SOIL QUALITY

Public comment focused on one issue in regard to the potential effects of travel management on soil quality.

EFFECTS ON SOIL QUALITY DUE TO MOTORIZED OHV TRAVEL.

There are concerns that OHVs may do significantly more damage to soils and vegetation than other modes of travel such as horse or hiker traffic.

1. EXISTING CONDITION

a. Natural Characteristics and Past Events and Conditions

The project area falls in the Middle (M332Cb) and Southern (M332Cc) Rocky Mountain Division Subsections (Nesser et al, 1997). The Middle Rocky Mountain Division Subsection is described as thrust faulted and folded mountains that formed from mudstone, sandstone and lesser amounts of limestone and dolomite. Elevations range from 5,000 to 9,000 feet. Drainage density is high. The Southern Rocky Mountain Division Subsection is faulted mountains that formed from limestone, dolomite and quartzite with argillite and diorite sills. Elevation and drainage density is similar to the Middle. Mean annual precipitation ranges from 20 to 60 inches with 50 to 70 percent falling as snow.

Land type mapping of the soils analysis area, the non wilderness portion of the Rocky Mountain Ranger District, follows Holdorf (1981). A summary of land types and extent are found in Table III-11. Soils of the project area are a result of a number of factors including: landforms, parent material, climate, vegetation and time. A variety of these factors is found in the project area resulting in a variety of soils and soil characteristics.

Table III-11.
Land Types and Extent in Project Area

Land Type	Soils	Acres	Compaction Hazard	Landforms	Slope class	Parent Material Geology
12	Typic Cryoborolls	1357	Mod	Ridges and upper slopes	10-25	Limestone
13A	Typic and Argic Cryoborolls	3009	Low	Glacial drift deposits	10-25	undiff
14C	Typic Cryochrepts	227	Mod	Rotational slumps and mudflows	25-40	Shale
14D	Typic Cryochrepts	4005	Mod	Rotational slumps and mudflows	25-40	Shale
18	Lithic Cryorthents	27375	Low	Steep west facing slopes	40-60	Limestone
20G	Typic Cryochrepts, Rockland	89	Low	Very Steep Valley slopes	>60	Sandstone, granite, basalt
21	Andic Cryochrepts	5065	Mod	Glacial drift deposits	10-25	undiff
21A	Andic Cryochrepts	12574	Mod	Steep, drift plastered trough walls	25-40	Sandstone and Shale
22	Andic Cryochrepts	8992	Mod	Clayey glacial drift deposits	25-40	Sandstone and Shale
23A	Typic Cryoboralfs	12023	Low	Steep, drift plastered trough walls	25-40	Sandstone and Shale

Land Type	Soils	Acres	Compaction Hazard	Landforms	Slope class	Parent Material Geology
24	Glossic Cryoboralfs	3391	Mod	Glacial outwash benches	0-10	undiff
25	Andic Cryochrepts	20502	Mod	Drift plastered trough walls	40-60	Sandstone and Shale
25A	Andic Cryochrepts	4849	Mod	Drift plastered slopes	25-40	Sandstone and Shale
25B	Andic Cryochrepts	8454	Mod	Hilly valley bottoms	10-40	Sandstone and shale
25C	Andic Cryochrepts	12586	Mod	Drift plastered trough walls	40-60	Sandstone and Shale
30	Pergelic Cryoborolls	2201	Low	Ridges	10-40	Limestone
63B	Typic, Argic Cryoborolls	547	Mod	Ridgetops and benches	10-40	Sandstone, granite
71	Typic, Andic Cryochrepts	31581	Mod	Steep glacial trough walls	40-60	Sandstone and Shale
71A	Typic, Andic Cryochrepts	19836	Mod	Steep valley sideslopes	25-60	Sandstone and Shale
71B	Andic Cryochrepts	5159	Mod	Ridges and upper slopes	10-40	Sandstone and Shale
71C	Andic, Typic Cryochrepts	3579	Mod	Steep valley sideslopes	25-60	Sandstone and Shale
72	Typic Cryoborolls, shallow	180	Mod	Steep upper slopes	40-60	Sandstone and Shale
160	Typic Cryoborolls, Typic Cryochrepts	337	Mod	Low relief ridges and slopes	10-40	Sandstone and Shale
161	Argic Cryoborolls, Typic Cryochrepts	20636	Mod	Low relief ridges and slopes	10-40	Sandstone and Shale
170	Typic Cryoborolls, Andic Cryochrepts	8655	Mod	High relief ridges and slopes	10-40	Sandstone and Shale
171	Typic Cryoborolls, Andic Cryochrepts	7023	Mod	High relief ridges and slopes	40-60	Sandstone and Shale
172	Argic Cryborolls, Andic Cryochrepts	2203	Mod	Hilly glaciated valleys	10-25	Sandstone and Shale
177	Andic Crochrepts	6759	Mod	Hilly glaciated valleys	10-25	Sandstone and Shale
181	Typic Cryochrepts, Rockland	16702	Low	Glacial cirque headwalls	>60	Non-carbonate rocks (all)
182	Rockland, Typic Cryochrepts	59065	Low	Very steep glacial breaks	>60	Limestone
183	Rockland, Typic Cryochrepts	13370	Low	Very steep peaks-upper slopes	>60	Non-carbonate rocks (all)
200	Fluvents, Borolls	4837	Mod	Well drained floodplains	0-10	undiff
201	Aquepts, Aquolls	1038	Mod	Wetland	0-10	undiff
202	Rockland	67178	Low	Rockland-limestone	>60	Limestone
203	Rockland	122	Low	Rockland-other	>60	Non-carbonate rocks (all)
Total		**396,881**				

b. Human Influences

The most important activities that have affected soils resources are livestock grazing and roads and trails. As described in the Water Quality Section, grazing allotments occur throughout the drainages, but because of steep terrain, grazing pressure is concentrated generally in the valleys, meadows and flat plateaus. Effects of livestock grazing on uplands are usually restricted to small concentrated areas where livestock bed, loaf under shade, water at developments, obtain salt and trail along fence lines and driveways. The soils of these areas are compacted and have increased wind and water erosion due to reduced vegetative cover and increased bare ground (Clary et al 2000). Grazing by cattle on riparian zone soils increases bare ground, increases erosion by water, ice and wind, decreases the litter layer, increases compaction, decreases infiltration and decreases fertility (Belsky et al 1999; Wheeler et al 2002). Even so, 73 percent of National Forest suitable range acres (22,000) in the Sun Canyon Range Analysis (1997) were in high or potential natural condition ecological status which indicates healthy soil functioning. 92 percent of the streams accessible to livestock were in functioning condition as well, with 4.5 miles (just under 5 percent) categorized as At-Risk or non-functioning, in part, due to livestock grazing.

Roads are limited to the major non-wilderness drainages while trails are found through out the Rocky Mountain Division. Approximately 70 percent of the land type soils in the analysis area have a moderate rating for compaction (Table III-11) as a part of erosion hazard. The rating is based on soils bare of vegetation and results from practices such as roads and primitive wheel tracks (Holdorf 1981).

In addition, certain soils and land types are identified as being "Sensitive" (Holdorf 1981). These soils have physical characteristics that may affect travel or be affected by travel routes. These characteristics include high clay contents in subsoils that are not stable when vegetation is removed by logging or when cut by road and possibly trail construction. Soils with severe erosion hazards are weakly developed and less than ten inches thick over weathered bedrock on steep slopes. Soils with slumping potential are formed over shales that weather readily to clay and are unstable when wet. Soils of floodplains and soils with shallow water tables are prone to flooding and may have poor bearing strength. Miles of roads and trails regardless of jurisdiction and including snow routes that cross sensitive soils are summarized below. See Map 15 for a display of Sensitive Soils in the analysis area.

Table III-12
Miles of Roads and Trails on Sensitive Soils by 6th Code Watersheds

6th Watershed	Severe Mass Failure Potential	Moderate Mass Failure Potential	Severe Erosion Potential	Moderate Slump Potential	Floodplains	Shallow Water Table
100302010102		2.72				
100302010104	34.94	3.29			6.04	0.41
100302010105	11.35	6.68			0.09	
100302010106	0.01					
100302010201	33.50					
100302010202	9.34				6.12	
100302010602	3.77				1.80	
Sub-Total BTM* area	**92.9**	**12.7**	**0**	**0**	**14.1**	**0.4**
100301020102		1.04			0.41	
100301020201		13.42			2.61	
100301020202		1.18				
100301020300		0.46				
100301040106						2.62
100301040303					1.24	

6th Watershed	Severe Mass Failure Potential	Moderate Mass Failure Potential	Severe Erosion Potential	Moderate Slump Potential	Floodplains	Shallow Water Table
100301040401	0.59	5.79				
100301040402	0.35	30.42			7.61	
100301040501	1.09	2.21				
100301040502	0.96					
100301040601					3.14	
100301040701		3.19				
100301040702		0.36				
100301040801					3.10	
100302010801		0.76		5.84	2.26	
100302050101					0.17	
100302050102	22.64	3.69			9.91	
100302050103	6.0	0.22			10.98	
100302050201	0.42					
100302050301	12.93					
100302050503			0.24	2.77		
Sub-Total BCS area**	**45.0**	**62.7**	**0.2**	**8.6**	**41.4**	**2.6**
Grand Total	**137.9**	**75.4**	**0.2**	**8.6**	**55.5**	**3.0**

* BTM refers to Badger-Two Medicine area. ** BCS refers to Birch Creek South area.

Road and trail maintenance is one monitoring tool of soil conditions affected by these practices. Only 10-30 percent of the most traveled, surfaced roads are maintained each year (see Hydrology Section) but approximately 80 percent of all trails receive some maintenance each year (Lang 2004). Trail maintenance measures consist of clearing, water bar maintenance, repair and cleaning ditches and limited new drainage feature construction. Some new construction, reconstruction or rerouting and restoration of abandoned segments occurs each year dependent upon funding. Erosion control is focused on with an emphasis on routing water off trails.

A soils team evaluated a small number of trails in two portions of the analysis area in September 2003 and 2004 (Archer 2003). The areas were chosen based on public comments of concern and GIS analysis techniques. The trails evaluated are shown in Table III-13 below:

Table III-13. Trails Surveyed for Soils Concerns

Area	Trail	User Group
Teton Mountain/Ear Mountain Area		
Clary Coulee	#177	Trail Bike/Hiker/Stock
Rierdon Gulch	#126	Trail Bike/Hiker/Stock
Green Gulch and Sheep Gulch	#127	Trail Bike/Hiker/Stock
Our Lake	#184	Hiker/ restricted Stock
Mt. Wright	#160	Hiker
Portion of West Fork Teton River	#144	Hiker/Stock
Headquarters Creek Pass	#165	Hiker/Stock
Jones Creek	#155	Trail Bike/Hiker/Stock
Badger Two Medicine Area		
Connecting trail to S. Fork Two Medicine River	#133.1	Trail Bike/Hiker/Stock
Connecting trail to S. Fork Two Medicine River	#137	ATV/Trail Bike/Hiker/Stock
South Fork Two Medicine River	#101	ATV/Trail Bike/Hiker/Stock
Whiterock Creek	#102	ATV/Trail Bike/Hiker/Stock

"Overall, trail erosion was concentrated near trailheads, along drainage crossings and in shale parent material areas. The Green Gulch Trail (#127) in the Teton River area and trails in the Badger/Two Medicine showed the greatest erosion concerns" (Archer 2003).

c. Applicable Laws, Regulations and Policy

Desired conditions are based on the applicable laws, regulations and policy which include:

- Forest and Rangeland Renewable Resource Planning Act of 1974 and National Forest Management Act of 1976
- Multiple Use Sustained Yield Act of 1960
- Executive Order 11644, Use of Off-Road Vehicles on the Public Lands (February 8, 1972), Amended by Executive Order 11989, Off-road Vehicles on Public Lands (May 25, 1977)
- Lewis and Clark National Forest Plan
- United States Forest Service Region 1/Region 4 Soil and Water Conservation Practices Handbook

More complete discussion of applicable Laws, Regulations and Policy are found in the project file, Appendix A, Montana Water Quality law **and Forest Plan direction** and Appendix G, Best Management Practices.

A critical component of the Desired Condition is meeting Forest Plan direction. An important Management Standard in the Lewis and Clark National Forest Plan for Soil, Water and Air Protection (F3) is: 1) Require application of Best Management Practices to project activities to ensure meeting or exceeding State water quality standards. Soil and Water Conservation Practices (SWCPs) (Forest Service 1995) are the equivalent of Best Management Practices (BMPs). SWCP 15.21, Maintenance of Roads, describes the minimum level of maintenance to be: "Provide the basic custodial care required to protect the road investment and to insure that damage to adjacent lands and resources is held to minimum."

As described above, the current level of road and trail maintenance is largely based on funding and Forest priority. Only 10-30 percent of the roads in the analysis area have been maintained yearly since 1999. The roads that have received maintenance are among the most improved and also thought to be most used roads in the analysis area. Approximately 80 percent of all trails receive some maintenance each year. The trail maintenance focuses on the most developed trails. From Table III-12, Miles of Roads and Trails in Sensitive Soils, approximately 280.7 miles of sensitive soils are crossed by roads and trails in the analysis area. The risk of soil impacts adjacent to roads and trails and the risk to water quality of perennial steams from roads and trails that are currently receiving no or little maintenance is moderate or greater. As will be shown in the Analysis of Action Alternatives below, the miles of roads and trails crossing sensitive soils change little with the Action Alternatives.

The current levels of road and trail maintenance will hold or decrease in the future (Gavrisheff 2004). This situation applies to the Existing Condition, or the No Action Alternative, as well as all the Action Alternatives. Meeting Forest Plan direction with the No Action Alternative or the Action Alternatives based on current levels of maintenance is doubtful.

2. ENVIRONMENTAL CONSEQUENCES

Watersheds, undisturbed by human influences, are not static systems. Deep snowpacks and heavy spring rains can cause flooding. Wildfire, wind or insect and disease mortality can drastically alter the vegetative composition of a watershed. Depending on the extent of mortality and rate of stand decomposition, impacts to soils as well as stream systems can be significant. However, watersheds left undisturbed after natural events, can and do recover. These natural disturbances occur infrequently, which allows for significant and generally rapid recovery of erosional and hydrologic processes prior to the next major disturbance.

a. Effects Common to All Alternatives

Natural disturbance events will continue to influence erosional and hydrologic processes within the watersheds of the analysis area. Given the current vegetative conditions, drought and associated fuel accumulations, there is potential for wildfires to occur that may be outside the range of conditions (intensity and duration) that have occurred over the last few hundred years. Depending on the intensity and area burned, accelerated soil erosion is possible, particularly where hydrophobic soils may be formed on moderately steep or steeper slopes of landforms that have had stream erosion as a primary process in their formation. Soil erosion could be expected, especially during years of average or higher precipitation/runoff conditions. Soils will stabilize as vegetative recovery progresses.

Road and trail systems have less of an impact to analysis area soils than natural disturbances such as wildfire or flooding. Construction and use of roads and trails are chronic sources of erosion and sediment to the analysis area watersheds.

Roads and trails affect the soil resource in a number of ways. The building and construction of roads and trails requires vegetation removal, soil disturbance and slope contouring. These actions disrupt the layering of soils and changes the physical properties of bulk density, infiltration rates, water holding capacities, nutrient concentrations and gas exchange rates. Established road and trail surfaces are essentially removed from the productive soils base (Gucinski et al 2001). Roads and trails can intercept surface flows, concentrating runoff and directing flows and erosion toward streams (Wemple and Jones 2003). Roads and trails built across sensitive soils with a high risk of mass movement undermine upper slopes and increase the risk of soil movement and mass failure (Gucinski et al 2001). Roads and trails built across shallow, weakly developed sensitive soils on steep slopes, especially at high elevations, are prone to erosion because these soils are difficult to stabilize. Segments of roads and trails may be jumbled and carried downslope if built on sensitive soils and landforms prone to slumping. Roads and trails built on floodplains may be severely eroded or removed during major flooding events. Roads and trails built on soil with shallow water tables may severely rut and lose structure due to low bearing strength.

Soil impacts from roads and trails tend to be more severe at high elevations due to higher precipitation rates, an extended period of snowmelt resulting in muddy soils, more severe freeze/thaw cycles causing more loose soil and increased exposure to wind erosion (Leung and Marion 1996).

Road and trail impacts to soils continue once established since the soil comprising the travelway is subject to continuing erosional forces of rainfall, running water, wind, freeze/thaw cycles, gravity and traffic (Leun and Marion 1996; Switalski et al 2004; Summer 1986). Soil impacts are lessened or removed with restoration of roads and trails and establishment of effective vegetation.

Soil impacts from roads and trails tend to increase with increased use, with some means of travel and on steeper slopes. Studies in southwest Montana and northwest Wyoming (Dale and Weaver 1974; Weaver and Dale 1978; Wilson and Seney 1994) have shown that on gentle slopes people and horse trails tend to be wider in meadows than in forests. Trail widths of horse trails in meadows were between 40 and 80 inches wide with 3000 or more uses per year. Horse trails on gentle slopes were nearly twice as deep as hiker trails in forested sites and 50 percent deeper in meadows. On sloping sites trail widths and depths increase over gentler slopes. Researchers found on meadow trails that motorcycle damage was greatest when traffic was upslope while horse and foot traffic was most damaging when the traffic was downhill. Weaver and Dale (1978) concluded: "Damage generally increased from hiker to motorcycle to horse in our study; if ridden at less conservative speeds, i.e. greater than 20 km/h, motorcycles might be more damaging than horses." Findings in the three state Off-Highway Vehicle EIS (USDI and USDA 2001) that included Montana: "The degree of disturbance and compaction varies by site and would correspond to the type of driver, vehicle, tire tread, tire width, weight, angle of force to the soil, and vegetative cover. Usually, compaction increases as tire size decreases, or vehicle weight increases and forces such as turning, accelerating or braking are added."

Most primary roads have been engineered and designed to limit erosion and sedimentation. Lack of maintenance leads to rutting and loss of surfacing, if present, and increased erosion and sedimentation (Seyedbagheri 1996; Swift 1984; Foltz and Burroughs 1990). Primitive two-track roads have little engineering and are prone to rutting and erosion if not maintained regularly. Trails have less impact but the travelway is usually bare and compacted with the risk of accelerated erosion and sedimentation.

The current level of road and trail maintenance is largely based on funding and Forest priority. Only 10-30 percent of the roads in the analysis area have been maintained yearly since 1999. The roads that have received maintenance are among the most improved and also thought to be most used roads in the analysis area. Approximately 80 percent of all trails receive some maintenance each year. The trail maintenance focuses on the most developed trails. From Table III-14 Miles of Roads and Trails Crossing Sensitive Soils by Alternative and Road Class, approximately **243.7** to **249.1** miles of sensitive soils are crossed by roads and trails in the analysis area **(93.8 to 94.4 miles in the Badger-Two Medicine)** depending on alternative. The risk of soil impacts adjacent to roads and trails and the risk to water quality of perennial steams from roads and trails that are currently receiving no or little maintenance is moderate or greater. The current levels of road and trail maintenance will hold or decrease in the future (Gavrisheff 2004).

The Cumulative Effects described for the No Action and Action Alternatives are very similar. Potential impacts from wildfire, prescribed fire, oil and gas development, and campground improvements along with continued impacts from livestock grazing are described above.

b. Alternative 1—No Action Alternative

Construction and use of roads and trails by different means of travel can cause detrimental soil displacement, compaction, erosion and other impacts. These detrimental soil impacts tend to be greater on sensitive soils. These detrimental impacts also tend to increase with greater levels of use. Regular maintenance of roads and trails can help minimize impacts, especially erosion. Identifying the miles of roads and trails that cross sensitive soils, reviewing road and trail maintenance levels and attempting to identify levels of use on sensitive soils by different means of travel are used to determine relative differences in impacts between alternatives.

1. Direct and Indirect Effects

Meyer (2002) evaluated OHV**(ATV)** trails in Alaska and found that problems arise when these vehicles use trails that were not designed for them. "Because of the unplanned nature of OHV**(ATV)** trails, many of them cross soils and sites poorly suited for the level of use occurring today." Findings in the three state Off-Highway Vehicle EIS (USDI and USDA 2001) that included Montana were somewhat similar to the studies above. "The degree of disturbance and compaction varies by site and would correspond to the type of driver, vehicle, tire tread, tire width, weight, angle of force to the soil, and vegetative cover. Usually, compaction increases as tire size decreases, or vehicle weight increases and forces such as turning, accelerating or braking are added." Further, sheet or rill erosion "would be most common on poorly designed or maintained roads and trails during periods of high soil moisture, rainfall and/or melting snow." **ATVs**, because of their wider tracking width, greater weight and relatively higher power would be ranked higher than hikers with respect to trail damage, but their placement with motorcycles and horses is not so clear.

The portion of the analysis area road and trail system that will be focused on is that part where roads and trails cross sensitive soils. Again, sensitive soils are: 1) soils with high clay contents in the subsoil layers that are prone to mass failure when cleared of vegetation or when cut by roads or trails; 2) thin, weakly developed soils on steep slopes that easily erode and are difficult to stabilize; 3) soils formed over shales that readily weather to clay and are unstable when wet; 4) soils of floodplains or soils with shallow water tables that have easily damaged structure. These are the areas of greatest likely hood of finding soils that have physical characteristics that may affect travel or be affected by travel routes. Table III-14 below provides a breakdown of road and trail use for the existing situation and also the action alternatives.

2. Cumulative Effects (Alt. 1)

The following apply from the list of Cumulative Effects for the project.

The effects of stand replacing fire within the analysis area would be compounded by existing roads. Roads can increase surface and subsurface drainage efficiency, routing upslope waters to natural channels at higher rates, increasing erosion. The effects are expected to be higher with **a high intensity burn** over a large area on moderately steep or steeper slopes and where road densities are higher.

Prescribed fire as a tool for managing vegetation can cause detrimental soil impacts when severities are too high. Severe burning can consume duff layers and cause physical damage to the surface mineral layers of soils, especially timbered soils. Some plant nutrients stored in the burned material are converted to a gaseous state and lost from the site by burning. Nitrogen and sulphur are especially susceptible (Harvey et al 1994). Fires may increase soil pH due to ash accumulation which directly effects availability of many nutrients. Endo- and ectomycorrhizae are particularly sensitive to soil heating by fire because they are concentrated in the organic and upper mineral soil layers (Keane et al 2002). Fires can also cause formation of water repellent layers in soils that impede infiltration and can cause massive erosion (Keane et al 2002).

Livestock grazing impacts to soil and water resources as described in the Existing Condition are expected to continue. Full implementation of the Sun Canyon Range Analysis (1997) improvements and grazing system changes are yet to be realized.

Table III-14. Miles of Roads and Trails Crossing Sensitive Soils by Alternative and Road Class

(Note that the total miles of roads and trails crossing sensitive soils in Table III-12, the Existing Condition, do not match the total miles of roads and trails crossing sensitive soils for Alternative 1, No Action Alternative, in Table III-14 (280.67 versus 246.21). Table III-14 does not include roads and trails administered by other agencies and also does not include over the snow routes.)

Map Coding-Road and Trail Class	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
	BTM	BCS	BTM	BCS	BTM	BCS	BTM	BCS	BTM	BCS
2-Road with No Restrictions	4.6	40.7	3.8	37.2	2.9	32	3.8	37.2	2.9	37.2
3-Road with Seasonal Restrictions	0.6	8.6	0.6	5.8	0.6	5.7	0.6	7.0	0.6	7.0
4-Road with Yearlong Restrictions	2.4	5.6	3.4	4.5	4.3	5.7	3.4	4.5	4.3	4.5
6-Other Roads	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8-Trail open to ATV's, motorcycles and non-motorized yearlong or seasonally	25.6	21.7	17.1	8.1	0	0	12.7	8.0	0	8.0
9-Trail open to motorcycles and non-motorized yearlong or seasonally	47.6	49.8	27.1	35.3	0	0	0.3	13.7	0.1	13.8
10-Non-motorized travel only	2.9	22.4	36.5	44.4	82.6	85.5	69.7	65.9	82.5	65.9
11-Non-mechanized travel only	0	0.4	0	0.4	0	0.4	0	0.4	0	0.4
12-Hikers only	0	0.8	0.3	1.0	0.3	1.8	0.3	1.8	0.3	1.8
13-Open to non-motorized only with exception of bicycles	0	0	0	3.6	0	2.8	0	2.8	0	2.8
14-Special use trail	0	2.4	0	3.4	0	3.4	0	3.4	0	3.4
19-4X4 Jeep trails	0	0	0	1.1	0	0	0	0	0	0
97-Decommission road, convert to or remains a trail	0	0	0.1	3.4	0.1	2.8	0.1	3.4	0.1	3.4
99-Decommission Road or Trail (System or Nonsystem route)	0	0	5.3	6.5	3.4	9.2	3.4	6.5	3.4	6.5
Totals Prior to Effective Restoration of Soil and Hydrologic Functioning	93.8	152.5	94.2	154.8	94.3	149.4	94.4	154.7	94.3	154.8
Totals Following Effective Restoration of Soil and Hydrologic Functioning (Potential with Decommissioning)	93.8	152.5	88.9	148.3	90.0	140.2	91.0	148.2	90.0	148.3

The direct and indirect effects to soils from roads and trails are expected to continue. The soils under established roads and trails will remain removed from the productive soils base. Erosion of the travel ways of roads and trails will continue, especially at the current level of maintenance. This level of maintenance is not expected to change. (Gavrisheff 2004). Soil compaction, cutbank sloughing, areas of mass movement, hillside slumping, flooding of roads and trails and rutting and breaking down of soil structure in soils with shallow water tables will continue.

If the Fina/Longwell oil and gas drilling proposal in Section 26, T30N, R13 W were to proceed, approximately 5.7 miles of new road construction and 0.3 miles of reconstruction would occur (4.5 miles on National Forest and 1.5 miles on private lands). The construction design would meet Forest Service engineering criteria for the level of use. If production was successful from the well the road would remain in place, if not the road prism would be rehabilitated. If the Chevron/Devon Energy drilling proposal in Section 5, T29N, R12W were to proceed approximately 6.4 miles of new road construction would be necessary from Palookaville. About 4.8 miles would be on National Forest. An alternative route would be approximately 17.5 miles of new construction from US Highway 2. The construction design would meet Forest Service engineering criteria and the road would remain in place if well production were successful. The road construction would be rehabilitated if well production were not successful. Soil impacts from road construction would include vegetation removal, soil layer mixing, compaction and erosion. The soils in the road prism would be effectively removed from the productive soils base. When the roads were rehabilitated the soil and hydrologic functioning of the road locations would be eventually restored.

Improvements are being **implemented at** the Wood Lake Campground and Picnic area in Section 6, T19N, R9W. Existing tables, wheel stops, fire rings, signing, bulletin boards and fence would be replaced. Three additional camp sites would be added. Campground loops and parking spurs within the campground would be graded and resurfaced. Soil impacts would include vegetation removal, soil layer mixing, compaction and erosion on a small area with existing soil impacts from previous use.

Northwest Energy has proposed 2.5 miles of new pipeline parallel to the existing line in Sections 1, 2 and 11 T30N, R13W and Section 36 T31N, R13W adjacent and just southeast of Highway 2. A temporary access road and new pipeline route would be cleared in the right of way and the new pipeline buried. The disturbance would be graded, permanently drained and revegetation initiated. Best Management Practices identified in the NEPA process would be implemented and would limit impacts to soil and water from the construction and pipeline burying. Impacts to soil and water would be localized and of short duration.

Approximately 107 acres of timber harvest have occurred in the analysis area since 1988. 90 percent of the harvest has occurred in four areas: 1) Benchmark, N ½ Section 22, T20N, R10 W. 24 acres of clear cut harvest with occurred on gentle topography against the landing strip in 1997 and 1998 with minimal impacts to soils and water; 2) Cyanide Creek, Section 12, T18N, R8W. 9 one acre units of Sanitation/Salvage harvest on gentle topography in 1989 with minimal impacts to soils and water; 3) Upper Beaver Creek, Sections 27, 28 and 35 T21N, R9W and Section 4 T20N, R9W. 28 acres of Group Selection, Single Tree Selection and Patch Clear cuts in 7 units again on gentle topography between 1988 and 1993 with minimal impacts to soils and water and; 4) Summit, Section 31, 32 and 33 T30N, R13W and Sections 3 and 5 T29N, R13W. 21 acres of Intermediate Thinning and 14 acres of Patch Clear cuts occurred in

10 units in 2002 again on gentle topography with minimal soil and water impacts. Soil impacts on all harvest units included vegetation removal, displacement, compaction, small areas of burned soil and erosion. Little sediment is thought to have reached streams due to gentle topography. No addition timber harvest has been proposed in the analysis area for the next 5 years, **with exception of some possible thinning along the Benchmark Road associated with fuels reduction efforts adjacent to cabins and lodges**.

c. Action Alternatives 2-5

The detrimental soil impacts from construction and use of roads and trails by different means of travel tend to be greater on sensitive soils compared to soils with physical characteristics that are not as affected by roads and trails or some kinds and levels of traffic (deep well drained soils with high coarse fragment contents and little clay accumulation on moderately steep or gentler slopes). Detrimental impacts to soils tend to increase with greater levels of use and with kinds of use that exceed the physical capabilities of soils. Regular maintenance of roads and trails can help minimize soil impacts, especially erosion.

1. Direct and Indirect Effects

Some road and trail decommissioning is proposed as part of the Action Alternatives. However, the specifics of decommissioning (methods and timing) have not been developed for this project. Decommissioning measures could range from a gated closure to an effective restoration of soil and hydrologic functioning (relieving compaction, recontouring, draining, grading and seeding (Switalski et al 2004). The rate of recovery of hydrologic and soil functioning would vary with the site. Recovery of hydrologic and soil functioning may be years away for some sites.

The major differences in the action alternatives with respect to sensitive soils are in the changes from authorized motorized to non-motorized travel on trails (see Table III-14. Note that the total miles of roads and trails crossing sensitive soils in Table III-12, the Existing Condition, do not match the total miles of roads and trails crossing sensitive soils for Alternative 1, No Action Alternative, in Table III-14 (280.67 versus 246.21). Table III-14 does not include roads and trails administered by other agencies and also does not include over the snow routes). Alternative 2 and especially 3, 4 and 5 would reduce the trail miles of sensitive soils open to ATVs and motorcycles from the existing situation **(Table III-14, map codes 8 and 9)**. Even though horse/stock traffic would still be authorized on trails open to non-motorized travel, and even though heavy levels of horse/stock traffic can significantly impact soils, removal of the impactive motorized modes of travel would potentially be important for the soil resource. Current levels of ATV and motorcycle traffic on most of the trails under current management are not well documented to know if a reduction in impacts would be real if management were changed as proposed in the Action Alternatives. *Even so, if trails with known moderate or greater levels of ATV and motorcycle traffic were to shift to non-motorized travel with light horse/stock use then a reduction of soil impacts and ultimately a reduction of vegetation removal, soil displacement, compaction ,erosion and sedimentation would be expected with regular trail maintenance.* Alternative 3 followed by Alternatives 5 and 4 have the most potential for improvement to soil **resources regardless of whether the Badger-Two Medicine or remaining 2/3 of the analysis area is being considered (see Table III-14).** Alternative 2 has the least potential for improvement.

2. Cumulative Effects

The Cumulative Effects for the Action Alternatives (Alts 2-5) are the same as for Alternative 1, the existing situation.

d. Effects Common to All Action Alternatives

The effects common to all Action Alternatives include the effects common to all Alternatives above with two exceptions.

1. The Action Alternatives include a limited amount of road and trail decommissioning but the details of decommissioning and timing are uncertain. Recovery of soil and hydrologic functioning will vary by site and may be years away.

2. The Action Alternatives propose changes in the amount of authorized motorized to non-motorized travel on trails. Alternative 2 and especially 3, 4 and 5 would reduce the trail miles of sensitive soils open to ATVs and motorcycles from the existing situation **(Table III-14, map codes 8 and 9)**. Even though horse/stock traffic would still be authorized on trails open to non-motorized travel, and even though heavy levels of horse/stock traffic can significantly impact soils, removal of the impactive motorized modes of travel would potentially be important for the soil resource. *Current levels of ATV and motorcycle traffic on most of the trails under current management are not well documented* to know if a reduction in impacts would be real if management were changed as proposed in the Action Alternatives. *Even so, if trails with known moderate or greater levels of ATV and motorcycle traffic were to shift to non-motorized travel with light horse/stock use then a reduction of soil impacts and ultimately a reduction of vegetation removal, soil displacement, compaction ,erosion and sedimentation would be expected with regular trail maintenance.* Alternative 3 followed by Alternatives 5 and 4 have the most potential for improvement to soil resources **regardless of whether considering the Badger-Two Medicine or the remaining 2/3 of the analysis area (see Table III-14).** Alternative 2 has the least potential for improvement.