ISSUE 19: SOILS

Changes from the Draft to the Final EIS

A review of route data on a spatial basis shows an approximate decrease of 5% motorized routes for Alternative 7-M compared to Alternative 7. This figure was applied to each table's results for Alternative 7 to give the figures for Alternative 7-M. At the scale of this analysis, other small changes in individual route designations are not significant, since the analysis would show no differences.

Introduction

The Travel Plan alternatives describe a range of allowed uses on roads and trails. This section will address how different users, and thus different alternatives affect soil resources. The methods used include spatial modeling on a "landtype" level. Landtypes are relatively uniform spatial combinations of landforms, soils, and vegetation mapped at an intermediate scale (Davis and Shovic, 1996.) All spatial modeling in the report below uses this database plus the route data provided by the Interdisciplinary team valid at the time of analysis. Since the landtype units are mapped at a scale of 1:62,250, small changes in routes and uses will not significantly affect results. Also, all results are designed to be reviewed using a "big picture" approach, rather than at an individual route level. Tables are given showing the numerical results of modeling and qualitative interpretations of this modeling. The qualitative results are based on judgments of the significance of the numerical differences between alternatives and soil mitigative practices applied to each alternative. The term "acceptable" means soil protection is improved or equivalent to the "Starting Benchmark" (Alternative 4). The term "unacceptable" means soil protection is generally reduced compared to that alternative. The term "best protection" indicates soil protection is significantly higher than other acceptable alternatives. The phrase "protecting soil quality" is used in this document. This refers to protecting soil productivity and resistance to erosion.

Affected Environment

The effects of road and trail use on soils are comprised of three facets:
1) Road use.
2) Trail use.
3) Off-road and trail use and new trail construction.

Roads

Roads and road building initiate two major soil erosion processes: surface soil erosion and mass wasting. The mechanisms for road-related mass-wasting failures include removing slope support in roadcuts, increasing the weight on fillslopes, intercepting subsurface flow, and hillslope drainage rerouting (Lewis 1998). Some mass wasting road failures extend long distances downhill from the failure site. If the failure track extends to a stream channel, the initial failure and subsequent chronic surface erosion of the slide will deliver sediment directly to the channel. These types of

failures are typical where unstable road or landing fill is placed on steep or rolling slopes. The factors that may influence the potential for road-related mass-wasting failures are hillslope gradient, slope position, soil type, presence of groundwater, geologic structure and geologic materials (McCashion and Rice 1983, Rice and Lewis 1991). On the Gallatin National Forest, many areas susceptible to mass-wasting are large, existing landslides that have occurred in the last 8,000 years. These areas are still unstable in parts, resulting in small-scale movements when triggered by disturbances.

Surface soil erosion potential is the second factor influencing erosion on Forest roads. Factors affecting soil erosion hazard are slope, the erodibility of the soil, and precipitation. Many studies have found that surface soil erosion (rill and sheet) contribute less than 20% of the measured erosion from Forest roads (Rice et. al. 1979, McCashion and Rice 1983, Peters and Litwin 1983). Road design practices such as surfacing, ditching and road alignment mitigate many of soil erosion hazard factors. Surface soil erosion hazard alone may not be a major contributor to overall sediment delivery from roads, but it influences mass-wasting potential related to roads. Areas having high erosion hazards can contribute to excess material in roadside ditches, increasing culvert failure rates and thus contributing to mass failures. On the Gallatin Forest, factors that influence soil erosion hazard are slope, soil erodibility, water-holding capacity and precipitation patterns (Davis and Shovic, 1996).

This travel planning process considers only the type of use on Forest roads. This is not a significant factor influencing either mass-wasting or soil erosion hazard. In addition, no new roads are proposed in any of the travel plan alternatives. Therefore, road impacts were dismissed from further analysis.

Trails

Leung and Marion (1996) published a paper chronicling the history of trail degradation research. They considered both construction impacts and post-construction changes. The Gallatin National Forest Travel Plan will address trails, as they exist currently, and thus their post-construction degradation. Leung and Marion (1996) found: *"The majority of post-construction changes occur with initial or low levels of use, with changes diminishing, on a per-capita basis, with increasing use. Subsequent degradation on established trails is mostly a function of site durability and other use-related factors such as type of use and use behavior."* Thus for this review, landscape (site) factors and type of use factors were the focus of the analysis.

Landscape factors affecting trail condition

Many studies have been conducted on landscape factors that may affect hiking trail erosion. Bryan (1977) and Welch and Churchill (1986) found finer textured soils had greater incision. Root and Knapik (1972) found soils composed of alluvium and till were more eroded than those on colluvium and bedrock. Willard and Marr (1970), Helgath (1975), Bryan (1977), Weaver and Dale (1978) and Urie (1994) all found soil moisture to be directly correlated to trail depth and width. The combination of fine-textured soils and high soil moisture presents an especially erosive opportunity. Fine-textured soils are often characterized by high clay contents. When wet, some clays swell, reducing the infiltration capacity of the soil; thus overland flow results sooner in these landscapes.

Finally, trail slope has been cited by many researchers as a significant factor in trail condition (Helgath 1975, Weaver and Dale 1978, Bratton et al. 1979)

User types and their effects on trail condition

Fewer studies have focused on the relative impacts of different user types on trail condition, but many of these studies were done on or very near the Gallatin National Forest (Dale and Weaver 1974, Weaver and Dale 1978, Wilson and Seney 1994, Deluca et al. 1998). Several studies have investigated the relative impacts of hikers and horses. Whittaker (1978) found that horse use increased trail width, depth and litter loss more than hiker use. Dale and Weaver (1974) found horse trails to be deeper than those used only by hikers. Deluca et al. (1998) found horses consistently made more sediment available for erosion than hikers or llamas. Wilson and Seney (1994) measured sediment yield from hikers, mountain bikers, motorcycles and horses, and found horses produced higher sediment yields on both dry and pre-wetted trails than the other users.

Weaver and Dale (1978) found that damage generally increased from hiker to motorcycle to horse. Weaver and Dale also noted that the motorcycle in their experiment was ridden at low speeds (less than 20 km per hour) and that higher speeds may lead to greater impacts. In addition, both motorcycle studies used relatively small motorcycles by today's standards. Weaver and Dale used a Honda 90 and Wilson and Seney used a Honda XL125. Newer, more powerful machines driven at higher speeds may have greater impacts. Wilson and Seney (1994) and Weaver and Dale (1978) were the only studies to assess the impacts of motorcycle use. No studies compared the impacts of ATVs to horses, hikers or mountain bikes.

Meyer (2002) studied management of OHVs (off-highway vehicles) in sensitive environments. Meyer presents a good description of the effects OHVs have on fine-textured, wet soils. "*Shearing describes a transfer of force through a soil. When an applied force exceeds the capacity of the soil body to absorb it, a portion of the soil body can be displaced along a shear plane… The most common example is when the passage of a wheeled vehicle forms ruts. The downward force of the wheel shears – or displaces – the soil beneath it, forcing the soil to bulge upward beside the wheel. The shearing action destroys soil structure by crushing soil peds and collapsing voids."*

The action described above leads to rutted areas and mud holes in wet, fine-textured soils. Without structure, the soil losses its ability to move water thus reducing infiltration rates, percolation and water storage capacity. Water then ponds on the surface, leading to mud hole creation.

Another major concern is the "braiding" of trails. A trail is considered braided when an originally single-track trail develops multiple treads. ATVs impact an average trail width of 5-8 feet wide compared to single track trail widths of 2-3 feet. When braiding occurs on ATV trails, Connery (1984) found average trail widths of 34.6 feet. This translates to a 5-7-fold increase in affected soil and vegetation. Single-track trails, in contrast, increase in smaller increments with each braid.

The above studies support the assertion that impacts to trails increase from hikers and mountain bikes to higher levels for horses and motorized vehicles. However, all of the above studies investigated trail use impacts. Off-road and trail use essentially constitutes trail construction or initial ecological damage and thus creates a much higher rate of erosion (Cole 1990). Off-road and trail impacts are discussed in the off-road and trail use section.

Off-road and trail Use and New Trail Construction

All alternatives of the Travel Plan limit off-road and trail travel. Unfortunately, the enforcement of these rules is very difficult. It can be assumed that some off-road and trail travel will continue to occur.

Studies have shown that the majority of environmental changes due to recreational trampling occur with initial trampling of vegetation or trail construction (Cole 1990).

Bell and Bliss (1973) found that the majority of damage to plants occurred with the first off-trail pass. Their research also showed that high alpine and tundra plants were especially vulnerable to trampling. Trampling also increases soil compaction, and decreased water infiltration (Cole 1988). Trampled areas with little visible vegetation wear may already have increased runoff from soil compaction and decreased infiltration (ibid). Increased runoff leads to increased erosion and loss of soil quality. Areas of sensitive soils, as described above in the on-trail use discussion, are especially vulnerable to changes in soil compaction, infiltration and erosion. Thus travel off-road and trail is especially impactive on high alpine vegetation and on trail erosion sensitive soils.

The effect of different users is similar off-trail to on-trail. Hikers and mountain bikers have the least effects and horses and motorized users the greatest effects (Weaver and Dale 1978).

Direct and Indirect Effects

Trail Use Effects

General Comparison of Alternatives
The literature cited in the Affected Environment sections suggests primarily three factors influence trail condition:
1) Fine-textured clay soils.
2) Parent material of alluvium or landslides (inherent instability).
3) Soil moisture – frequency of wet areas.

Landtypes (mapped in the Gallatin National Forest Soil Survey (Davis and Shovic, 1996)) containing two or three of the above parameters were intersected with trails to determine which trail segments were on sensitive soils. These sections of trail are the most negatively affected by human users and thus require a higher degree of maintenance. Also, these areas are prone to be wet, and eroded, causing widening and braiding of the trail. The initial trail width is dedicated to trail use. However, the widening trail in wet, erosive areas, though, leads to increased vegetation loss, soil compaction, reduced infiltration and a reduction in soil quality.

The above literature review also discusses the significance of user type. Since no trails are specifically prohibited to hikers, there are no differences between alternatives for this use, and it is excluded from further analysis. Bicyclists have a transport system similar to motorized vehicles, so the motorized uses are used as a proxy for this use. The above literature suggests that motorized users and horses cause the greatest impacts on and off existing trail treads. Analysis is therefore

focused on these two user types. Alternatives are compared based on number of motorized trails on sensitive soils and number of trails on sensitive soils with prohibitions on horse use. Table 3.19.1 compares the miles of motorized trail on sensitive soils by alternative.

Table 3.19. 1 Miles of existing motorized trail on sensitive soils, by alternative.

Total Miles of Existing Motorized Trail on Sensitive Soil						
Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M *
79.94	69	62	52	41	2	43

* Reviewing the data from Alternative 7-M shows a probable decrease of 5% in miles of trail on sensitive soil from that given in Alternative 7. This number reflects this reduction.

Alternative 6 most limits the effects on soils from motorized trails braiding in sensitive soil areas. It should be noted, however, that the presence of sensitive soils varies greatly by Travel Planning Area (TPA). In addition, different motorized user types contribute to the effects on soil differently. Table 3.19.1 does not account for these differences. Analysis of the individual TPA's and the mitigations applied to those areas is necessary to fully examine the effects to sensitive soils and vegetation by on-trail users.

Trail use by horses is managed differently than motorized use in this travel planning process. Trails are closed to motorized users unless specified as open motorized trails. Trails are open to horses unless specifically prohibited in certain areas. Only two travel areas, Bear Canyon and Hyalite, have sections of trail on sensitive soil that are closed to horse use (Table 3.19.2).

Table 3.19.2 Miles of trail on sensitive soils closed to horses, by alternative.

	Miles of Trail on Sensitive Soils Closed to Horses		
Travel Planning Area	Alt. 1	Alt. 4	Alt. 5
Bear Canyon TPA	0.0	0.0	4.6
Hyalite TPA	0.1	0.1	0.0

The miles of open trail in Hyalite TPA do not significantly change by alternative, thus for all TPA's except Bear Canyon, the alternatives do not significantly differ in their management of horse use on existing trails with sensitive soils. Alternative 5 is the only alternative which prohibits horse use in portions of Bear Canyon thus has less soils impact when compared to other alternatives which do not limit horse use on sensitive soils.

Motorized Trail Use Effects by TPA

TPA's with zero miles of motorized trail on sensitive soil

Twenty-two TPA's have no miles of motorized trail on sensitive soils under any of the alternatives. Therefore, there is no difference in effect to soil among alternatives and all are acceptable from a soil management perspective. They are: Absaroka Beartooth Plateau, Absaroka Beartooth Wilderness, Bozeman Creek, Cherry Creek, Cooke City, East Crazies, Gardiner Basin, Hebgen Lake Basin, Ibex, Lionhead, Lee Metcalf Wilderness Hilgards, Lee Metcalf Wilderness Monument, Lee Metcalf Wilderness Spanish Peaks, North Bridgers, Sawtooth, Shields, South Plateau, Tom Miner Rock, West Bridgers North, Yankee Jim Canyon and Yellowstone.

TPA's with less than one mile of motorized trail on sensitive soil

The TPA's in Table 3.19. 3 have less than one mile of motorized trail on sensitive soils for all alternatives. These mileages are broken up into short sections of trail, which are relatively easy to maintain. All four TPA's include seasonal restrictions in Alternatives 2 through 7-M. These restrictions eliminate use during the wettest, most vulnerable season. Alternative 7-M includes seasonal restrictions on the most vulnerable trails, thus reducing impacts to soils. The combination of relatively small areas of motorized trails on sensitive soils and seasonal restrictions on use make Alternatives 2 through 7-M acceptable from a soil management perspective. Alternative 1 does not include these restrictions and would be less desirable from this perspective.

Table 3.19. 3 TPA's with less than one mile of motorized trail on sensitive soil.

	Miles of Existing Motorized Trail on Sensitive Soil						
Travel Planning Area	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M*
Bangtails TPA	0.2	0.2	0.2	0.0	0.0	0.0	0.1
Big Sky TPA	0.1	0.1	0.1	0.1	0.1	0.0	0.1
Hyalite TPA	0.6	0.6	0.0	0.0	0.0	0.0	0.0
West Bridgers South TPA	0.1	0.1	0.0	0.0	0.0	0.0	0.0

* Reviewing the data from Alternative 7-M shows a probable decrease of 5% in miles of trail on sensitive soil from that given in Alternative 7. This number reflects this reduction.

Travel Planning Areas with More Than One Mile of Motorized Trail on Sensitive Soil

For those TPA's with more than one mile of motorized trail on sensitive soil, Table 3.19.4 illustrates the number of miles of trail by alternative.

Table 3.19. 4 TPA's with more than one mile of motorized trail on sensitive soil.

Travel Planning Area	Miles of Existing Motorized Trail on Sensitive Soil						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M*
Bear Canyon TPA	3.8	4.6	4.4	4.4	2.0	2.0	4.0
Cabin Creek TPA	18.1	18.1	12.2	13.7	13.7	0.0	12.8
Deer Creeks TPA	2.2	2.2	1.3	1.7	0.0	0.0	1.2
East Boulder TPA	1.00	1.00	0.2	0.0	0.0	0.0	0.2
Fairy Lake TPA	1.1	1.1	1.1	1.1	1.1	0.0	1.1
Gallatin Crest TPA	8.5	8.5	7.2	0.9	0.8	0.0	0.8
Gallatin River Canyon TPA	1.6	1.6	0.2	0.1	0.5	0.0	0.1
Gallatin Roaded TPA	1.1	1.1	1.1	1.1	1.1	0.20	1,1
Main Boulder TPA	2.1	2.4	1.0	0.0	0.0	0.0	0.0
Mill Creek TPA	2.1	1.4	1.2	0.0	0.0	0.0	0.0
Mission TPA	1.6	1.5	0.0	0.0	0.0	0.0	0.0
Porcupine Buffalo Horn TPA	22.4	22.4	22.9	21.5	14.5	0.0	13.8
Taylor Fork TPA	13.5	12.1	9.2	8.1	8.1	0.0	7.7

*Reviewing the data from Alternative 7-M shows a probable decrease of 5% in miles of trail on sensitive soil from that given in Alternative 7. This number reflects this reduction.

Bear Canyon TPA

Bear Canyon TPA is a popular motorized use area only a 20-minute drive from the city of Bozeman. Alternative 1 represents current use in Bear Canyon. Bear Canyon has 3.77 miles of motorized trail on sensitive soils (Table 3.19. 4). These areas are characterized by muddy areas much wider than the original trail prism. These widening muddy areas negatively affect soil quality. The miles of motorized trail on sensitive soils increases with Alternatives 2, 3, 4 and 7-M and would result in increased negative effect on soil quality.

Several mitigation measures are proposed for Alternatives 2 through 7-M. First, trails in Bear Canyon would be open to motorized use, mountain bikes and stock only during conditions that prevents adverse erosion and watershed damage, as well as having seasonal restrictions (trails in Bear Canyon would be closed to motorized use from October 15 to July 15, thus limiting use to the driest period. Mountain bikes and stock are prohibited from Apr. 11 through July 15. Secondly, all off route travel is prohibited (including the 300 foot allowance permitted in other areas). These mitigations greatly reduce negative effects on soil quality in Alternatives 2 through 7-M. Alternative 1 is not acceptable from a soil quality perspective, since disturbance actually increases with no mitigation. With the implementations of the above goal, Alternatives 2, 3, 4, 5, 6 or 7-M are acceptable. Alternatives 5 or 6 provide the best protection of soil quality and ensure a net improvement in soil quality (Table 3.19.5).

Table 3.19. 5 Soil quality with mitigation.

Travel Planning Area	Best Protection (P), Acceptable (A) or Unacceptable (U)						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
Bear Canyon TPA	U	A	A	A	P	P	A

Cabin Creek TPA

Cabin Creek TPA is a popular motorized area north of West Yellowstone. Currently, 18 miles of motorized trail in Cabin Creek are on sensitive soil. The high number of miles on sensitive soils leads to a greater incidence of trail widening and the creation of large muddy areas. Soil quality has been affected by current use in this area. Mitigation measures are needed to encourage minimal impacts to soil quality. Alternative 6 provides the best opportunity for improved soil quality (Table 3.19.6).

Alternatives 2, 3, 4, 5, 6, and 7-M provide mitigation measures where seasonal restrictions would be applied to most trails. See the detailed descriptions of Alternatives for exact dates, since they vary by trail and use.

Table 3.19. 6 Soil quality with mitigation.

Travel Planning Area	Best Protection (P), Acceptable (A) or Unacceptable (U)						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
Cabin Creek TPA	U	A	A	A	A	P	A

Gallatin Crest TPA

Motorized trails on the Gallatin Crest TPA are popular with motorcycle users. Most of the trails are unavailable to ATVs due to their narrow width, thus less damage has occurred in the absence of wider, heavier ATVs. Alternatives 4, 5 and 7-M limit the motorized trails on sensitive soils to less than one mile. Alternative 6 has no miles of motorized trail, therefore Alternatives 4, 5, 6 or 7-M would be best at minimizing effects to soil quality (Table 3.19.7).

Mitigation proposed includes seasonal restrictions on use. Trails on sensitive soils would be closed to motorized use from September 15 to July 15 and closed to mountain bikers and stock from April 1 to July 15 in Alternatives 2-6. In Alternative 7-M, not all trails are closed to stock and mountain bikes in the Spring. These mitigations make Alternatives 2, 3, 4, 5, 6, and 7-M acceptable, but Alternative 7-M is not preferred.

Table 3.19. 7 Soil quality with mitigation.

	Best Protection (P), Acceptable (A) or Unacceptable (U)						
Travel Planning Area	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
Gallatin Crest TPA	U	A	A	P	P	P	A

Porcupine-Buffalo Horn TPA

Currently there are 22 miles of motorized trail on sensitive soils in the Porcupine-Buffalo Horn TPA. The area has had problems with ATV use creating watershed impacts. As a result the TPA has been closed to ATVs yearly by temporary special order for the past 9-10 years. Alternative 1 reflects this closure.

In Alternatives 1, 2, 3, and 4, 22 miles of motorized trail on sensitive soils may increase the creation of widening trails. Widening outside the trail prism negatively impacts soil quality. Alternatives 5 and 7M both have about 14 miles of motorized trail on sensitive soils. This represents an improvement over current conditions (22 miles). Alternative 6 has no miles of motorized trail on sensitive soils.

Mitigation proposed includes motorized closures from September 15 to July 15 and mountain bike and stock closures from April 1 to June 15 for Alternatives 2 through 6. Alternative 7-M provides restrictions on some routes. These closures would protect the trail system and surrounding soils during the wettest period of the year. Alternative 1 (current conditions) does not include seasonal closures and thus is unacceptable from a soil quality perspective. Alternative 6 provides for the best protection of soil quality (Table 3.19.8). All other alternatives represent an improvement in soil quality over current conditions.

Table 3.19. 8 Soil quality with mitigation.

	Best Protection (P), Acceptable (A) or Unacceptable (U)						
Travel Planning Area	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
Porcupine-Buffalo Horn TPA	U	A	A	A	A	P	A

Taylor Fork TPA

The Taylor Fork TPA currently has 13 miles of trail on sensitive soils. Thirteen miles of trail on sensitive soils encourages significant areas of widening trails. Widening outside the trail prism can negatively impact soil quality. Alternatives 3, 4, 5, 6 and 7-M reduce the miles of trail on sensitive soil, thus minimizing or eliminating the concern of soil quality impacts. Alternative 2 varies only slightly over current conditions and is thus not an improvement over current conditions. Alternatives 3 through 7-M are all acceptable, with Alternative 6 preferred since it has no miles of trail on sensitive soils.

Proposed mitigation includes closures on most motorized trails from December 2 to July 15 and mountain bike and stock closures from April 1 to June 15 for Alternatives 2 through 6. These closures would protect the trail system and surrounding soils during the wettest period. Since Alternative 1 (current condition) does not include seasonal closures, it is unacceptable from a soil quality perspective. All other alternatives represent an improvement in soil quality over current conditions and would be acceptable (Table 3.19.9). There are no stock and mountain bike closures in Alternative 7-M so Alternative 6 provides for the best protection of soil quality.

Table 3.19. 9 Soil quality with mitigation.

	Best Protection (P), Acceptable (A) or Unacceptable (U)						
Travel Planning Area	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
Taylor Fork TPA	U	A	A	A	A	P	A

Deer Creeks, East Boulder, Fairy Lake, Gallatin River Canyon, Gallatin Roaded, Main Boulder, Mill Creek, Mission TPA's

These TPA's currently have two miles or less of motorized trails on sensitive soils. All have zero or nearly zero miles of motorized trails in Alternative 6. Alternatives 2 through 7-M include elevation-adjusted seasonal restrictions on most trails. These closures would protect the trail system and surrounding soils during the wettest period. Since Alternative 1 (current condition) does not include seasonal closures, it is unacceptable from a soil quality perspective (Table 3.19.10). All other alternatives represent an improvement in soil quality over current conditions and would be acceptable. Alternative 6 provides for the best protection of soil quality.

Table 3.19. 10 Soil quality with mitigation.

	Best Protection (P), Acceptable (A) or Unacceptable (U)						
Travel Planning Area	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
Deer Creeks TPA, East Boulder TPA, Fairy Lake TPA, Gallatin River Canyon TPA, Gallatin Roaded TPA, Main Boulder TPA, Mill Creek TPA, Mission TPA	U	A	A	A	A	P	A

Effects by Users Off Roads and Trails or New Trail Construction

General Comparison of Alternatives

Studies have shown that the majority of environmental changes due to recreational trampling occur with initial trampling of vegetation or trail construction (Cole 1990). Bell and Bliss (1973) found that the majority of damage to plants occurred with the first off-trail pass. Thus, new trail construction and off-road and trail use have the potential to cause the greatest impact to soil resources. The travel plan alternatives include restrictions on motorized off-road and trail use and some limited restrictions on horse use off roads and trails.

Off-Road and Trail Use

Off-road and trail use causes soil impacts similar to new trail construction. When users leave a trail to travel overland vegetation is destroyed, soil is compacted, infiltration of water is reduced and greater water runoff and erosion results. Areas of sensitive soil and high alpine vegetation are especially vulnerable to off-road and trail use (Bell and Bliss, 1973).

The above literature review discusses the significance of user type. Since no trails are specifically prohibited to hikers, there are no differences between alternatives for this use, and it is excluded from further analysis. Bicyclists have a transport system similar to motorized vehicles, so the motorized uses are used as a proxy for this use. The above literature suggests that motorized users and horses cause the greatest impacts on and off existing trail treads. Analysis is therefore focused on these two user types.

Motorized Off-Road and Trail Use

Motorized off-road and trail use is allowed in Alternative 1. In all other alternatives, motorized travel is restricted to designated roads and trails. Enforcement of these rules is very difficult and some off-road and trail motorized use is assumed to continue. Spatial modeling was used to estimate the acres of terrain available (both legal or illegal) for off-road and trail motorized use.

Areas available for motorized off trail use were modeled using the following spatial parameters:

1) Slopes less than 40%.
2) Open forest cover types – Douglas fir, high elevation whitebark pine.
3) Grasslands and meadows.
4) Fires burned since 1980.
5) Clear cuts – seedling/sapling and unstocked vegetation types
6) Intersection with buffered motorized roads and trails (0.25 miles on each side)

Table 3.19. 11 illustrates the acres available for off-road and trail motorized use by alternative. In Alternative 1, off-road and trail use is permitted. In all other alternatives, off-road and trail use is illegal but assumed to occur at some level of frequency. Alternative 6 has the lowest levels of

accessible area. Alternative 7-M has the next lowest, resulting in the lowest and next-lowest potential off-trail impacts, respectively.

Table 3.19. 11 Acres accessible for motorized off trail use (non-wilderness)

All Travel Planning Areas	Acres accessible for motorized off-road and trail use						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M*
Total	256,041	221,044	218,816	206,350	199,425	157,047	191,676

*Reviewing the data from Alternative 7-M shows a probable decrease of 5% in miles of trail on sensitive soil from that given in Alternative 7. This number reflects this reduction.

Of these areas, those most sensitive to off-road and trail travel have sensitive soil and high alpine vegetation. Tables 3.19. 12 and 3.19.13 illustrate, by alternative the acres of sensitive soil and high alpine vegetation accessible by motorized users. Again, Alternative 6 has the lowest levels of accessible area. Alternative 7-M has the next lowest, resulting in the lowest and next-lowest potential off-trail impacts, respectively.

Table 3.19. 12 Acres accessible for motorized off-road and trail use on sensitive soil.

All Travel Planning Areas	Acres Accessible for Motorized Off-road and Trail Use on Sensitive Soil						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M*
Total	53,717	47,571	45,865	42,949	42,184	27,533	40,128

*Reviewing the data from Alternative 7-M shows a probable decrease of 5% in miles of trail on sensitive soil from that given in Alternative 7. This number reflects this reduction.

Table 3.19. 13 Acres accessible for motorized off-road and trail use on high alpine vegetation.

All Travel Planning Areas	Acres Accessible for Motorized Off-road and Trail Use on High Alpine Vegetation						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M*
Total	46,018	41,640	43,911	39,574	37,693	11,918	36,527

*Reviewing the data from Alternative 7-M shows a probable decrease of 5% in miles of trail on sensitive soil from that given in Alternative 7. This number reflects this reduction.

In summary, (Table 3.19.14), Alternatives 2, 3, 4, 5, 6 and 7-M all prohibit off-road and trail travel, thus they have lower potential off-road and off-trail impacts than does Alternative 1, in terms of protecting soil quality and high alpine vegetation. Alternative 6 limits the impact to sensitive soils and high alpine vegetation to the smallest number of acres and thus is the lowest-impact alternative, though Alternative 7-M also has significantly lower impacted area than Alternatives 2, 3, 4, and 5.

Table 3.19. 14 Soil quality with mitigation.

Travel Planning Area	Best Protection (P), Acceptable (A) or Unacceptable (U)						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
All Others	U	A	A	A	A	P	A

Horse Off-Trail Use

In all alternatives, horses are allowed off-trail. However, there are area stock restrictions in Alternatives 3, 4, 5, and 7-M. Stock travel is prohibited seasonally from Dec 2 through Aug. 1, and all overnight stock use is prohibited year round.

Based on spatial modeling, there are no sensitive soils with in the restriction area. Thus, the restriction does not have a significant effect on reducing impacts to soil quality from horse off trail use. However, high-elevation alpine vegetation is intersected by these restrictions. Table 3.19.15 illustrates the number of acres of high-elevation vegetation protected by area restrictions to horses by alternative. Alternatives 1 and 2 do not improve protections for high-elevation vegetation. Alternatives 3, 4, 5, 6 and 7-M all provide improved protection to vegetation (and thus to soil quality), and are thus acceptable alternatives from this point of view (Table 3.19.16).

Table 3.19. 15 Acres of sensitive vegetation closed to horses.

Travel Planning Area	Acres Sensitive Vegetation Closed to Horses						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
All	0.0	0.0	17,856	17,501	19,208	19,208	18,943

Table 3.19. 16 Soil quality with mitigation.

Travel Planning Area	Best Protection (P), Acceptable (A) or Unacceptable (U)						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
All	U	U	A	A	P	P	A

New Trail Construction

New trail construction causes disturbance to soil infiltration, soil compaction and vegetation removal. Trail construction also impacts soil erosion due to increased availability of soil for transport. Alternatives 1 and 2 have the least amount of new trail construction (Table 3.19. 17). Corridors have been established for these trails, primarily to link particular points and determine use. These corridors are over 1000' wide on the final maps. Because of this, no quantitative spatial evaluation of these corridors was made. However, the corridors are wide enough that it is likely sensitive soils can be avoided during project development.

Table 3.19. 17 Proposed new motorized trails, by alternative.

All Travel Planning Areas	Number of New Motorized Trails						
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7-M
Total	1	1	55	46	31	13	39

Cumulative Effects

This section discusses the general effects that various programs and categories of activity have had or could have on soils. The programs and activities considered are those that have occurred, or could reasonably occur on the Gallatin National Forest, nearby private land, and nearby lands and facilities under other agency or other National Forest jurisdiction. This report incorporates by

reference the General description of other activities and programs (Gnf Activities and Programs, 2005).

Scope of the Cumulative Effects Analysis for Soils

Spatial Scope: On the Gallatin National Forest most soil impacts occur only when the soil is directly affected by ground-disturbance. The exception is where runoff from a disturbed site may cause erosion and deposition at a site lower on the hillslope. Hence the spatial scope is the soil directly beneath any activity, with associated down-slope areas.

Temporal Scope: Disturbed soils recover very slowly after detrimental disturbance. On the Gallatin Forest, over 100 years is required to significantly improve soils disturbed by timber harvest. Five to twenty years is sufficient to show improvement after compaction by cattle grazing.

Net Effects of Past and Present Programs and Activities

Almost all soil effects are limited to ground-disturbing activities. Timber harvest and road building represent by far the most effects, and have had large impacts on soil productivity over the past forty years. Other activities have had little effect on soils (06.04.12_Shovic).

Projected Combined Effects of Reasonably Foreseeable Programs and Activities

Timber harvest and road-building are unlikely to be a large impact in the future. Increases in dispersed recreation and consequent off-trail use are much more likely to be a significant factor in future soil disturbance (06.04.12_Shovic).

Cumulative Effects of Past, Present and Reasonably Foreseeable Programs and Activities with the Travel Plan Alternatives

Alternatives that do the most to control off-trail use will have the smallest cumulative effects, when combined with the inevitable increase in dispersed recreation. These are measured by miles of existing motorized trails on sensitive soil and vegetation, miles of proposed new motorized trails, and acres of sensitive soils or high alpine vegetation accessible to off-trail use on existing trails. Together, they indicate the effects of travel planning combined with the activity of increased dispersed recreation.

Alternative 1

This alternative has the most probable off-trail use, since no restrictions are planned, and off trail use is still allowed, thereby having the **greatest** cumulative effect on soils and vegetation when combined with the increase in dispersed recreation. This alternative also has no restrictions on horse use in sensitive vegetation types.

Alternative 2

Alternatives 2, 3, 4, 5, and 7-M are all similar in terms of probable off-trail use. They all have similar miles of new and existing motorized trails and acres of sensitive soils or high alpine vegetation potentially available for off trail use. They all prohibit motorized off-trail use. This alternative is therefore **intermediate** in cumulative effects on soils and vegetation when combined with the probable increase in dispersed recreation activities.

This alternative also has no restrictions on horse use in sensitive vegetation types, so it has somewhat higher cumulative impacts than 3, 4, 5, and 7-M.

Alternative 3

Alternatives 2, 3, 4, 5, and 7-M are all similar in terms of probable off-trail use. They all have similar miles of new and existing motorized trails and acres of sensitive soils or high alpine vegetation potentially available for off trail use. They all prohibit motorized off-trail use. This alternative is therefore **intermediate** in cumulative effects on soils and vegetation when combined with the probable increase in dispersed recreation activities.

This alternative also has restrictions on horse use in sensitive vegetation types, similar to Alternatives 4, 5, and 7-M.

Alternative 4

Alternatives 2, 3, 4, 5, and 7-M are all similar in terms of probable off-trail use. They all have similar miles of new and existing motorized trails and acres of sensitive soils or high alpine vegetation potentially available for off trail use. They all prohibit motorized off-trail use. This alternative is therefore **intermediate** in cumulative effects on soils and vegetation when combined with the probable increase in dispersed recreation activities.

This alternative also has restrictions on horse use in sensitive vegetation types, similar to Alternatives 3, 5, and 7-M.

Alternative 5

Alternatives 2, 3, 4, 5, and 7-M are all similar in terms of probable off-trail use. They all have similar miles of new and existing motorized trails and acres of sensitive soils or high alpine vegetation potentially available for off trail use. They all prohibit motorized off-trail use. This alternative is therefore **intermediate** in cumulative effects on soils and vegetation when combined with the probable increase in dispersed recreation activities.

However, this alternative also has restrictions on horse use in sensitive vegetation types, similar to Alternatives 3, 4, and 7-M.

Alternative 6

This alternative has the least probable motorized off-trail use in total and also on sensitive soils and high alpine areas, as well as in total miles of existing and new trails. When combined with the probable increase in dispersed recreation, this would have the **least** cumulative effect on soils and vegetation. Off-trail motorized use is prohibited in this alternative. Horse restrictions are similar to 3, 4, 5, and 7-M.

Alternative 7-M

Alternatives 2, 3, 4, 5, and 7-M are all similar in terms of probable off-trail motorized use. They all have similar miles of new and existing motorized trails and acres of sensitive soils or high alpine vegetation potentially available for off trail use. They all prohibit motorized off-trail use. This alternative is therefore **intermediate** in cumulative effects on soils and vegetation when combined with the probable increase in dispersed recreation activities. This alternative also has restrictions on horse use in sensitive vegetation types, similar to Alternatives 4, 5, and 6.

Effects of Proposed Goals, Objectives, Standards and Guidelines

These standards and objectives apply to Alternatives 2 through 7-M.

Roads

Standard A-8: Prohibits off-route travel by summer motorized vehicles, which would significantly reduce impacts to soils from off-road and off-trail travel.

Trails

Standard A-8: Prohibits off-route travel by summer motorized vehicles, which would significantly reduce impacts to soils from off-road and off-trail travel.

OBJ. 1(1) (Absaroka-Beartooth TPA, both wilderness and plateau) Manage the trail system to provide for the following types of summer recreation use. This specifies horse use restrictions in the Absaroka Beartooth TPA, which is beneficial for the protection of high alpine vegetation.

STANDARD 3-3 (Bear Canyon TPA): Trails in the Bear Canyon drainage are not to be opened for the summer season to ATV, motorcycle, mountain bike and/or horse use until the trail system is of a condition that prevents adverse erosion and watershed damage. ***This standard applies to Alternatives 2 through 7-M and helps prevent soil damage.***

STANDARD 3-4 (Bear Canyon TPA): Due to sensitive soils in this area, wheeled motorized vehicle travel shall be prohibited off of designated routes within this travel planning area (i.e. the 300-foot off-route allowance provided in Forest-wide standard A-1 shall not apply). ***This standard applies to Alternatives 2 through 7-M, and helps prevent damage of sensitive soils.***

Seasonal Restrictions: The Route tables included in the FEIS show seasonal restrictions by TPA. These restrictions benefit soils by prohibiting traffic during the periods that soils are likely to be wet, reducing erosion, compaction, and sedimentation potential.

Consistency with Laws, Regulations, Policy, and Federal, Regional, State and Local Land Use Plans (including the Forest Plan)

There are no standards, laws, or regulations in the Gallatin Forest Plan or in Regional Policy that pertaining to soils that specifically apply to the decisions made in the Proposed Travel Management plan.