WATER QUALITY

Public comment focused on two issues in regard to the potential effects of travel management on water quality.

EFFECTS ON WATER QUALITY FROM THE EXISTING ROAD AND TRAIL SYSTEM UNDER CURRENT LEVELS OF MAINTENANCE.

There are concerns about the effects on water quality from the existing road and trail system under current levels of maintenance. There are also concerns about the effects on water quality if human use levels or road/trail mileages increase.

1. EXISTING CONDITION

a. Natural Characteristics and Past Events and Conditions

The majority of the landforms comprising the Rocky Mountain Division are steep east facing limestone and dolomite reefs and westerly facing sandstone/shale/mudstone slopes. The hard limestone is relatively resistant to weathering. The sandstone/shale/mudstone parent material weathers to fine-grained sands, silts and clays. The sandstone/shale/mudstone produces both a continual source (low to moderate yield) of upslope sediment and an intermittent source of mass wasting material with high to very high yields.

The relatively high elevations along the Rocky Mountain Division allow for high average precipitation amounts of nearly 60 inches. The combination of late, deep snow packs, steep slopes and chinooks can produce rapid runoff conditions on an approximate 10 year basis. Past flood events typically occurred in late spring when heavy rains on saturated soils added significant flows to channels already full with snowmelt runoff.

The flood of June 1964 produced the highest discharge levels ever recorded for most streams and rivers along the Rocky Mountain Division (Boner and Stermitz, 1967). While the 1975 flood generally had lower peak flows than the 1964 flood, the flood levels were sustained longer, exceeding the total monthly discharge of the 1964 flood.

These recent flood events have played an important role in forming existing channel conditions. Some of the headwater channels are deeply entrenched with scoured banks (Johnson and Omang 1976). Wide, open floodplains with large cobbly/gravelly deposits are typical of the middle and lower portions of mainstem channels. The channels are still adjusting in these open floodplains with common, active meandering along the unstable alluvial banks. Natural stream sediment is due to dry creep (gravitational movement of surface soils), overland flow and mass failures in the upper reaches and in-channel erosion in the lower reaches. In general, *sediment supply exceeds sediment transport capacity* under average flow regimes.

Stream flow varies throughout the front range. Watersheds that lie within the limestone reefs have intermittent flow by mid-summer as stream flow subsides and resurfaces in response to limestone solution channels (cavities that have formed through water movement and dissolution of minerals) and coarse alluvial deposits in the valley bottoms.

The type and degree of vegetative cover is also a determinant of stream flow, sediment yield and stream type. Vegetation is largely defined by climate and soils, but other natural agents of fire or insects and disease may alter vegetative composition and ground cover.

Two 1988 fires had significant impacts on streams in the Rocky Mountain Division. The Canyon Creek fire burned nearly 70,000 acres between Smith Creek and Burned Point. The Gates Park fires burned nearly 55,000 acres in the North Fork of the Sun River drainage. The combination of steep slopes and reduced infiltration resulted in significant increases in peak flows and subsequent channel alterations. Extensive deposits of silt and sand occurred along the lower gradient portions of burned streams. Although surface and instream erosion was high for the years immediately following the fire, current sediment loads have diminished considerably. Flow levels are expected to be higher than normal until effective vegetation is reestablished.

All geologic units underlying the Rocky Mountain Division can potentially contain groundwater, with variability in yields and quantity dependent on the lithology of the formation. Those units with a high degree of porosity and permeability (unconsolidated surface gravels, sandstones and limestones) have the potential to contain large amounts of water. Conversely, those units with low porosities and permeability will contain little free water and have low transmissivity.

The Madison Limestone formation is an important, deep aquifer in Central and Eastern Montana. It is unknown whether or not the Madison Limestone within the front range is an important recharge zone for this aquifer.

There is a large amount of glacial till overlain by recent accumulations of alluvial material throughout the valley bottoms. The permeability of these materials is generally a function of their clay content. Near-surface groundwater is usually present in the valley bottoms, but limited in extent due to adjacent steep slopes.

b. Human Influences

The most important activities that have affected water resources are livestock grazing, water uses and roads and trails. Grazing allotments occur throughout the drainages, but because of the steep terrain, grazing pressure is concentrated generally in the valleys, meadows and flat plateaus. Headwater channels with flat gradients and banks composed of fine sediments, are sensitive to grazing and generally have been impacted to some degree from bank trampling. The mainstem channels have a lower sensitivity to grazing due to depositional bars with high rock content and general lack of forage in these areas.

The Sun Canyon Range Analysis (1997) project area extended south from approximately the southern perimeter of the Gates Park fire on the North Fork Sun River to Burned Point. The project area contained approximately 400 miles of streams, of which 95 miles are accessible to livestock. These 95 miles were surveyed and categorized into three condition classes according to the Proper Functioning Condition Assessment process (USDI-BLM, 1995). The three condition classes are Functioning, Functioning At-Risk and Non-functioning. 92 percent of the streams were classified as functioning even though many had been impacted by past flood and wildfire events. Nine reaches, (4.5 miles) or just under 5 percent, were categorized as At-Risk or non-functioning, in part, due to livestock grazing. These reaches included portions of Beaver Creek, Willow Creek and Smith Creek. Five additional reaches (3.4 miles or just under 4 percent) were determined to be not functioning properly due to effects other than livestock grazing. **All of these reaches have been significantly impacted by past flood events and are currently recovering from those impacts. Three of these reaches (two reaches on West Fork Beaver Creek and one reach on Little Willow Creek) are impacted by existing roads.** Two more reaches on Willow Creek were affected by the loss of beaver and old beaver ponds that were no longer stable.

Water impoundments and diversions can affect downstream channels by disrupting sediment transport processes and flow regimes. Regulated flows may not provide the high flow levels that are necessary to flush sediment that may be accumulating in downstream channels. Other channels can become sediment deficient as fine sediment is trapped within impoundments. The greatest benefit of impoundments is reducing flood flows resulting in lower flood impacts to channels. Two major reservoirs occur on or near the Forest boundary. Gibson Reservoir is located on the Sun River just inside the Forest boundary and has a storage capacity of 105,000 acre feet. Swift Reservoir is found on Birch creek and has a storage capacity of 30,000 acre feet.

Roads are limited to the major non-wilderness drainages while trails are found throughout the Rocky Mountain Division. Roads have resulted in elevated sediment levels where stream channels are confined by fill slopes, when vegetation buffers between roads and streams are not adequate and at crossing locations (Taylor et al 1999). Trails have also resulted in elevated levels of sediment when there is an inadequate vegetation buffer between the trail and stream and at crossing locations. A summary of perennial stream crossings or GIS indicated intersections of perennial streams with roads and trails and miles of roads and trails within 100 feet of streams by 6th Code Watershed is found in Table III-6. Map 14 shows the location of the 6th Code Watersheds. Crossings of streams vary from bridges to culverts to fords. The stability of the crossing, amount of use and kinds of use vary the impacts to water quality. More discussion of these factors is found under the Alternative discussions below. A 100 foot vegetative buffer from streams was chosen based on: 1) National Forest Management Act (NFMA) of 1976; 2) Lewis and Clark National Forest Plan and 3) Results from modeling of typical conditions using climate tailored to the analysis area (Water Erosion Prediction Project 2004). First, in CFR 219.27, volume 47, #190, 09/30/02 (Federal Register 1982) under part (e) of NFMA: "Special attention shall be given to land and vegetation for approximately 100 feet from the edges of all perennial streams, lakes and other bodies of water. No management practices causing detrimental changes in water temperature or chemical composition, blockages of water courses, or deposits of sediment shall be permitted within these areas that seriously and adversely affect water conditions or fish habitat." Second, in the Lewis and Clark National Forest Plan under Forest-Wide Management Standards for Facilities on page 2-65: "Locate facilities, including roads, drill pads or pipelines, as far from riparian areas as practical. This will generally be no closer than 100 feet." Third, Water Erosion Prediction Project (WEPP) modeling tailored for the area shows a 100 foot vegetative buffer will stop most sediment from reaching a stream if the road or trail is native surface with less than 8 percent grade, has low amounts of traffic and the gradient of the vegetation buffer between the road and stream is less than 10 percent.

Road densities can be an indication of runoff and water quality concerns. High road densities can compound the effects of infrequent, high intensity precipitation events. Roads can increase surface and subsurface drainage efficiency, routing upslope waters to natural channels at higher rates and increasing erosion and floodwater levels (Gucinski et al 2001; Trombulak and Frissell 2000; Eaglin and Hubert 1993). The combination of high road density and human development in floodplains increase the risk of more flood damage to streams during these extreme events. The Interior Columbia Basin Assessment (ICBA) evaluated road density in relation to surface fines in streams and found "The effects of roads on surface fines is unclear, though the highest mean values were found in the highest road density class" (Quigley 1997). **The road density class referred to is greater than 4.7 miles per square mile.** At the 6th Code Watershed level, the road densities of the analysis area ranged from 0-0.63 miles per square mile (Table III-6, Summary of Roads and Trails within 100' of Perennial Streams and Perennial Stream Crossings). **A "moving windows" GIS analysis**

was also used to visually identify where the highest concentration of roads are within the project area (Map 11/16/05). The moving windows method calculates road density by individual 640 acre blocks and then compiles the information for a spatial display. With the exception of small areas with concentrations of campgrounds and roads including West Fork Teton campground, Mortimer Gulch campground and Sawmill Flats, road densities in the analysis area do not exceed the ICBA indicator of 4.7 miles per square mile. Additionally, the ICBA did find that surface fines in streams are affected by factors other than road density in two areas where they had enough data to construct linear models (Lower Clark Fork and Central Idaho Mountains) including rock type, topography and vegetation (Quigley 1997).

Erosion and the potential for sedimentation tend to increase with an increase in the use levels of roads and trails. Use damages soils of unsurfaced roads and trails when the type and level of use exceed the soil's capacity to resist impact. The soils of unsurfaced roads and trails are damaged directly by mechanical impact from surface traffic and indirectly by hydraulic modifications, soil transport and deposition (Meyer 2002). A sequence of degradation starts with an increase in the amount of bare soil due to increased injury and loss of vegetation. Next, soil compaction increases with increased use especially when soils are wet and if they have low coarse fragment contents and the road or trail surface subsides. In conjunction with increased compaction soil structure breaks down from the shearing and pumping action of traffic. Overall, road and trail shapes tend to widen and deepen (Weaver and Dale 1978). With increased establishment of roads and trails surface water flow is rerouted, infiltration and percolation of water is reduced, ponding of water on the surface increases and water holding capacity of the soils decrease. Soil loss by water and wind erosion increases and deposition of transported soil particles increases (Meyer 2002).

Use of graveled surfaced roads and trails, especially by heavy motorized traffic, breaks down the surfacing material and provides loose material for erosion in the next precipitation event (Burroughs et al, 1984). A greater level of use of gravel surfaced roads can result in rutting, ponding and more erosion especially if used when rainfall is occurring.

The impacts from different kinds of trail use are not always consistent. Weaver and Dale (1978) evaluated trails on a grassland site in the Bridger Range and timberland site in the Gallatin Range of Montana. On level ground horses were most destructive and hikers least destructive but on grassy slopes motorcycles were the most destructive. On both level and sloping sites, trail widths and depths were greatest for horses and least for hikers. On the grassland site motorcycle damage was greatest when traffic was upslope while horse and foot traffic was most damaging when the traffic was downslope. "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." 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 on them 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." Because of their wider tracking width, greater weight and relatively

Table III-6. Summary of Roads and Trails within 100' of Perennial Streams and Perennial Stream Crossings

6th Code Watershed	Watershed Sq. Miles	Major Stream or Streams in Watershed	Total Road Miles/Road Density (mi/mi²)	Trail Miles within 100' of Streams	Road Miles within 100' of Streams	Stream Crossings By Trails	Stream Crossings By Roads
100302010104	35.8	Upper S. Fk. Two Med	4.3/0.12	14.9	0.4	43	1
100302010105	67.7	Lower S. Fk. Two Med	5.6/0.08	10.9	0.6	28	3
100302010106	59.8	Little Badger	5.4/0.09	3.1	1.4	7	1
100302010201	60.0	N/S Badger	0	21.9	0	44	0
100302010202	64.5	Lower Badger	2.5/0.04	11.3	0.3	31	1
100302010204	62.4	Mowitch Basin	4.1/0.07	2.3	1.6	13	2
100302010602	32.6	N.Fk. Birch	0	4.1	0	6	0
Totals for Badger-Two Medicine area			**21.9**	**68.5**	**4.3**	**172**	**8**
100301020102	31.3	Dearborn	0	2.3	0	2	0
100301020201	40.0	Falls Ck	0	15.5	0	43	0
100301020202	45.8	Cuniff Ck	0	0.2	0	1	0
100301040106	33.4	Arsenic Ck	0	3.3	0	12	0
100301040201	47.5	Straight Ck	0	1.6	0	1	0
100301040202	38.7	Head of S. Fk. Sun	0	1.8	0	1	0
100301040203	29.7	Wood Ck.	16.8/0.56	7.5	7.4	33	21
100301040303	51.9	Upper S. Fk. Sun	0	3.6	0	6	0
100301040401	37.0	Big George/Lange	3/0.08	6.7	0.5	12	0
100301040402	54.8	Beaver/Blacktail	34.3/0.63	16.6	16.7	19	48
100301040501	37.0	Willow Ck	5.5/0.15	2.1	2.6	5	7
100301040502	38.6	Cutrock Ck	0	1.4	0	9	0
100301040601	38.7	Lower Sun	4.8/0.12	0	1.1	0	1
100301040701	36.2	Petty/Smith	0	11.4	0	24	0
100301040702	26.1	Ford Ck	10.1/0.39	1.9	6.3	9	23
100301040801	33.2	Elk Ck	3.3/0.10	6.0	2.3	8	8
100302010801	46.6	Dupuyer Ck	3.3/0.07	1.7	1.1	7	2
100302050101	20.8	Upper N. Fk. Teton	0	0.2	0	0	0
100302050102	42.7	Waldron/N.Fk. Teton	19.7/0.46	8.2	7.6	48	14
100302050103	46.6	S. Fk. Teton	11.7/0.25	13.9	6.7	36	7
100302050201	69.0	Edwards/Wilson	0	0.9	0	1	0
100302050301	53.4	Deep Ck	0	14.1	0	32	0
100302050501	51.3	Muddy Ck	0	1.6	0	2	0
100302050503	26.7	Blackleaf Ck	1.6/0.06	1.6	0.3	7	0
Totals for Birch Creek South area			**114.1**	**124.1**	**52.6**	**318**	**131**
Totals for Analysis Area			**136**	**192.6**	**56.9**	**490**	**139**

(See Appendices N and O for further breakdowns of miles of roads and trails within 100 feet of perennial steams and individual stream crossings by roads and trails).

high power, **ATVs** would be ranked higher than hikers with respect to trail damage, but their placement with motorcycles and horses is not so clear.

In general, the impacts to Forest roads are greatest from full size cars, pickups and trucks compared to hikers, horses, motorcycles or **ATVs** due to the greater size, weight, power and ease of using full size vehicles under wet or inclement conditions.

Regular road maintenance is important in reducing sediment production from road running surfaces and drainage systems. Removing ruts, reestablishing surface drainage and maintaining surfacing when present are effective measures in controlling sediment (Packer and Christensen 1977, Foltz and Burroughs 1990, Burroughs and King 1989). Maintenance of roads in the analysis area has been limited to a few most heavily used. The table below (Lewis and Clark National Forest 2004) summarizes road maintenance since 1999.

Table III-7.
Summary of Road Maintenance Since 1999

Road Number	Name	6th Code HUC	Miles	Mt'd 1999	Mt'd 2000	Mt'd 2001	Mt'd 2002	Mt's 2003	Mt'd 2004	Mt'd 2005
235	Benchmark	1040203 1040702	16.0			**X**	**X**	**X**	**X**	**X**
144	North Fork Teton River	2050102	11.7			**X**	**X**	**X**	**X (3.9)**	**X (7)**
109	South Fork Teton River	2050103	6.6			**X**	**X**		**X (5.2)**	
233	Beaver Ck /Willow Ck	1040402 1040501	13.4		**X**		**Portion**		**X (2.6)**	
196	Elk Creek		3.0			**X**				
Total			50.7	0	13.4	37.3	~41.3	27.7	27.7	**23**

Trail maintenance is also important for reducing erosion and sediment production. Maintaining drainage, protecting segments that stay wet longer, and minimizing multiple parallel trails are effective measures (Leung and Marion 1996, Meyer 2002). Trail maintenance in the analysis area has varied according to funding, level of use and trail class. On average approximately 80 percent of all trails receive some maintenance each year (Lang 2004). Mainline trails (TC3-Developed/Improved) and secondary trails (TC2-Simple/minor development) generally see some level of maintenance annually. Way trails (TC1-Primitive/undeveloped) receive some maintenance approximately one time in three years. Maintenance measures consist of clearing, water bar maintenance, repair and cleaning ditches and limited new drainage feature construction. The focus is on problem areas with an emphasis to route water off trails. Some new construction, reconstruction or rerouting is implemented each year dependent upon funding.

Monitoring the condition of roads and trails is most consistently done through maintenance activities. Minor concerns (cleaning waterbars, ditches and culverts) are addressed through normal maintenance activities. Major or more extensive concerns noted through maintenance or use may involve Forest specialists. Appropriate solutions are proposed, projects are developed, NEPA steps are completed and solutions are implemented according to priority and funding.

Reports of motorized vehicle damage, travel plan effectiveness, social conflicts and law enforcement violations are reported in Forest Monitoring Reports based on Law Enforcement Records (Lewis and Clark National Forest 2002). The most recent monitoring report notes

undetermined roads in Teton, Hannan, Home Gulch, Red Lake, McCarty Hill and Willow Creek drainages from 4X4 users. 100 incidents, 20 warning notices, and 5 violation notices regarding the use of Forest roads or trails and off-road vehicle use were reported for the Rocky Mountain Ranger District during the FY00-01 monitoring period.

c. Applicable Laws, Regulations and Policy

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

- Federal Clean Water Act
- Montana Water Quality Law
- 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 (May 25, 1977), Off Road Vehicles on Public Lands
- Lewis and Clark National Forest Plan
- United States Forest Service Region 1, Policy Direction found in R1/R4 Forest Service Soil and Water Conservation Practices Handbook.

More complete discussion of applicable Laws, Regulations and Policy are found in the project file, and Appendix A, Montana Water Quality law, including *Water Quality Limited Streams* from the 1996 through the 2004 lists and **Forest Plan compliance**.

A critical component of the Desired Condition is meeting Forest Plan direction. An important Management Standard in the 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. On Forest Service Lands there are approximately 249.6 miles of roads and trails within 100 feet of perennial streams and 629 stream crossings in the analysis area (Tables III-8 and III-9 below). The risk of soil and water impacts from roads and trails that are currently receiving no or little maintenance is moderate or greater. As will be shown in Analysis below, the miles of roads and trails within 100 feet of perennial streams and the number of stream crossings by roads and trails changes little with the Action Alternatives.

The current levels of road and trail maintenance will hold or decrease in the future. 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 stream systems can be significant. However, watersheds left undisturbed after natural events, can and do recover rapidly and ultimately provide conditions that fully support all beneficial uses within a relatively short time. These natural disturbances occur infrequently, which allows for significant and generally rapid recovery of hydrologic and erosional processes prior to the next major disturbance. This results in pulse effects, which are moderate to high in magnitude, but low in frequency.

a. Effects Common to All Alternatives

The majority of the landforms comprising the Rocky Mountain Division are steep east facing limestone and dolomite reefs and westerly facing sandstone/shale/mudstone slopes. The hard limestone is relatively resistant to weathering. The sandstone/shale/mudstone parent material weathers to fine-grained sands, silts and clays. The sandstone/shale/mudstone produces both a continual source (low to moderate yield) of upslope sediment and an intermittent source of mass wasting material with high to very high yields.

Recent flood events have played an important role in forming existing channel conditions. Some of the headwater channels are deeply entrenched with scoured banks (Johnson and Omang 1976). Wide, open floodplains with large cobbly/gravelly deposits are typical of the middle and lower portions of mainstem channels. The channels are still adjusting in these open floodplains with common, active meandering along the unstable alluvial banks. Natural stream sediment is due to dry creep (gravitational movement of surface soils), overland flow and mass failures in the upper reaches and in-channel erosion in the lower reaches. In general, *sediment supply exceeds sediment transport capacity* under average flow regimes.

Natural disturbance events will continue to influence hydrologic and erosional 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. Channel adjustments could be expected, especially during years of average or higher precipitation/runoff conditions. Stream systems will stabilize however as vegetative recovery progresses.

Road and trail systems have less of an impact to analysis area soils and water 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. Only activities such as stream crossing construction or replacement or the use of fords by vehicles and stock are considered a direct effect to the water resource. The sediment delivery and flow disruption that occurs with these actions is immediate.

The erosion and sedimentation from the use and minor maintenance of culverts and bridges and from the use of roads and trails within 100 feet of streams are removed from being direct effects by short distances and time, but are never the less considered indirect effects. These indirect impacts continue as long as the roads and trails are in place in their current locations.

This is because once a trail or road becomes established; the soil of the tread is subject to the continuing erosional forces of rainfall, running water, wind, freeze/thaw cycles, gravity and traffic (Leung and Marion 1996; USDI and USDA 2001). Further, roads and trails at higher elevations show greater soil loss than those at lower elevations. Higher precipitation rates, longer snowmelt periods, more loose soil from more severe freeze/thaw cycles and increased exposure to wind all contribute to higher erosion rates. Some considerations such as road and trail design, surfacing of roads and trails, limiting season of use, limiting kinds of use and *maintaining water controlling devices* will lower the risk of erosion and sediment reaching streams, but the impacts and the risk exists as long as the roads and trails are in place. The risks and impacts to water resources are lessened or eliminated over time by decommissioning and rehabilitating roads and trails within a 100 foot stream buffer, rehabilitating the stream crossings and reestablishing vegetation effective in controlling erosion on the associated disturbance.

Road densities can be an indication of runoff and water quality concerns. High road densities can compound the effects of infrequent, high intensity precipitation events. Roads can increase surface and subsurface drainage efficiency, routing upslope waters to natural channels at higher rates and increasing erosion and floodwater levels (Gucinski et al 2001; Trombulak and Frissell 2000; Eaglin and Hubert 1993). The combination of high road density and human development in floodplains increase the risk of more flood damage to streams during these extreme events. **With the exception of small areas with concentrations of campgrounds and roads including West Fork Teton campground Mortimer Gulch campground and Sawmill Flats road densities in the analysis area do not exceed the ICBA indicator of 4.7 miles per square mile.**

The levels of road and trail maintenance are largely based on Forest Service funding and to some extent on volunteers for trails. Forest Service funding for maintenance is not projected to increase but to likely stay similar to current levels or decrease (Gavrisheff 2004). The Forest priority list of roads for maintenance is also not likely to change. 10 to 30 percent of the roads in the analysis area have been maintained yearly in the last 5 years. Rutted running surfaces, lack of functioning water control devices (rolling dips, water bars, ditches and cross drainage culverts) and the breakdown and loss of road and trail surfacing where present increase the risk of sediment reaching perennial streams. Some level of maintenance on approximately 80 percent of trails in the project area yearly with Way trails (TC1-Primitive/undeveloped) receiving some maintenance approximately once in three years increases the risk of sediment reaching perennial streams. Trail rutting, erosion, lack of drainage and trail widening have been noted in District files and in comments from the public.

From Tables III-8 and III-9 (Summary of Miles of Roads and Trails Within 100 Foot Buffer of Perennial Streams by Alternative and Summary of Road and Trail Stream Crossing by Alternative) approximately 249.6 to **251.0** miles of roads and trails are within 100 feet of perennial steams depending on alternative. There are approximately **627** to 631 stream crossings by roads and trails depending on alternative. The risk to water quality of perennial streams from roads and trails that are currently receiving no or little maintenance is moderate or greater depending on individual site factors.

The Cumulative Effects as 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

Water quality impacts from existing roads and trails are occurring in the analysis area. The risk is greatest at stream crossings and where roads and trails are located close to streams. Current annual maintenance of roads is limited to 10-30 percent of those most heavily used. Some annual maintenance is preformed on approximately 80 percent of the trail system. The actual use levels of analysis area roads and trails are not well documented but impacts to water quality tend to increase with increased use and with certain kinds of use. The Existing Situation and the Action Alternatives are compared using stream crossings and miles of roads and trails within 100 feet of perennial streams.

1. Direct and Indirect Effects

Only activities such as stream crossing construction or replacement or the use of fords by vehicles and stock are considered a direct effect to the water resource. The sediment delivery and flow disruption that occurs with these actions is immediate.

The levels of road and trail maintenance are largely based on Forest Service funding and to some extent on volunteers for trails. Forest Service funding for maintenance is not projected to increase but to likely stay similar to current levels or decrease (Gavrisheff 2004). The Forest priority list of roads for maintenance is also not likely to change. 10 to 30 percent of the roads in the analysis area have been maintained yearly in the last 5 years. Rutted running surfaces, lack of functioning water control devices (rolling dips, water bars, ditches and cross drainage culverts) and the breakdown and loss of road and trail surfacing where present increase the risk of sediment reaching perennial streams. Some level of maintenance on approximately 80 percent of trails in the project area yearly with Way trails (TC1-Primitive/undeveloped) receiving some maintenance approximately once in three years increases the risk of sediment reaching perennial streams. Trail rutting, erosion, lack of drainage and trail widening have been noted in District files and in comments from the public.

2. Cumulative Effects

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

Existing cumulative effects models are not adequate to quantify to a single cumulative value, the effects of all the diverse activities in the watersheds including wildfire, livestock grazing, water uses and road and trail use. The only way to address these cumulatively is to address each activity individually and then quantify, in general terms, the cumulative effects between specific activities where appropriate.

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. The effects are expected to be higher with **a high intensity burn** over a large area 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 and/or create a water repellant layer that impedes infiltration and can cause massive erosion with sediment reaching streams. (Keane et al 2002). Prescribed fire could be applied throughout the analysis area. Applying prescribed fire within restricted conditions designed to minimize severe burning of soils would minimize risk of water quality impacts.

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

The direct effects to water resources of the occasional replacement of a stream crossing structure for maintenance or improvement needs and the use of fords by vehicles and stock would continue.

The indirect effects of erosion and sedimentation from the use of stream crossings other than fords and from the use of roads and trails within 100 feet of streams would also continue similar in distribution to that shown in Table III-6. Road and trail design would stay similar to the existing condition with upgrading and rerouting implemented as funding allowed. Surfacing of major roads and trails would not likely change in extent in the foreseeable future. The current levels of road and trail maintenance would likely continue or decrease. Maintaining only 10-30 percent of the existing road system each year would likely continue. Some level of maintenance on approximately 80 percent of the trail system each year would continue. Existing impacts to soil and water resources from these activities are expected to continue.

If the Fina/Longwell oil and gas drilling proposal in Section 26, T30N, R13W or the Chevron/Devon Energy proposal in Section 5, T29N, R12W were to proceed then additional soil disturbance would result from construction of access roads and well sites. About 5.7 miles of new road construction and 0.3 miles of reconstruction would occur associated with the Fina/Longwell project and either 6.4 or 17.5 miles of new road construction would be associated with the Chevron/Devon project depending on the chosen route. Additional stream crossings would also be associated with these projects. Direct and indirect impacts to water quality are possible from construction and use of the access routes and well sites. Soil and hydrologic functioning of the disturbance related to these projects would be restored eventually following their rehabilitation and the risk of water quality impacts would be reduced. Rehabilitation timing would occur following the life of well production if any.

Improvements **are being implemented at** the Wood Lake Campground and Picnic area in Section 6, T19N, R9W. Soil disturbance is anticipated with replacing existing facilities and expansion by three additional camp sites. Campground loops and parking would be graded and surfaced. Water quality impacts are likely minimal.

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. About 90 percent of the harvest has occurred in four areas: 1) Benchmark, N ½ Section 22, T20N, R10W. About 24 acres of clear cut harvest 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. About 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 in T21N, R9W and Section 4 T 20N, R9W. About 28 acres of Group Selection, Single Tree Selection and Patch Clearcuts in 7 units again on gentle topography between 1988 and 1993 with minimal impacts to soils and water and; 4) Summit, Sections 31, 32 and 33

T30N, R13W and Sections 3 and 5, T29N, R13W. About 21 acres of Intermediate Thinning and 14 acres of Patch Clearcuts 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. **Some additional thinning is possible along the Benchmark Road in the next several years associated with fuels reductions adjacent to cabins and lodges.**

c. Action Alternatives 2-5

The risk of detrimental impacts to water quality is greater at crossings and when roads and trails are within 100 feet of streams. The risk of detrimental impacts to water quality increases with greater levels of use on roads and trails, with some kinds of uses and with the lack of adequate maintenance of water controlling devises. Even though use levels on many roads and trails in the analysis area are not well documented some comparisons about the risks to water quality between alternatives can be drawn by the number of crossings and miles of roads and trails within 100 feet of streams.

1. Direct and Indirect Effects

Tables III-8 and III-9 display the miles of roads and trails within 100 feet of streams and the number of stream crossings organized by road and trail class by Alternative rather than watersheds. This table arrangement was chosen rather than one organized by watersheds since the Action Alternatives provide little change in total miles or total number of crossings from the existing condition. Further, little difference is found between Action Alternatives in total miles or number of crossings.

The specifics of decommissioning roads (methods, timing) have not been developed for this project. Decommissioning measures for roads could range from a gated closure to a more complete effort including relieving compaction, grading to contour, establishing permanent drain**age**, and seeding. The rate of recovery of soil and hydrologic functioning would vary by site. Full recovery (soil and water functioning) of the sites chosen for decommissioning could be years away.

Table III-8 does show the major shift from authorized motorized trails to non-motorized trails by Alternative. Alternatives 3, 4 and 5 would reduce the motorized trail miles **(trail classes 8 and 9)** within 100 feet of streams compared to the existing situation. 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 impact soils, removal of motorized modes of travel would potentially be important for reducing erosion from soils of these trails. 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 and water resources **whether in the Badger-Two Medicine portion or the remaining portion of the analysis area (See Table III-8).** Alternative 2 has the least potential for improvement.

Table III-8. Summary of Miles of Roads and Trails Within 100 Foot Buffer of Perennial Streams by Alternative

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	0.9	39.2	0.9	35.2	0.7	34.1	0.9	35.1	0.9	34.8
3-Road with Seasonal Restrictions	1.8	11.3	1.8	7.0	0.2	8.7	1.7	9.3	1.7	9.3
4-Road with Yearlong Restrictions	0.6	2.7	0.8	2.2	2.3	2.7	0.8	2.2	0.9	2.0
6-Other Roads	0	0	0	0	0	0	0	0	0	0
8-Trail open to ATVs, motorcycles and non-motorized yearlong or seasonally	27.8	16.8	21.1	7.1	0	0	14.4	7.1	0	6.0
9-Trail open to motorcycles and non-motorized yearlong or seasonally	34.0	53.9	23.3	35.8	0	0	1.0	11.7	0	16.2
10-Non-motorized travel only	6.9	49.9	19.4	69.5	63.8	112.2	48	93.7	62.4	90.2
11-Non-mechanized travel only	0	0.2	0	0.2	0	0.2	0	0.2	0	0.3
12-Hikers only	0	0.2	0	0.2	0	0.2	0	0.2	0	0.2
13-Open to non-motorized only with exception of bicycles	0	0	0	6	0	6	0	6	1.2	6.3
14-Special use trail	0	3.3	0	7.7	0	7.7	0	7.7	0	7.7
19-4X4 Jeep trails	0	0	0	2.2	0	0	0	0	0	0
97-Decommission road, convert to or remains trail	0	0	0.5	2.9	0.9	2.7	0.5	2.8	0.5	3.2
99-System road or trail to be decommissioned	0	0	5.3	2.4	5.7	2.7	5.7	2.4	5.7	2.5
Totals Prior to Decommissioning	72.9	176.7	73.3	178.4	73.8	177.2	73.4	178.4	73.3	178.6
Totals following Decommissioning and Eventual Recovery of Hydrologic and Soil Functioning	72.9	176.7	68.0	176.0	68.1	174.5	67.7	176	67.6	175.9

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

Table III-9. Summary of Road and Trail Stream Crossings by Alternative

Map Code	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
	BTM*	BCS**	BTM	BCS	BTM	BCS	BTM	BCS	BTM	BCS
4-Roads	8	131	7	113	7	113	15	105	7	110
5-Trails	172	318	150	328	152	328	158	320	147	330
7-Road Decommission	0	0	0	8	0	8	0	8	0	9
8-Trail Decommission	0	0	23	0	23	0	23	0	24	0
Totals Prior to Decommissioning	180	449	180	449	182	449	196	433	178	449
Totals Following Eventual Effective Decommissioning	180	449	157	441	159	441	173	425	154	440

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

Table III-10. Miles of Selected Roads and Trails Within 100 Feet of Perennial Streams

6th Code HUC	HUC Main Drainage	Trail or Road	Trail or Road Name	Trail Length	Designated Use, Existing Cond	Road/Trail Class	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
2010104	Upper South Fk 2-Med	TR 101, 137	2-Med, Elk Calf Mtn	27.6	ATV-All Terrain Vehicle	TC3-Developed/Improved	11.6	11.6	12	11.6	11.5
		TR 170	East Fk and Main Woods Ck	5.43	Pack-Pack and Saddle	TC2-Simple/Minor Dev	2.8	2.8	2.8	2.8	2.8
		TR 102	Whiterock Ck	4.15	ATV-All Terrain Vehicle	TC2-Simple/Minor Dev	1.3	1.3	1.3	1.3	1.3
2010105	Lower South Fk 2-Med	TR 172	Mettler Coulee	6.62	ATV-All Terrain Vehicle/Pack	TC2-Simple/Minor Dev	4	3.1	3.1	3.1	3.1
		TR 139	Hyde Ck/Hall Ck	2.9	Pack-Pack and Saddle	TC2-Simple/Minor Dev	0.3	0.3	0.3	0.3	0.3
		TR 138	Lower South Fk 2-Med	5.25	ATV-All Terrain Vehicle	TC2-Simple/Minor Dev	1.6	1.6	1.6	1.6	1.6
2010201	North/South Badger	TR 101	Badger (also in 2010104)	27.6	ATV-All Terrain Vehicle	TC2-Simple/Minor Dev	11.6	11.6	12	11.6	11.5
		TR 103	North Badger Ck	8.2	ATV-All Terrain Vehicle/Pack	TC3-Developed/Improved	4.3	4.3	4.3	4.3	4.3
		TR 104	South Badger Ck	10.9	Pack-Pack and Saddle	TC3-Developed/Improved	8.4	8.4	8.4	8.4	8.4
		TR 145	Elbow Ck	5.59	Pack-Pack and Saddle	TC3-Developed/Improved	1.9	1.9	1.9	1.9	1.9
		TR 146	Crucifixion Ck	2.05	Pack-Pack and Saddle	TC2-Simple/Minor Dev	1.6	1.6	1.6	1.6	1.6
2010202	Lower Badger	TR 101	Badger (also in 2010104, 2010201)	27.6	ATV-All Terain Vehicle	TC3-Developed/Improved	11.6	11.6	12	11.6	11.5
		TR 120	Lower Badger	10.04	Pack-Pack and Saddle	TC1-Primitive/Undeveloped	1.9	1.9	1.9	1.9	1.9
1020201	Falls Creek	TR 229	West Fk Falls Ck, Falls Ck	11.4	Pack-Pack and Saddle	TC2-Simple/Minor Dev	8.1	8.1	8.1	8.1	8.1
1040203	Woods Creek	TR 256	Benchmark Ck	7.42	Pack-Pack and Saddle	TC3-Developed/Improved	3.7	3.7	3.7	3.7	3.7
		TR 204	Fairview Ck	10.93	Pack-Pack and Saddle	TC3-Developed/Improved	3.6	3.6	3.6	3.6	3.6
		FR 235	Benchmark Road, Wood Ck	16	Arterial/Collector	Maintenance Level 4	7.7	7.7	7.7	7.7	7.7

6th Code HUC	HUC Main Drainage	Trail or Road	Trail or Road Name	Trail Length	Designated Use, Existing Cond	Road/Trail Class	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
1040402	Beaver/Blacktail	FR 233	Beaver/Willow	13.4	Local	Maintenance Level 3	6.7	6.7	6.7	6.7	6.7
		FR 108	Sun River	7.2?	Arterial/Collector	Maintenance Level 5	3.3	3.3	3.3	3.3	3.3
		TR 267	Home Gulch	11.63	Pack-Pack and Saddle	TC2-Simple/Minor Dev	3.8	3.8	3.8	3.8	3.8
1040701	Petty/Smith	TR 215	Smith Ck	7.42	Pack-Pack and Saddle	TC3-Developed/Improved	3.5	3.5	3.5	3.5	3.5
		TR214	Jakie Creek	3.6	Pack-Pack and Saddle	TC2-Simple/Minor Dev	1.7	1.7	1.7	1.7	1.7
2050102	Waldron/N.Fk Teton	FR 144	West/North Fk Teton	11.7	Arterial/Collector	Maintenance Level 4	4.9	4.9	4.9	4.9	4.9
		TR 155	Jones Ck	3.24	Pack-Pack and Saddle	TC2-Simple/Minor Dev	1.3	1.3	1.3	1.3	1.3
		TR 107	North Fk Teton	18.15	Pack-Pack and Saddle	TC2-Simple/Minor Dev	4	4	4	4	4
		TR 114	West Fk North Fk Teton	5.79	Pack-Pack and Saddle	TC3-Developed/Improved	1.8	1.8	1.8	1.8	1.8
2050103	South Fk Teton	TR 108	Route Ck Pass	5.5	Pack-Pack and Saddle	TC3-Developed/Improved	4	4	4	4	4
		FR 109	South Fk Teton	6.6	Collector	Maintenance Level 3	3	3	3	3	3
		TR 127	Green Gulch	6.43	Pack-Pack and Saddle	TC3-Developed/Improved	2	2	2	2	2
		TR 126	Rierdon Gulch	12.76	Pack-Pack and Saddle	TC3-Developed/Improved	5.1	5.1	5.1	5.1	5.1
2050301	Deep Creek	TR 135	North Fk Deep Ck	2.07	Pack-Pack and Saddle	TC2-Simple/Minor Dev	1.6	1.6	1.6	1.6	1.6
		TR 128	Deep Creek-Biggs Creek	7.1	Pack-Pack and Saddle	TC2-Simple/Minor Dev	5.7	5.7	5.7	5.7	5.7
		TR 168	Erosion Ck (Portion of S.Fk.Teton)	4+	Pack-Pack and Saddle	TC2-Simple/Minor Dev	3.3	3.3	3.3	3.3	3.3
		TR 126	Slim Gulch (Portion of Rierdon Gul)	12.76	Pack-Pack and Saddle	TC3-Developed/Improved	5.1	5.1	5.1	5.1	5.1

A more detailed look was taken of selected roads and trails in 6th Code watersheds that have the greatest risk of eroding and contributing sediment to streams based on having the most miles of roads and trails within a 100 foot buffer of perennial streams and the most stream crossings. These roads and trails were tracked through the Existing Condition and Action Alternatives. The results of this evaluation are shown in Table III-10. Little change to the existing situation is proposed.

As described earlier, the levels of road and trail maintenance are largely based on Forest Service funding and to some extent on volunteers. Forest Service funding for maintenance is not projected to increase but it **will likely stay** at current levels or decrease. The Forest priority of roads for maintenance is also not likely to change. About 10 to 30 percent of the roads most used in the analysis area have been maintained yearly in the last 5 years. Some level of maintenance on approximately 80 percent of trails in the project area yearly with Way trails (TC1-Primitive/undeveloped) receiving some maintenance approximately once in three years increases the risk of sediment reaching perennial streams. Trail rutting, erosion, lack of drainage and trail widening have been noted in District files and in comments from the public. *The risk to water quality of perennial streams from roads and trails that are currently receiving no or little maintenance is moderate or greater.*

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 yet to be developed. 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 Alternatives 3, 4 and 5 would reduce the trail miles within 100 feet of perennial streams open to ATVs and motorcycles from the existing situation **(See Table III-8, trail classes 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 impact soils, removal of motorized modes of travel would potentially be important for reducing erosion from soils of these trails. However, 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 and water resources **(whether in the Badger-Two Medicine portion or the remaining portion of the analysis area, see Table III-8).** Alternative 2 has the least potential for improvement.

EFFECTS ON WATER QUALITY IF HUMAN USE LEVELS OR ROAD/TRAIL MILEAGES INCREASE.

1. EXISTING CONDITION

a. Natural Characteristics and Past Events and Conditions

The natural characteristics and past events and conditions are the same as for the previous water quality issue, effects on water quality from existing road and trail system under current levels of maintenance.

b. Human Influences

The human influences are also the same as for the previous water quality issue.

c. Desired Condition, Applicable Laws, Regulations and Policy

The applicable Laws, Regulations and Policy would be the same as for the previous water quality issue.

2. ENVIRONMENTAL CONSEQUENCES

As described in the previous water quality issue, watersheds are not static systems, including those undisturbed by human influences. 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 stream systems can be significant. However, watersheds left undisturbed after natural events, can and do recover rapidly and ultimately provide conditions that fully support all beneficial uses within a relatively short time. These natural disturbances occur infrequently, which allows for significant and generally rapid recovery of hydrologic and erosional processes prior to the next major disturbance. This results in pulse effects, which are moderate to high in magnitude, but low in frequency.

a. Alternative 1--No Action Alternative

Water quality impacts from existing roads and trails are occurring in the analysis area. The risk is greatest at stream crossings and where roads and trails are located close to streams (within 100 feet). Current annual maintenance of roads is limited to 10-30 percent of those most heavily used. Some annual maintenance is preformed on approximately 80 percent of the trail system. The actual use levels of analysis area roads and trails are not well documented, but impacts to water quality tend to increase with increased use and with certain kinds of use. The Existing Situation and the Action

Alternatives are compared using stream crossings and miles of roads and trails within 100 feet of perennial steams.

1. Direct and Indirect Effects

Natural disturbance events will continue to influence hydrologic and erosional processes within the watersheds of the analysis area. Given 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. Channel adjustments could be expected, especially during years of average or higher precipitation/runoff conditions. Stream systems will stabilize however as vegetative recovery progresses.

Only activities such as stream crossing construction and replacement or use of fords by vehicles or pack stock are considered a direct effect to the water resource. The sediment delivery and flow disruption that occurs with these actions is immediate.

The erosion and sedimentation from the use and minor maintenance (grading approaches, cleaning of water control devices on approaches) of culverts and bridges and from the use of roads and trails primarily within 100 feet of streams are removed from being direct effects by short distances and time, and are considered indirect effects instead.

Table III-6, Summary of Roads and Trails within 100 feet of Perennial Streams and Perennial Stream Crossings, indicates the relative levels of direct and indirect impacts of roads and trails on the water quality of perennial streams in the analysis area organized by 6th code watersheds. The kinds of stream crossings, the gradients of approaches to stream crossings, erodibility of different soils, continuity of vegetative buffers between the roads or trails and streams, impacts to ephemeral and intermittent streams from roads and trails or other factors that influence erosion and sedimentation are not separated in this table so some crossings and some road and trail locations are more of a concern than others. Even so, these indices of measure are useful for comparison at this scale of analysis.

The indirect impacts continue as long as the roads and trails are in place in their current locations. This is because once a trail or road becomes established; the soil of the tread is subject to the continuing erosional forces of rainfall, running water, wind, freeze/thaw cycles, gravity and traffic (Leung and Marion 1996; USDI and USDA 2001, Summer 1986). Further, roads and trails at higher elevations show greater soil loss than those at lower elevations. Higher precipitation rates, longer snowmelt periods, more loose soil from more severe freeze/thaw cycles, and increased exposure to wind all contribute to higher erosion rates. Some considerations such as road and trail design, surfacing of roads and trails, limiting season of use, limiting kinds of use and maintaining water controlling devices (cross drains, water bars, ditches, culverts etc) will lower the risk of erosion and sediment reaching streams, but the impacts and risk exists as long as the roads and trails are in place. The risks and impacts to water resources are lessened or eliminated over time by restoring soil and hydrologic functioning that was lost with

construction and use of roads and trails (USDA Forest Service 1999). This may mean relieving soil compaction, grading the disturbance to original contours, establishing permanent drainage, establishing effective vegetation cover and preventing disturbance from unauthorized use.

The current levels of road and trail maintenance are largely based on Forest Service funding and volunteers, especially for trail maintenance. Forest Service funding for maintenance of roads and trails is projected to stay similar to current levels or decrease (Gavrisheff 2004). The current Forest priority list of roads for maintenance is also not likely to change. About 10 to 30 percent of the roads in the analysis area have been maintained yearly in the last 5 years (Table III-7). Rutted running surfaces, water control devices that are not functioning and the breakdown and loss of road and trail surfacing (where present) increase the risk of sediment reaching perennial streams (Swift 1984, Foltz and Burroughs 1990, Burroughs et al 1984). Some level of maintenance on approximately 80 percent of trails in the project area yearly (Lang 2004) with Way trails (TC1-Primitive /undeveloped) receiving some maintenance approximately once in three years increases the risk of sediment reaching perennial streams. Trail rutting, erosion, lack of drainage and trail widening have been noted in District files and in comments from the public.

2. Cumulative Effects

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

Existing cumulative effects models are not adequate to quantify to a single cumulative value, the effects of all the diverse activities in the watersheds including wildfire, livestock grazing, water uses and road and trail use. The only way to address these cumulatively is to address each activity individually and then quantify, in general terms, the cumulative effects between specific activities where appropriate.

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. The effects are expected to be higher with a burn with high intensity over a large area 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 and/or create a water repellant layer that impedes infiltration and can cause massive erosion with sediment reaching streams. (Keane et al 2002). Prescribed fire could be applied throughout the analysis area. Applying prescribed fire within restricted conditions designed to minimize severe burning of soils would minimize risk of water quality impacts.

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

The direct effects to water resources of the occasional replacement of a stream crossing structure for maintenance or improvement needs and the use of fords by vehicles and stock would continue.

The indirect effects of erosion and sedimentation from the use of stream crossings other than fords and from the use of roads and trails within 100 feet of streams would also continue similar in distribution to that shown in Table III-6. Road and trail design would stay similar to the existing condition with upgrading and rerouting implemented as funding allowed. Surfacing of major roads and trails would not likely change in extent in the foreseeable future. The current levels of road and trail maintenance would likely continue or decrease. Maintaining only 10-30 percent of the existing road system each year would likely continue. Some level of maintenance on approximately 80 percent of the trail system each year would continue. Existing impacts to soil and water resources from these activities are expected to continue.

If the Fina/Longwell oil and gas drilling proposal in Section 26, T30N, R13W or the Chevron/Devon Energy proposal in Section 5, T29N, R12W were to proceed then additional soil disturbance would result from construction of access roads and well sites. About 5.7 miles of new road construction and 0.3 miles of reconstruction would occur associated with the Fina/Longwell project and either 6.4 or 17.5 miles of new road construction would be associated with the Chevron/Devon project depending on the chosen route. Additional stream crossings would also be associated with these projects. Direct and indirect impacts to water quality are possible from construction and use of the access routes and well sites. Soil and hydrologic functioning of the disturbance related to these projects would be restored eventually following their rehabilitation and the risk of water quality impacts would be reduced. Rehabilitation timing would depend on whether the wells are producers or not.

Improvements **are being implemented at** the Wood Lake Campground and Picnic area in Section 6, T19N, R9W. Soil disturbance is anticipated with replacing existing facilities and expansion by three additional camp sites. Campground loops and parking would be graded and surfaced. Water quality impacts are likely minimal.

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. About 90 percent of the harvest has occurred in four areas: 1) Benchmark, N ½ Section 22, T20N, R10W. About 24 acres of clear cut harvest 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. About 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 in T21N, R9W and Section 4 T 20N, R9W. About

28 acres of Group Selection, Single Tree Selection and Patch Clearcuts in 7 units again on gentle topography between 1988 and 1993 with minimal impacts to soils and water and; 4) Summit, Sections 31, 32 and 33, T30N, R13W and Sections 3 and 5, T29N, R13W. About 21 acres of Intermediate Thinning and 14 acres of Patch Clearcuts 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. **Some additional thinning is possible in the next several years along the Benchmark Road associated with fuels reduction work adjacent to cabins and lodges.**

b. Action Alternatives 2-5

The risk of detrimental impacts to water quality is greater at crossings and when roads and trails are within 100 feet of streams. The risk of detrimental impacts to water quality tend to increase with greater levels of use on roads and trails, with some kinds of uses and with the lack of adequate maintenance of water controlling devises. Even though use levels on many roads and trails in the analysis area are not well documented some comparisons about the risks to water quality between alternatives can be drawn by the number of crossings and miles of roads and trails within 100 feet of streams.

1. Direct and Indirect Effects

Only activities such as stream crossing construction and replacement or use of fords by vehicles or pack stock are considered a direct effect to the water resource. The sediment delivery and flow disruption that occurs with these actions is immediate. Road and trail crossings are a major sediment source because crossings serve as focal points for introducing sediment-laden runoff into streams (Taylor et al 1999). Although culverts are more expensive to install and maintain than fords, their water quality impacts are generally thought to be less than fords. Culvert installation and continuing impacts until effective vegetation is reestablished are when most sediment is introduced into streams. Culverts that are not properly designed, installed or maintained can clog, wash out and the fill around the culvert enters the stream. Bridges are generally the most expensive stream crossings. However the impacts to streams during construction can be less compared to culverts and fords and they potentially have the least impact during use (Taylor et al 1999).

The erosion and sediment produced from the use and minor maintenance (grading approaches, cleaning of water control devices on approaches) of culverts and bridges and from the use of roads and trails primarily within 100 feet of streams are removed from being direct effects by short distances and time, and are considered indirect effects instead.

Roads have three primary effects on water: they intercept rainfall directly on the road surface and road cutbanks and intercept subsurface flows moving down the hillslope; they concentrate flow, either on the surface or in an adjacent ditch or channel; and they

divert or reroute water from flow paths that it would take were the road not present (Gucinski et al 2001, Wemple and Jones 2003). Trails can have similar impacts but at a smaller scale. By intercepting surface and subsurface flows and concentrating flows through diversion to ditches, gullies and channels road and trail systems increase the density of streams in the landscape. This changes the time required for water to enter a stream channel and can increase incision and erosion especially in headwater areas. Surface erosion from road and trail surfaces, cut banks and ditches is also an important source of sediment. Surface erosion problems are greatest in highly erodible terrain particularly the westerly facing sandstone/shale and mudstone slopes of the analysis area. When segments of roads and trails approach streams at crossings or parallel streams at distances too small for vegetative buffers to stop sediment from reaching streams the risk of impacts to water quality and beneficial uses increases.

As use levels of roads and trails increase, the risk of impacts to water quality and beneficial uses tend to increase. A number of factors influence the movement of surface and subsurface water, the stability of road and trail segments and the amount of sediment reaching streams. Level of use is only one of these factors. Other important factors considered in published studies include: hillslope length, soil depth and cutbank depth (Wemple and Jones 2003); surfacing with gravel, degradation of the running surface and levels of maintenance (Burroughs et al 1984, Foltz and Burroughs 1990, Swift 1984, Luce and Black 2001); kinds of uses, soil texture, soil moisture, trail slope, landforms, location of trails on landforms, climate, catastrophic events and timing of use (Weaver and Dale 1978, Summer 1986, Godwin 2000, Lanehart 1998, Wilson and Seney 1994, USDA and USDA 2001). An increase in level of use on roads and trails may be an important factor related to stream water quality, but *its measure of importance varies by site.*

Again, *current use levels* on roads and trails in the analysis are not well documented. Impacts from an increase in use levels may have an impact on water quality of streams but a site level of analysis would be needed to determine this. A site level of analysis (segment by segment of road and trail related to an individual segment of a stream) is too detailed for this project but would be applicable to projects that focus on individual trails or roads.

The areas of greatest risk for water quality and beneficial use concerns in this issue are similar to the previous water quality issue. They are where roads and trails are within 100 feet of perennial streams and at stream crossings. Table III-8 Summary of Miles of Roads and Trails Within a 100 Foot Buffer of Perennial Streams by Alternative and Table III-9 Summary of Road and Trail Stream Crossings by Alternative provide a breakdown by kinds of roads and trails for each alternative. Once again, there is very little difference between the Action Alternatives (Alternatives 2-5) and the Existing Condition (Alternative 1) **in the Badger-Two Medicine portion or the southern 2/3 of the analysis area.** Further, there is very little difference between the Action Alternatives.

The Action Alternatives differ in the shift from motorized to non-motorized travel on trails. Alternatives 2, and especially 3, 4 and 5 reduce the miles within the 100 foot stream buffer of trails open to ATVs and motorcycles from the existing situation **(see Table III-8, trail classes 8 and 9).** Even though horse traffic is still included in the trails open to non-motorized travel, the reduction of the impactive mechanized modes of travel

would potentially be important for water quality. Again current use levels of ATVs and motorcycle traffic on these trails under current management is not well documented to know if a reduction in impacts would be real were management changed. *If trails with known moderate or greater levels of ATV and motorcycle traffic* ***were*** *to shift to non-motorized travel with light stock use a reduction of trail impacts and ultimately a reduction of erosion and sedimentation would be possible* *with regular* *trail maintenance*. Alternatives 3 and 5 have the potential for the most improvement to water quality followed by Alternatives 4 and 2 **(see Table III-8).**

2. Cumulative Effects

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

c. Effects Common to All Alternatives

The majority of the landforms comprising the Rocky Mountain Division are steep east facing limestone and dolomite reefs and westerly facing sandstone/shale/mudstone slopes. The hard limestone is relatively resistant to weathering. The sandstone/shale/mudstone parent material weathers to fine-grained sands, silts and clays. The sandstone/shale/mudstone produces both a continual source (low to moderate yield) of upslope sediment and an intermittent source of mass wasting material with high to very high yields.

Recent flood events have played an important role in forming existing channel conditions. Some of the headwater channels are deeply entrenched with scoured banks (Johnson and Omang 1976). Wide, open floodplains with large cobbly/gravelly deposits are typical of the middle and lower portions of mainstem channels. The channels are still adjusting in these open floodplains with common, active meandering along the unstable alluvial banks. Natural stream sediment is due to dry creep (gravitational movement of surface soils), overland flow and mass failures in the upper reaches and in-channel erosion in the lower reaches. In general, *sediment supply exceeds sediment transport capacity* under average flow regimes.

Natural disturbance events will continue to influence hydrologic and erosional 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. Channel adjustments could be expected, especially during years of average or higher precipitation/runoff conditions. Stream systems will stabilize however as vegetative recovery progresses.

Road and trail systems have less of an impact to analysis area soils and water 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. Only activities such as stream crossing construction or replacement or the use of fords by vehicles and stock are considered a direct effect to the water resource. The sediment delivery and flow disruption that occurs with these actions is immediate.

Table III-6, Summary of Roads and Trails within 100 feet of Perennial Streams and Perennial Stream Crossings indicates the *relative* levels of direct and indirect impacts of roads and trails on the water quality of perennial streams in the analysis area organized by 6th code watersheds. The kinds of stream crossings, the gradients of approaches to stream crossings, erodibility of different soils, continuity of vegetative buffers between the roads or trails and streams, impacts to ephemeral and intermittent streams from roads and trails or other factors that influence erosion and sedimentation are not separated in this table so some crossings and some road and trail locations are more of a concern than others. Even so, these indices of measure are useful for comparison at this scale of analysis.

The indirect impacts continue as long as the roads and trails are in place in their current locations. This is because once a trail or road becomes established; the soil of the tread is subject to the continuing erosional forces of rainfall, running water, wind, freeze/thaw cycles, gravity and traffic (Leung and Marion 1996; USDI and USDA 2001, Summer 1986). Further, roads and trails at higher elevations show greater soil loss than those at lower elevations. Higher precipitation rates, longer snowmelt periods, more loose soil from more severe freeze/thaw cycles, and increased exposure to wind all contribute to higher erosion rates. Some considerations such as road and trail design, surfacing of roads and trails, limiting season of use, limiting kinds of use and maintaining water controlling devices (cross drains, water bars, ditches, culverts etc) will lower the risk of erosion and sediment reaching streams, but the impacts and risk exists as long as the roads and trails are in place. The risks and impacts to water resources are lessened or eliminated over time by restoring soil and hydrologic functioning that was lost with construction and use of roads and trails (USDA Forest Service 1999). This may mean relieving soil compaction, grading the disturbance to original contours, establishing permanent drainage, establishing effective vegetation cover and preventing disturbance from unauthorized use.

The current levels of road and trail maintenance are largely based on Forest Service funding and volunteers, especially for trail maintenance. Forest Service funding for maintenance of roads and trails is projected to stay similar to current levels or decrease (Gavrisheff 2004). The current Forest priority list of roads for maintenance is also not likely to change. 10 to 30 percent of the roads in the analysis area have been maintained yearly in the last 5 years (Table III-7). Rutted running surfaces, water control devices that are not functioning and the breakdown and loss of road and trail surfacing (where present) increase the risk of sediment reaching perennial streams (Swift 1984, Foltz and Burroughs 1990, Burroughs et al 1984). Some level of maintenance on approximately 80 percent of trails in the project area yearly (Lang 2004) with Way trails (TC1-Primitive/undeveloped) receiving some maintenance approximately once in three years increases the risk of sediment reaching perennial streams. Trail rutting, erosion, lack of drainage and trail widening have been noted in District files and in comments from the public.

From Tables III-8 and III-9 (Summary of Miles of Roads and Trails Within 100 Foot Buffer of Perennial Streams by Alternative and Summary of Road and Trail Stream Crossing by Alternative) approximately 249.6 to **251.0** miles of roads and trails are within 100 feet of perennial steams depending on alternative. There are approximately **627** to 631 stream crossings by roads and trails depending on alternative. The risk to water quality of perennial streams from roads and trails that are currently receiving no or little maintenance is moderate or greater depending on individual site factors.

The Cumulative Effects as described above 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.

d. Effects Common to All Action Alternatives

The effects common to all Action Alternatives include the effects common to all Alternatives above.

One additional consideration common to all Alternatives but more important to the Action Alternatives is the effect on water quality when the level of use on roads and trails increase. As use levels of roads and trails increase, the risk of impacts to water quality and beneficial uses tend to increase. A number of factors influence the movement of surface and subsurface water, the stability of road and trail segments and the amount of sediment reaching streams. Level of use is only one of these factors. Other important factors considered in published studies include: hillslope length, soil depth and cutbank depth (Wemple and Jones 2003); surfacing with gravel, degradation of the running surface and levels of maintenance (Burroughs et al 1984, Foltz and Burroughs 1990, Swift 1984, Luce and Black 2001); kinds of uses, soil texture, soil moisture, trail slope, landforms, location of trails on landforms, climate, catastrophic events and timing of use (Weaver and Dale 1978, Summer 1986, Godwin 2000, Lanehart 1998, Wilson and Seney 1994, USDA and USDA 2001). An increase in level of use on roads and trails may be an important factor related to stream water quality, but *its measure of importance varies by site.*

Again, *current use levels* on roads and trails in the analysis are not well documented. Impacts from an increase in use levels may have an impact on water quality of streams but a site level of analysis would be needed to determine this. A site level of analysis (segment by segment of road and trail related to an individual segment of a stream) is too detailed for this project but would be applicable to projects that focus on individual trails or roads.

The areas of greatest risk for water quality and beneficial use concerns in this issue are similar to the previous water quality issue. They are where roads and trails are within 100 feet of perennial streams and at stream crossings. Table III-8 Summary of Miles of Roads and Trails Within a 100 Foot Buffer of Perennial Streams by Alternative and Table III-9 Summary of Road and Trail Stream Crossings by Alternative provide a breakdown by kinds of roads and trails for each alternative. Once again, there is very little difference

between the Action Alternatives (Alternatives 2-5) and the Existing Condition (Alternative 1). Further, there is very little difference between the Action Alternatives.

The Action Alternatives differ in the shift from motorized to non-motorized travel on trails. Alternatives 2, and especially 3, 4 and 5 reduce the miles within the 100 foot stream buffer of trails open to ATVs and motorcycles from the existing situation **(see Table III-8, trail classes 8 and 9).** Even though horse traffic is still included in the trails open to non-motorized travel, the reduction of the impactive mechanized modes of travel would potentially be important for water quality. Again current use levels of ATVs and motorcycle traffic on these trails under current management are not well documented to know if a reduction in impacts would be real were management changed. *If trails with known moderate or greater levels of ATV and motorcycle traffic were to shift to non-motorized travel with light stock use a reduction of trail impacts and ultimately a reduction of erosion and sedimentation would be possible with regular trail maintenance.* Alternatives 3 and 5 have the potential for the most improvement to water quality followed by Alternatives 4 and 2 **(see Table III-8).**