recommended specifically for soil resources.

3.9 Water Resources

3.9.1 Regulatory Framework

Major regulations and agency policies guiding water resources management include:

- Clean Water Act Section 303 – Water Quality Standards and Implementation Plans. This requires each state to review, establish, and revise water quality standards for all surface waters within the state. Designated beneficial uses are assigned to surface waters.
- Clean Water Act Section 404 – Permits for Dredged or Fill Material. This regulates activities in wetlands and waters of the U.S. Subsequent court decisions and regional guidelines apply.
- Safe Drinking Water Act – 40 CFR Chapter 1, Subchapter D, Part 142 (National Primary Drinking Water Regulations) and Part 143 (National Secondary Drinking Water Standards).
- Title 40 Nevada Revised Statutes, Chapter 445A – State of Nevada water controls (authority for waterbody designated uses and water quality criteria).
- Title 48, Nevada Revised Statutes – State of Nevada water use administration.
- Nevada Administrative Code Chapter 445A.070 through 445A.2234, "Water Pollution Control" including beneficial use categories, water quality classes, and associated water quality criteria and standards promulgated from the Clean Water Act and Nevada Revised Statutes listed above.

Additional important policies and procedures involving water resources for the project area include water rights and water quality programs administered in the Nevada Division of Water Resources and Nevada Division of Environmental Protection; Memoranda of Understanding between the BLM and other state or federal agencies; and BLM policies developed under the Rangeland Health Standards promulgated under 43 CFR § 4180.2. The Federal Land Policy and Management Act, BLM Handbook H-4180-1 (*Rangeland Health Standards*; USDOI BLM 2001), and BLM Manual H-1601-1 (*Land Use Planning Handbook*; USDOI BLM 2005c), describe the agency goals and management approaches for water resources and riparian zones.

3.9.2 Affected Environment

3.9.2.1 Study Methods and Study Area

Information sources consulted for this study include data collections, maps, and publications from the Nevada Division of Water Resources, USGS, a Montgomery and Associates (2010) report entitled *Hydrogeology and Numerical Flow Modeling*, and the Mount Hope Project EIS and references cited therein (USDOI BLM 2012c).

The study area for direct and indirect effects to water resources lies within the 3 Bars Project area. The study area for cumulative effects to water resources is the Hydrologic Unit Code 10 watersheds wholly or partially within the project area (**Figure 3-1**). This area includes parts of the drainages and groundwater basins as defined by the Nevada Division of Water Resources and identified in **Table 3-14**.

3.9.2.2 Hydrologic Setting

3.9.2.2.1 Overview

Most precipitation accumulates as snow on the mountain ranges. The highest elevations consist of moderately to steeply sloping mountains and ridges such as the Roberts Mountains. Rock outcrops are common at elevations above about 8,000 feet amsl and contribute to the increased extent of impervious areas there. Moderate to high gradient headwater streams occur at these elevations, mainly supplied by cold springs and snowmelt. In this zone, riffle sections in the streams generally have cobbly substrates (Bryce et al. 2003).

TABLE 3-14

Nevada Hydrographic Areas Included in the Water Resources Assessment

Hydrographic Area	Basin Number	Basin Area (acres)	Area within Project Boundary (acres)	Approximate Percentage of Basin Area within 3 Bars Project Area
Pine Valley	053	641,280	269,482	42
Grass Valley	138	380,800	59,174	16
Kobeh Valley	139	555,520	341,495	61
Diamond Valley	153	481,280	79,659	17
Total		**2,058,880**	**749,810**	**36**

Source: Nevada Division of Water Resources (2012).

Most of the annual runoff within the project area is derived from snowmelt. In the spring months, typically April through June, snowmelt produces runoff, which often results in the highest seasonal flows in the high mountain drainages. Occasionally, spring season rainfall coincides with the snowmelt, resulting in extremely high runoff. While there is potential for heavy thunderstorm events in mid- to late summer, spawned by moisture from the desert southwest, the hot, dry weather at this time of year, typically combined with little or no rain and high evaporation rates, generally produces the lowest flows of the year (USDOI BLM 2012c).

During the spring snowmelt period, water flows from the mountain ranges into nearby basins. As water flows from the mountains towards the valleys, it infiltrates into basin fill deposits along the range fronts. Thus, recharge into the basin fill deposits occurs along the margins of the valleys (or at higher elevations), and, except during times of high runoff, not in the central portion of the valleys.

Soils at mid-elevations are commonly rocky and shallow, promoting runoff. Perennial or intermittent moderate gradient streams occur at middle elevations, and are supplied by snowmelt and springs. Broad alluvial fans and flatter saline playa deposits commonly accumulate in the extensive lower-elevation terrain. Eroded gullies are generally more common at lower elevations, and permanent lakes are uncommon to absent. In general, the lower elevation streams are relatively low-gradient, with substrates consisting of finer sediments (Bryce et al. 2003).

3.9.2.2.2 Basin Hydrology

Of the major basins in the study area, only Pine Valley drains outward to a larger surface water system (the Humboldt River). Kobeh Valley drains to Diamond Valley. The remaining three basins (Diamond, Grass, and Antelope Basins) are closed, with no external surface drainage.

Kobeh Valley is a large basin with a drainage area of approximately 870 square miles. This basin is bounded on the north by the Roberts Mountains, on the west by the Simpson Park Mountains, on the east by Whistler Mountain, and on the south by the Monitor Range and Monitor and Antelope Valleys. Elevations on the basin floor range from 6,400 feet amsl on the west side of the basin to around 6,000 feet amsl on the east side at Devils Gate, an erosional gap that allows surface water from Kobeh Valley to enter Diamond Valley. Surface water also occasionally flows into the southern part of Kobeh Valley via the main ephemeral drainages in Antelope Valley (Antelope Wash) and the northern part of Monitor Valley (Stoneberger Creek). Ephemeral streams bring mountain-front runoff from the north, east, and south, and converge in the vicinity of U.S. Highway 50. This water is sufficiently close to the surface to allow for the development of an extensive area of phreatophytes, which are deep-rooted plants that obtain water from a permanent ground supply or from the water table. Springs in Kobeh Valley are found mainly within the mountains that border the valley, while wells are found throughout the basin (USDOI BLM 2012c).

Diamond Valley has a drainage area of approximately 750 square miles and is bounded on the west by the Sulphur Spring Range and Whistler Mountain, on the north by Diamond Hills, on the east by the Diamond Mountains, and on the south by the Fish Creek Range. The valley floor of Diamond Valley ranges in elevation from 6,200 feet amsl to 5,770 feet amsl at the playa found in the north end of the valley. Surficial drainage is from the bounding mountain ranges to the central axis of the valley and then northward to the playa. Diamond Valley is a closed basin and an extensive playa occupies the northern end of the valley, where all shallow groundwater flow converges. Agricultural irrigation and withdrawals of groundwater for municipal water supply occur in the southern part of the valley, north of Eureka, Nevada. Shallow alluvial groundwater in this area is recharged by mountain-front runoff from the major drainages near Eureka. Many springs are found within Diamond Valley at the north end, where groundwater flow converges and the water table in the shallow alluvial aquifer approaches the surface (USDOI BLM 2012c).

Pine Valley is north of Kobeh Valley and west of Diamond Valley. This basin is bounded on the south by Roberts Mountains, on the west by the Sulphur Spring Range, and on the north and west by the Cortez Mountains. The basin occupies approximately 1,000 square miles and drains northward to the Humboldt River. Basin floor elevations range from 5,800 feet amsl at the south end near Henderson Creek to 4,840 feet amsl at the north end. The Garden Valley sub-basin occupies the southeastern part of Pine Valley and is a separate basin between the Roberts Mountains and the Sulphur Spring Range. Drainage in this sub-basin converges on Henderson Creek and flows into Pine Valley. Springs in Pine Valley are mostly in the bounding mountain ranges, with local areas of springs in the basin along major drainages. Wells are found at the north end of Pine Valley in the area where ephemeral drainages from the mountains converge. There are a few wells in the Garden Valley sub-basin near Henderson Creek (USDOI BLM 2012c).

Grass Valley is west of Kobeh Valley and is a closed hydrographic basin bounded on the east by the Simpson Park Mountains and on the west by the Toiyabe Range. The Cortez Mountains bound the valley to the north (Everett and Rush 1966). The valley consists of two sub-basins that are interconnected, a smaller basin at the southwest end of the valley that is east of Mount Callaghan and the main part of Grass Valley. The lowest elevation in the valley is 5,611 feet amsl in the playa that occupies the northern part of the basin. The highest point is Mount Callaghan in the Toiyabe Range at 10,187 feet amsl. The basin has internal drainage only and groundwater is recharged by mountain-

front runoff. Springs are found mainly in the smaller sub-basin at the southwest end of Grass Valley and along the mountain fronts where the basin alluvium contacts the bedrock of the bounding mountain ranges. All water in the basin flows toward the playa in the northern part of the basin and groundwater comes sufficiently close to the surface in the vicinity of the playa to allow for the development of an extensive area of phreatophytes. Limited irrigation and farming of alfalfa are found south of the playa (USDOI BLM 2012c).

Antelope Valley, although not a part of the hydrologic study area, is located south of Kobeh Valley and south of Diamond Valley. It is part of the regional groundwater flow system. This basin occupies 450 square miles and drains into Kobeh Valley. Groundwater in Antelope Valley also flows north into Kobeh Valley through the same gap as the surface water drainages. Elevations in Antelope Valley range from 6,800 feet amsl on the south end to around 6,075 feet amsl a the gap between Antelope Valley and Kobeh Valley (USDOI BLM 2012c).

Kobeh Valley, Diamond Valley, and Antelope Valley are part of the Diamond Valley Regional Flow System as described by Harrill et al. (1988). Basins that are part of this flow system are internally connected by ephemeral streams and subsurface groundwater flow through the alluvial basin aquifers and the bedrock carbonate aquifers (Tumbusch and Plume 2006). Diamond Valley is the terminus of this flow system and the water resources at the south end of Diamond Valley have been developed for use in agricultural irrigation, mining in the Eureka area, and for municipal water supply for Eureka. Pine Valley, the Garden Valley sub-basin connected to Pine Valley, and Grass Valley are part of the Humboldt Regional Flow System (Harrill et al. 1988), where surface and groundwater flows northward to the Humboldt River system.

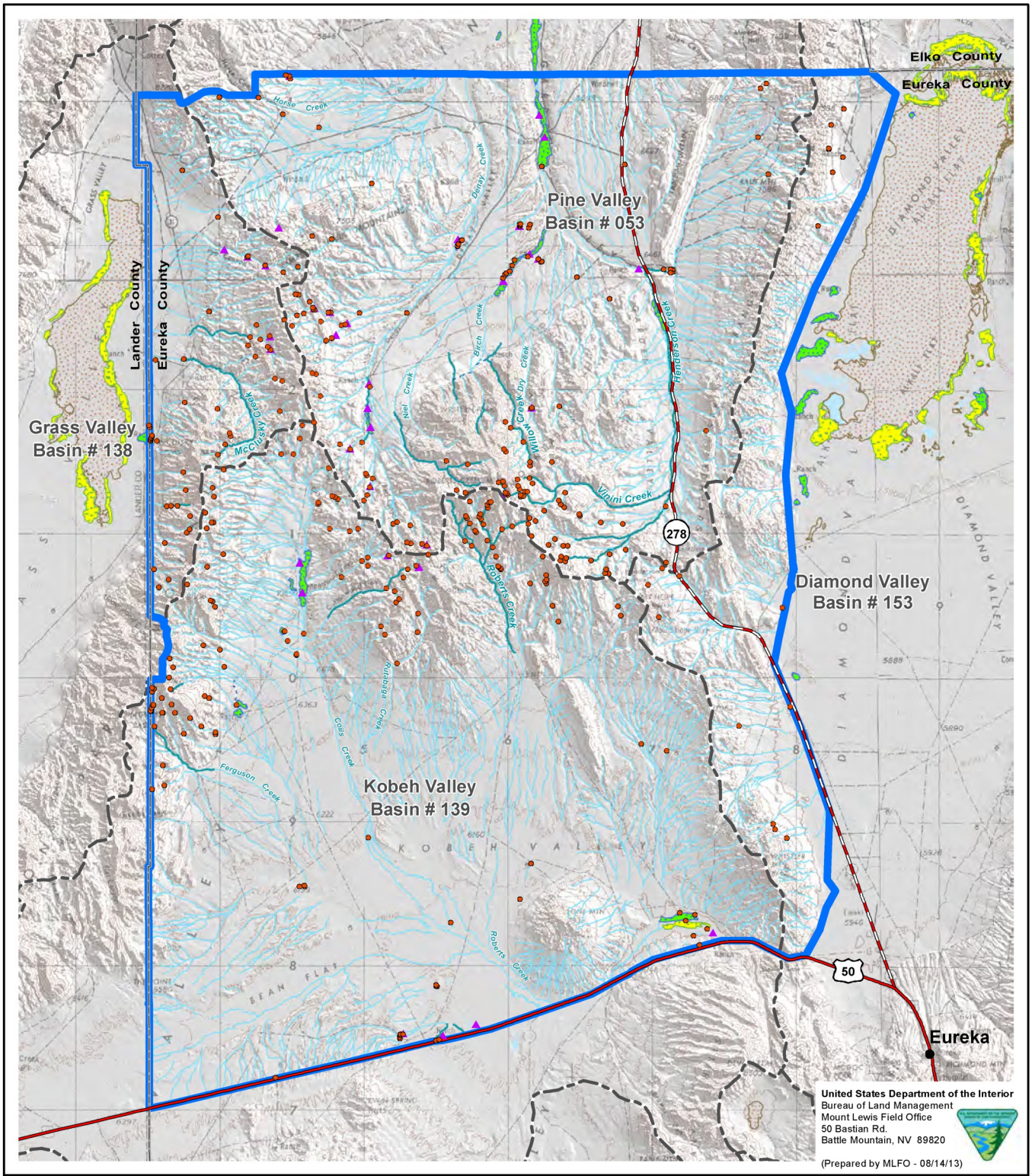
3.9.2.3 Surface Water Resources

3.9.2.3.1 Streams and Creeks - Overview

Numerous perennial, intermittent, and ephemeral streams occur within the project area (**Table 3-15)**. In general, perennial segments have their source in the mountains and, although they do respond to snowmelt and rainfall events, much of their flow is provided by groundwater discharge that occurs as spring flow. Perennial flow only occurs in a relatively few isolated stream reaches (**Figure 3-23**). Stream flows in the 3 Bars Project area primarily occur as intermittent flows from isolated springs, as short-term seasonal runoff from snowmelt or winter storms, or as ephemeral flow from intense but infrequent thunderstorms.[1] Numerous drainages leave the mountain fronts and cross over alluvial fans, where flows typically dissipate. When water does reach the valley floor during larger runoff events, the water is soon taken up by evapotranspiration and seepage into valley-floor sediments. Channels become poorly defined as they near the flatter portion of the basins and runoff infiltrates into permeable alluvial fan material (USDOI BLM 2012c).

Major perennial stream reaches include parts of Henderson Creek, McClusky Creek, Pete Hanson Creek, Roberts Creek, Vinini Creek, and Willow Creek. Additional, shorter perennial reaches occur on Birch Creek, Kelley Creek, Ferguson Creek, and in scattered locations on other streams throughout the project area.

[1] The USGS does not distinguish between intermittent and ephemeral streams. The majority of streams classified as intermittent on the 3 Bars Project area do not have seasonal water, but only have water occasionally and would be classified as ephemeral.



Legend

- Spring
- Moist Site
- Perennial Stream
- Intermittent Stream
- Canal/Ditch
- Lake or Pond
- Playa
- Freshwater Emergent Wetland
- Freshwater Forested/ Shrub Wetland
- Hydrographic Basin
- 3 Bars Project Area

Source: BLM 2012g, USFWS 2012, NDOW 2012a, NDWR 2012, USGS 2012b.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-23

Streams, Lakes, Ponds, and Wetlands

0 1 2 3 4 5 10 Miles

0 1 2 3 4 5 10 Kilometers

N

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data.
Original data were compiled from various sources. This information may not meet National Map Accuracy Standards.
This product was developed through digital means and may be updated without notice.

TABLE 3-15

Perennial and Intermittent/Ephemeral Streams in the Project Area

Basin Number	Basin Name	Stream Name	Perennial Stream Miles	Intermittent/ Ephemeral Stream Miles[1]	Canal/ Ditch	Total Miles
053	Pine Valley	Birch Creek	1.50	5.07		6.57
		Denay Creek	2.22	22.61		24.83
		Dry Creek		8.38		8.38
		Frazier Creek		5.86		5.86
		Garden Pass Creek		0.98		0.98
		Geyser Creek		7.33		7.33
		Grouse Creek		2.30		2.30
		Henderson Creek	18.34	11.28		29.62
		Horse Creek		9.08		9.08
		Indian Creek		8.68		8.68
		Kelley Creek	2.20	0.68		2.89
		Niel Creek		5.21		5.21
		North Fork Pete Hanson Creek	1.71	0.69		2.40
		Pete Hanson Creek	6.07	12.84		18.91
		Pine Creek		12.84		12.84
		Vinini Creek	9.51			9.51
		Willow Creek	6.74	6.31		13.05
		Unnamed Creeks	7.85	728.76	1.87	738.47
138	Grass Valley	Coils Creek		0.94		0.94
		Indian Creek		0.01		0.01
		McClusky Creek	7.12	3.26		10.39
		Pine Creek		0.04		0.04
		Unnamed Creeks	5.09	138.46		143.55
139	Kobeh Valley	Coils Creek		35.62		35.62
		Cottonwood Creek	4.42	2.45		6.87
		Ferguson Creek	5.09	4.53		9
		Horse Creek		4.56		4.56
		Jackass Creek		2.96		2.96
		North Branch Horse Creek		0.89		0.89
		North Fork Horse Creek		2.42		2.42
		Roberts Creek	8.38	15.31		23.69
		Rutabaga Creek		12.79		12.79
		Slough Creek		7.78		7.78
		South Fork Horse Creek		1.64		1.64
		Stoneberger Creek		5.67		5.67
		U’ans-in-dame Creek		15.14		15.14
		Underwood Creek		11.06		11.06
		Willow Creek		0.27		0.27
		Unnamed Creeks	9.22	1,015.89	1.33	1,019.57

TABLE 3-15 (Cont.)

Perennial and Intermittent/Ephemeral Streams in the Project Area

Basin Number	Basin Name	Stream Name	Perennial Stream Miles	Intermittent/ Ephemeral Stream Miles[1]		Total Miles
153	Diamond Valley	Garden Pass Creek		6.01		6.01
		Slough Creek		0.57		0.57
		Tyrone Creek		4.57		4.57
		Unnamed Creeks	0.11	192.53		192.64
Totals			**96.24**	**2,326.75**	**3.20**	**2,426.18**

[1] The USGS does not distinguish between intermittent and ephemeral streams. The majority of streams classified as intermittent on the 3 Bars Project area do not have seasonal water, but only have water occasionally and would be classified as ephemeral.

Sources: JBR (2009), Montgomery and Associates (2010), and USGS (2012a).

The USGS (2012b) is monitoring streamflow at several locations within the project area (**Table 3-16**). Although monitoring only began in 2011, it is apparent that daily surface flows vary widely. The maximum flow months generally occur in spring, and the smallest flows are usually in late summer. Tonkin Spring has the steadiest flow of the stations in the USGS monitoring program.

In addition to USGS monitoring, stream studies were carried out for the Mount Hope Project EIS (JBR 2009, USDOI BLM 2012c). The results of these investigations, which were conducted in the Pine Valley basin draining the northern and eastern Roberts Mountains, are summarized in **Table 3-17**. These investigations included the upper portions of Birch Creek, Henderson Creek, Pete Hanson Creek, and Vinini Creek. All measurements and samples were collected within the mountainous portions of the streams. They were conducted in a short time frame in late March and early April, 2009. Based on the amount of snow pack and occurrence of bare ground during the investigation, it was evident that some snowmelt and spring run-off had occurred prior to the initial sampling round. The air temperature was typically above freezing during the days, and snowmelt and runoff were observed (JBR 2009).

An important result of these flow investigations is that flow-gaining and flow-losing reaches occurred within short distances on upper Birch Creek and Pete Hanson Creek. These flow increases and decreases often occurred within several hundred feet (or less) of each other, and are likely to result mainly from groundwater and geologic factors along these headwater channel lengths. On Vinini and Henderson Creeks, snowmelt conditions and other complicating factors prevented conclusions about gaining and losing stream sections (JBR 2009).

3.9.2.3.2 Streams and Creek Flows by Basin

The following describes stream and creek flows by basins within the 3 Bars Project area. This information is based on studies for the Mount Hope Project EIS, and references cited therein (USDOI BLM 2012c). Major perennial stream reaches occur within the Pine Valley (56.1 miles), Grass Valley (12.2 miles), Kobeh Valley (27.1 miles), and Diamond Valley (0.11 mile) watersheds. In addition, approximately 2,327 miles of intermittent/ephemeral stream reaches have been identified in the project area.

TABLE 3-16

Flow Summary from U.S. Geological Survey Monitoring Stations

Waterbody	USGS Station Number	Monitored Location (Latitude / Longitude)	Monitoring Period	Average Recorded Flow (cfs)	Maximum Recorded Flow (cfs)	Minimum Recorded Flow (cfs)	Maximum Monthly Average Flow (cfs)	Minimum Monthly Average Flow (cfs)
Coils Creek above Horse Creek	10245960	39° 46’ 11” 116° 27’ 52”	1/12/2011 to 9/30/2011	11.0	64 (1/17/2011)	0 (many)	24 (Apr)	0.01 (Aug)
Henderson Creek below Vinini Creek	10322535	39° 52’ 08” 116° 10’ 01”	1/11/2011 to 6/2/2012	8.1	19 (5/23/2011)	0 (many)	14 (May)	0.02 (Sep)
Pete Hanson Creek above Henderson Creek	10322555	39° 53’ 25” 116° 22’ 42”	5/5/2011 to 6/2/2012	9.7	17 (6/15/2011)	0 (4/2012)	12 (Jun)	0.84 (Sep)
Roberts Creek	10245970	39° 47’ 23” 116° 18’ 03”	6/4/2011 to 6/2/2012	2.8	11 (6/2012)	0.18 (1/2012)	8.9 (Jun)	0.68 (Aug)
Tonkin Spring above Denay Creek	10322510	39° 54’ 17” 116° 24’ 45”	8/26/2010 to 6/2/2012	1.7	2.4 (9/2011)	1.0 (1/2011)	2.0 (May, Aug)	1.2 (Jan)

cfs = cubic feet per second.
Source: USGS (2012b).

TABLE 3-17

Site-specific Stream Investigations

Stream	Measurement Date	Range in Channel Widths (feet)	Flow Range (gpm)	Flow Range (cfs)
Birch Creek	March 22-26, 2009	2.7 to 3.9	64 to 274	0.14 to 0.61
Pete Hanson Creek	March 3-27, 2009	0.9 to 5.7	269 to 614	0.60 to 1.37
Vinini Creek	March 25, 2009	1.3 to 3.8	15 to 269	0.03 to 0.60
Henderson Creek	April 7, 2009	2.2 to 2.5	269 to 359	0.60 to 0.80

gpm = gallons per minute.
cfs = cubic feet per second.
Source: JBR (2009).

Kobeh Valley

In Kobeh Valley, surface drainage is directed generally from the mountains to the central valley floor and then eastward toward Devils Gate, where flow occasionally passes into Diamond Valley via Slough Creek (**Figure 3-23**, **Table 3-15**). Surface water occasionally flows into the southern part of Kobeh Valley via the main ephemeral drainages in Antelope Valley (Antelope Wash) and the northern part of Monitor Valley (Stoneberger Creek). The Stoneberger Creek drainage enters the southwestern side of Kobeh Valley from Monitor Valley and crosses southern Kobeh Valley in a west to east direction through Bean Flat. Antelope Wash enters Kobeh Valley from the south at a point where several ephemeral drainages join on the southeastern side of Kobeh Valley to form Slough Creek. Slough Creek, also ephemeral, drains east through Devils Gate into southern Diamond Valley. Channel geomorphology and a

lack of vegetation scour indicate that outflow through Devils Gate is a rare occurrence related to low frequency, high runoff events.

The two main internal drainages within Kobeh Valley are Coils Creek in the western part of the valley, which drains the east side of the Simpson Park Mountains and the western side of the Roberts Mountains, and Roberts Creek, which drains the central and southeastern part of the Roberts Mountains. Rutabaga Creek lies between these two drainages and drains the southern part of the Roberts Mountains.

Roberts Creek is perennial from the headwaters of its middle and east fork tributaries to near the base of the mountain. A segment of the Cottonwood Canyon drainage, on the southwest side of the Roberts Mountains, is also identified as containing perennial flow upstream of its confluence with the Coils Creek drainage. The only other identified perennial stream reaches in Kobeh Valley are Snow Water Canyon and Ferguson Creek on the east side of the Simpson Park Mountains, as well as Ackerman Creek, Basin Creek, Coils Creek, Dry Canyon, Dry Creek, Kelly Creek, Jackass Creek, and Meadow Canyon. A small segment of U'ans-in-dame Creek to the east-northeast of Lone Mountain has also been classified by the USGS as perennial. However, other investigations indicate that based on 2010 field observations, a review of Landsat images, and the USDA's National Agricultural Imaging Program aerial photography, it is now believed that this stream segment is not perennial (Montgomery and Associates 2010, USGS 2012b).

Stream discharge measurements were taken along the course of Roberts Creek in 2007 (Montgomery and Associates 2010). Measurements made during August 2007 on the tributaries of Roberts Creek indicated that most of the flow originated from the east fork, at 108 gallons per minute (gpm; 0.24 cubic feet per second [cfs]), which received its flow from springs along the west and south to southeast flanks of the Roberts Mountains. The west and middle forks of Roberts Creek contributed little flow at that time, with the west fork being dry, and the middle fork discharge estimated at 4.5 gpm (0.01 cfs; Montgomery and Associates 2010). Measured discharge below the confluence of the three forks of Roberts Creek consistently decreased with distance downstream, indicating that Roberts Creek loses water over most of its length. These stream losses are assumed to result in recharge to the local alluvial and carbonate aquifer systems. Flow loss due to evaporation and transpiration from riparian vegetation adjacent to the stream bed may also be a contributing factor to the consistent downstream decrease in flow.

Coils Creek is interpreted by Rush and Everett (1964) to be the principal tributary to Slough Creek. They reported a flow of approximately 3,600 gpm (8 cfs) in May 1964 at a location in Section 27, Township 22 North, Range 49 East, in the west-central portion of the project area. Intermittent reaches of upper Coils Creek are mainly fed by spring flow and are used for irrigation purposes. More recent estimates of flows in Coils Creek are presented in **Table 3-16**.

In August 2007, Montgomery and Associates (2010) measured a flow of 9 gpm (0.02 cfs) in Rutabaga Creek on the southern flanks of the Roberts Mountains. Along the east slope of the Simpson Park Mountains, on the west side of Kobeh Valley, no surface flow was observed by Montgomery and Associates (2010) in Snow Water Canyon during June and December 2007, and April 2008. No surface flow was observed in Ackerman Canyon in April 2008, but a flow of 27 gpm (0.06 cfs) was observed in May 2008. An estimated surface flow of less than 112 gpm (0.25 cfs) was observed in Ferguson Creek in May, but not in August 2007. No surface flow was observed in Dry Canyon in June 2007. At the stream gauge on Roberts Creek, flows were 561 and 1,872 gpm (1.25 and 4.17 cfs) during April and May 2008, respectively.

Reported flows in Willow Creek and Dagget Creek, which drain the north end of the Monitor Range in southern Kobeh Valley, were approximately 450 and 670 gpm (1 and 1.5 cfs), respectively, in May 1964 (Robinson et al. 1967). No other drainages within the Kobeh Valley basin have recorded stream flows.

Pine Valley

The main streams in Pine Valley are in the Horse Creek, Denay Creek, Henderson Creek, and Pine Creek drainages (**Figure 3-23**, **Table 3-15**). Pine Creek is the principal stream in the valley and is a tributary to the Humboldt River. Eakin (1961) reported that the flow in Pine Creek is maintained primarily by the discharge from hot springs.

Numerous headwater tributaries to Pine Creek form on the east- and southeast-facing slopes of the Cortez Mountains (Horse Creek drainage) and the northern part of the Simpson Park Mountains (Denay Creek drainage); on the north to northwest flanks of the Roberts Mountains (Pete Hanson Creek, Neil Creek, Kelly Creek, Birch Creek, Willow Creek, and Dry Creek); and on the northeast side of the Roberts Mountains in the Garden Valley subbasin (Henderson Creek, Vinini Creek, and Frazier Creek). Perennial streamflow segments have only been identified on portions of Denay Creek, Pete Hanson Creek, Willow Creek, Vinini Creek, and Henderson Creek (USDOI BLM 1997 *in* USDOI BLM 2012c).

Isolated reaches in the Horse Creek drainage of Pine Valley were reported to have flows ranging from 9 to 58 gpm (0.02 to 0.13 cfs) during August 2005 before surface flows were lost to infiltration or evapotranspiration (USDOI BLM 2008g). The Denay Creek drainage arises from headwater springs in Red Canyon on the north slope of the Roberts Mountains, and is fed lower down in the drainage by perennial discharge from Tonkin Spring (**Table 3-16**). Denay Creek discharges into Tonkin Springs Reservoir, a small surface-water impoundment, approximately 1 mile downstream of Tonkin Spring. Between August 2007 and September 2009, Montgomery and Associates (2010) measured the discharge from Tonkin Spring during all months of the year, and the range of observed flows was from 525 to 1,086 gpm (1.17 to 2.42 cfs). This is generally within the range reported by the USGS (2012b) in **Table 3-16**. This provides an estimate of the flows in Denay Creek just downstream of Tonkin Spring. Further east, along the north side of the Roberts Mountains, no flow was reported in Pete Hanson Creek during August 2007, but a flow of 1,023 gpm (2.28 cfs) was reported in June of 2009. Also, Willow Creek was observed to have flows of 31 and 9 gpm (0.07 and 0.02 cfs) in August and October 2007, respectively (Montgomery and Associates 2010).

As part of the baseline characterization investigations for the proposed Mount Hope Project, three surface water monitoring stations were established on Henderson Creek in 2006, allowing two distinct reaches of the creek to be studied (**Table 3-17**). The upper monitoring station is approximately one-half mile southeast and downgradient of Spring 585 at an elevation of approximately 7,177 feet amsl. SRK (2008) reported that the creek flow is perennial at the upper monitoring station, with the flow sustained by discharge from local springs and seeps. The middle monitoring station is approximately 2 miles downgradient of the upper station and is approximately 50 feet below the confluence of the north and south forks of Henderson Creek at an elevation of approximately 6,688 feet amsl. The creek flow at this location is also thought to be perennial and fed by springs and seeps in the upper part of the watershed. The stream channel morphology at the middle monitoring station is described as being substantially incised, with arroyo-like features. The lower monitoring station is approximately 2.5 miles downgradient of the middle station and is located roughly 60 feet west of State Route 278 at an elevation of approximately 6,446 feet amsl. SRK characterized the lower reach as being perennial, but noted that the actual flowing locations of the creek near the lower monitoring station vary on a seasonal basis, such that the established sampling-point location was observed to be dry in the third and fourth quarters of 2006 and the first quarter of 2007.

During site visits in May 2006 and 2007, SRK (2008) recorded maximum flow rates of approximately 400, 3,180, and 2,600 gpm (0.9, 7.1, and 5.8 cfs) at the upper, middle, and lower monitoring stations, respectively, on Henderson Creek. Subsequent monitoring events recorded smaller flow rates, ranging from 45 to 112 gpm (0.1 to 0.25 cfs), at the upper and middle monitoring stations and no flow at the lower station.

Stream flow measurements were also made on Henderson and Vinini Creeks, north of Mount Hope in the Garden Valley subbasin of Pine Valley (Montgomery and Associates 2010). During August and October 2007, Vinini Creek was observed to be dry, whereas in May 2008 and June 2009 flows of 3,110 and 950 gpm (6.93 and 2.12 cfs), respectively, were recorded. Henderson Creek was measured in August 2007 at the confluence of its north and south fork tributaries. No stream flow was observed from the north fork at that time, whereas discharge from the south fork was reported to be 27 gpm (0.06 cfs). Other flow measurements in Henderson Creek were 36 gpm (0.08 cfs) in December 2007 and 135 gpm (0.3 cfs) in May of 2008. Henderson Creek contained observable flow in a reach approximately 2.3 miles long before losing all of its surface flow to infiltration and evapotranspiration (Montgomery and Associates 2010).

Diamond Valley

Harrill (1968) described the existence of only a few perennial streams in Diamond Valley, all of which are on the east side of the valley on the western slopes of the Diamond Mountains (**Figure 3-23**, **Table 3-15**). This area is outside the 3 Bars Project area, but within the cumulative effects study area. Cottonwood and Simpson Creeks were mentioned as the two most prominent perennial streams, and the only ones that supported ranching operations in the 1960s. The only intermittent streams in Diamond Valley with a significant volume of seasonal runoff are also in the Diamond Mountains. The rest of the streams in Diamond Valley are intermittent or ephemeral and were reported to have only minor flows.

Between May of 1965 and October of 1966, reported stream flows in 11 drainages within the CESA along the western side of the Diamond Mountains ranged from zero flow to a maximum of 785 gpm (1.75 cfs) in Cottonwood Creek on one occasion; all other observed flows during that time period were less than 287 gpm (0.64 cfs; Harrill 1968). No flow was observed during March and June of 1966 in Garden Pass Creek, an ephemeral creek on the western side of Diamond Valley that originates at the topographic divide between Pine and Diamond Valleys, and an unnamed drainage on the eastern slopes of the Sulphur Spring Range in the northern part of Diamond Valley was also reported to be dry in April and October of 1966 (Harrill 1968). Peak flow measurements made by the USGS in Garden Pass Creek between 1965 and 1981 ranged from 314 to over 290,000 gpm (0.7 to 650 cfs).

3.9.2.3.3 Springs

Approximately 334 springs occur within or immediately adjacent to the project area, including 141 known sites in Pine Valley, 131 in Kobeh Valley, 49 in Grass Valley, and 13 in Diamond Valley (**Figure 3-23**). Most springs are in mountainous parts of the project area, although some occur on alluvial fans or in valley floor positions. At any specific site, spring flows are either perennial (flowing year-round) or intermittent (flowing part of the year), depending on historic precipitation and geologic factors that govern the groundwater source of the spring. Some general flow characteristics are indicated in **Table 3-18** for springs where data are available. A substantial range in flows is apparent. Additional geologic aspects of spring origins and characteristics are discussed in the groundwater section.

3.9.2.3.4 Other Surface Water Features

There are no naturally occurring lakes or ponds within the project area. However, range water improvements, windmills, reservoirs, and improved springs occur throughout the project area (**Figure 3-24**). Agricultural water uses for irrigation and stock watering occur in Garden Valley and along the western edge of Diamond Valley. Other surface water impoundments that intermittently or perennially contain water include the following: 1) Tonkin Reservoir on upper Denay Creek, JD Ranch reservoirs on lower Henderson Creek and Pete Hanson Creek, and the Alpha Ranch impoundments of Henderson Creek and Chimney Springs in Pine Valley; 2) the Roberts Creek Ranch impoundment on Roberts Creek in Kobeh Valley; 3) the Shipley Hot Spring pond and the Flynn Ranch springs water impoundments in Diamond Valley; and 4) several small reservoirs on the upper Antelope Wash and its tributaries near the Segura Ranch in Antelope Valley. There may be other, smaller man-made impoundments in various drainages and downgradient of certain springs within the project area that were not located in the field or identified on maps or aerial photographs.

Saline flats or playas exist where streams empty or ground water discharges into areas with no outflow. Temporary ponding occurs in such areas after snowmelt or prolonged rainfall, but the accumulated water typically soon evaporates.

TABLE 3-18

Flow Measurements at Springs

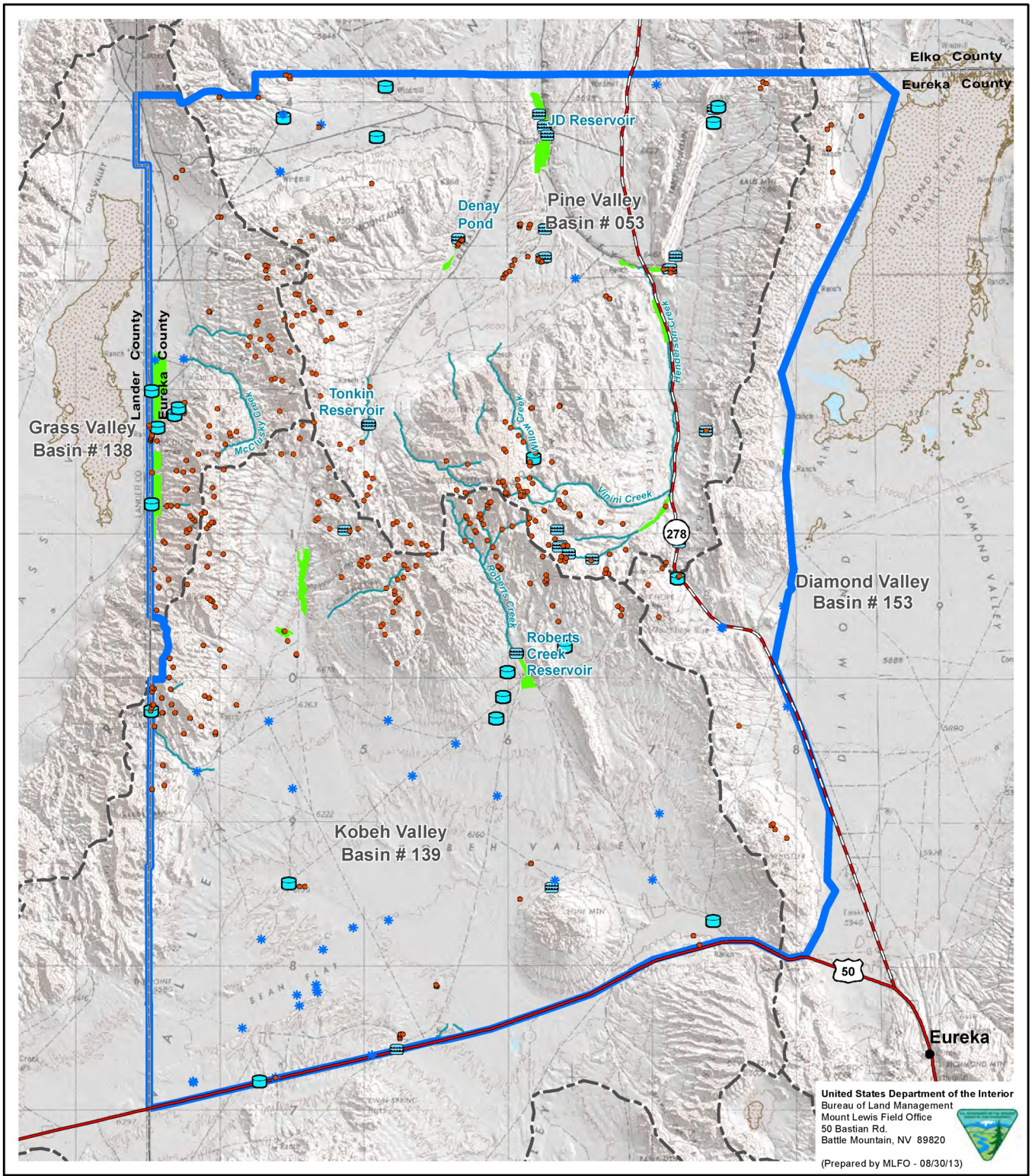
Spring	Associated Drainage	Flow (gpm)	Flow (cfs)	Measurement Date
Tonkin Spring	Denay Creek	449 to 1,077	1.0 to 2.4	Continuous
BC-1	Upper Birch Creek	78	0.17	03/22/2009
PH-2	Upper Pete Hanson Creek	10	0.02	03/27/2009
PH-7	Upper Pete Hanson Creek	2	0.004	03/27/2009
PH-7A	Upper Pete Hanson Creek	8	0.018	03/27/2009
PH-8	Upper Pete Hanson Creek	0	0	03/23/2009
PH-14	Upper Pete Hanson Creek	1	0.002	03/23/2009
PH-15	Upper Pete Hanson Creek	0	0	03/23/2009
HC-10A	Upper Henderson Creek	1	0.002	03/28/2009

gpm = gallons per minute.
cfs = cubic feet per second.
Source: JBR (2009) and USGS (2012a).

3.9.2.4 Surface Water Quality

Beneficial uses of surface water in the project area include livestock watering, irrigation, aquatic life support, recreation with either contact or noncontact with water, municipal supply, and wildlife propagation (Nevada Administrative Code 445A).

The Nevada Water Pollution Control Law provides the State of Nevada the authority to maintain water quality for public use, wildlife, industry, agriculture, and the economic development of the site. The Nevada Division of Environmental Protection defines waters of the state to include surface water courses, waterways, drainage systems, and underground water. The Nevada Water Pollution Control Law also gives the State Environmental Commission authority to require controls on diffuse sources of pollutants, if these sources have the potential to degrade the quality



Legend

Water Developments and Water Uses
- Spring
- Windmill/Well
- Reservoir
- Stock Tank, Trough, or Waterhaul
- Irrigated Crop
- Perennial Stream
- Lake or Pond
- Playa
- Hydrographic Basin
- 3 Bars Project Area

Source: BLM 2012c,g; NDWR 2012; USGS 2012b.

3 Bars Ecosystem and Landscape Restoration Project

Figure 3-24

Water Developments and Water Uses

0 1 2 3 4 5 10 Miles
0 1 2 3 4 5 10 Kilometers
N

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data.
Original data were compiled from various sources. This information may not meet National Map Accuracy Standards.
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of the waters of the state. The USEPA has also granted Nevada authority to enforce drinking water standards established under the Safe Drinking Water Act.

The State of Nevada classifies surface water bodies into four classes—A, B, C, and D. Each class has associated water quality standards. Class A waters include waters or portions of waters in areas of little human habitation, and no industrial development or intensive agriculture, and where the watershed is relatively undisturbed by human activity. The beneficial uses of Class A waters are municipal or domestic supply, or both, with treatment by disinfection only, aquatic life, propagation of wildlife, irrigation, watering of livestock, recreation including contact with the water, and recreation not involving contact with the water. Class B waters include waters or portions of waters that are on areas of light or moderate human habitation, little industrial development, light-to-moderate agricultural development, and where the watershed is only moderately influenced by human activity (USDOI BLM 2012c).

The beneficial uses of Class B water are municipal or domestic supply, or both, with treatment by disinfection and filtration only, irrigation, watering of livestock, aquatic life and propagation of wildlife, recreation involving contact with the water, recreation not involving contact with the water, and industrial supply. Class C waters include waters or portions of waters that are located in areas of moderate to urban human habitation, where industrial development is present in moderate amounts, where agricultural practices are intensive, and where the watershed is considerably altered by human activity (USDOI BLM 2012c).

The beneficial uses of Class C water are municipal or domestic supply, or both, following complete treatment, irrigation, watering of livestock, aquatic life, propagation of wildlife, recreation involving contact with the water, recreation not involving contact with the water, and industrial supply. Class D waters include waters or portions of waters in areas of urban development, are highly industrialized or intensively used for agriculture, or a combination of these, and where effluent sources include a multiplicity of waste discharges from the highly altered watershed. The beneficial uses of Class D waters are recreation not involving contact with the water, aquatic life, propagation of wildlife, irrigation, watering of livestock, and industrial supply, except for food processing purposes (USDOI BLM 2012c).

Roberts Creek and its tributaries are Class A water bodies from the headwaters to the reservoir and Class B water bodies below the reservoir. Denay Creek and its tributaries from the headwaters to Tonkin Reservoir and the Reservoir itself are Class A water bodies. Denay Creek below Tonkin Reservoir is a Class B water body. J.D. ponds are Class C water bodies. These waterbodies have aquatic life, livestock, recreation, irrigation, and other beneficial uses. All other perennial streams in the vicinity of the project area are unclassified (USDOI BLM 2012c).

The Nevada Division of Environmental Protection requires compliance with National Pollution Discharge Elimination System permits related to discharge to waters of the U.S., including discharges of stormwater runoff. The Nevada Division of Environmental Protection requires that discharges into subsurface waters be controlled if the potential for contamination of groundwater supplies exist.

Surface water quality has been investigated through more intensive sampling at several locations within the Roberts Mountains by the USGS and JBR from 2009 to 2011 (JBR 2009, USGS 2012a). No water quality assessments are known to have occurred outside the Roberts Mountains. Results indicate generally good to excellent water quality in drainages within the Roberts Mountains. The waters are a calcium/magnesium bicarbonate type, with pH ranging generally between 7.8 to 8.6 standard units. Some pH values are slightly higher. Hardness ranges between approximately 200 to 300 milligrams per liter (mg/L) as calcium carbonate. In Birch Creek and Vinini Creek, the electrical conductivities are somewhat elevated (on the order of 6,500 micromhos per centimeter), indicating higher

levels of dissolved salts. Elsewhere, conductivity values were moderate to low (200 to 400 microSiemens per centimeter). At springs such as PH-14 on Pete Hanson Creek, HC-10 on Henderson Creek, and Tonkin Spring above Denay Creek, somewhat greater concentrations of magnesium occurred in comparison to other locations. Dissolved oxygen concentrations were moderate in the USGS samples (6.6 to 8.1 mg/L). The lower dissolved oxygen values (e.g., below 7 mg/L) occurred with warmer water temperatures during June 2011 (USGS 2012b).

It is anticipated that water quality from these upgradient streams and springs would generally decline with increasing distance from the mountain headwaters. As the streams traverse lower-elevation alluvial fans and valley deposits, remaining flows are likely to have increased salinity and sediment concentrations.

3.9.2.5 Groundwater Resources

3.9.2.5.1 General Hydrogeologic Setting

The mountains that border the basins consist of complexly faulted and folded Paleozoic sedimentary rocks, with widespread occurrences of Jurassic, Cretaceous, and Tertiary intrusive and volcanic rocks. Carbonate rocks dominate the Sulphur Spring Range and Roberts Mountains, as well as the mountains bordering Eureka, Nevada. Siliceous clastic rocks are found in the Diamond Mountains along the east side of Diamond Valley. Tertiary intrusive and volcanic rocks are predominant in most of the other mountain ranges. The approximate axis of the Northern Nevada Rift extends from Eureka northeastward through the Roberts Mountains and northeast into Grass Valley (Ponce and Glen 2002).

The basin fill deposits consist of middle Tertiary through Quaternary sedimentary rocks and unconsolidated to partially consolidated alluvial, fluvial, and lacustrine sediments. Ash-flow and air-fall tuffs are interbedded with the sediments. Coarse alluvial sediments found along the mountain fronts grade basinward into finer alluvial fan, fluvial, and lacustrine sediments. Pliocene and Pleistocene lakes formed in many of the valleys during a period of wetter climate in the Great Basin. Pine Valley, Kobeh Valley, Grass Valley, and Diamond Valley contained extensive lakes during the Pliocene and early Pleistocene. Remnants of these pluvial lakes are elevated terrace deposits and a thick sequence of clay, silt, freshwater limestone, and evaporites that underlie the shallow alluvial sediments of the basins.

3.9.2.5.2 Groundwater Hydrology of Kobeh Valley

The Kobeh Valley basin is a roughly equidimensional basin. Descriptions of the valley have been taken from Rush and Everett (1964) and USDOI BLM (2012c). Geologically, Kobeh Valley consists of basin-fill alluvium within the main part of the basin and alluvial fan sediments along the mountain fronts surrounding the basin.

Montgomery and Associates (2010) completed a water balance study for Kobeh Valley basin during 2009. This is presented in **Table 3-19** along with their estimates for the 2009 water balance for Antelope, Diamond, and Pine Valley basins. The total outflow for the Kobeh Valley basin for 2009 was 20,800 acre-feet/year and exceeded the inflow of 18,000 acre-feet/year (Montgomery and Associates 2010). By this water balance estimate, Kobeh Valley basin is losing water from storage due to groundwater pumpage and water levels in the valley should begin to decline. This may eventually affect the growth of phreatophytes.

3.9.2.5.3 Groundwater Hydrology of Diamond Valley

Diamond Valley is an elongate basin oriented approximately north–south. The north end of the valley is occupied by an extensive playa. The south end of the basin near Eureka is used for agricultural irrigation. The valley-fill sediments

consist of at least 7,845 feet amsl of interbedded gravels, silts, clays, evaporates, Pleistocene lake-bed sediments, and volcanic tuffs.

Groundwater flow in the Diamond Valley basin has been noticeably altered by extensive agricultural irrigation in the southern part of the valley. Prior to the onset of intensive irrigation, groundwater in the Diamond Valley basin flowed from south to north and terminated in the playa at the north end of the basin. Eakin (1962) completed a groundwater appraisal of the Diamond Valley basin and showed that water elevations in the southern part of the valley were around 5,870 feet amsl and those in the northern part near the playa were around 5,770 feet amsl. Water elevations in 2005 were around 5,800 feet amsl in the southern part of the basin. Irrigation pumping has created a groundwater depression that has concentrated groundwater flow into the southern part of the basin. Consequently, groundwater no longer flows into the playa area in the northern part of the basin from the south. Agricultural irrigation in the southern part of the basin has resulted in subsidence of the basin sediments.

TABLE 3-19

2009 Estimated Annual Groundwater Budget for Individual Basins

Budget Component	Antelope Valley	Diamond Valley	Kobeh Valley	Pine Valley[1]
Groundwater Inflow (acre-feet per year)				
Precipitation Recharge	4,100	21,400	13,200	34,900
Subsurface Inflow	0	7,800 (5,800 from Pine Valley and 2,000 from Kobeh Valley)	4,800 (1,600 from Monitor Valley, 2,700 from Antelope Valley, and 500 from Pine Valley)	0
Total Inflow	**4,100**	**29,200**	**18,000**	**34,900**
Groundwater Outflow (acre-feet per year)				
Evapotranspiration	1,400	14,700	15,900	17,100
Net Groundwater Pumping	Negligible	55,800	2,900	negligible
Subsurface Outflow	2,700 (to Kobeh Valley)	0	2,000 (to Diamond Valley)	17,600 (5,800 to Diamond Valley, 500 to Kobeh Valley, and 11,300 to northern Pine Valley)
Total Outflow	**4,100**	**70,500**	**20,800**	**34,700**
Inflow (Outflow)	**0**	**(41,300)**	**(2,800)**	**200**

[1] Within Hydrologic Unit Code 10 watersheds on/within 3 Bars Project area.
Source: Montgomery and Associates (2010) *in* USDOI BLM (2012c:3-55 to 3-56).

Eakin (1962) completed a preliminary water balance for the Diamond Valley basin. He estimated that groundwater recharge was around 16,000 acre-feet/year and that groundwater discharge was about 23,000 acre-feet/year. Evapotranspiration from natural vegetation was estimated at 14,100 acre-feet/year and water loss from meadow and pasture grass was estimated at 8,900 acre-feet/year. Pumpage from irrigation wells was around 5,000 acre-feet/year and the wells were screened in the upper 200 feet of the basin fill with well yields in the range of 1,000 to 2,500 gpm. Montgomery and Associates (2010) estimated the pre-development water balance for the Diamond Valley basin. Their values are considerably different from those of Eakin (1962), with precipitation recharge at 21,400 acre-

feet/year and 8,900 acre-feet/year of groundwater inflow from Pine and Kobeh valley basins. Their evapotranspiration loss was 30,300 acre-feet/year and groundwater pumpage was only 800 acre-feet/year. As of 2009, the water balance estimate of Montgomery and Associates (2010) has groundwater pumpage at 55,800 acre-feet/year with groundwater inflow from Pine Valley and Kobeh Valley basins and precipitation recharge being about the same as in the 1960s. The main change for 2009 is the substantial increase in irrigation pumpage.

With irrigation pumpage resulting in a groundwater sink in the southern part of the Diamond Valley basin and accompanying basin sediment subsidence, the playa at the north end of the valley no longer receives groundwater flow from the southern part of the valley. Prior to agricultural development of Diamond Valley, the playa at the north end of the valley was the terminus of the Diamond Valley regional groundwater flow system. Now, the groundwater sink created by irrigation pumpage is the terminus of the flow system. Without groundwater flow from the southern part of the valley, the playa at the north end of Diamond Valley can be expected to become progressively dryer, resulting in a change in vegetation types and a reduction in phreatophytes surrounding the playa.

3.9.2.5.4 Groundwater Hydrogeology of Pine Valley

Pine Valley is an elongate basin, 55 miles long by 30 miles wide, northwest of Diamond Valley and north of Kobeh Valley. The principal drainage is Pine Creek and this drainage flows into the Humboldt River, placing Pine Valley in the Humboldt River Flow System. Garden Valley is a sub-basin of Pine Valley and is along the southeastern part of the basin, adjacent to Mount Hope. Henderson Creek drains Garden Valley and flows into Pine Creek. Most of the drainages that feed into Pine Creek originate in the Cortez Mountains or the Roberts Mountains.

The Pine Valley basin is characterized by shallow groundwater levels in the valley-fill alluvial aquifer. Groundwater elevations in the basin alluvial aquifer are around 5,800 feet amsl at the southern end of the valley and around 4,800 feet amsl near the northern end of the basin where Pine Creek flows into the Humboldt River. The hydrology of Pine Valley is characterized by shallow groundwater levels in the valley-fill alluvial aquifer (Eakin 1961). Depth to groundwater, in the valley fill along Pine Creek, ranges from 0 to 10 feet below ground surface. Pine Creek is fed by groundwater baseflow on a year-round basis and by mountain-front runoff during the spring snowmelt in the bordering mountains, especially the Cortez Range and the Roberts Mountains. Eakin (1961) estimated the recharge to Pine Valley at 46,000 acre-feet/year with discharge by evapotranspiration from natural vegetation and pasture grass at 24,000 acre-feet/year. Pine Creek discharges from 30 acre-feet/year during low flow periods to 2,100 acre-feet/year during high flow periods (Eakin 1961). Montgomery and Associates (2010) estimated the precipitation recharge for 2009 to be 34,900 acre-feet/year for the southern two-thirds of the basin (the area within the project area). Their water balance estimate had 17,100 acre-feet/year of evapotranspiration loss and 17,600 acre-feet/year of subsurface groundwater outflow to Diamond Valley (5,800 acre-feet/year), Kobeh Valley (500 acre-feet/year), and the northern one-third of Pine Valley (11,300 acre-feet/year). Montgomery and Associates (2010) did not discuss groundwater baseflow to the Pine Creek basin and the discharge of this groundwater eventually to the Humboldt River.

3.9.2.5.5 Groundwater Hydrology of Grass Valley

Grass Valley is a closed hydrographic basin that has not received much study. Everett and Rush (1966) described the general features of the basin hydrology. The Grass Valley basin is topographically and hydrologically closed and consists of two interconnected basins. The smaller basin is in the southwest corner of Grass Valley and is adjacent to Mt. Callaghan and fed by Current Creek and Skull Creek. This smaller basin contains abundant springs and drains through a gap in the bounding mountain ranges into the main part of the Grass Valley basin. The main basin of Grass Valley is elongate in a north-south direction and fed by ephemeral streams draining the Toiyabe Range that bounds

the west side of the valley. Springs are found along both the east and west sides of Grass Valley near the contact between the alluvial fans that form the margins of the basin and the bounding bedrock of the fault-block ranges that border the basin. The Grass Valley basin is dominated by a large playa and the surrounding area phreatophytes that tap the shallow groundwater of the basin.

Groundwater recharge in the valley was estimated to be around 13,000 acre-feet/year. This is approximately balanced by evapotranspiration from the phreatophytes and groundwater pumpage of about 200 acre-feet/year. Estimated total precipitation for Grass Valley is around 29,000 acre-feet/year and approximately 4.5 percent of this precipitation recharges groundwater. This is balanced by evapotranspiration from the phreatophytes estimated at 12,000 acre-feet/year and by both limited groundwater pumpage and consumption of groundwater by alfalfa grown south of the playa in the central part of the valley (Everett and Rush 1966).

3.9.2.5.6 Basin Groundwater Quality

Groundwater quality in all the basins is similar and generally suitable for irrigation and stock watering. Over most of the basins, the groundwater is dominated by calcium-sodium bicarbonate or sodium-calcium bicarbonate with the total dissolved solids generally below 1,000 mg/L and often below 500 mg/L. Water quality is best in the alluvial fans near the mountain fronts and becomes more saline near the valley centers. For valleys with playas, the water quality can become quite saline, with the total dissolved solids exceeding 1,000 mg/L and the groundwater near the playas being dominated by calcium sulfate. Chloride can be locally elevated near the playas. Shallow groundwater near the basins centers is generally more saline than groundwater in the alluvial fans near the mountain fronts.

Grass Valley has calcium bicarbonate dominated groundwater, with a total dissolved solids in the range of 300 to 500 mg/L (Everett and Rush 1966). Sulfate ranges up to 116 mg/L. Near the playas, groundwater in Grass Valley becomes saline with the total dissolved solids ranging up to 1,800 mg/L (Cohen 1964). Groundwater quality is suitable for irrigation, except beneath the playa area. Surrounding the playa and in the area of the phreatophytes, groundwater is dominated by sodium-calcium bicarbonate with a total dissolved solids in the range of 300 to 500 mg/L, sulfate ranging from 40 to 120 mg/L, and chloride less than 25 mg/L. In the area of the playa, the groundwater quality becomes saline due to evaporation in the playa. There are 23 wells of record and the deepest well is only 327 feet below ground surface. Water levels in the wells are generally within 50 feet of the surface, with only two wells having water levels deeper than 100 feet below ground surface (Everett and Rush 1966).

Big Smoky Valley has groundwater that increases in total dissolved solids with depth (Handman and Kilroy 1997). The total dissolved solids ranged from a low around 65 mg/L up to 600 mg/L for groundwater in the alluvium away from the playas. Near the playas, total dissolved solids can reach 9,000 mg/L and the groundwater becomes dominated by calcium sulfate.

Diamond Valley is divided into two valleys (Eakin 1962). The lower or southern part of the valley has good groundwater used for irrigation that is dominated by calcium bicarbonate, with total dissolved solids generally below 500 mg/L. The northern part of the valley is dominated by a playa and the groundwater becomes quite saline and dominated by calcium sulfate.

Monitor, Antelope, and Kobeh Valleys have groundwater dominated by calcium bicarbonate and a total dissolved solids below 500 mg/L. Near the centers of the basins and especially near playas, the groundwater quality becomes more saline and the total dissolved solids exceed 1,000 mg/L (Rush and Everett 1964).

3.9.3 Environmental Consequences

3.9.3.1 Key Issues of Concern Considered during Evaluation of the Environmental Consequences

Based on the AECC and public scoping comments, the following issues were identified for water resources:

- How will water rights be addressed?
- How will treatments maintain or improve water quality?
- How will treatments protect surface and groundwater resources from degradation by fuel or oil spills and other human activities in the 3 Bars ecosystem that could result in the pollution of water resources?
- How will treatments maintain or improve watershed and streams/riparian zone conditions?
- How will treatments reduce the threat of knickpoints and/or headcuts, which indicate vertical instability and are a point source for accelerated erosion?
- Will pinyon-juniper treatments help to lessen water demands (through decreased evapotranspiration and sublimation), and increase the amount of water that infiltrates into the ground and discharges to seeps and springs?
- Will treatments remove stock ponds that have inhibited sediment transport conditions locally, stored sediment, and caused channel incision downstream?
- Will treatments improve bank stability?
- Will treatments benefit deep-rooted perennial upland herbaceous species that have declined due to decreasing infiltration rates and increasing run-off and surface erosion?
- What kinds of water developments that are being considered for the planning area, and what are the projected water flow production rates and availability to wild horses, wildlife, and livestock?
- How will treatments reduce the impacts of wildfires on groundwater and surface water resources?
- Would there be effects on local aquifers from the removal of pinyon-juniper and from mining and other projects in the CESA?

3.9.3.2 Significance Criteria

Impacts to water resources would be considered significant if BLM actions resulted in:

- Release of contaminants such as sediment, fuels, or lubricants into perennial or intermittent streams or springs, creating a change of water quality that often or regularly exceeds the applicable Nevada Division of Environmental Protection water quality standards specified in Nevada Administrative Code 445A for existing uses such as aquatic life, irrigation, livestock watering, or propagation of wildlife.
- Prevention of access, consumptive use, or long-term diversion of surface water that adversely affects recognized water rights holders. This would include flows and seasons of use where existing beneficial water uses, as defined by the Nevada Division of Water Resources, may be affected.

- Accelerated erosion occurs from watershed slopes and leads to increased sedimentation in streams or ponds, or to other uncontrolled stream channel and bank instabilities (including conditions that foster aggradation and lateral migration, bank erosion or piping, or channel degradation through scour or collapse at knickpoints or headcuts).
- Treatments result in lower groundwater levels due to decreased recharge. For groundwater levels, the water level decline would need to be greater than seasonal fluctuations in water levels and persist for several years or more to be statistically verifiable.

3.9.3.3 Direct and Indirect Effects

3.9.3.3.1 Direct and Indirect Effects Common to All Action Alternatives

Much of the focus of restoration treatments would be on maintaining connections between streams and floodplains, increasing infiltration, decreasing overland flow, reducing discharge velocity, and encouraging riparian plant establishment. Numerous streams lack characteristics necessary for properly functioning riparian habitats. Invasive plant species, hazardous fuels buildup, pinyon-juniper encroachment, disturbance by historic livestock use, wild horses, and wild ungulates, and climatic conditions are factors that have degraded riparian function on the 3 Bars Project area.

Groundwater in the 3 Bars ecosystem is an important component of riparian and wetland ecosystem health because it provides baseflow to streams, springs, and seeps that are an important source of water in riparian and wetland areas. Improvement of ecosystem health in riparian zones and increasing stream flows are expressed goals for the 3 Bars Project area (USDOI BLM 2009a:50). When functioning properly, streams, springs, seeps, and associated floodplains and wetlands absorb snowmelt and storm runoff, extend flows further into the year, and attenuate flood discharges.

Water Access

There could be short-term access restrictions to water access along portions of streams, or at developed or undeveloped springs to promote site restoration and establishment of native vegetation. Access to surface water sources could be temporarily interrupted through road closures, fencing, or other factors. However, the BLM would not completely block access to water for livestock, wild horses, and wildlife and access to water resources would be ensured to meet the needs of those species in accordance with Nevada Water Law and to ensure that existing water rights are satisfied and unimpaired.

Hillslope Erosion and Runoff

Removal of vegetation and disturbance of the soil could lead to increased water runoff and soil erosion. Interception and infiltration of rainfall and snowmelt would decrease as a result of overstory vegetation removal, formation of water resistant soil surfaces, or compaction. These effects could be minimized through the application of mulch and/or other erosion controls. After restoration with desirable vegetation, the erosive effects of snowmelt and rainfall would decrease, surface retention and infiltration would increase, and runoff and erosion conditions would improve.

Streambed or Bank Instability

Treatments could lead to short-term degradation of streambeds and banks due to removal of undesirable riparian vegetation, short-term impacts to desirable vegetation, and from in-channel earthwork. Adverse effects could include

initiating or increasing the occurrence and migration rate of knickpoints, headcuts, or bank caving and lateral migration, with the largest expected effect being an increase in sedimentation. Restoration at treatment sites, stabilization practices along streams, and post-project monitoring and maintenance would reduce the severity and duration of these impacts. Long term, treatments would ultimately improve stream function.

Surface Water Quantity

Restoration treatments would affect surface water quantity. Removal of vegetation could lead to increased runoff, and decreased infiltration, groundwater recharge, stream flows, and flow duration. Reductions in baseflows (groundwater contributions to streams) may result from increased surface runoff and reduced infiltration and ground water recharge. Revegetation may increase evapotranspiration demands on springs and perennial or intermittent streams at some sites. Some treatments may increase demands by phreatophytic vegetation and reduce water flows at or near treatment sites. These effects may contribute to increased episodes of little or no flow in ephemeral streams. Use of water from nearby sources to extinguish wildfires could reduce the quantity of surface water resources, particularly in arid climates or during dry seasons (USDOI BLM 2007c:4-22).

Several studies have shown that removal of pinyon-juniper that is encroaching into riparian habitat can improve stream flow. Buckhouse (2008) and deBoodt (2008) found that in areas where all junipers were cut from a watershed, late season spring flow, days of recorded ground flow, and late season soil moisture increased compared to pre-treatment conditions. As a result, flows may endure longer into the summer months at some springs and perennial or intermittent streams where dense, deep-rooted pinyon-juniper or other stands were treated. The lengths of perennial or intermittent stream reaches may also increase. These benefits would be more likely in Phase II and III pinyon-juniper stands, or in the mountains or on upstream reaches of mountain-front alluvial fan channels.

Pierson et al. (2013) found that 2 years post fire, erosion remained 20-fold greater on burned than unburned pinyon-juniper woodland plots, but concentrated flow erosion from the intercanopy was reduced by growth of forbs and grasses in the understory. Their study suggested that burning may amplify runoff and erosion immediately post fire, but that activities that stimulate vegetation productivity may provide long-term reduction of soil loss, especially when compared to untreated areas with pinyon-juniper. Burning of Phase II and III woodlands enhanced herbaceous cover, decreased bare ground connectivity, improved infiltration, and reduced concentrated flow erosion within the intercanopy over the first 2 years following the fire. Short-term improvements in infiltration and erosion suggest that tree removal by burning may create a restoration pathway for woodland-encroached sagebrush steppe habitat, but that improvements may take 3 or more years to take effect, depending on the rate of vegetation and ground cover recruitment. In contrast, Pierson et al. (2013) observed that simply placing cut-downed trees into the unburned intercanopy had minimal immediate impact on infiltration and soil loss.

If slash and other downed woody material from treatments are used as mulch, this material should slow runoff and sedimentation, and infiltration and soil moisture would likely increase. Mulch would also help to capture sediments and decrease peak flows. As treated areas revegetate, there should be long-term benefits to stream flow and soil moisture.

Surface Water Quality

The water quality of perennial and intermittent streams could decrease in the short term after treatments, due to runoff and erosion from loss of vegetative cover and soil disturbance. Some treatments would be on soils that are susceptible

to water and wind erosion (see **Figures 3-14** and **3-15**). However, by retaining downed woody material in treatment areas, these effects can be minimized or avoided.

If streamside vegetation is removed, the loss of shade could result in higher water temperatures and lower dissolved oxygen, to the detriment of fish and other aquatic organisms (USDOI BLM 2007c:4-22). Removal of vegetation and an increase in erosion and sedimentation could result in an increase in salts in receiving water bodies. Birch Creek and Vinini Creek have elevated electrical conductivities, indicating higher levels of dissolved salts. However, other streams on Roberts Mountains have lower conductivity values, so the potential for adverse salinity effects varies across the project area.

There is potential for fuel and lubricants used for equipment and transport vehicles to spill into water bodies. The BLM would minimize this risk by refueling and servicing equipment away from water bodies, and minimizing equipment use in aquatic bodies, where feasible.

The removal of hazardous fuels from public lands would result in a long-term benefit to surface water quality by reducing the risk of a future high-severity wildfire on the treatment site. A high-severity wildfire that removes excessive plants and litter could subsequently increase surface soil erosion and cause soil mass failures and debris flow, resulting in short-term increases in stream flows. In addition, fire retardants could affect water quality. Fire retardants that are used most extensively for emergency suppression contain nitrogen and phosphorus that could cause nutrient enrichment of surface waters. When mixed with water and exposed to ultraviolet radiation, some fire retardants break down into hydrogen cyanide, an extremely toxic substance (Fresquez et al. 2002).

Over the long term, vegetation treatments that move the 3 Bars ecosystem toward historical ranges of variability, with a preponderance of native plant communities in natural mosaic patterns and relatively uninterrupted disturbance regimes, would provide favorable conditions for surface water quality by reducing the incidence of soil erosion and sedimentation.

Groundwater Quantity and Recharge

As discussed above, studies by Buckhouse (2008), deBoodt (2008), and Pierson et al. (2013) showed that the removal of vegetation could increase surface water runoff and reduce infiltration in treatment areas in the short term, to the detriment of local-area groundwater recharge and availability, although some water may be retained in the system due to reduced evapotranspiration; on a basin-wide scale, groundwater recharge would increase. Long term, treatments may improve groundwater availability as native vegetation re-establishes on treatment sites, which would reduce runoff and increase infiltration; these effects would be most noticeable in Phase II and III pinyon-juniper stands where there is little understory. Baseflow to streams may also increase due to increased infiltration of precipitation and an increase in recharge to shallow groundwater. The increase in baseflow may be temporary unless long groundwater flow paths are involved. Removal of pinyon-juniper and replacement with a less water consumptive species is often cited as the prime example of the beneficial effect to groundwater recharge from removal of an invasive water consumptive species (USDOI BLM 2007c:4-21).

The key factors relating removal of a water consumptive species and increased infiltration are topographic slope, soil permeability, precipitation frequency and duration, and the water consumptive nature of the replacement species. Steep slopes with tight or compact soils would have a greater tendency to show increased runoff after removal of a species. This increased runoff would be temporary and would decline once the replacement species has established. However, the increased runoff would cause a reduction in infiltration and thus a potential reduction in recharge to

shallow aquifers. Mulching treated areas with chopped vegetation would mitigate for these effects by slowing runoff and enhancing infiltration. Areas with frequent or intense precipitation would be expected to show a greater potential for increased infiltration after removal of a water consumptive species. Similarly, if the replacement species has a high capacity for soil water retention and consumption, then the benefits of removal of the less desirable species would be only temporary.

Groundwater Quality

Improvements in groundwater quality from vegetation treatments are more difficult to quantify, primarily due to the lack of long-term groundwater quality data needed to statistically defend an improvement in water quality. If vegetation treatments reduce nutrient uptake by plants, either by removing plants or replacing one species with another that requires less or different nutrients, then soluble nutrients like nitrogen may enter streams via groundwater baseflow from shallow aquifers due to dissolution of these nutrients by infiltrating precipitation (USDOI BLM 2007c:4-21). In areas with high salt levels in soils, a change in vegetation species may result in increased flushing of salts to groundwater. Nutrients sorbed onto soil particles, such as phosphorous, may be carried to streams in runoff. Groundwater quality may be affected, at least temporarily, by an influx of nutrients that would otherwise have been consumed by the vegetation that has been removed. Conversely, since runoff beneath pinyon-juniper has been shown to far exceed that of non-pinyon-juniper terrain, removing pinyon-juniper, placing mulch, and allowing native vegetation to stabilize the soil could decrease runoff and the associated erosion which carries sediment loads and increases total dissolved salts and other pollutants.

3.9.3.3.2 Direct and Indirect Effects under Alternative A (Preferred Alternative)

Riparian Treatments

The BLM has identified about 3,885 acres of riparian zone treatments. Most of the riparian treatments would be in the Kobeh Valley and Pine Valley watersheds. Treatment acres comprise only a small portion of the watershed basins within the project area (**Table 3-20**) and only 3 percent of all project treatment acreage. The BLM would restore 31 miles of perennial streams (**Table 3-21**), 17 miles of intermittent streams, and 40 springs that are within the riparian treatment zone.

Riparian area treatments would focus on restoring stream and habitat functionality in areas where the stream channel morphology, and the plant species composition within the riparian zone, have been compromised by past actions. Because of the loss of structural integrity in compromised channels, stream velocities have increased over historic levels, nutrient-rich sediment is not being delivered to riparian vegetation, and there is less groundwater recharge within the floodplains. Near-stream groundwater levels have also dropped as a result of stream incision.

The following discussion focuses on the effects of riparian treatments on water resources. A discussion of stream processes, and how proposed stream engineering treatments would affect stream morphology and functionality, including processes related to water quantity and quality, is in Section 3.10.3 under Wetland, Floodplain, and Riparian Zone Resources.

Adverse Effects

Because riparian treatments would, by definition, be conducted close to surface water features, of all of the treatment types they would have the most potential to have adverse and beneficial impacts on water resources. Avoidance of

these impacts would be particularly critical for occupied and potential Lahontan cutthroat trout streams, stream segments on the Roberts Mountains, such as Roberts Creek, and those tributaries that have Class A stream standards.

Degraded stream systems on the 3 Bars Project area reflect degraded conditions in their contributing watersheds. These conditions tend to increase the magnitude and frequency of high flows after precipitation events, increase sediment inputs into stream systems, and diminish the streams' ability to resist degradation. The annual hydrograph, as differentiated from the storm event flow response described above, is also changed. High spring runoff flows often increase, while seasonal low flows (baseflows) decline or cease. Direct alterations include channel straightening, dredging, widening, narrowing, levee construction, floodplain fill, and riparian zone modification. Indirect activities include those that alter the principal processes that create and maintain stream channel conditions. Tree harvest, road building, and grazing also influence the supply and transport of water, sediment, energy (light and heat), nutrients, solutes, and organic matter (ranging from woody material to leaf litter; Saldi-Caromile 2004). Stream restoration treatments could further degrade conditions within the stream until it stabilizes. Channel restoration and vegetation removal and planting may temporarily increase erosion in treated areas.

TABLE 3-20

Percent of Watershed Basin within Treatment Areas

Basin Name	Basin Acres	Riparian	Aspen	Pinyon-juniper	Sagebrush
Diamond Valley	477,506	<0.1	0	6.8	1.4
Grass Valley	379,846	<0.1	0.0	0	2.2
Kobeh Valley	551,961	0.2	<0.1	8.9	8.1
Pine Valley	640,588	0.3	<0.1	7.8	8.0

TABLE 3-21

Perennial Stream Miles within Treatment Areas

Stream Name	Miles by Treatment Type			
	Aspen	Pinyon-juniper	Riparian	Sagebrush
Birch Creek	0.6	1.5	0	0
Denay Creek	0	0.1	0	0
Henderson Creek	0	1.8	5.6	4.6
McClusky Creek	0	0	3.3	0
Pete Hanson Creek	1.2	1.4	0	0
Roberts Creek	0	3.2	5.4	0
Vinini Creek	0.3	0	5.2	1.3
Willow Creek	0	0	5.0	0
Unnamed	1.7	5.7	6.7	0.5
Total Miles	**3.8**	**13.7**	**31.2**	**6.4**

Treatments at the Black Spring, Cadet Spring, and Indian Creek Headwaters units groups, as well as those streams identified for Lahontan cutthroat trout habitat improvements, would involve using heavy equipment such as bulldozers and backhoes to reconstruct streams and improve riparian habitat. The soil disturbance associated with machinery used to remove vegetation and reconstruct streams, such as digging, plowing, or scraping, and from wheels and tracks of machinery, would increase the likelihood of soil and plant material being carried into streams by surface runoff. In addition, the compaction of soil by heavy equipment would increase the likelihood of surface runoff by reducing the soil's infiltration capacity. However, leaving debris in place after treatments would limit these negative effects on infiltration rates and stream sedimentation (USDOI BLM 2007c:4-23).

Manual and mechanical methods and prescribed fire could be used at the Frazier Creek Unit, and at Garden Spring, Hash Spring and several other springs to remove pinyon-juniper. Because manual treatments would occur over small areas, and would involve little soil disturbance or vegetation removal, the effects on water resources would be minimal. Manual treatment seldom results in exposed soil, and plant materials would remain in the treatment areas, minimizing the risks of sedimentation and alteration to water flow (USDOI BLM 2007c:4-23).

The burning of vegetation would be expected to lead to an increase in surface runoff and sediment inputs to water, and a decrease in infiltration and groundwater recharge. The amount of runoff would be a function of the timing and severity of the fire, the slope of the treatment site, and the timing, amount, and intensity of precipitation. As discussed earlier, Pierson et al. (2013) found that 2 years post fire, erosion remained 20-fold greater on burned than unburned pinyon-juniper woodland plots, but concentrated flow erosion from the intercanopy was reduced by growth of forbs and grasses in the understory. Their study suggested that burning may amplify runoff and erosion immediately post fire, but that activities that stimulate vegetation productivity may provide long-term reduction of soil loss, especially when compared to untreated areas with pinyon-juniper.

High severity fires tend to burn much of the organic material on a site, exposing mineral soil and sometimes forming hydrophobic, or water repellant, soil layers. In severe, slow-moving fires, the combustion of vegetative materials creates a gas that penetrates the soil profile. As the soil cools, this gas condenses and forms a waxy coating, which in turn causes the soil to repel water. This increases the rate of water runoff. Percolation of water into the soil profile is reduced, making it difficult for seeds to germinate and for the roots of surviving plants to obtain moisture. Hydrophobic soils do not form in every fire. Factors contributing to their formation are a thick layer of litter before the fire, a severe slow-moving surface and crown fire, and coarse textured soils such as sand or decomposed granite. Finely textured soils such as clay are less prone to hydrophobicity (Moench and Fusara 2012). Approximately 90 percent of riparian treatment acreage has high fire damage susceptibility, so fire use should be limited to small treatment areas in areas with low fire damage susceptibility.

After a low severity prescribed burn, erosion, runoff, and water quality are often unaffected on level areas, whereas adverse effects to water resources may persist for 9 to 15 months on moderate slopes, and for 15 to 30 months on steep slopes (USDOI BLM 2007c:4-23). As only a few, if any, acres would be burned annually in riparian zones, and only in areas where hydrophytic vegetation was absent, these impacts to water conditions from prescribed fire should be minor. It is unlikely that burning would be conducted along streams with Lahontan cutthroat trout due to the potential for adverse impacts to stream water quality and loss of vegetative cover adjacent to streams. The BLM would consult with the USFWS before conducting treatments on streams occupied by Lahontan cutthroat trout.

Beneficial Effects

The primary objective of riparian management is to restore degraded streams to Proper Functioning Condition to benefit riparian habitat, riparian-dependent wildlife, and Lahontan cutthroat trout and other aquatic species. A proper functioning riparian zone has the necessary physical and structural components to dissipate stream energy associated with high water flows, as well as conditions that support a diverse and healthy population of fish and other aquatic organisms.

Stream bioengineering treatments that include improvements to stream channel morphology and plantings should reduce the occurrence of high flow events and allow higher flows to be distributed across the floodplain rather than focused in the channel. Where flows are restricted to narrow channels, the increase in energy confined within the channel has resulted in stream degradation. By creating conditions that slow water flow, and creating associated floodplains and wet meadows, the energy associated with water flow would be dissipated, reducing the potential for future channel degradation. In-channel work and road mitigation projects would provide additional benefits. Grade control structures would reduce incision rates and in some cases, reverse it through aggradation (one rock dam series). Post vanes and baffles would induce meanders and help restore natural sinuosity and slow discharge velocity. Road mitigation, such as rolling dips, berms, swales, and spill pads, would help move water off of roads and into the riparian and wetland areas. These structures may be installed in conjunction with stream bioengineering to improve and expand riparian habitat.

Hydrologic functions would improve over the long term due to stream restoration, including stabilization or reduction of drainageway erosion features such as knickpoints, headcuts, gullies, and bank caving, and as a result of reconnecting hydrologic pathways, from overland flow through infiltration. Pinyon-juniper removal from riparian zones and adjacent upland areas may benefit hydrologic function as well, by generating some minor improvement in water flow in treated streams. Greater infiltration and interception of precipitation from improvement in riparian vegetation would help increase groundwater recharge and attenuate runoff peaks. Local increases in flow durations and flowing reaches could occur at some streams and springs (Tague et al. 2008). Incised channels and channel straightening from roads have caused water levels to drop along many proposed treatment streams, causing nearby areas to dry out. By creating conditions that reduce channel incision, reduce surface runoff, and increase infiltration, the deep-rooted herbaceous species that are being lost in many riparian zones should benefit from these actions. In turn, as these species become reestablished, they should help to stabilize soils and improve water quality.

Treatments to remove pinyon-juniper from riparian treatment units and in nearby upland areas where pinyon-juniper is encroaching into riparian and sagebrush habitat may increase groundwater recharge. Longleaf pinyon pine and Utah juniper are not riparian species, and are not as effective as native vegetation in stabilizing soil near streams. Encroaching pinyon-juniper in Phase II and III stands has led to the loss of understory vegetation through shading, which has resulted in increased runoff and higher-than-normal flows in streams and accelerated the erosion of natural stream meander bends. Since sinuosity and slope are inversely proportional, the streambeds have begun incising to compensate for the increased flow rates, resulting in the lowering of the streambed and water table. By removing trees and leaving treatment slash and other woody debris on the ground as mulch, and allowing understory vegetation to re-establish, surface runoff rates and peak stream flows should lessen, less sediment would be transported to streams, and more water should infiltrate into the soil and recharge the groundwater (Lossing 2012, Noelle 2012).

Improvement in riparian habitat and construction of fire breaks would help to slow or stop the spread of wildfire, to the benefit of water resources. Exclosure fencing would control access to treatment sites by livestock, wild horses, and wild ungulates and allow treatment areas to revegetate. Livestock, wild horses, and wild ungulates can affect surface

runoff through trampling, soil disturbance, and soil compaction. Past studies found that runoff from a heavily grazed watershed was 1.4 times that of a moderately grazed watershed, and 9 times greater than that of lightly grazed watershed. In some cases, however, light grazing may actually improve soil infiltration by breaking up physical crusts on the soil (USDOI BLM 2007c:4-24). Small breaks would be provided in the fencing, as needed, to ensure that animals have access to water in the vicinity of treatments.

Aspen Treatments

Aspen treatment areas overlap with approximately 4 miles of perennial streams, 55 miles of intermittent/ephemeral streams, and 35 springs. Efforts to stimulate aspen suckering and sucker survival would cause short-term soil disturbance and erosion, but as aspen stands improve, treatment actions should stabilize soils and improve hydrologic functions to the benefit of water resources. The BLM would remove pinyon-juniper and other non-riparian trees near aspen stands. Although it is unlikely that these treatments would enhance water yields, except perhaps at RM-A2 and RM-A10 along upper Roberts Creek and Upper Pete Hanson Creek, respectively, they would help to enhance fire breaks. Efforts to reduce the risk of catastrophic wildfires would reduce the potential for excessive loss of plant and litter cover and the potential for soil erosion and mass failures that would cause a decrease in water quality. Fire use and other treatments that restore natural fire regimes and ecosystem processes would reduce the effects of fire suppression and benefit water resources and quality (USDOI BLM 2007c:4-26).

Pinyon-juniper Treatments

Treatments that reduce the abundance of pinyon-juniper near water bodies, promote the development of native forbs, grasses, and shrubs, and reduce the risk of fire spread in pinyon-juniper stands would provide the most benefits to surface and groundwater resources. Pinyon-juniper treatments would overlap with approximately 14 miles of perennial streams, 464 miles of intermittent/ephemeral streams, and 63 springs.

Adverse Effects

Impacts to water quantity and quality could be greater for pinyon-juniper treatment areas than for other treatment types because of the large acreage treated, and because pinyon-juniper treatment areas are generally on moderate to steep hillslopes that are prone to water erosion. In addition, where trees are in dense stands, removal of these trees could lead to short-term water and wind erosion as vegetative ground cover is mostly absent from these areas. Thurow and Hester (2012) found that runoff and erosion were greater from manual, mechanical, and fire treatments in pinyon treatment areas than untreated areas, and that it could take up to 10 years to return to normal levels, especially for mechanical treatments that disturb the soil. They noted that fire can increase the water repellency of soils, and increase runoff and erosion and loss of soil nutrients from the site until the burned site is revegetated. They noted that studies have shown that burning can significantly reduce the infiltration rate and increase erosion due to loss of vegetation. These effects lessen as sites are revegetated.

Pierson et al. (2013) found that 2 years post fire, burning may amplify runoff and erosion immediately post fire, but that activities that stimulate vegetation productivity may provide long-term reduction of soil loss, especially when compared to untreated areas with pinyon-juniper. Burning of Phase II and III woodlands enhanced herbaceous cover, decreased bare ground connectivity, improved infiltration, and reduced concentrated flow erosion within the intercanopy over the first 2 years following the fire. Short-term improvements in infiltration and erosion suggest that tree removal by burning may create a restoration pathway for woodland-encroached sagebrush steppe habitat, but that

improvements may take 3 or more years to take effect, depending on the rate of vegetation and ground cover recruitment.

Several thousand acres could be burned each year using prescribed fire and wildland fire for resource benefits. The potential effects of fire on water resources would depend largely on the severity and size of the fire, with a low severity burn being less likely to degrade water quality and quantity than a severe burn, and a small fire affecting a smaller surface area than a large fire. In addition, the closer the fire is to a water body, the more likely it would be to affect water quality. The BLM would use fire and fuel breaks to limit the spread of fire. Most fire treatments would occur along the western slopes of the Roberts Mountains, and at the Whistler and Sulphur Spring Wildfire Management units.

Prescribed fire could be used on all pinyon-juniper treatment areas except Lone Mountain; only wildland fire for resource benefit would be used at the Sulphur Spring Wildfire Management Unit. The BLM would thin and remove pinyon-juniper and create fire breaks in several drainages on Roberts Mountains. Approximately one-third of the proposed treatment acres are on soils that are susceptible to compacting, and the resulting adverse impacts to erosion, runoff, sedimentation, and degraded soil quality would be of concern for this treatment group. In addition, approximately 17 percent of acres have severe water erosion hazard. Nearly 80 percent of the acreage associated with the Atlas, Birch, Frazier, Gable, Henderson, Upper Pete Hanson, Upper Roberts, and Vinini units has moderate or high fire damage susceptibility, while about 70 percent of acreage of the 3 Bars Ranch, Cottonwood/Meadow Canyon, Dry Canyon, Lower Pete Hanson, Tonkin North, Tonkin South, and Whistler units, and Sulphur Spring Wildfire Management Unit, has moderate to high fire damage susceptibility. Thus, mechanical treatments may be preferable to fire treatments if there is concern about soil damage and loss. If fire is used, effort should be made to burn during the cooler periods of the year and keep fire intensity low.

Beneficial Effects

Historical fire suppression has affected water quality and quantity on the 3 Bars Project area, as fire suppression is partly responsible for the spread of pinyon-juniper woodlands. The spread of Utah juniper and increase in the density of juniper stands has led to conditions that favor decreased soil infiltration and increase in peak discharges, especially in areas where dense pinyon-juniper cover has resulted in a lack of understory vegetation.

An important objective of pinyon-juniper treatments is to remove encroaching pinyon-juniper to restore the natural hydrologic regime. Treatments should lead to a long-term decrease in runoff, and an increase in infiltration, which should help to reduce the short-term intensity of stream flows during high rainfall events to the benefit of stream function and stability.

Hydrologic functions may ultimately improve along some perennial and intermittent streams and springs within the pinyon-juniper treatment areas. Petersen and Stringham (2008) found that water infiltration decreased as juniper canopy cover increased due to the loss of herbaceous and shrub vegetation. Depth of water was also lowest in plots dominated by juniper. Pierson et al. (2008) and Thurow and Hester (2012) found that runoff and erosion are greater from interspace areas than vegetated areas within pinyon-juniper woodlands. Lossing (2012) observed that removal of pinyon-juniper resulted in a 40 percent increase in the amount of rainfall reaching the soil surface compared to untreated stands. Thus, removal of trees should increase runoff, but could also increase infiltration in the short term.

Noelle (2012) observed that by leaving slash and other woody debris on the ground, sediment yield was significantly reduced. It is unlikely that additional water yields (flow durations and volumes) would be widespread, but they may

occur at some treatment sites where dense pinyon-juniper stands occur along streams or near springs. As discussed earlier, removal of pinyon-juniper that is encroaching into riparian habitat can improve stream flow. These benefits would be more likely in Phase II and III pinyon-juniper stands, or in the mountains or on upstream reaches of mountain-front alluvial fan channels (Buckhouse 2008, deBoodt 2008). However, Ffolliott and Gottfried (2012:15), in their literature review of hydrologic processes in pinyon-juniper woodlands, came to the conclusion "that the potential for increasing streamflow volumes by converting tree overstories to an herbaceous cover is poor." They attributed this to the fact that there are few opportunities to reduce evapotranspiration losses in areas with little rainfall where pinyon-juniper is typically found. The low amount of annual precipitation also has little influence on soil moisture.

Treatments along riparian corridors, including Atlas, Birch, Frazier, Henderson, Upper Pete Hanson, Upper Roberts Creek, and Vinini units may result in some streamflow increases and water quality improvement, while improvement to the understory should reduce soil erosion and impacts to water quality long term. These treatment areas are within and along the flanks of the Roberts Mountains. Removal of pinyon-juniper from these areas can be expected to improve infiltration and recharge to shallow groundwater along and near stream areas. The degree of improvement would depend on the depth to groundwater and the nature of the bedrock hosting the shallow aquifer. Thurow and Hester (2012) found that runoff and erosion was greater from manual and mechanical treatments when slash was removed than allowed to remain on the ground. They also reported that runoff increased and water quality declined on chained sites, but that after 5 to 11 years there was little difference in these parameters compared to undisturbed sites.

At the 3 Bars Project hazardous fuels reduction site-specific treatment units, including Cottonwood/Meadow Canyon, Dry Canyon, Lower Pete Hanson, Sulphur Spring Wildfire Management, and Tonkin units, some flow increases may occur at springs or along streams. Hydrologic and wetland functions may improve at the base of alluvial fans and along the valley axis in the upper Coils Creek drainage, near Meadow Canyon, and in the western part of the 3 Bars Ranch treatment area. The Sulphur Spring Wildfire Management and Whistler units are along the western side of Diamond Valley and are in recharge areas for the shallow alluvial aquifer in Diamond Valley. Removal of pinyon-juniper could lead to an increase in groundwater recharge in Diamond Valley.

Efforts to reduce the risk of catastrophic wildfires through reduction of hazardous fuels and creation of fire and fuel breaks would reduce the potential for excessive loss of plant and litter cover and the potential for soil erosion and soil mass failures that cause a decrease in water quality. Fire use and other treatments that restore natural fire regimes and ecosystem processes would reduce the effects of fire suppression and benefit water resources and quality.

Sagebrush Treatments

Adverse Effects

Approximately 5 miles of perennial stream are associated with riparian management projects within the larger sagebrush treatment area (Lower Henderson 1 and 3, and Lower Vinini Creek units). Only 1.3 miles of perennial stream habitat are associated exclusively with sagebrush treatment projects—Table Mountain (Henderson and Vinini creeks), and West Simpson Park (unnamed) units. Approximately 400 acres of treatments are associated with intermittent/ephemeral streams. Water erosion risk is low for most sagebrush treatment areas, except at West Simpson Park, where most (84 percent) of the treatment area would be susceptible to severe water erosion, and at the Three Corners Unit, where 27 percent of unit has severe or moderate risk of water erosion.

If animals are used as a method of biological treatment, the action of their hooves would cause some disturbance, shearing, and compaction of soil, increasing its susceptibility to both water and wind erosion. Severe compaction often reduces the availability of water and air to the roots, sometimes reducing plant vitality.

Beneficial Effects

Treatments that promote the development of understory vegetation within sagebrush habitats, and seedings and plantings to promote sagebrush development in areas where sagebrush should occur based on ecological site description reference, desired state, or management objective, would help to stabilize soils and reduce the risk of wind and water erosion. Removal of pinyon-juniper from sagebrush treatment areas could improve water flows and groundwater recharge.

Mechanical treatments could improve infiltration in clayey or compacted soils. Henderson Creek is found within the Table Mountain area. Sagebrush reductions, enhancement of native riparian species, and pinyon-juniper thinning in this area may improve hydrologic functions along the creek, particularly by improving runoff conditions and reducing accelerated erosion and related suspended sediment and turbidity.

For some treatment areas, the removal of vegetation, especially in large quantities, could improve groundwater recharge by limiting the amount of water lost through plant evapotranspiration. In this case, base flows, which are dependent on the quantity of groundwater discharge, would increase. These changes could be very minor or short-lived if areas were revegetated quickly.

Under some circumstances, vegetation removal could result in the reduction of groundwater discharge and baseflow as a function of reduced infiltration rates. Reduced infiltration rates result in more surface runoff reaching streams and lakes immediately after a rain event, thus increasing the velocity, frequency, and magnitude of peak stream flows. These changes in water quantity could alter the physical characteristics of stream channels and affect the speed of water movement. Any changes would last until the site was revegetated. Stream restoration projects adjacent to sagebrush treatment areas that improve stream function and restore riparian communities, however, should mitigate the short-term increase in runoff from these sites.

Non-native vegetation, specifically cheatgrass, on the 3 Bars Project area is associated with the occurrence of wildfires, which in turn have detrimental effects on water quality. Use of mechanical and biological methods and fire use can benefit water quantity and quality if non-native vegetation removal reduces the risk of catastrophic wildfire.

3.9.3.3.3 Direct and Indirect Effects under Alternative B (No Fire Use Alternative)

Of the approximately 6,350 acres that would be treated annually under Alternative B, about 2,000 acres would be treated in areas that have moderate to high water erosion potential, or about half that of Alternative A. Because prescribed fire and wildland fire for resource benefit would not be allowed under Alternative B, there would be no risks to water resources from fire use. Excluding prescribed burns would avoid the increases in runoff and erosion common to burned areas. Reduced soil infiltration, due to resinous sealing after intense burning than can occur in high fire susceptibility risk areas, would not occur as a result of prescribed burns. This may not be particularly beneficial however, if more extensive and intense wildfires occur in place of controlled burns.

By not being able to use prescribed fire, however, the BLM would be limited to mechanical and biological control treatments to slow pinyon-juniper encroachment, thin pinyon-juniper and sagebrush to promote understory vegetation, and to control noxious weeds and invasive non-native vegetation. In addition, mechanical methods could result in

more soil disturbance than the use of fire, which could lead to water degradation in areas with high water erosion risk. The Table Mountain and West Simpson Park units are on rugged terrain, and use of mechanical equipment to control cheatgrass would be difficult and erosion potential from treatments in these areas would be great. If not controlled, large infestations of cheatgrass and other noxious weeds and invasive non-native vegetation could result in frequent wildfires that would degrade water quality.

3.9.3.3.4 Direct and Indirect Effects under Alternative C (Minimal Land Disturbance Alternative)

Under Alternative C, the BLM would only be able to use manual and classical biological control methods to treat vegetation and would only treat about one-fourth as many acres as would be treated under Alternative A.

The risk of localized soil compaction and short term accelerated erosion from treatments, and its contribution to water quality degradation, would be less under Alternative C than the other alternatives, as there would be little ground disturbance under Alternative C. By not being able to use mechanical methods and fire to reduce hazardous fuels and create fire and fuel breaks, the risk of wildfire and its impacts on soil would be greater under this alternative than the other action alternatives. In addition, fewer acres would be treated to improve stream function and capability, and to remove pinyon-juniper and improve key sagebrush habitat, and benefits to surface and groundwater availability and quality from treatments under Alternative C would be less than under Alternatives A and B.

3.9.3.3.5 Direct and Indirect Effects under Alternative D (No Action Alternative)

There would be no direct effects to soil resources from this alternative as no treatments would be authorized under this alternative. The BLM would not create fire and fuel breaks; thin and remove pinyon-juniper to promote healthy, diverse stands; slow the spread of noxious weeds and other invasive non-native vegetation, especially cheatgrass; restore fire as an integral part of the ecosystem; or reduce the risk of a large-scale wildfire. The processes that create knickpoints, headcuts, and unstable streambanks would remain active, there would be few benefits to deep-rooted vegetation near streams, and there would be little improvement in stream flows. Thus, the health of the landscape would continue to deteriorate, and water quality and quantity would also deteriorate due to loss of soil due to erosion, stream channel instability, pinyon-juniper encroachment, and wildfire. These long-term effects would be greatest under Alternative D.

3.9.3.4 Cumulative Effects

The CESA for water resources is approximately 1,841,700 million acres and includes those watersheds at the Hydrologic Unit Code 10 level that are all or partially within the 3 Bars Project area (**Figure 3-1**). Approximately 92 percent of the area is administered by the BLM, 6 percent is privately owned, and 2 percent is administered by the Forest Service. Past and present actions that have influenced water resources in the 3 Bars ecosystem are discussed in Section 3.2.2.3.3.

3.9.3.4.1 Cumulative Effects under Alternative A (Preferred Alternative)

Actions to better distribute livestock across the rangeland and keep wild horse populations near the Appropriate Management Level, and the use of temporary fencing to protect treatment areas within the CESA, should benefit water resources. The measures that the BLM would take to minimize livestock and wild horse impacts to treatment areas are discussed in more detail in Section 3.17.4 (Livestock Grazing Mitigation), and in **Appendix C**.

The BLM would continue to use ground-based herbicide applications to remove noxious weeds, and aerial-based application methods to remove cheatgrass, and would restore burned areas under the Burned Area Emergency Stabilization and Rehabilitation program, under existing authorizations on about 1,000 acres annually. These treatments could have short-term effects on water quality, primarily through ground disturbance and erosion associated with use of mechanical equipment, or if herbicides were accidentally spilled into a water body, but these risks would be negligible. Treatments would help to reduce hazardous fuels, slow the spread of noxious weeds and other invasive non-native vegetation, and reduce surface runoff and erosion associated with burn sites on about 1,000 acres annually, to the benefit of water resources.

Five herbicides are typically used on the 3 Bars Project area—2,4-D, glyphosate, imazapyr, metsulfuron methyl, and picloram. For the 3 Bars Project, it is likely that the BLM would also use imazapic to treat cheatgrass. Based on an assessment of risks from the use of herbicides, there is potential for glyphosate and metsulfuron methyl to be transported by wind and water in areas with moderate to high risk of wind or water erosion. Several herbicides are known groundwater contaminants (USDOI BLM 2007b:4-29 to 4-34). The BLM would minimize the risk of contamination of water bodies from herbicides by using appropriate buffer zones for herbicides not labeled for aquatic use based on risk assessment guidance, with minimum widths of 100 feet for aerial, 25 feet for vehicle, and 10 feet for hand spray applications.

Land development, mineral development, and oil, gas, and hydrothermal exploration and development would disturb soil, which would lead to soil erosion and water quality impacts and use of groundwater for public and industrial uses. Land development and development of natural resources would involve the use of equipment and drilling wells, which could result in spills of hydrocarbons and other hazardous materials. This, in turn, could impact surface water and groundwater. For example, a recent oil spill at the Blackburn oil well in Pine Valley impacted over 3 acres (USDOI BLM 2012b:4-47).

Modeling suggests that there could be a significant impact to groundwater levels near the Mount Hope Project due to mining and other activities in the CESA, and that it may be 100 years or more before groundwater levels have recovered to their pre-mining levels (USDOI BLM 2012b:4-48 to 4-50). Mining activities within the CESA may also create significant adverse impacts to surface water resources including 2 perennial stream segments (Roberts Creek and Henderson Creek) and 22 springs, mainly by altering drainage features, by dewatering springs or stream segments, and by water quality impacts from disturbed area runoff or escapes from processing facilities. Most of these impacts from mining activities would be avoided or reduced through state and federal mining regulations and related compliance programs. However, modelers did not feel that agriculture, mining, and oil and gas development would lead to significant water quantity and quality issues in the CESA (USDOI BLM 2012b:3-74 to 3-112).

Hazardous fuels reduction, habitat improvement, and noxious weeds and invasive non-native species control projects would occur on approximately 142,000 acres (127,000 for the 3 Bars Project and 15,000 acres for other hazardous fuels projects in the CESA), or 8 percent of the CESA (about 1 percent of the CESA annually). These treatments would lead to short-term increases in soil erosion and surface water runoff, but would have long-term benefits to water quality and possibly to water flows. The disturbance effects resulting from restoration activities are predicted to have less impact and be less severe than effects and erosion caused by catastrophic wildfire, which could occur on about 6,900 acres annually. In addition, a reduction in the spread of noxious weeds and other invasive non-native vegetation is expected to help reduce soil erosion, especially in areas that are prone to water erosion. Overall, 3 Bars Project actions would have a minor contribution to water resources effects occurring within the CESA under Alternative A.

3.9.3.4.2 Cumulative Effects under Alternative B (No Fire Use Alternative)

Under Alternative B, effects from non-3 Bars Project reasonably foreseeable future actions on water resources would be similar to those described under Alternative A. The BLM anticipates treating about half as many acres under Alternative B as under Alternative A, and less effort would be spent by the BLM on treatments to reduce wildfire risk and loss of soil from erosion, including use of fire to restore natural fire regimes.

Adverse effects to water resources would generally be the same as described for Alternative A. However, by not using fire, there would be no risks to water quality from fire on several thousand acres annually within the 3 Bars Project area.

Instead, the BLM would be limited to disking and plowing and using livestock to control non-native vegetation on several thousand acres annually. These methods could result in more soil disturbance and soil erosion that could impact water quality, than the use of fire. The Table Mountain and West Simpson Park units are on rugged terrain, and use of mechanical equipment to control cheatgrass would be difficult and erosion potential from treatments would be great, especially on the West Simpson Park Unit.

Under Alternative B, annual hazardous fuels reduction and habitat improvement projects could occur on about 6,300 acres within the 3 Bars Project area, and on an additional 1,500 acres within the CESA under current or reasonably foreseeable future authorizations, or less than 1 percent of acreage within the CESA. Because of the large acreage treated, water quantity and quality should improve within the 3 Bars Project area and CESA, although not to the extent as would occur under Alternative A.

3.9.3.4.3 Cumulative Effects under Alternative C (Minimal Land Disturbance Alternative)

Under Alternative C, effects from non-3 Bars Project reasonably foreseeable future actions on water resources would be similar to those described under Alternative A. Under Alternative C, the BLM would treat about 3,200 acres annually within the 3 Bars Project area. Adverse, short-term effects to water resources associated with the use of prescribed fire and wildland fire for resource benefit and mechanized equipment would not occur under Alternative C. However, fire use, herbicides, and mechanized equipment would be used in other portions of the CESA. These treatments in other portions of the CESA would affect about 1,500 acres annually. 3 Bars Project restoration treatments would have short-term adverse and long-term beneficial effects on water resources, but these effects would be negligible (0.2 percent of acreage within the CESA on an annual basis) in the context of the acreage within the CESA and other types of activities that have effects on water resources, such as the Mount Hope Project and irrigation. By not being able to use mechanical methods to thin and remove pinyon-juniper and sagebrush to encourage development of the understory, create fire and fuel breaks, and remove slash and other downed woody debris and reduce hazardous fuels, however, the risk of wildfire and its impacts on water resources would likely increase on the 3 Bars Project area. Because of the acreage treated, water quantity and quality would improve within the 3 Bars Project area and provide a minor benefit to water resources within the CESA, although not to the extent as would occur under Alternatives A and B.

3.9.3.4.4 Cumulative Effects under Alternative D (No Action Alternative)

Under Alternative D, effects from non-3 Bars Project reasonably foreseeable future actions on water resources would be similar to those described under Alternative A. There would be no cumulative impacts to water resources from this alternative as no treatments would be authorized under this alternative. The BLM could conduct stream bioengineering treatments; create fire and fuel breaks; thin and remove pinyon-juniper to promote healthy, diverse

stands; slow the spread of noxious weeds and other invasive non-native vegetation, especially cheatgrass; restore fire as an integral part of the ecosystem; and reduce the risk of a large-scale wildfire, but on a very limited acreage. Thus, factors that contribute to reduction in water quantity and degradation of water quality would remain, including soil erosion, stream channel instability, spread of noxious weeds and other invasive non-native vegetation, pinyon-juniper encroachment, and wildfire, and would likely be greatest under this alternative.

3.9.3.5 Unavoidable Adverse Effects

An increase in soil erosion and surface water runoff could result from restoration treatments, which could lead to streambank erosion and sedimentation. Rates of runoff would be influenced by precipitation rates, soil types, and proximity to the treated area. All vegetation removal activities could disturb the soil and reduce the amount of vegetation binding to soil, potentially causing erosion and increased sedimentation. The removal of vegetation would decrease the amount of rainfall captured by plants, detritus, and soil, potentially leading to increased stormwater flows, runoff velocity, and sedimentation.

3.9.3.6 Relationship between Local Short-term Uses and Maintenance and Enhancement of Long-term Productivity

Over the short-term (several months or a few years), access for some users to surface water features within treatment areas would be restricted. The BLM would investigate the status of any water right associated with an affected water feature to determine whether, and to what extent, it could implement the proposed treatment, and if any mitigation was needed and the effectiveness of the mitigation. This would be an adverse impact to existing water rights holders and beneficial uses. The BLM would offset those impacts to existing water rights holders.

Treatment of vegetation would cause a short-term increase in soil erosion and surface water runoff. Successful control of noxious weeds and other invasive non-native plants, however, would lead to improved conditions in watersheds over the long term, with the greatest improvement likely to occur in degraded watersheds. The eventual growth of desirable vegetation in treated areas would moderate water temperatures, buffer the input of sediment from runoff, and promote streambank stability. Ongoing efforts by the BLM to enhance vegetation would also help to increase the acreage of watersheds that are functioning properly. Improvement of watersheds and water resources and quality would benefit salmonids and other species of concern that depend upon these habitats for their survival.

Vegetation treatments that reduce hazardous fuels would benefit ecosystems by reducing the chances of a large, uncontrolled wildfire, which could destroy a large amount of high quality habitat and potentially lead to erosion, especially if followed by heavy rainfall. Hazardous fuels reduction would also decrease the likelihood that wildfire suppression activities would occur in or near aquatic habitats (USDOI BLM 2007b:4-247).

3.9.3.7 Irreversible and Irretrievable Commitment of Resources

An accidental fuel spill or uncontrolled wildland fire could cause damage to water bodies and the ability to use water resources in the affected area could be lost for a short period of time. However, these impacts would be highly unlikely and could be reversed if restoration treatments were successful. Other treatments should not result in irreversible or irretrievable commitments of water resources.

Under all alternatives, there could be a short-term (less than 5 years) increase in soil erosion from 3 Bars Project treatments, primarily those where the soil is disturbed by mechanical or fire treatments. This increase in erosion could

lead to increased sedimentation or turbidity in streams or ponds. These impacts from soil erosion would accrue with soil erosion and loss of soil associated with other land disturbance activities in the CESA. These losses of soil due to erosion and its impacts to water quality in streams and ponds in the 3 Bars Project area would be offset by long-term benefits from: 1) stream restoration projects that promote stream stability and riparian vegetation development; 2) improvements in vegetation in areas where thinning pinyon-juniper and sagebrush promotes understory development; 3) removal and control of non-native vegetation and revegetation of treatment sites with native vegetation; and 4) hazardous fuels treatments that reduce the risk of a catastrophic wildfire, including prescribed burning and use of wildland fire for resource benefit, and the creation of fire and fuel breaks.

It is possible that prescribed fire and wildland fire for resource benefit treatments could result in erosion that could adversely affect water quality. However, the BLM would use SOPs to minimize this risk, including disking on contour, avoiding treatments on steep slopes, and limiting the amount of time that livestock graze on treatment sites. Loss of soil, and its effects on water quality, could be greater in areas burned by catastrophic wildfire, as these areas can be large, are often in remote areas, and can be difficult to revegetate. Thus, BLM treatments that reduce the risk of a catastrophic wildfire should help to slow soil erosion and improve water quality.

3.9.3.8 Significance of the Effects under the Alternatives

Under all alternatives, there could be short-term releases of sediments and fuels and lubricants from equipment into water bodies from actions within the CESA. The BLM would prevent or minimize the movement of fuels and lubricants into water bodies by fueling and servicing equipment off-site or away from streams. Although multiple treatments could occur on some treatment units or sites, especially those where prescribed fire and wildland fire for resource benefits are used (e.g., fire treatment followed by mechanical treatment to control non-native species and seeding), treatments would likely occur only once or twice a year. By retaining buffers between treatment areas and water bodies where feasible, and following other SOPs that protect water quality, it is unlikely that there would be a change in water quality that would often or regularly exceed Nevada water quality standards.

The BLM could, but is not likely to, divert water while reconstructing streams, and use water to manage prescribed fires and wildland fires for resource benefit. The BLM also may prevent access by livestock, wild horses, and wild ungulates to treatment sites near water in riparian and aspen treatment areas until these areas were restored and able to accommodate use by these animals. It is anticipated that diversions and access restrictions would be in place for a minimum of 2 growing seasons, or until establishment criteria are met, while use of water for fire control would only last a few days. If access to treatment areas is restricted, the BLM would provide breaks in the fencing to allow livestock, wild horses, and wild ungulates to access water within small portions of the treatment area. Thus, there should be no significant long-term diversion, access restriction, or consumptive use of surface water that substantially reduces water availability and the uses recognized by Nevada Department of Water Resources in the CESA under all alternatives. This would include flows and seasons of use in springs or streams where existing beneficial water uses, as defined by Nevada Division of Environmental Protection and recorded by Nevada Department of Water Resources, may be affected.

Nearly all 3 Bars Project restoration treatments would cause short-term erosion that leads to increased sedimentation in streams or ponds. These risks would be greatest in restoration areas with moderate to severe water or wind erosion potential, or where soils are susceptible to fire degradation. Treatments that disturb the soil or remove large amounts of vegetation, including the use of mechanical treatments such as disking and plowing, and prescribed fire and wildland fire for resource benefit, would also lead to short-term erosion and sedimentation. Long term, restoration treatments would lead to conditions that should reduce the risk of erosion, including revegetation of treatment sites

with native vegetation and treatments to stimulate growth of the understory. Treatments that reduce the risk of wildfire, including hazardous fuels treatments, control of noxious weeds and invasive non-native vegetation, and create fire and fuel breaks would reduce the risk of erosion resulting from wildfire and its effects on water quality. Thus, none of the alternatives would result in a significant long-term (greater than 5 years) accelerated erosion from watershed slopes or increased sedimentation in streams or ponds.

None of the treatments proposed under the alternatives should lead to significant uncontrolled stream channel and bank instabilities. However, stream channel improvements are not proposed under Alternative D, and only about 8 miles of degraded streams would be treated under Alternative C. Thus, it is likely that the number of miles of streams with stream and bank channel instability within the 3 Bars Project Area and CESA would continue to increase under Alternative D, while there would be little improvement in stream and bank channel stability under Alternative C, long term.

As discussed in the Mount Hope Project EIS, mining, agriculture, and other activities in the CESA are predicted to have a significant impacts to surface and groundwater quantity, including 2 perennial stream segments and 22 springs (USDOI BLM 2012b:4-48 to 4-50); these impacts could last 100 years or more. To reduce these impacts, the BLM identified several mitigation measures, including installation of new wells or deepening of existing wells, development of existing water sources, including springs, and fencing to protect water sources (USDOI BLM 2012b:19-22). Short-term, 3 Bars Project restoration treatments also could contribute to localized, minor declines in groundwater levels, especially in large-scale fire treatment areas. However, these declines would likely not exceed seasonal fluctuations in water levels. Long term, 3 Bars Project treatments should result in improved surface water flows and groundwater recharge. Thus, the effects of 3 Bars Project treatments would not, by themselves, result in a significant cumulative effect to water resources.

3.9.4 Mitigation

Water resources would benefit from mitigation measures identified in Section 3.17.4 (Livestock Grazing Mitigation). No mitigation or monitoring measures are recommended specifically for water resources.

3.10 Wetlands, Floodplains, and Riparian Zones

3.10.1 Regulatory Framework

This section discusses the laws and regulations that apply to wetlands, floodplains, and riparian zones potentially affected by the 3 Bars Project. These resources are considered valuable natural resources that provide habitat for a variety of dependent plant and wildlife species.

3.10.1.1 Definition of Wetlands

Wetlands are defined by the U.S. Army Corps of Engineers (USACE) and USEPA in 33 CFR § 328.3 and 40 CFR § 230.3 as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal conditions do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, wet meadows, and similar areas.