CHAPTER 3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This Chapter summarizes the physical, biological, social, and economic environments of the project area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented in the alternatives chapter.

Physical Environment

Hydrology and Soils

Affected Environmet:

Geology

The three main geological units underlying the project area are Tertiary undifferentiated intrusive rocks, the Madison (Pahasapa) Limestone and Englewood Formations, and the Minnelusa Formation.

The Tertiary igneous rocks are found in the southwest portion of the project area. The upper third of the Madison/Englewood is dominated by karst topography. The karst topography consists of large solution or collapse structures, which act as conduits for transporting surface runoff and snowmelt into the groundwater system (Williams, MIS report, 20002, pg. 98). These features have resulted in extensive secondary permeability and have created potentially the most productive aquifer in the Black Hills.

The Whitewood Dolomite, Minnelusa Formation, and the White River Group are the other dominant sedimentary units within the project. The Minnelusa is also another major aquifer, due to the presence of solution collapse structures forming secondary permeability (Stroebel, et. Al, 1999).

Climate and Watersheds

The Black Hills, located near the continents center, has a near perfect semi-arid continental climate, modified by the influences of a mountain climate. Winters are comparatively cold and summers warm (FEIS, 1996, pg. Preface-11). April, May and June have the highest mean precipitation with 3.07, 4.09 and 4.01 inches per month, respectively. The maximum mean temperatures are in July and August at 86.0 and

86.9° F. The coldest month is January with a mean minimum temperature of 12.8 °F. Research indicates that 6-27% of the precipitation is available for stream flow and groundwater recharge is primarily through snowmelt. Water yields are greatest in April, May and June from rain events. Typically precipitation in the northern Black Hills is enough to sustain perennial flow in areas where the underlying geology will maintain surface flow (FEIS, 1996, pg. III-39-41).

Watersheds are defined as an area of land that drains water, sediment and dissolved materials into a common outlet. The U.S. Geological Survey has devised hydrologic unit codes (HUC) that divide the lower contiguous states into regions and assigns numbers to them. These regions are in turn divided into smaller and smaller units, with each unit having their own number or field (Nelson, 2002). For data analysis purposes, the 7th field sub-watersheds were selected. The Elk Bug and Fuels project includes 13 7th level sub-watersheds (See Figure 2). Eight of these watersheds are only partially within the project area, with less than 1% to 70% inclusion within the project area. Four watersheds are completely within the project area. Watershed 20103 has 88% of its area within the project boundary and was considered as entirely within the project area for analysis purposes. Table 29 summarizes this information under cumulative effects.

Elevations range from approximately 3600 feet to 5880 feet. Land-type Associations found within the project area include: Limestone Canyons, Crystalline Hills and Ridges, Moderately Rolling Uplands, North Gently Dipping and Steeply Dipping Plateau Lands, Valley Land, and Volcanic Hills and Ridges. The Limestone Canyon's association has narrow ridges, very steep side-slopes, narrow valley bottoms, and rock outcrops. Side-slopes are typically steeper than 40%. The limestone geology is key in controlling the location and type of streams, and local aquifers, in the Black Hills. Karst topography and solution and collapse structures characterize the Madison Limestone, Englewood, and Minnelusa Formations. These features act as conduits for transmitting surface runoff and snowmelt to groundwater systems.

The Moderately Rolling Uplands Association is characterized by broad ridges, moderately sloping to steep sideslopes, narrow to broad valley bottoms and rock outcrops. Sideslopes are predominantly 15-30 percent. Metamorphic rock typify outcrops. Gently Dipping Plateau Lands have broad and narrow ridges and valley bottoms. Some rock outcrops occur and sideslopes tend to be 15-30% compared to 30-50% for the Steeply Dipping Plateau Lands. Although this land type has broad ridges, valley bottoms are narrow. Rock outcrops are of sandstone, limestone and shale.

[See Figure 2]

Valley lands have gentle sideslopes of 5-20%, broad ridges, and broad valley bottoms. Rock outcrops occur and consist of sandstone, shale, siltstone, and gypsum. Volcanic Hills and Ridge lands have steep to very steep sideslopes ranging from 30-45 percent. Valley bottoms are narrow and rock outcrops can occur. The Crystalline Hills and Ridges Association have narrow ridges and valley bottoms, and slopes ranging from 20-35% slopes. Rock outcrops are present (FEIS, 1996, Appendix K).

A watershed assessment summarizing conditions existing at the time of the development of the Forest Plan FEIS (1996) is located in Appendix J of the 1996 Revised Land Resource Management Plan. Figure III-3 of the FEIS displays the 5th and 6th level HUC's defined at that time. Appendix J (FEIS, 1996) summarizes existing watershed conditions by documenting the Natural Watershed Sensitivity Index, the Impact Index, and Watershed Class.

The Natural Watershed Sensitivity Index (NWSI) was determined by taking the sum of stream buffered areas, high erosion hazard soils, and slopes over 80%, divided by total watershed acreage. Sensitivity indices over 65 indicate that a watershed may be highly sensitive to impacts from management activities. The Impact Index is defined as the sum of management activities within the NWSI areas as modified by observations, divided by the total Natural Watershed Sensitivity acres. Impact Indices over 11 indicate the need for further analyses. Watershed Class compares the NWSI and the Impact Index. Class II watersheds are of moderate concern. Class III watersheds are of high concern and must be managed with care (USDA, 2002, Peak EA, p. 80-81).

Since the completion of the FEIS and the Forest Plan, watershed boundaries have been revised. GIS analysis overlaid "old" and "new" watershed boundaries and determined which 7th level sub-watersheds were related to the 5th level watersheds defined in the FEIS. Analysis for this project is being conducted at the 7th level sub-watershed due to the project's large scale.

Table 11 documents the inter-relationship between the 1996 5th level watersheds and the 2003 7th level sub-watersheds.

Watersheds 90-01 (Alkali Creek), 89-01 (Box Elder Creek), and 87-02 (Bear Butte Creek) are rated as Class II watersheds. Watersheds 88-01, 02, 04 (Elk Creek), 87-01 (Bear Butte Creek) and 86-01 (Whitewood Creek) are rated as Class III watersheds.

These indices and class designations for the 5th level watersheds serve as a general indicator of 7th level HUC or watershed conditions at the time the Forest Plan FEIS was completed. Similar analysis at the 7th level sub-watersheds is not available.

Since the completion of the Forest Plan FEIS and the 1997 Forest Plan, there have been no significant changes in the amount of mining or grazing within the project area (D. Murray, 2003, Personal communication.). Timber harvest activities have continued, including the Veteran Boulder, Kirk, Roubaix, Deadman, and Boxelder timber sales. Specialist reports for each of these sales noted no significant impacts, although effects were discussed. Water yield increases were noted as possible, but not significant, for the Veteran Boulder and Roubaix sales and were not expected for the Kirk, Deadman, and Boxelder sales. Water quality, or soil health, were not expected to be significantly impacted if South Dakota Best Management Practices, Watershed Conservation Practices and Forest Plan Standards and Guidelines were implemented as recommended (Macy, 1996, 1998a, 1998b, 1999). Based on the information in Macy's 1996, 1998a, 1998b, and 1999 reports it is reasonable to assume that there have been no major changes to watershed class within the project area.

Table 1 Summary of Natural Watershed Sensitivity and Impact Indices, and Watershed Class*

Current Watershed Number	1996 Forest Plan Watershed Number	Old Watershed Name	Old watershed # Natural Watershed Sensitivity Index (NWSI)	Old watershed # Impact Index	Old Watershed # Watershed Class
10120202070101	90-01	Alkali Creek	58.85	23.64	II
10120111010103	89-01	Box Elder Creek	37.47	20.62	II
10120111010204	89-01	Box Elder Creek	37.47	20.62	II
10120111010301	89-01	Box Elder Creek	37.47	20.62	II
10120111020102	88-01	Elk Creek	56.83	38.65	III
10120111020103	88-01	Elk Creek	56.83	38.65	III
10120111020104	88-01	Elk Creek	56.83	38.65	III
10120111020305	88-01	Elk Creek	56.83	38.65	III
10120111020301	88-01	Elk Creek	56.83	38.65	III
10120202020105	88-02	Elk Creek	52.84	33.36	III
10120111020201	88-04	Elk Creek	43.23	25.5	III
10120202060102	87-01	Bear Butte Creek	70.12	32.73	III
10120202060103	87-01	Bear Butte Creek	70.12	32.73	III
10120202060104	87-01	Bear Butte Creek	70.12	32.73	III
10120202060105	87-01	Bear Butte Creek	70.12	32.73	III

Current Watershed Number	1996 Forest Plan Watershed Number	Old Watershed Name	Old watershed # Natural Watershed Sensitivity Index (NWSI)	Old watershed # Impact Index	Old Watershed # Watershed Class
10120202060106	87-01	Bear Butte Creek	70.12	32.73	III
10120202060202	87-02	Bear Butte Creek	48.24	16.65	II
10120111010103	86-01	Whitewood Creek	83.5	37.63	III
10120111010204	86-01	Whitewood Creek	83.5	37.63	III
10120111010301	86-01	Whitewood Creek	83.5	37.63	III

*FEIS, 1996, Appendix J

Soils, Erosion, Compaction, Heating, and Nutrient Loss

The dominant soils within the project area are the Citadel, Vanocker Citadel, and Grizzly Virkula soils of Lawrence County, and the Citadel and Vanocker-Citadel Associations of Meade County. Their characteristics are summarized in Table 12 Major Soil Types and Their Characteristics of the Elk Bugs and Fuel Project Area.. Because the soil characteristics varied slightly between counties for the Citadel soil/Citadel Association and the Citadel Vanocker soil/Citadel Vanocker Association, these soils were listed separately in the following table.

Table 2 Major Soil Types and Their Characteristics of the Elk Bugs and Fuel Project Area.

Soil Name	*# Acres in Project Area*	*Slope Range*	*Mass Movement Potential**	*Erosion Potential**	*% Ground Cover Needed to Control Erosion*	*Concerns Related to Road Building***
Citadel	9358	10-30%	Some	Moderate	40-70	1
Vanocker-Citadel	12938	25-60	Some	Moderate To Very High	70-95	1, 2, 3,4
Grizzly-Virkula	5063	25-60	Some	Moderate To Very High	75-90	1, 2, 5
Citadel Association	6542	15-25	High	High	40-70***	6
Vanocker Citadel Association	11756	25-60	High	High	70-95***	6

* when disturbed
** 1: Road slippery when wet;
2: Construction on steep slopes result in long cut and fill and increased erosion
3: Cutslope slumping and road failure may occur after construction;
4: Avoid active landslide and wet seepy areas
5: Cutslope slumping may occur where rock layers are parallel to cutslopes;
6: A decrease in rock fragments may result in spongy roadbed.
7: steep slopes, low shear strength, and high shrink-swell potential
***NRCS, J.Westerman, Personal Communication, 2003

In 2002, the western portion of the project area was involved in the Grizzly Gulch fire. Burn severity relates directly to the effects of fire on soil conditions and hydrologic function, such as soil structure, the amount of surface litter and duff, infiltration rates and runoff response. Soils in the Pee Dee Gulch and Two Bit Gulch areas were moderately burned while soils in the Dome, Bear Den, and Pillar Peak areas experienced high severity burns (Interagency Baer Report, 2002). In areas of high burn severity, the fire consumed all the forest floor litter and duff, leaving no groundcover, and the soils are characterized by hydrophobic, or water repellency.

Although there is a natural degree of water repellency to these soils, it is expected that natural erosion rates will increase due to the hydrophobic soils (Interagency Baer Report, 2002). In Two Bit Gulch the dominant soils are Citadel, Grizzly-Virkula, and Maitland (9-50%). Grizzly-Virkula and Vanocker-Citadel are the major soil types present, while in the Dome/ Bear Den/Pillar Peak areas the principal soils are Grizzly-Virkula and Virkula soils. Erosion rates for these soils, once they have been disturbed, range from low to very high.

Modeling was conducted to estimate pre and post-fire erosion rates, using the modified Revised Universal Soil Loss Equation (RUSLE). The equation has been modified for use on national forests. Modeling projected a six-fold increase in post fire erosion rates for the Two-Bit Gulch area and a four fold increase in the Pee Dee Gulch area relative to existing erosion rates (Interagency Baer Report, 2002). However, monitoring since the fire, in the Dome Mountain, Pillar Peak, and Bear Den Mountain areas, has shown that increased runoff from these sources has been filtered by downslope vegetation and is not affecting the creeks (E. Krueger, 2003, Personal Communication).

Within the project area the other soil types found include: Marshdale-Maitland, Maitland, Nevee, Nevee Spearfish, Paunsauguant with Rock Outcrop, Vanocker with Rock Outcrops, Savo, St. Onge, Tilford, Virkula, Hisega,Vale and Winetti.

Of these soils, Maitland, some Nevee and Vale, Nevee Spearfish, Paunsaugaunt and Vanocker with Rock Outcrop, and Hisega have moderate to very high erosion potentials when disturbed. The sources for these erosion potentials range from the steep slopes associated with the soil, the underlying geology, or from concentration of water in streams, ditches or trails(Lawrence County Soil Survey, 1979). St. Onge, Tilford, Savo, and Winetti soils have low erosion potentials that are associated with their position in valley bottoms and lowlands.

The Lawrence County soil survey did not document any mass movement locations in their soil surveys but they did note their existence (NRCS, 1979 and 1978). Mass movement potential by soil type is documented in the 1979 Lawrence County Soil Survey and is summarized in Table 13. Although the Meade County Survey did not address mass movement potential in describing soil characteristics, erosive potential was noted. Based on the similarity in erosive characteristics for these soil types between counties, and discussions with NRCS personnel, it is assumed that the mass movement potential for Vanocker/Citadel and Citadel Association is the same as in Lawrence County.

All soils, except the Citadel Soil (Lawrence Co.)/Citadel Association (Meade Co), are typically found on slopes of 25-60% or somewhere near these percentages. For Grizzly-Virkula and Hisega soils the mass movement potential appears to be related to the underlying geology. When underlying rock layers are parallel to topography, the layering in the rock acts as a conduit for water infiltrating into the subsurface, facilitating slope failure. This geological influence and the associated slope gradients of 25-60% increase the potential for soil erosion, the slumping of cut slopes associated with roads, and landslides.

All soils listed in Table 13 have moderate to very high erosion potentials, when disturbed. This means that if slope failure occurs, associated soils will be even more susceptible to erosion.

Citadel soils in Lawrence County are classified as having “some” mass movement potential, but slopes range from only 10-30%. Wet seepy areas and old landslides (although none were noted during NRCS mapping) were documented as having some potential (NRCS 1979). NRCS 1979 suggests that old landslides may be present in Maitland soils but none were noted during mapping. Citadel soils are moderately to highly susceptible to erosion once disturbed while Maitland soils range from moderately to very highly susceptible to erosion once disturbed (NRCS, 1979). Soil distribution is summarized as Map 2, and is located in Section C.1.1 of the Project File.

Table 14 lists by watershed, the acreage for the soils listed in Table 13, and the amount of road mileage on that soil type.

Table 3 Soils with Mass Movement Potential

	Vanocker-Citadel/Vanocker Citadel Assoc. (VBF/VaE)	Citadel/Citadel Association (CBE/ CtE)*	Grizzly-Virkula (GBE)	Hisega (HBF)	Maitland (MaD)	Vanocker w/ Rock Outcrop (RCF)
Slope Range %	25-60	10-30	25-60	25-60	9-50	30-75
Mass Movement Potential	Some	Some potential	Some potential where rock layers are parallel to slope	Some potential where rock layers are parallel to slope	Some potential	Some
Erosion Potential-when disturbed	M-VH	M-H	M-VH	M-VH	M-VH	H to VH
Road Related Slope Stability Concerns	1, 3, 4**	5	1, 2	1, 2	5	4, 3

*CBE/CtE: where one soil has two abbreviations this denotes a name change between Lawrence and Meade Counties. The code for Lawrence County is listed first.

** Definitions for road related slope stability concerns are:

1.Construction on steep slopes result in long cut and fill slopes, which increase soil erosion
2.Cutslope slumping when rock layers are parallel to the slope
3.Landslide areas may be present as well as wet and seepy areas.
4.Cut-slope slumping and road failure may occur after road construction on steep slopes
5.No mass wasting concerns noted other than Erosion Potential Rating
6. Rockslides may be present

Table 4 Soils with Mass Movement Potential, Their Acreage, and Number of Road Miles on Each Soil Type

Watershed Number	Soil Type	Acreage	Road Miles
10120202070101	Citadel Association	232	0
10120202060202	Citadel Soil	437	4.18
10120202060106	Vanocker-Citadel Association	3302	10.86
	Citadel Soil	1239	11.24
10120202060105	Vanocker-Citadel	645	2.3
	Vanocker-Citadel Association	109	0.42
	Vanocker With Rock Outcrop	185	0.94
	Citadel Association	268	91.58
	Citadel Soil	967	9.08
10120202060104	Vanocker-Citadel	2338	11.88
	Grizzly-Virkula	3031	6.64
	Maitland (9-50%)	367	2.52
	Citadel Soil	1532	12.13
10120202060103	Vanocker-Citadel	2319	18.65
	Grizzly-Virkula	1088	6.35
	Citadel Association	337	3.05
	Citadel Soil	1128	10.60
10120202060102	Vanocker-Citadel	3365	15.61
	Hisega	248	2.12
	Grizzly-Virkula	834	4.53
	Citadel Association	36	0.34
	Citadel Soil	2051	21.67
10120202020105	Vanocker-Citadel	3389	14.85
	Vanocker With Rock Outcrop	7112	2.09
	Grizzly-Virkula	98	0.77
	Citadel Soil	1599	11.57
10120111020305	Citadel Association	278	3.94
10120111020301	Citadel Association	20	0.31
10120111020104	Vanocker-Citadel	32	0.36
	Citadel Association	1074	10.6
10120111020103	Vanocker-Citadel	508	3.21
	Hisega	1	0.1
	Citadel Association	2512	23.86
	Citadel Soil	651	5.14
10120111020102	Vanocker-Citadel	987	3.62
	Hisega	2202	10.54
	Grizzly-Virkula	12	0.27
	Citadel Association	546	4.75
	Citadel Soil	993	11.37

Although Citadel/Citadel Association and Maitland soils are noted as having mass movement potential the only road concerns noted in the Lawrence County Survey was that roads through these soil types may be slippery when wet. Table 15 below summarizes soils characteristics related to potential road concerns.

Table 5 Soils Characteristics Related to Potential Road Concerns

Soil Type	Road Concern
Grizzly-Virkula (GBE)	• Without gravel, roads are slippery when wet • Steeper slopes may have increased erosion on long cut and fills • Cutslope slumping when rock parallel to slope
Hisega (HBF)	• Fractured bedrock 1.5-3 ft and outcrops present construction problems • Some slumping of cut-slopes may occur where rock layers parallel cut-slopes • May include spongy areas which have few rock fragments.
Maitland (MaD)	• Old landslides may be present • Avoid activities on active slides and wet seepy areas
Vanocker w/ Rock Outcrop (RCF)	• Steep slopes and rock outcrops present construction problems • Large boulders present in association with outcrops • Some slumping of cut-slopes may occur where rock layers parallel cut-slopes • Landslide areas may be present as well as wet and seepy areas. • Clay soils components will need gravelling
Vanocker Citadel (VBF/VaE)	• Steep slopes present construction problems. Construction on steep slopes result in long cut and fill slopes, which increase soil erosion • Citadel components will require gravelling • Cut-slope slumping and road failure may occur after road construction on steep slopes • Landslide areas may be present as well as wet and seepy areas.

Stream Flow Regimes

Flow regimes within the project area range from ephemeral to intermittent to perennial. Ephemeral reaches are typically dry, grassy or timbered swales that carry water infrequently and during intense runoff-events. They typically do not have any evidence of recent flow, their channels are not defined, and there is a lack of channel scour, which exposes gravel and or sandy substrates (Tangenberg, 2003, pg. 3; South Dakota Forestry BMPs-Best Management Practices, updated, pg. 18).

Flow regimes are highly influenced by both climate and the underlying geology. Base flow of most streams in the Black Hills begins in the higher elevations where there is more precipitation relative to evapotranspiration. However, base flow of streams often can't be maintained where streams cross the Madison/Englewood and Minnulusa Formations. As a result, the large numbers of intermittent streams within the project area are formed. Even large streams which are considered "perennial" in nature include intermittent reaches were base flow can't be sustained due to the secondary permeability found within the Madison/Englewood and Minnulusa formations. Perennial streams within the study area include: Elk, Bear Butte, Boulder, Meadow and Park creeks.

As surface water and groundwater are intimately connected in the Black Hills, both aquifers are highly susceptible to contamination due the large amount of secondary permeability and recharge related to surface waters (FEIS, 1996, pg. 111-37, Driscoll, et. al, 2002, pg. 60). The most damaging floods in the Black Hills are related to severe spring and summer thunderstorms. Typically, snowmelt is not a significant factor in affecting storm runoff. However, during April, May, and June, soils moisture conditions are typically high as this is when the majority of precipitation is received (See Climate and Watershed section).

Water Quality

Water quality refers to the physical, chemical and biological components of a given stream and its assigned beneficial uses. In 1972 the Federal Water Pollution Control Act Amendment of 1972 was passed. This act, more commonly known as the Clean Water Act (CWA), regulates the discharges of pollutants into the waters of the United States and was intended to maintain and restore the chemical, physical, and biological integrity of the Nation's waters. Waters of the US include perennial and intermittent streams (R2 WCHB, pg. 4 of 4; www.epa.gov/region5/water/cwa.htm).

Section 305(b) of the CWA also requires the establishment and implementation of water quality standards and criteria. It also requires each state to conduct water quality surveys to determine a water body's overall health, including whether or not basic uses are being met. States, tribes, and other jurisdictions define appropriate uses for a waterbody and incorporate these uses into water quality standards that are approved by the Environmental Protection Agency (EPA). Water body uses include aquatic life protection, fish and shellfish production, drinking water supply, swimming, boating, fishing, and agricultural irrigation, among others (http://www.epa.gov/unix0008/water/305b/305what.html).

South Dakota has assigned a minimum beneficial use of wildlife propagation, stock water and irrigation to all streams. Page III-72, 1996 Forest Plan FEIS defines South Dakota stream classes and beneficial uses as follows:
•Class 1s-domestic water supply
•Class 2s-coldwater permanent fish life propagation waters
•Class 3s-Coldwater marginal fish life propagation waters
•Class 7s-Immersion recreation waters
•Class 8s-Limited contact recreation waters
•Class 9s-Wildlife propagation/stock watering/irrigation (rec)
•Class 10s-irrigation

Section 313 of the CWA requires the Forest Service to comply with water quality laws and rules, coordinate actions that affect water quality with the States, and control nonpoint-source pollution. Sections 208, 303, and 319 require the Forest Service to apply Best Management Practices (BMPs), considering local factors, to control nonpoint-source pollution and meet water quality standards (R2 WCPHB, 1999).

Table 16 documents designated Stream Class and Beneficial Uses within the project area. The table includes the names of streams in the study area for which data was available.

Table 6 Summary of Beneficial Uses for Designated Stream Segments Within the Project Area

Name	Designated Stream Segment	Beneficial Use Stream Class
Alkali Creek	From Interstate 90 to S4, T4N, R5E of the Black Hills Meridian	1, 3, 8, 9 and 10
Bear Butte Creek	S 2 T4N, R4E	2, 8, 9, and 10s
Boulder Creek	From Bear Butte Creek to Two Bit Creek	3s, 8s, 9s and 10s
Two Bit Creek	From Boulder Creek To S30, T5N, R4E	3s, 8s, 9s and 10s
Park Creek	From Bear Butte Creek To S11, T4N, R4E	3s, 8s, 9s and 10s
Vanocker Creek	From Bear Butte Creek To S32, T5N, R5E	3s, 8s, 9s and 10s
Meadow Creek	From Elk Creek To S25, T4N, R4E	3s, 8s, 9s and 10s

Table 17 summarizes streams with known beneficial uses flowing through the project area, but do not have designated stream reaches within the project area. The beneficial uses for these streams are provided for informational purposes. The beneficial uses for stream segments, within the proposed project area and downstream, were determined from the State of South Dakota's Surface Water Quality Standards, Chapter 74:51:03.

Table 7 Summary of Beneficial Uses for Streams Crossing Through the Project Area, But Without Designated Stream Segments

Elk Creek	2s, 7s, 8s, 9s
Whitewood Creek	2s, 7s, 8s, 9s*, 10s*

* The asterisked designations for Class 9s and 10s denote a difference between the Forest Plan and the State of South Dakota. The Forest Plan defines Class 9s as wildlife propagation/stock watering/irrigation. The State defines Class 9s as Fish/Wildlife propagation/recreation/stock and places irrigation in Class 10s.

The EPA requires states to enforce water quality standards for surface waters and provide a report to the EPA every two years. Section 305(b) of the report documents those water bodies that are not meeting water quality criteria. Section 303 (d) requires states to identify waters for which effluent limitations are not stringent enough to meet water quality standards (http://www.state.ma.us/mgis/mgic/10_00/dallaire/sld008.htm). For 2002, no streams within the project area were placed the 305(b) or 303(d) list.

Although the state does not have a monitoring site on Elk Creek, the Forest monitored water quality on the creek from 1982 through 1996. Violations of state water quality criteria for water temperature, pH, and total suspended solids occurred intermittently (FEIS, 1996, III-82).

Water-Road Interactions, Sediment and Connected Disturbed Areas

A full inventory and discussion of existing road conditions within the project area can be found in the Roads Analysis Report located in Section D of the Project File.

Existing overall road densities are summarized below in Table 18. The densities were calculated by dividing the total number of road miles, for Forest Service and other roads, by the total acreage within the watershed.

Table 8 Existing Overall Road Densities for Portions of Watersheds Located Within the Project Area

Watershed Number	*Road Density (mi./sq. mi)*
10120111020102	3.5
10120111020103	3.6
10120111020104	3.4
10120111020301	9.7
10120111020305	3.7
10120202020105	2.7
10120202060102	3.7
10120202060103	4.6
10120202060104	2.2
10120202060105	4.7
10120202060106	2.4
10120202060202	4.5
10120202070101	0.6

Watersheds highlighted in gray are located entirely within the project area. As a result, the overall road densities reflect the existing condition for the entire watershed. Road densities for these watersheds range from 2.2 - 4.6 mi./sq. mi. Watersheds that are not highlighted only have part of their area located within the project boundary. For these watersheds the road densities are a function of the amount of area, for that watershed, located within the project boundary. It should be noted that 26 acres of Watershed 101202111020301 is located within the project area boundary. This portion of the watershed is not in the Beaver Park roadless area.

The location of roads, relative to streams is especially important, as they are the single largest source and delivery system of sediment to channels (FEIS, 1996, pg. III-73). Roads intercept both surface and ground water. Waters running down and off road surfaces can enter directly into a creek or through associated road ditches emptying into streams. Roads result in lower infiltration rates and can affect groundwater when they are located near springs (Tangenberg, 2002). These factors can result in increased sediment delivery to streams as well as higher peak flows and accelerated timing of peak flows (Tangenberg, 2002, Nelson, 2002).

Accurately monitoring and estimating the amounts of sediment delivery is very difficult due to the large number of variables involved. As a result, the affected environment will be discussed in terms of potential sediment sources. A distance of 300 ft was selected to ensure that the effect of all potential runoff was evaluated (Nelson, 2002). Preliminary GIS analysis determined that portions of approximately 413 roads were within 300 ft of streams in the project area. A list of these roads is found in the roads analysis report, Section D of the Project File.

Road density (miles of road/square mile) within 300 ft of streams provides a relative measure of road-stream interaction and the relative risk for increases flows and sediment input into the hydrologic system. It also allows comparison between watersheds within the project area. Areas with higher road densities within 300 ft of streams are at greater risk for modification of flow and sediment loading.

Table 19 displays road densities, by ownership, within 300 ft of streams. The row designated “NFS” shows Forest Service roads while “Other” indicates road densities for roads in other than Forest Service ownership. Watersheds highlighted in gray are located entirely within the project area and the stated road densities reflect existing conditions in the entire watershed. Forest Service road densities were calculated by totaling the miles of Forest Service road divided by the number of acres of Forest Service land within 300 ft of streams. Road densities for the “Other” category was calculated by dividing the number of miles of non-Forest Service roads was divided by the number of acres of non-forest service land.

Table 9 Summary of Road Densities within 300 ft of Streams, By Ownership and Watershed Number (# Miles/Sq. Miles)

Watershed #	NFS	Other
10120111020102	4.7	1.2
10120111020103	4.1	5.1
10120111020104	2.2	3.5
10120111020301	0	0
10120111020305	4.2	3.4
10120202020105	3.8	2.9
10120202060102	6.6	2.7
10120202060103	6.4	6.6
10120202060104	3.1	1.9
10120202060105	3.4	6.0
10120202060106	3.4	4.1
10120202060202	6.9	13.8
10120202070101	0.2	2.0

For watersheds located entirely within the project area, Forest Service road densities within 300 ft of streams, ranges from a low of 3.1 mi/sq. mi (watershed 10120202060104) to a high of 6.6 mi/sq. mi (watershed 10120202060102). Watersheds 10120202060102 and 60103 have the largest potential for road influence on hydrology and sediment due to their densities of 6.6 and 6.4 mi/sq. mi. respectively. This is due to not only the higher number of road miles but also to the predominant road surface type. The majority of the roads found in the project area are surfaced naturally or with aggregate. Both these surface types have higher potential for contributing sediment via surface runoff than pavement. Watershed 10120111060104 has the lowest road densities and the lowest relative measure of road-stream interaction. Road densities on “Other” lands range from 1.2-6.6 mi./sq. mi.

For watersheds located partially within the project area, Forest Service road densities range from 0-6.9 mi./sq. mi while on "Other" land the road densities range from 0 to 13.8 mi/sq. mile. Watershed 10120202060202 has a very high road density within 300 ft of streams, however, only a small portion of that watershed is located within the project area. Watershed 10120111020301 also has only a very small portion located within the project area. Typically "Other" road densities are less than Forest Service riparian road densities, which is a function of land ownership.
Connected Disturbed Areas (CDAs) are included as potential sediment sources associated with roads. Existing CDAs were mapped during the 2002 field season. CDAs occur where roads contribute water and sediment directly to streams through surface erosion (Ohlander, 1998). More information on CDAs, and on the influence roads have on project area hydrology, can be found in the Roads Analysis Report located in Section D of the Project File.

Riparian Areas and Wetlands

The term, "wetlands" is generic, referring to areas that are not totally terrestrial or fully aquatic. Wetlands classification is based on the source type of the water for the area and includes precipitation, ground water and surface water dominated systems. Surface water dominated wetlands are referred to as riparian systems (http://h20sparc.wq.ncsu.edu./info/wetlands/types3.html). Riparian areas adjacent to streams were identified by analysis of the Forest Service's GIS riparian layer. Wetlands within the project area were evaluated using maps obtained from the U.S. Fish and Wildlife Service (USFWS).

Roads located within riparian areas have the potential to compact soils, increase erosion, introduce sediment, affect surface and subsurface water relationships, and modify flood protection function. Table 20 summarizes road densities within the riparian zone.

Table 10 Summary of Road Densities within the Riparian Zone, By Ownership and Watershed Number (mi/sq. miles)

Watershed #	NFS	Other
10120111020102	4.1	1.6
10120111020103	6.3	8.9
10120111020104	2.1	2.3
10120111020301	0	0
10120111020305	6.8	6.0
10120202020105	5.5	3.9
10120202060102	6.3	2.7
10120202060103	12.6	5.0
10120202060104	4.2	0.6
10120202060105	3.8	6.8
10120202060106	5.6	6.6
10120202060202	4.9	21.6
10120202070101	0	4.3

Watersheds highlighted in gray are located entirely within the project area and the road densities reflect riparian zone road densities for the entire watershed. For watersheds located completely within the project area boundary, Forest Service riparian road densities range from 4.1 – 12.6 mi./sq. mile. Watershed 10120202060103 has the highest road density of 12.6 mi./sq. mile. All the other watersheds, except for 10120111020104, have similar road densities ranging from 4.1-6.8 mi./sq. mile. Road densities range from 1.6 – 8.9 mi./sq. mile on non-Forest Service land within the project area.

Watersheds with only a portion of their area located within the project have densities ranging from 0 – 21.6 mi./sq. mile. Watersheds 10120111020301 and 10120202060202 have only small portions of their area within project boundary. The densities of "0" and 21.6 mi./sq. mile do not reflect road densities within the riparian zone for the entire watershed, but are the road densities for the small portions of the watershed within the project area (See Table 20).

Table 21 summarizes roads that are currently located in or adjacent to wetlands as mapped by the Fish and Wildlife Service in 1995. All but one of the wetlands are related to road activity or construction of stock ponds as defined in the USFWS codes, which are explained following Table 21.

Table 11 Summary of Roads Affecting Wetlands Mapped By US Fish and Wildlife, 1995 (USFWS, 1995)

Watershed Number	Road	Wetland Type
10120111020102		
	575.1B	PEMCh*
	Unauthorized and Unnumbered	PEMCh and PABFh
	CO 044	PEMCh
10120111020103		
	Unauthorized and Unnumbered	PABFh
	FH 26	PABFh
10120202060102		
	Unauthorized and Unnumbered	PABFh
	180.1	PABFh
10120202060105	US Highway 14A	PABFh and PSSA

*Definitions are from the USFWS Wetlands Definition Key.
U: uplands
PEMCh: Palustrine, emergent, seasonally flooded, diked/impounded
PABFh: Palustrine, aquatic bed, semi-permanently flooded, diked/impounded
PSSA: Palustrine, scrub, shrub, temporarily flooded

Channel Morphology

Streams represent systems that are complex and dynamic. The channel morphology, including streambed and streambank stability, reflects the existing balance between streamflow, sediment input, and substrate/bank composition (Macy, 1996a).
As one component of this triad varies a corresponding change results in the other two. As a result, changes in channel morphology (shape), stability and changes in the streambed or streambank are often seen, especially over time. Increases in peak flow increases the energy available for sediment transport and bank erosion. Increases in sediment input result in a decrease of energy available for erosion, deposition of sediment, channel widening and a decrease in bankfull depth (Macy 1996a).

Within the analysis area, the majority of drainages are either ephemeral or intermittent. Ephemeral channels typically appeared stable and vegetated and were defined by a swale type morphology. No evidence of flow was observed (Fryxell, 2002). Intermittent channels observed in the area exhibited bank incision. Streambeds showed evidence of recent flow and a variety of substrate sizes.

Perennial streams within the project area include: Elk Creek, Bear Butte Creek, Boulder Creek, Meadow and Park Creek. These streams show evidence of erosion and deposition, as indicated by bank scour and deposition. Field verification of stream reaches within the Kirk, and Boxelder, and the Veteran Boulder timber sales documented stream reaches as 90% or more stable or mostly stable (Macy, 1996b, 1998a, 1998b).
Along with the influences of road construction and maintenance issues, major channel modifications are related to periods of high run-off that is associated with severe spring and summer thunderstorms, rain on snow events, and long lasting intense storms (FEIS, 1996, III-64). April, May and June have the highest mean precipitation with 3.07, 4.09 and 4.01 inches per month, respectively.

Floodplains

Floodplains within the project are most affected by roads and their location with respect to the individual drainages. Flood plain dynamics, channel migration, flow volumes and velocities can be modified when roads are located within a channels flood plain, especially when channel locations have been modified to accommodate road placement. As a result of road placement within floodplains, the ability of channel to migrate, change flow volumes and modify its channel morphology is altered. Roads also affect the ability of a system to distribute floodwaters.

Table 22 lists major streams with modified physical channel dynamics.

Table 12 List of Streams with Modified and/or Isolated Floodplains

Road Number	Stream (Name if Available)	Type of Modification
699.1	Sandy Creek	Road in drainage bottom; Road surface erosion and ditches emptying directly into creek adding to channel sediment load; Channel straightened and prevented from channel migration, some "rip-rap" like lining of channel.
US 14 A	Boulder Creek	Road in drainage bottom, restricts lateral migration, channel rip-rapped and straightened
FH 26	Meadow Creek	Floodplain isolation and disruption
FH 26	Big Elk Creek	Floodplain isolation and disruption
170.2	Vanocker Creek	Road crosses creek multiple times; Closely parallels creek. Channel moved around to fit in road. Road side cast functioning as riparian on one bank.
180.1	Park Creek	Floodplain Disruption
135.2C	Unnamed	Road has intercepted channel floodplain; Road surface erosion adding sediment to floodplain
536.1	Elk Creek	Initial crossing causing accelerated erosion on downstream outerbank, ruts, sediment from road into creek

Map evaluation indicates that the following non-system roads cross drainages multiple times or appear to be located within drainage bottoms and would likely affect sediment transport, channel migration, floodplain integrity, and may modify flows. These roads are summarized below in Table 23.

Table 13 Roads Crossing Streams Multiple Times or Located in Drainage Bottoms

U030030	U080042B
U040012	U080046
U040040A	U080049
U070021C	U080059A
U070012B	U080059C
U070024	U080059D
U070037	U080071
U070066	U080088
U080014A	U080127
U080015	U080155
U080017	U080117
U080017A	U080118
U080018	U090004
U080019B	U090005

Other Activities within the Project Area Influencing Hydrology

Grazing and mining have been historical activities within the project area. With the project area are four active grazing allotments and four inactive allotments. The four active allotments are the Bear Butte, Runkle, Elk, and Crook Mountain Allotments (Smith, 2003).

Bear Butte Allotment is mostly within Elk Creek, with minor portions in the Virkula drainage. Major drainages within the Runkle Allotment are Elk Creek, Meadow Creek, Dry Elk, and Virkula. Other drainages are included in the allotment, but are outside the project area. The portion of the Elk Allotment, which is within the project area, is found in the Little Elk and Elk Creek drainages. Whitewood Creek and Sandy Creek are the major drainages in the Crook Mountain allotment. All of the allotments include riparian zones associated with these streams and various cold water fisheries are also present (Smith, Tom, 2003a, 2003b).

Grazing improvements included water developments, cattle guards, and fencing for the Runkle, Elk, and Crook Mountain allotments (Smith, Tom, 2003b).

Historically there has been mining within the project area. Currently there are no active mines within the project area on FS land and there are no abandoned mines that have any issues associated with them on the forest. There are three mines on private property with associated issues (D. Murray, 2003, Personal Communication). The Guilt Edge mine is located just outside of the project boundary and has resulted in Strawberry Creek being on both the 305(b) and 303(d) lists. Water quality analytes of concern are metals, conductivity, salinity, total dissolved solids, and total suspended solids (State of South Dakota, Dept. of Environment and Natural Resources, 2002a, 20002b). The mine is a superfund site and cleanup is ongoing. The junction between Strawberry Creek and Bear Butte Creek is located at the project boundary.

Double rainbow mine on Bear Butte Creek is located one mile before Galena. There have been problems associated with acid rock drainage, due to mine tailings located on a spring. Clean up has been done and inspections to determine compliance will be done in the near future. Elk Creek has some minor problems associated with arsenic levels related to the Uncle Sam mine, near the old town of Roubaix. These levels are minor and active clean up is not being pursued at this time.

Environmental Consequences:

Direct and Indirect Effects

Table 24 summarizes, by alternative, the number of acres of soils proposed for treatment which have mass movement potential and moderate to very high erosion potentials, once the soils have been disturbed (NRCS, 1979). Soils included as having mass movement potential are: the Citadel/Citadel Association, Grizzly-Virkula, Hisega, Vanocker Rock Outcrop, and the Vanocker-Citadel/Vanocker-Citadel, and Maitland (9-50% slopes). These soils also have moderate to very high erosion potential, once they are disturbed, as well as the Nevee (6-9% slopes), Nevee-Spearfish and Paunsaugaunt Rock Outcrop soils (NRCS, 1978, 1979). Although these soils comprise a high percentage of the project area, several limitations should be noted. Soil survey maps have been done at a broad scale and detail is limited.

Other soils listed in the affected environment, and not listed here, do not have mass movement potential or the moderate to very high erosion potential once they are disturbed. The total number of acres proposed for commercial thinning and fuel breaks was calculated by adding together all the acreages where these two prescriptions were either the sole method prescribed or were used in combination with another method. The total acreage for the prescribed burns was calculated the same way. The table summarizing acreage totals for each type of individual prescription is found in Appendix D.

Table 14 Soil Effects and Treatments Summary Table

Watershed #	# Acres of Soil With Mass Movement Potential Within the Project Area	# Acres of Soil With Moderate To Very High Erosion Potential Within the Project Area	Total Number of Acres Proposed for Treatment	Total Number of Acres Where Commercial Thinning and Fuel Breaks are Included in the Prescription	Total Number of Acres Where Prescribed Burning is Included in the Prescription
Alternative 1					
10120111020102	5118	6634.9	0	0	0
10120111020103	7457	7457	0	0	0
10120111020104	4431.7	4601.2	0	0	0
10120111020301	2379	0	0	0	0
10120111020305	4583.4	4583.4	0	0	0
10120202020105	5797.9	5797.9	0	0	0
10120202060102	7087.3	7087.3	0	0	0
10120202060103	5038.1	5050.3	0	0	0
10120202060104	4170.5	4538.1	0	0	0
10120202060105	2173.6	3131	0	0	0
10120202060106	4845.4	4845.4	0	0	0
10120202060202	444.5	696.6	0	0	0
10120202070101	1640	0	0	0	0
TOTAL ACRES	**55,167**	**54,422**	**0**	**0**	**0**

Alternative 2					
Watershed #	# Acres of Soil With Mass Movement Potential Involved in Proposed Treatments	# Acres of Soil With Moderate To Very High Erosion Potential Involved in Proposed Treatments	Total Number of Acres Proposed for Treatment	Total Number of Acres Where Commercial Thinning and Fuel Breaks are Included in the Prescription	Total Number of Acres Where Prescribed Burning are Included in the Prescription
10120111020102	2093	2781	3049	2389	58
10120111020103	1107	1107	1205	811	12
10120111020104	1206	1207	1600	321	225
10120111020301	0	0	0	0	0
10120111020305	46	46	315	307	0
10120202020105	1169	1169	1168	1051	26
10120202060102	817	817	979	863	0
10120202060103	481	481	541	437	0
10120202060104	420	420	482	454	0
10120202060105	253	394	394	328	18
10120202060106	635	635	635	468	0
10120202060202	0	0	0	0	0
10120202070101	19	19	19	0	0
TOTAL ACRES	**8246**	**9076**	**10387**	**7429**	**339**

Watershed #	# Acres of Soil With Mass Movement Potential Involved in Proposed Treatments	# Acres of Soil With Moderate To Very High Erosion Potential Involved in Proposed Treatments	Total Number of Acres Proposed for Treatment	Total Number of Acres Where Commercial Thinning and Fuel Breaks are Included in the Prescription	Total Number of Acres Where Prescribed Burning are Included in the Prescription
Alternative 3					
10120111020102	1439	1962	2172	1279	1151
10120111020103	1391	1391	1518	735	619
10120111020104	1131	1131	1533	385	761
10120111020301	0	0	0	0	0
10120111020305	38	38	312	306	228
10120202020105	869	869	865	686	421
10120202060102	1120	1120	1223	767	740
10120202060103	1042	1042	1068	819	458
10120202060104	460	460	457	418	2
10120202060105	262	263	259	228	81
10120202060106	943	943	995	441	408
10120202060202	33	119	126	8	32
10120202070101	80	80	76	0	61
TOTAL ACRES	**8808**	**9418**	**10604**	**6072**	**4962**
Alternative 4					
10120111020102	2452	3167	3444	2501	936
10120111020103	1331	1331	1449	851	280
10120111020104	1246	1247	1657	321	1331
10120111020301	0	0	0	0	0
10120111020305	46	46	315	307	247
10120202020105	1205	1205	1205	1087	114
10120202060102	824	824	986	863	8
10120202060103	503	503	563	437	0
10120202060104	420	420	482	454	0
10120202060105	287	429	429	363	44
10120202060106	704	704	705	485	0
10120202060202	0	0	0	0	0
10120202070101	19	19	19	0	0
TOTAL ACRES	**9037**	**9895**	**11254**	**7669**	**2960**

Table 25 summarizes existing road densities and how road densities will change for each action alternative. Numbers in the “Overall Road Densities By Alternative” reflect the road densities that would result from the construction and decommissioning of roads under each alternative. The road densities within riparian zones and within 300 ft of streams, for each of the action alternatives, have been calculated in the same way.

Soils in Table 25, designated as MVHEP, are defined as those having moderate to very high erosion potential, once they have been disturbed.

Table 15 Summary of Existing and Alternative Road Densities

Watershed #	Miles of Proposed New Road	Miles of Proposed Decom Road	Existing Overall Road Density	Overall Road Density By Ale	Existing Total # of Miles of Road on Soils With MVHEP By Alt	# Of New Miles of Proposed Road on Soils With MVHEP By Alt	Existing FS Road Density W/in 300 ft of Streams	FS Road Density W/in 300 ft of Streams By Alt	Existing FS Road Density W/in Riparian	Road Density W/in Riparian By Alt
Alternative 1										
10120111020102	0	0	3.5	3.5	32.4	0	4.7	4.7	4.1	4.1
10120111020103	0	0	3.6	3.6	33.9	0	4.1	4.1	6.3	6.3
10120111020104	0	0	3.4	3.4	19.7	0	2.2	2.2	2.1	2.1
10120111020301	0	0	9.7	9.7	0	0	0	0	0	0
10120111020305	0	0	3.7	3.7	4.2	0	4.2	4.2	6.8	6.8
10120202020105	0	0	2.7	2.7	17.5	0	3.8	3.8	5.5	5.5
10120202060102	0	0	3.7	3.7	34.3	0	6.6	6.6	6.3	6.3
10120202060103	0	0	4.6	4.6	32.1	0	6.4	6.4	12.6	12.6
10120202060104	0	0	2.2	2.2	14.6	0	3.1	3.1	4.2	4.2
10120202060105	0	0	4.7	4.7	10.6	0	3.4	3.4	3.8	3.8
10120202060106	0	0	2.4	2.4	16.4	0	3.4	3.4	5.6	5.6
10120202060202	0	0	4.5	4.5	3.0	0	6.9	6.9	4.9	4.9
10120202070101	0	0	0.6	0.6	0.3	0	0.2	0.2	0	0
Alternative 2										
10120111020102	4.0	10.8	3.5	3.0	32.4	2.7	4.7	4.0	4.1	2.7
10120111020103	1	6.3	3.6	3.2	33.9	0.6	4.1	3.6	6.3	5.5
10120111020104	0	10.6	3.4	2.21	19.7	0	2.2	1.0	2.1	1.1
10120111020301	0	0	9.7	9.71	0	0	0	0	0	6.8
10120111020305	0	2.8	3.7	2.6	4.2	0	4.2	3.8	6.8	0
10120202020105	5.4	1.9	2.7	3.1	17.5	5.4	3.8	3.8	5.5	4.5
10120202060102	2.2	8.4	3.7	3.2	34.3	2.2	6.6	5.4	6.3	5.1
10120202060103	0.7	13.4	4.6	3.3	32.1	0.6	6.4	3.9	12.6	8.0
10120202060104	1.7	3.1	2.2	2.1	14.6	1.3	3.1	3.2	4.2	4.5
10120202060105	0.5	1.9	4.7	4.5	10.6	0.4	3.4	3.6	3.8	3.7
10120202060106	0.7	1.0	2.4	2.4	16.4	0.7	3.4	3.3	5.6	5.3
10120202060202	0	0.5	4.5	4.1	3.0	0	6.9	6.2	4.9	4.8
10120202070101	0	0	0.6	0.6	0.3	0	0.2	0.2	0	0
Alternative 3										
10120111020102	2.4	10.8	3.5	2.9	32.4	1.9	4.7	3.9	4.1	2.7
10120111020103	0.6	6.3	3.6	3.1	33.9	0.4	4.1	3.2	6.3	5.3
10120111020104	0.9	10.8	3.4	2.5	19.7	0.8	2.2	1.0	2.1	1.1
10120111020301	0	0	9.7	9.7	0	0	0	0	0	0
10120111020305	0	2.8	3.7	2.3	4.2	0	4.2	3.4	6.8	4.7
10120202020105	3.4	1.7	2.7	2.9	17.5	3.4	3.8	3.7	5.5	4.5
10120202060102	1.3	8.7	3.7	3.2	34.3	1.2	6.6	5.2	6.3	4.8
10120202060103	1.1	13.4	4.6	3.3	32.1	1.0	6.4	3.8	12.6	7.9
10120202060104	0.7	4.1	2.2	2.0	14.6	0.6	3.1	3.0	4.2	4.2
10120202060105	0.4	1.8	4.7	4.4	10.6	0.4	3.4	3.6	3.8	3.7
10120202060106	0.7	1.0	2.4	2.4	16.4	0.7	3.4	3.3	5.6	5.3
10120202060202	0	0.6	4.5	3.8	3.0	0	6.9	5.9	4.9	4.8
10120202070101	0	0	0.6	0.6	0.3	0	0.2	0.2	0	0
Alternative 4										
10120111020102	4.0	10.9	3.5	3.0	32.4	2.7	4.7	3.9	4.1	3.2
10120111020103	1	6.4	3.6	3.1	33.9	0.6	4.1	3.6	6.3	5.5
10120111020104	0	7.8	3.4	2.5	19.7	0	2.2	1.1	2.1	1.2
10120111020301	0	0	9.7	9.7	0	0	0	0	0	0
10120111020305	0	2.9	3.7	2.5	4.2	0	4.2	3.6	6.8	6.8
10120202020105	5.4	1.2	2.7	3.2	17.5	5.4	3.8	3.7	5.5	4.6
10120202060102	2.2	7.9	3.7	3.2	34.3	2.2	6.6	5.3	6.3	5.2
10120202060103	0.7	12.5	4.6	3.3	32.1	0.6	6.4	4.0	12.6	8.2
10120202060104	1.7	3.1	2.2	2.1	14.6	1.3	3.1	3.2	4.2	4.9
10120202060105	0.5	2.0	4.7	4.4	10.6	0.4	3.4	3.5	3.8	3.7
10120202060106	0.7	0.6	2.4	2.4	16.4	0.7	3.4	3.4	5.6	5.6
10120202060202		0.6	4.5	4.0	3.0	0	6.9	6.2	4.9	4.9
10120202070101		0	0.6	0.6	0.3	0	0.2	0.2	0	0

Erosion rates discussed in each alternative were calculated using the Water Erosion Prediction Project (WEPP) computer program. WEPP was used to estimate the effects of soil erosion and sediment generation for each alternative. The model was run using climate data for 40 years and the predicted yearly erosion rates were averaged. The model incorporates input of five elements: climate, soil texture, local topography, residual plant community and residual surface cover to derive erosion estimates. The accuracy of predicted erosion numbers is highly variable as well as being very dependant on precipitation. The greatest utility of the model is that it allows comparison between alternatives (http://forest.moscowfsl.wsu.edu/fswepp/docs/distweppdoc.html). Tables summarizing the range of slopes, soil types, and conditions for which the model was run as well as the assumptions used in the modeling process are located in Section C.1.1 of the Project File.

Table 26 compiles the estimated sediment numbers derived from using WEPP. The resultant values are shown in Tons Per Year (T/Y), Tons Per Project (T/P), and Avg. Tons Per Year (Avg. T/Y). Existing Conditions values represent estimated erosion associated with natural conditions, past, and current activities. The values associated with T/P values reflect the amount of potential sediment that could be eroded, by alternative and watershed, associated with the project. Average T/Y values are based on the assumption that all activities associated with this project will occur over a period of at least three years.

Table 16 Summary of Potential Erosion Rates

Watershed Number	Grizzly Gulch Fire 2003 Estimates Tons/1st year	Grizzly Gulch Fire 2004 Estimates Tons/2nd year	*(Baseline) (T/Y)*	Alt 1 Existing Conditions Avg T/Y	Alt 2 SUM (T/P)	Alt 2 Avg T/Y (over 3 Year Period)	Alt 3 SUM (T/P)	Alt 3 Avg T/Y (over 3 Year Period)	Alt 4 SUM (T/P)	Alt 4 Avg T/Y (over 3 Year Period)
10120111020102	9,364	2,341	799	3,140	1,094	365	2,171	724	2,778	926
10120111020103	17,529	4,382	807	5,189	636	212	1,282	759	1,282	427
10120111020104	50,720	12,690	690	13,381	974	325	4,091	768	4,091	1364
10120111020301	0	0	3	3	0	0	0	0	0	0
10120111020305	0	0	153	153	48	16	204	62	204	68
10120202020105	0	0	690	690	1,016	339	1,175	322	1,175	392
10120202060102	0	0	849	849	542	181	600	693	600	200
10120202060103	0	0	618	618	263	88	263	356	263	88
10120202060104	0	0	1,000	1,000	237	79	237	74	237	79
10120202060105	0	0	367	367	99	33	168	72	168	56
10120202060106	0	0	587	587	350	117	365	481	365	122
10120202060202	0	0	69	69	0	0	4	20	4	1
10120202070101	0	0	208	208	0	0	0	73	0	0

Watersheds highlighted in light gray are entirely within the project area.

Soil Erosion, Compaction, Heating, and Nutrient Loss

Alternative 1:

Under this No Action Alternative, current management plans would continue to guide management of the project area. No commercial or non-commercial treatments would occur as proposed under this project. However, timber sales currently in progress would continue. Effects from these ongoing activities are not expected to be significant due to the implementation of Forest Standard and Guidelines for soils, Region 2 Water Conservation Practices, and South Dakota Best management Practices, Updated.

Current logging practices disturb less than 15% of a harvest area and compaction is expected in the area of landings and primary skid trails leading away from landing. With the application of forest standards and guidelines, South Dakota forestry BMP's and practices from the WCPHB compaction is expected to be within acceptable limits (Reyher, 2003, Personal Communication).

Estimates of existing erosion rates for forested stands, for watersheds located entirely within the project area range from 618 T/Y to 5,189 T/Y. This is equal to 0.1 to 0.7 tons per acre (Table 26, Existing Conditions). The high erosion rate of 5,189 T/Y reflects the effects of the Grizzly Gulch fire in watershed 10120111020102.
However, if a large wildfire did occur and burned throughout a watershed, WEPP modeling estimates that potential erosion rates would increase to 5 to 23 tons per acre depending on slope and soils types (See Project File, Section C.1.1). Watersheds 10120111020102 and 10120111020103 have the largest number of acres of soil with moderate to very high erosion potentials, once they are disturbed, and would most likely have the largest increases in erosion associated with fire activity (Table 24). Since no timber harvest or fuels reduction is proposed under this alternative, the risk of a catastrophic fire will only increase over time. As a result, Alternative 1 has the most risk for increased erosion, nutrient loss, soil heating and the development of hydrophobic soils, compared to the other three alternatives.

Existing erosion rates reflect natural conditions and influences from recent and ongoing timbers sales as well as the Grizzly Gulch fire. Erosion rates and rates of nutrient loss in the areas burned during the Grizzly Gulch fire will likely decrease as the area recovers, and is supported by estimates of potential erosion rates (Table 26). Under Alternative 1, erosion associated with roads would continue, and may worsen without effective closure and decommissioning of system and non-system roads. Without additional activity on the ground, soil productivity and nutrients for the area may increase over time.

Alternatives 2, 3, and 4:

Direct effects to soil erosion, compaction, heating and nutrient loss will be a reflection of numerous factors. Among these are the number of acres of soils involved with mass movement potential and moderate to very high erosion potential, the types of treatment type proposed on these soils, the miles of proposed and decommissioned roads, the amount of prescribed burning, and the number of acres where whole tree harvesting is used.

Alternative 3 has the highest potential for associated erosion issues and Alternative 2 has the least. This potential is reflected in the estimated potential rates summarized in Table 26. These higher potential rates reflect the amount of prescribed burning proposed, the number of soil acres proposed for treatment that involve moderate to very high erosion potential (once they have been disturbed) as well as some mass movement potential. There are 15.1 miles of new road proposed for construction on these soils.

Alternative 4 has the highest potential for ground disturbance, compaction, and nutrient loss compared to Alternatives 2 and 3. Alternative 4 proposes to involve the largest number acres for commercial thinning, which will be logged using whole tree harvest. The FEIS notes that whole tree skidding has the greatest potential for impact to a soil's organic matter over a large area (FEIS, 1996). However, remaining vegetation and litter-fall will help offset the loss of nutrients. In addition, soils in the northern Black Hills contain higher amounts of organic matter, compared to the southern Black Hills (Natvig, 2003, Personal Communication). Compaction is expected in the area of existing landings and skid trails. However, additional impacts to nutrients and soil compaction, is expected to be offset by the use of landings and skid trails used in earlier sales. In addition, Forest Standard 1103 requires that no more than 15% of a land polygon or mapped soil unit is detrimentally compacted, eroded or displaced. BMP's such as harvest when the ground is dry or frozen will minimize compaction. Alternative 2 has the lowest potential for associated erosion issues (Table 24, Table 25, Table 26).

All three action alternatives propose the use of prescribed burning to some degree. Alternative 4 proposes to use prescribed burning on nearly 5,000 acres either as the sole prescription or in conjunction with another, such as fuel breaks or commercial thinning. Alternative 2 proposes only 339 acres (Table 24). Heating effects on soils will be less under Alternative 2, compared to Alternatives 3 or 4, because of the acreage amounts involved. However, most of the prescribed burning is broadcast burns, which burn at lower temperatures and should not detrimentally affect soil textures or nutrients (Lewis, 2003, Personal communication). Burning the large slash piles associated with whole tree yarding will occur. Some affects due to heating will develop, as these piles burn much hotter. However they will occur on landings, which will minimize nutrient loss within the harvest areas.

Mass Movement

Alternative 1:

The project area encompasses 60,371 acres. Of that total acreage, approximately 53,224 acres (88% of the project area) consists of soils with some mass movement potential as defined by the Lawrence and Meade County Soil Surveys (NRCS, 1979, 1978; Table 12, 24). The Lawrence County Soil survey notes that for Vanocker-Citadel and Citadel soils, old landslides were present but not observed during soil mapping. Wet seepy areas were also identified as potential areas of mass movement. The survey noted the potential for landslides for Hisega, Grizzly Virkula, Maitland, and Vanocker with Rock Outcrop soils, but did not observe them during mapping.

District personnel have not observed landslides or other types of mass movement. Under Alternative 1, no commercial or non-commercial harvest would occur and no additional roads would be built. As a result, it is expected that any additional mass movement events would be scarce if there are not catastrophic fires. However, if a large and intense fire did occur, it is very likely that there would be mass movement events given that 88% of the soils within the project area have moderate to very high erosion potential once they are disturbed.

Alternatives 2, 3, and 4:

Landslides and other types of mass movement have the highest chance of happening when timber harvest and road building occurs on soils with some mass movement potential (Table 12, Table 13, Table 14 and Table 15). With the occurrence of mass movement, soils with potential for erosion are more susceptible, once they have been disturbed. It is important to note although NRCS states that the potential for soil erosion is moderate to very high for the soils referred to in (Table 12, Table 13, Table 14 and Table 15). They emphasize that this potential is applicable once the soils have been disturbed.

Alternative 4 proposes timber harvest and road construction activities on the largest acreages of soils with some mass movement potential and soils with moderate to very high erosion potential, once they have been disturbed. Alternatives 3 and 2 follow Alternative 4 in the number of acres involved for mass movement potential and potentially erosive soils. Alternatives 4 and 2 propose 15.1 miles of new road on soils with potential erodible soils while Alternative 3 proposes 11.5 miles of new construction on these same soils.

Landslides are not expected to occur within the planning area due to the scarcity of natural landslide features. However, in order not to accelerate natural mass movement activities, South Dakota BMP's for road location, design, construction, surface drainage, and maintenance would be implemented to reduce any potential for road failures for the soils listed in Table 13 and Table 15.

In addition, slope stability analyses will be conducted on all Citadel soils located on slopes greater than 30% and for all other soils on slopes greater than 55%. These stability analyses will be conducted where road building is planned or where timber harvest removes most or all of the canopy (Forest Plan, 1997, Std 1108).

Stream Flow Regime

Alternative 1:

Alternative 1 proposes no additional timber harvest activities. There are current legislative and other sales that are planned or on-going. Since existing sales are not expected to result in any significant changes to water yield, and if there was no catastrophic fire, flow volumes would be a function of existing vegetation structures and variations in climate. As vegetation increases over time, water yield may actually decrease. Due to the increased chance of catastrophic fire, there is increased potential for decreased infiltration capacity due to the development of water resistant, or hydrophobic soils. This could lead to increases in overland flow during runoff events, as well as increased surface erosion and stream sediment (FEIS, 1996, pg. III-55).

As roads would not be decommissioned under this alternative, the current road system would continue to function as an extension of the area's drainage system. Any associated increases in the amount of water and sediment delivered to the drainage network from existing roads would continue, along with any elevations in peak flow and acceleration in the timing of flows.

Alternatives 2, 3, and 4:

Under this proposed project, changes in water yield would primarily be a function of changes in stand and vegetation density and road density. However, any changes in flow volumes may not be reflected as changes in surface flow due to the underlying karst topography (see geology section).

Changes in stand and vegetation density result in changes to the amount of water lost due to interception, evaporation of snow and evapotranspiration. The Forest Plan indicates, on pages. III-45 and 46, that generally it is necessary to reduce the basal area of a forested watershed by 25% before there is a noticeable increase in stream flow. Roads influence water yield through soil compaction, reduction of percolation area, and by acting as conduits for transporting surface runoff into streams. Potential increases in stream flow are associated with possible increases in surface erosion and sedimentation in stream channels (FEIS, 1996, p. 111-45). Although it is known that these factors may affect flow volume, changes are very hard to measure, as numerous variables affect flow volume. Alternatives 2 and 3 propose to decommission 60.7 and 62.0 miles of road respectively. Alternative 4 proposes to decommission 55.9 miles of road. Reductions in overall road density, and within 300 ft of streams, due to decommissioning, are displayed by alternative and watershed in Table 25.

Region 2 guidelines direct that water yield is typically analyzed and discussed at the Forest level. However, a very general analysis as conducted to evaluate potential water yield changes, due to the projects size and levels of treatment proposed to implement the projects purpose and need. Analysis of the 13 7th level HUC's, within the project area, indicated that no significant change to water yield is expected, due to timber harvest activities. As a result, no significant change to existing annual or peak flows, in any of the watersheds under Alternatives 2, 3, or 4 is expected (Mabey, 2003). The majority of the roads being decommissioned are non-system roads, which are typically two-track type roads, which are often vegetated with grasses and similar vegetation. Due to these road characteristics, little change in flow is expected due to decommissioning

Water Quality

The principal water quality issue related to the proposed project is sediment. Table 27 summarizes potential sediment sources within 300 ft of streams. The potential sediment values summarized below were derived from the amount of potential sediment erosion that would reach the base of timber harvest units. The estimates were derived using the WEPP model. To determine potential sediment sources that could be available for transport to streams, GIS analysis intersected unit boundaries with a 300 ft buffer around streams throughout the project area. These numbers yielded Tons per Project (T/P) for all the watersheds under each alternative. Tons Per Year (T/Y) was derived by assuming that the project will be conducted over a 3 year period and dividing the Tons per Project number by three. The alternative average maximum value was based on those units whose boundaries either touch or are within the 300 ft buffer. The alternative average minimum values were generated using the number of acres of proposed units within the 300 ft buffer.

Table 17 Summary of Potential Sediment Sources within 300 ft of Streams

Watershed Number	Alt 1 Avg T/Y (over 3 Year Period) Maximum	Alt 1 Avg T/Y (over 3 Year Period) Minimum	Alt 2 Avg T/Y (over 3 Year Period) Maximum	Alt 2 Avg T/Y (over 3 Year Period) Minimum	Alt 3 Avg T/Y (over 3 Year Period) Maximum	Alt 3 Avg T/Y (over 3 Year Period) Minimum	Alt 4 Avg T/Y (over 3 Year Period) Maximum	Alt 4 Avg T/Y (over 3 Year Period) Minimum
10120111020102	1,161	289	295	109	497	165	651	232
10120111020103	741	282	192	82	531	172	326	155
10120111020104	4,183	322	300	106	613	241	1095	485
10120111020301	1	0	0	0	0	0	0	0
10120111020305	139	69	12	5	47	15	47	18
10120202020105	633	243	129	40	224	85	160	91
10120202060102	770	322	119	44	513	235	135	58
10120202060103	563	255	73	49	267	108	73	51
10120202060104	940	397	73	45	71	43	73	45
10120202060105	350	147	30	16	45	15	45	19
10120202060106	508	216	92	45	363	116	96	52
10120202060202	54	22	0	0	11	7	0	0
10120202070101	194	88	0	0	56	38	0	0
TOTALS	**10,136**	**2,655**	**1314**	**541**	**3238**	**1239**	**2701**	**1205**

Alternative 1:

Existing roads would continue to supply sediment to the area's drainage network where connected CDA's exists (Project File, Section C.1.1). Under this alternative, no new roads or skid trails would be built and no new potential sources of sediment would be created. Current water quality conditions would continue for analytes such as dissolved oxygen, temperature, pH, and total suspended solids.

However, if a catastrophic fire occurred, the potential and likely increases in erosion would most likely result in water quality degradation for temperature, total suspended solids, conductivity, and nitrates. Increased sediment input would also impact macro-invertebrate populations and fisheries habitat.

Alternatives 2, 3, and 4:

As stated above, sediment is the primary issue related to the proposed management activities for water quality. Potential supplies of sediment are a function of the number of miles of roads and the predominant surface type within 300 ft of streams, the amounts of road proposed for decommissioning and construction, and the amount of prescribed burning proposed for that alternative and the access of that material to the stream.

For all three action Alternatives, the proposed decommissioning of roads reduces road densities within 300 ft of streams and in riparian zones, except for watersheds 10120202060104 and 105. Road density increases only by 0.1-0.2 mile, which is not significant. Any sediment originating from these naturally surfaced roads should decrease over the long term.

Alternative 3 has the largest amount of potential sediment within 300 ft of streams. Alternative 3's larger potential sediment sources could influence water quality. The larger potential sediment sources are due to a combination of a larger amount of proposed commercial thinning, prescribed burning, and fuel breaks (Table 24, Table 25, and Table 27). Table 27 (imme. above) indicates that Alternative 3 has the highest average maximum for sediment, estimated to be 531 T/Y, with an average minimum of 45 T/Y. Alternative 4 is next and Alternative 2, the Modified Proposed Action, would have the smallest potential sediment sources within 300 ft of streams, with a range from 109 T/Y to 16 T/Y.

The greatest potential threat to water quality develops under the scenario of a large wildfire. In that case, potential sediment volumes within 300 feet of streams increase dramatically. WEPP modeling estimates that potential sediment volume, within 300 feet of streams, would range from 312 T/Y to 25,529 T/Y for the first year after a fire. These estimates are based on correlations with the Grizzly Gulch fire. The same slopes and soil type for this area were used in modeling for the effects of a 10,000 acre fire. Glen Lewis, project Fuels Specialist, estimated that there is a 28% probability that a fire of 10, 0000 acres within the project area will occur within the next 10 years.

Sediment volumes escalate due to increased runoff increasing erosion and the development of hydrophobic or water resistant soils. Mass movement events are common after large fires, which also increase the volume of sediment being eroded. Such large influxes of sediment into the system would degrade water quality, including dissolved oxygen, and aquatic habitat as a result of increased total suspended solids, total dissolved solids and turbidity. MacDonald, 1991, indicates that there is only a weak correlation between temperature increases and sediment. As a result, sediment related increases in temperature are unlikely.

Bear Butte, Boulder, Two Bit, Park, Vanocker, and Meadow Creeks all have designated uses for coldwater marginal fish life propagation, limited contact recreation, wildlife/stock watering, and irrigation. Alkali Creek, in addition to these designations, has a designated use of domestic water supply, although water is not currently being withdrawn for domestic use. Deadman Gulch, although it does not have a state designated reach with assigned beneficial uses, functions as the primary source of drinking water for the Ft. Meade Veterans Association.

Under Alternatives 2 and 4, Alkali Creek would experience no change to existing potential sources of sediment within 300 ft of streams (Table 27, Alt 1). Under Alternative 3, existing potential sediment sources could increase by up to 56 T/Y. However, only 17% of the watershed is within the project area. With the application of BMP's, no impacts to water quality are expected. In watershed 10120202060102, which includes the Deadman Gulch Area, the largest potential sediment source increase within 300 ft of streams would occur under Alternative 3 and the smallest would occur under Alternative 2 (Table 27). Road densities within 300 ft of streams are reduced the most under Alternative 4 for Deadman Gulch. Densities remain essentially unchanged for Alkali Creek under all action alternatives.

Sites where activities have the potential to contribute to erosion will be stabilized and maintained with erosion control measures in accordance with Forest Plan Standards, BMP's and the WCPHB. Site-specific mitigation measures will be designed to reduce effects to soils and water quality (See Appendix B). With the application of these BMP's and mitigation measures, no significant impacts to water quality are expected.

Channel Morphology

Alternative 1:

Alternative 1 does not proposes any timber harvest, road building or decommissioning. As a result, there would be no effects to stream morphology. Current influences to drainage systems would continue. Stream channels that are presently unstable would continue to contribute influences to the drainage network until they stabilize. Existing roads and associated CDA's, and stream crossings, will continue their present influences on channel morphology (Project File, Section D). With no road decommissioning there would be no reduction in the amount of water delivered to drainages via existing roads. Peak flows and their timing will remain at their present levels and occurrences. However, if a large and intense fire occurred, sediment sources available to channels may be increased due to vegetation loss, possible development of hydrophobic soils, and increased runoff.

Alternatives 2, 3, and 4:

As no significant changes in flow volume, or timing of flows are expected, flow related changes to channel morphology are not anticipated for Alternative 2, 3, or 4 (See Stream Flow Section).

Changes in channel morphology can also be related to increased sediment loading. Alternative 3 would generate the largest increase in potential sediment sources within 300 ft of streams, from existing conditions, while Alternative 2 would generate the smallest increase (Table 27). Alternative 3 would add only five additional stream crossings compared to Alternatives 2 and 4, which both add nine stream crossings.
Existing locations of Connected Disturbed Areas (CDA's) located on system roads within 300 ft of streams are summarized in the Hydrology Report located in Section C.1.1 of the Project file. Such CDA's are defined as areas contributing sediment and water from disturbed areas that access a water body (Ohlander, 1998). Removal of CDA-related sediment sources would provide watershed improvement opportunities. Eliminating road related sediment sources would reduce excessive sediment loading. Sediment loading would be reduced by eliminating vehicle use that creates ruts and potholes and other types of road damage. This reduction would improve channel morphology over the long term and reduce the potential for sediment related water quality exceedances.

Additional opportunities for watershed improvement projects are defined in Table AQ 9.1 of the hydrology roads analysis report, which can be found in Section D of the Project File. All of these roads could either benefit from relocation, improvement of existing drainage measures, or improvement of riparian vegetation. Implementation of such watershed improvements would provide improvement by reducing sedimentation, improving local water quality, floodplain function, and riparian zone health.

Floodplains

Alternative 1:

Existing impacts to floodplains will continue. As this alternative proposes no additional vegetation management or road building, no new impacts to floodplains would occur. No existing system or non-system roads located on floodplains would be decommissioned. However, if a large and intense fire did occur, changes in the floodplain associated with increased water yield and sediment loads are likely.

Alternatives 2, 3, and 4:

Alternative 3 proposes portions of 66 units totaling approximately 111 acres within the floodplain and Alternatives 2 and 4 propose portions of 70 units, encompassing approximately 112 acres.

Fuel breaks are the predominant treatment type proposed within floodplains for all action alternatives. The fuel breaks would parallel the roads and adjacent streams. Whole tree harvesting and skidding will be used to construct the breaks. Soils within the floodplain are influenced by water and would be susceptible to disturbance, erosion and compaction. Erosion occurring within floodplains has a higher probability of contributing sediment to the associated stream. Alternative 2 would generate the smallest increase over existing conditions (Table 27). Alternative 3 has the highest potential for contributing additional sediment in addition to existing conditions compared to Alternatives 2 and 4, which is a reflection of the number of acres involved in prescribed burning.

Alternatives 2 and 4 propose 0.4 miles of construction within the riparian zone while alternative 3 proposes only 0.1 miles. All three alternatives propose approximately 4.5 miles of decommissioning in the riparian zone. As a result, implementation of the action alternatives would improve floodplain function and condition compared to existing conditions.

Since increased erosion could impact floodplain function and conditions, numerous site-specific mitigation measures have been prescribed, which have been determined to be effective in controlling erosion (See Site Specific Mitigation Measures; USDA Forest Service, 1996, State of South Dakota, updated). As a result, it is expected that there will be no significant impacts to existing floodplain conditions.

No modification of floodplain function and condition, based on significant changes in flow are expected (see Stream Flow section).

Riparian Zones and Wetlands

The term, "wetlands" is generic, referring to areas that are not totally terrestrial or fully aquatic.

Wetlands classification is based on the source type of the water for the area and includes precipitation, ground water and surface water dominated systems. Surface water dominated wetlands are referred to as riparian systems (http://h20sparc.wq.ncsu.edu./info/wetlands/types3.html).

Alternative 1:

There will be no new impacts to riparian ecosystems under this alternative. Existing impacts resulting from roads, past harvest activities, and grazing would persist. Existing road densities within riparian zones is summarized in Table 25.

Alternatives 2, 3 and 4:

Harvest within riparian zones can produced localized soil compaction, erosion and introduction of sediment into the riparian zone, affect surface and groundwater relationships, and modify floodplain function (FEIS, 1996, Fryxell, 2003). The highest potential for adverse impacts to involved riparian zones would be where there is the greatest amount of surface disturbance from whole tree harvesting and road development (FEIS, 1996, Natvig, 2003, Personal communication).

Approximately 2.8 acres of Fish and Wildlife defined wetlands are involved in proposed treatments for all three action alternatives. The units with involved wetlands are listed in Section C.1.1 of the Project File. For all but two units, the amounts are less than 0.5

acres. These units are 0814060034 and 0814440048, which contain 0.71 and 1.6 acres of wetlands respectively.

Current impacts to wetlands due to existing roads would continue as none of them are proposed for decommissioning (Fryxell, 2003). Effects due to sedimentation and disturbance associated harvest are expected to be minimized through the application of BMP's and Forestwide Standard and Guides for Soil, Water, and Riparian zones.

Existing riparian road densities will be reduced in all action alternatives. Alternative 3 will decommission 4.7 miles of road within the riparian and construct only 0.12 miles compared to Alternatives 2 and 4 which propose to decommission and construct essentially the same number of miles of road (4.5/0.4 and 4.4/0.4 respectively. Short-term impacts due to sedimentation and disturbance of vegetation may occur as decommissioning and restoration activities occur. However, over the long term, riparian health is expected to improve as vegetation is reestablished and sedimentation associated with restoration activities declines.

All three action alternatives propose to involve approximately 106 acres of riparian habitat contained in portions of proposed units with 5 or more acres of riparian vegetation. Alternative 3 contains units with the largest amounts of riparian habitat associated with individual units. See Section C.1.1 of the Project File for proposed treatment units with wetlands components and riparian components.

Shaded fuel breaks involve timber harvest within the riparian zone. As discussed in the Vegetation section of Chapter 3, overstory trees will be removed to 15-20 ft spacing with understory confers removed and surface fuels intensively managed or removed. Fuel breaks will be developed using whole tree harvesting. Whole tree harvest activities have the largest potential for impacts for erosion, disturbance of the soils organic layer, and nutrient removal. Removal of understory conifers could contribute to impacting habitat, large woody debris supply, and thermal modification when within 100 ft or less of perennial streams (FEIS, 1996).

The development of site specific mitigation measures, in addition to the application of South Dakota BMP's for timber harvest, streams side management and site preparation, will be the key to achieving improved forest health and meeting required Forest Standard and Guidelines for soil, water, and riparian zone health. Such site specific measures could include harvest in the winter when the ground is frozen, conduct no commercial thinning within the streamside management zone (as defined in BMP IIIB1), or do group harvest selections where large trees are within the SMZ, and can still provide shading and large woody debris. Selective harvest could also be used to enhance the growth of hardwoods, especially within 100 ft of perennial streams, to supply vegetation for food, and large woody debris (Lewis, 2003, Personal communication).

As discussed, there are potential effects of implementing the action alternatives regarding soil compaction, erosion and sedimentation within the riparian zone. Without conducting thinning within the riparian zone, the risk of a large wildfire and resultant potential increase in effects to soil and water are much greater than compared to each of the action alternatives. Details on such consequences may be found in the “Soil Erosion, Compaction, Heating, and Nutrient Loss” and “Water Quality” section located earlier in this document.

Cumulative Effects

Cumulative effects include effects from past or present activities, activities that have been approved but not implemented, proposed activities within the project area and associated watersheds, and for this project, the larger cumulative effects area.
Cumulative effects under Alternative 1 include baseline conditions, discussed under direct and indirect effects, ongoing timber sales, and legislated treatments (Table 28).

Table 28 summarizes the acres of vegetation treatments from ongoing timber sales and legislated actions within both the project area and analysis area by 7th field watershed or HUC. The letter beside the watershed number denotes whether the watershed is I (inside project area), O (outside project area), P (partially inside project area), and I (watershed is outside the project area but hydrologically connected at the 6th field watershed or HUC level).

Table 18 Summary of Ongoing Timber sales and Legislated Actions

For analysis area HUC7		Ongoing timber sales and commercial legislated units			Noncommercial legislated units
		Total Acres commercial treatments	Acres treated inside project	Acres treated outside project	Acres treated outside project
10120111010103	O	286	0	286	
10120111010204	O	892	0	892	
10120111010301	O	312	0	312	
10120111020102	I	1241	1241	0	
10120111020103	P	2011	1575	436	
10120111020104	P	195	195	0	
10120111020105	*	1948	0	1948	
10120111020201	O	2265	0	2265	
10120111020301	P	342	0	342	191
10120111020305	P	704	239	465	670
10120202020105	P	527	527	0	
10120202060102	I	403	403	0	
10120202060103	I	189	189	0	
10120202060104	I	257	257	0	
10120202060105	P	347	347	0	
10120202060106	P	959	819	140	
10120202060202	P	231	231	0	
10120202070101	P	518	358	160	
total		**13626**	**6382**	**7245**	**861**

Cumulative Effects inside the Project Area

Under Alternative 1 approximately 6382 acres of vegetative treatments in 12 watersheds would occur in the project area within the next few years (Table 28). This is less than 11% of the project area (Table 28).
While a total of 60,371 acres are within the project area, these acres are in many different watersheds, meaning the streams within the project area do not flow into a common stream within the project area. The thirteen 7th field HUCs in the project area belong to six 6th field HUCS, four 5th fields and two 4th fields (Table 29). The watersheds highlighted in light gray are watersheds located completely within the project boundary. The northern part of the project area flows into the Lower Belle Fourche River (4th field) and the southern part of the project area flows into the Middle Cheyenne River-Elk (4th field). This is important because project related effects are dispersed over a very large area.

Table 19 Summary of Relationship between 6th and 7th Level HUC's and Percent of HUC7 Watersheds in the Project Area

HUC6	HUC7	7th field Watershed acres in project area	Total 7th field watershed acres	%watershed in project area
101201110201	10120111020102	7932	7932	100
101201110201	10120111020103	7368	8332	88
101201110201	10120111020104	5840	8692	67
101201110203	10120111020301	26	5608	<1
101201110203	10120111020305	1415	7839	18
101202020201	10120202020105	5856	8360	70
101202020601	10120202060102	7350	7350	100
101202020601	10120202060103	5525	5524	100
101202020601	10120202060104	8965	8965	100
101202020601	10120202060105	3319	9049	37
101202020601	10120202060106	4799	7105	68
101202020602	10120202060202	689	11590	6
101202020701	10120202070101	1290	7587	17

Soil Erosion, Compaction, Heating, and Nutrient Loss

Numerous factors will affect erosion and natural rates of erosion are highly variable. Natural factors include geology, topography, and vegetation. Natural disturbances such as wildfires, large rainfall, or rain on snow events, can also lead to higher erosion rates. Surface erosion in managed forestlands can accelerate due to roads, timber harvest and prescribed burning. Grazing, mining, and off-road recreation can also affect erosion rates. Best management practices are designed and implemented to limit any increased potential for erosion from planned activities.

Alternative 1:

There would be no increase in erosion due to increased harvest activities or controlled burns associated with this project. Roads densities would remain the same and no additional decommissioning would occur. Any road related erosion would continue as would accelerate erosion from the Grizzly Gulch fire. Over time, the area affected by the Grizzly Gulch Fire would revegetate and the erosion rate would decrease. Mining activities would continue at present levels. Cattle grazing would continue at approximately the present level. Increased population growth would lead to increased recreational use of the forest and the dispersed impacts from these activities (camping, hunting, OHV use etc). There may be a short-term increase in erosion from ongoing timber sales and legislated treatments.

The proposed fuel reduction associated with this project would not occur. This could increase the risk of accelerated soil erosion under Alternative 1 due to wildfire. Modeling and analysis of past fire events indicates that there is a 28% probability of a fire of 10,000 acres within the project area in the next ten years (G. Lewis, Pers. Comm., 2003). The WEPP model estimated accelerated erosion of 77,655 tons/year for the Grizzly Gulch fire within the Elk Bug Project area. Assuming similar slope and soil types, erosion from a 10,000-acre fire estimated at 123,536 tons/year the first year after a fire. Soil heating from a high intensity wildfire can create a hydrophobic layer in the soil that lowers infiltration and increases erosion. A large fire would also lead to a great loss of productivity and loss of nutrients due to volatilization of nitrogen, burning the organic soil layer, as well as from soil erosion associated with the fire.

Soil heating would occur only where piles of vegetation are burned. These small areas dispersed throughout the project area are insignificant from a cumulative effects perspective. Skid trails from past entries would be reused, limiting the amount of additional compaction. Minor nutrient loss would occur from harvest. Due to the small percentage of the watersheds being treated under Alternative 1, as well as the reuse of old skid trails, cumulative effects for compaction and nutrient loss would be minimal.

There are approximately 15,605 acres of private land and land in other ownership scattered throughout the project area. There is no data available to accurately predict the amount and type of treatments that will be accomplished on non-Forest Service lands. Concerned land owner's, within the project area, and other agencies indicated during the scoping process that they are actively pursuing treatment options to reduce the spread on mountain pine beetles and the potential threat of catastrophic fire events.

Alternatives 2, 3, and 4

The WEPP model used to produce this table does not take into account BMPs or site specific mitigations used to reduce impacts from land management activities. The table is most useful to compare potential changes between the alternatives, not specific amounts of erosion.

Table 20 Summarizing the Increase in Potential Erosion from vegetation treatments by Alternative and Watershed

HU6	HUC7	Baseline Tons/year	Alt1 Tons/year	Alt2 Tons/year	Alt3 Tons/year	Alt4 Tons/year
	10120111020102*	3140	3348	3713	4071	4274
	10120111020103**	5503	5503	5715	6262	5930
	10120111020104	13459	13459	13783	14227	14822
101201110201		**21710**	**22310**	**23211**	**24561**	**25027**
	10120111020301	3	3	3	3	3
	10120111020305	153	186	202	248	254
101201110203		**156174**	**189**	**205**	**251**	**257**
	10120202020105	690740	925	1263	1247	1316
101202020201		**690740**	**925**	**1263**	**1247**	**1316**
	10120202060102*	849	927	1108	1620	1127
	10120202060103*	618	668	756	1025	756
	10120202060104*	1000	1052	1131	1126	1131
	10120202060105	367	444	477	516	500
	10120202060106	587	817	934	1298	938
101202020601		**3421**	**3909**	**4406**	**5584**	**4453**
	10120202060202	69	105	105	125	106
101202020602		**69**	**105**	**105**	**125**	**106**
	10120202070101	208	328	328	401	328
101202020701		**208**	**328**	**328**	**401**	**328**
total		**26253**	**27764**	**29517**	**32169**	**31486**

*Watersheds are entirely within the project area.
*Watersheds are entirely within the project area.

Alternative 2 would have the smallest cumulative increase in potential erosion from vegetative treatments, while Alternative 3 has the largest, due to the larger number of acres proposed for harvest and prescribed burning. Alternative 4 has slightly less potential for increased erosion than Alternative 3.

For all action alternatives, more miles of roads are proposed for decommissioning than construction (Table 25). As a result, cumulative erosion from roads would decrease for all action alternatives, with Alternative 3 having the most positive effect and the least for Alternative 4. Additional information on existing road densities is summarized in Table 31 “Summary of Existing and Alternative Road Densities”.

While there may be short-term increases in erosion from vegetative treatments, in the long-term cumulative effects will be reduced for all action alternatives by the large number of miles decommissioned.

Table 21 Summary of Roads Decommissioned and Built By Alternative

Alternative	Road Miles Decommissioned	Road Miles Built	Net decrease
Alternative 1	0	0	0
Alternative 2	60.2	16.2	44
Alternative 3	62	11.5	50.5
Alternative 4	55.9	16.2	39.7

Controlled burns are burned at a cool temperature in the Black Hills and rarely burn through the duff to bare mineral soil (Glen Lewis, personal communication, 2003). This lowers the erosion potential and speeds the recovery process. The elevated erosion potential due to burning would last only two to three years before the watersheds returned to baseline conditions. Temporary roads and skid trails would be reseeded under BMPs, so the accelerated erosion associated with harvest activities is expected to recover within two years of seeding (John Natvig, personal communication, 2003). No cumulative effects are expected from soil heating from prescribed burning. Some heating will take place at large landings where whole tree yarding occurs but these will be small areas dispersed throughout the project area and would be insignificant from a cumulative effects perspective.

Under the frequent entry land management approach practiced on the Black Hills, residual compaction persists between entries on the main skid trails and landings. Cumulative effects from compaction would be minimized by reusing old skid trails and landings or harvesting soils prone to compaction when they are frozen, under snow, or dry. The cumulative nutrient loss from treatments is greatest for Alternative 3 due to the larger number of acres recommended for commercial harvest and prescribed burning. It is least for Alternative 2, which has the fewest acres recommended for commercial harvest or prescribed burning.

Mass movement

Alternative 1:
While some units to be treated in ongoing timber sales or through legislated actions will occur on soils prone to mass movement, most, if not all, of these units have been treated in the past and district personnel have not observed landslides or other types of mass movement. Under Alternative 1, any mass movement would be from conditions already in effect such as connected disturbed areas, or culverts that get blocked or washed away during a large storm event. No roads will be decommissioned under Alternative 1. There are presently 219 miles of roads on soils with some potential for mass movement. Wildfire would increase the potential for mass movement, as has been seen with the Grizzly Gulch Fire, in the Lead Deadwood area.

Alternatives 2, 3, and 4:

Older roads are often built in the drainages and have smaller culverts (or none) than roads built today. These older roads are more likely to cause slope failure than roads built under current practices. Therefore removing older roads will lower the risk of road caused slope failure. Table 32 lists the miles of road on soils prone to mass movement to be decommissioned or built under each alternative. Negative numbers show more construction than decommissioning.

Table 22 Cumulative Effect of Proposed Road Decommissioning or Construction on Soils with Mass Movement Potential

	Decommissioned			New Construction			Overall Decrease		
HUC7	**ALT2**	**ALT3**	**ALT4**	**Alt2**	**Alt3**	**Alt4**	**Alt2**	**Alt3**	**Alt4**
	miles	**miles**	**miles**	**miles**	**miles**	**miles**	**miles**	**miles**	**miles**
10120111020102*	5.5	5.5	5.5	2.7	1.9	2.7	3.6	2.8	1.9
10120111020103 **	5.5	5.5	5.5	1.0	0.6	1.0	4.9	4.5	0.6
10120111020104	8.4	8.4	5.7	0.0	0.8	0.0	7.6	8.4	-1.9
10120111020305	0.6	0.6	0.6	0.0	0.0	0.0	0.6	0.6	0.0
10120202020105	1.9	1.6	1.1	5.4	3.4	5.4	-1.6	-3.8	2.6
10120202060 102*	8.3	8.5	7.8	2.2	1.2	2.2	7.1	6.3	0.7
10120202060103*	12.3	12.3	11.4	0.6	1.0	0.6	11.3	11.7	0.1
10120202060104 *	2.9	3.5	2.8	1.7	0.6	1.7	2.3	1.8	0.5
10120202060105	1.7	1.6	1.7	0.4	0.4	0.4	1.3	1.2	0.4
10120202060106	1.0	1.0	0.5	0.7	0.7	0.7	0.3	0.3	0.2
10120202060202	0.2	0.2	0.2	0.0	0.0	0.0	0.2	0.2	0.0
10120202070101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**48.4**	**48.8**	**42.8**	**14.7**	**10.8**	**14.7**	**37.6**	**34.1**	**5.2**

All the alternatives remove over 40 miles of roads on soils prone to mass movement, lowering the probability of a road induced mass movement. Alternative 2 has an overall decrease of 37.6 miles of road on soils prone to mass movement, with Alternative 3 showing an overall decrease of 34.1 miles. Both alternative 2 and 3 add more roads on these soils than they decommission for watershed 10120202020105. Alternative 4 decommissions fewer roads on these soils and has an overall decrease of 5.2 miles and an increase in watershed 10120111020103.

Table 24 shows the acres of treatment on soils prone to mass movement for each alternative. Most, if not all, of these units have been harvested in the past and district personnel have not observed landslides or other types of mass movement. Slope stability analyses will be conducted in areas of concern as stated in the direct and indirect effects. Given the slope stability analyses and South Dakota BMPs it is unlikely that any of the alternatives will lead to an increase in mass movement events.

Stream Flow Regime

Alternative 1:

The legislated activities are too dispersed to affect stream flow, therefore cumulative effects would be negligible. There would be no addition of sediment from project activities. In the watershed affected by the Grizzly Gulch Fire runoff will be higher than pre-fire conditions due to lack of interception of precipitation by vegetation, loss of cover, and hydrophobic soils. Most of the area will recover in 3 to 5 years, athough it could take 10 years or longer on the severely burned areas (Grizzly Gulch Fire Watershed Analysis Report, 2002).
If a large high intensity fire occurs, there is potential for increased flow in the short-term until vegetation is reestablished.

Alternatives 2, 3, and 4:

It is necessary to reduce the basal area of a forested watershed by 25% before there is a noticeable increase in stream flow (FEIS, 1996). There are thirteen 7th field watersheds that flow into six 6th fields. Four 7th order HUC's would have cumulative harvest impacts from ongoing timber sales, legislated units and the proposed alternatives. HUC's 10120111020102, 03, 04, which are all in the same 6th field HUC, would have treatments above 25%, but water yield increases are expected to be less than four percent (Mabey, 2003). HUC 10120202060106 would also have treatment levels above 25%, but the geology of this watershed is not very susceptible to water yield increases (Mabey, 2003). The other watersheds do not have harvest levels that would have an appreciable effect on flow. Therefore, no appreciable cumulative effects are anticipated to stream flow.

Water Quality

Sediment delivered to streams is the most important water quality issue for management activities. Table 26 summarizes potential sediment rates within the project area.

Alternative 1:
The potential addition of sediment from the ongoing timber sales and legislated units is shown in Table 33 below. There would be no additional sediment from project activities. No roads would be decommissioned, roads with sediment problems would continue adding sediment to streams. Sediment from the Grizzly Gulch fire and roadwork along HWY 385 was contributing sediment to Bear Butte Creek, a fish-bearing stream, during a snowmelt runoff event springing the Spring of 2003 (S.Tangenberg, 2003, Pers. Comm). Runoff events would continue to contribute sediment to the stream until the area affected by the fire or road work are revegetated and stabilized.
Bear Butte, Strawberry, and Whitewood Creeks all have designated reaches, by the State, that are located outside the project area. All three streams were on the 305(b) and 303(d) lists for water quality criteria and Total Mean Daily Load (TMDL) requirements in 2002. Bear Butte Creek, from its headwaters to Strawberry Creek, only partially supported designated beneficial uses for flow and temperature and did not meet TMDL requirements for suspended solids. Strawberry Creek in 2002 did not meet criteria for

cadmium, conductivity, copper, metals, salinity, Total Dissolved Solids (TDS), chlorides, and zinc. These exceedances are related to historical mining and subsequent treatments to remove metals from the water column. It did not meet TMDL requirements for cadmium, conductivity, copper and TDS. Whitewood creek did not meet criteria for pathogens, suspended solids, thermal modifications. TMDL's for fecal coliform, Total Suspended Solids (TSS) and temperature.
No cumulative effects to water quality, including stream flow, temperature, TDS and TSS, are expected as no additional land management activities are proposed.

Alternatives 2,3 & 4 :
Table 33 gives a range of potential increases in sediment delivered to streams for each alternative due to harvest and prescribed burning. The model used to produce this table does not take BMP's or site specific mitigations into account. The table is most useful to for making comparisons of potential change between alternatives. Alternative 1 is the baseline plus effects from ongoing timber sales and legislated actions. All action alternatives combine Alternative 1 with effects from the specific action alternative.

Table 23 Ranges in Potential Sediment Increases to Streams

HUC7	Baseline	Baseline	Alt1	Alt1	Alt2	Alt2	Alt3	Alt3	Alt4	Alt4
	Minimum tons/year	Maximum tons/year	Minimum tons/year	Maximum tons/year	Minimum tons/year	Maximum tons/year	Minimum tons/year	Maximum tons/year	Minimum tons/year	Maximum tons/year
10120111020102	289	1061	417	1247	526	1541	582	1744	648	1897
10120111020103	284	741	457	935	539	1127	629	1466	612	1262
10120111020104	322	4183	366	4230	473	4530	608	4843	851	5325
10120111020301	0	1	0	1	0	1	0	1	0	1
10120111020305	69	139	98	167	103	178	113	213	116	213
10120202020105	243	633	561	848	601	977	646	1072	652	1008
10120202060102	322	770	395	833	439	952	630	1345	453	968
10120202060103	255	563	279	612	327	684	386	879	329	684
10120202060104	397	940	416	993	461	1066	459	1064	461	1066
10120202060105	147	350	259	422	275	452	274	467	278	467
10120202060106	216	508	469	723	514	815	585	1086	521	819
10120202060202	22	54	62	87	62	87	69	98	62	87
10120202070101	0	194	242	293	242	293	280	349	242	293
total	**2655**	**10136**	**4021**	**11389**	**4562**	**12703**	**5260**	**14627**	**5226**	**14091**

Alternative 3 has the highest potential increase and Alternative 2 shows the lowest potential increase for sediment available for delivery to streams. The increase in sediment is expected to last only two to three years after activities associated with the project end. As a result, any cumulative effects due to these increases in potential sediment delivery are expected to be short-term. Many of the streams (both ephemeral and intermittent) within the project area are also vegetated. The vegetation will filter much of the sediment delivered to smaller streams higher in the system, before it has been transported downstream to a larger system.

Roads are an important contributor of sediment to stream systems. Decommissioning will remove potential sediment sources and lower the connectivity between roads and streams. Table 25 gives road density by watershed for the different alternatives. Alternative 2 will decommission 21 roads within drainage bottoms, Alternative 3, 22 roads, and Alternative 4, 23 roads within drainages, lowering connectivity of roads and streams. Alternative 2 & 4 will build roads with a total of nine stream crossings, and alternative 3 will have five new stream crossings. Road densities decrease under all three alternatives, leading to reduced cumulative effects from roads.

Approximately 10 miles of fuel breaks follow streams. Site specific mitigation measures will be used to retain canopy for streams that require cool temperatures to meet designated beneficial uses (See Appendix B for site specific mitigation measures).

Channel Morphology

Alternative 1:

Grazing would continue at approximately the current rate with the current impact on stream bank stability, no mining is planned for this area, but recreational use will increase over time. Additional recreation, particularly OHV's could have an impact to stream banks at water crossings.

No additional cumulative effects for Alternative 1 are expected. The ongoing timber sales and legislative actions will occur but BMPs, and site specific mitigations should minimize the effects on channel morphology. The pulse of sediment from the Grizzly Gulch fire will work through the system over time. If a large wildfire occurred a large amount of sediment could be released and affect the channel morphology until the sediment worked through the system.

Alternatives 2, 3, and 4:

As stated in direct and indirect effects, no significant changes in flow volume, or timing of flows are expected, for Alternatives 2, 3, or 4. However, lower road densities and removal of roads within riparian buffers will decrease the rapid transport of runoff and sediment to channels from connectivity of roads and streams, lowering the cumulative effects from road, stream interaction.

Floodplains, Riparian Zones and Wetlands

Alternative 1:
As the legislated treatments widely scattered over the project area there will be negligible impacts to floodplains, riparian zones or wetlands under this alternative. Roads currently affecting these areas will continue to do so. The three watersheds affected by the Grizzly Gulch fire will continue to have impacts from changes in flow and sediment regimes but will recover within a few years.

Alternatives 2, 3 and 4:

As stated in the direct and indirect effects floodplains, riparian zones and wetlands are susceptible to negative impacts from harvest, roads and fire. Application of BMPs are required to minimize impacts. Mitigation measures are required for these areas as discussed in direct and indirect effects.

Only 106 acres out of 3762 acres of riparian habitat within the project area are being treated in all alternatives. Given the small acreage, the use of BMPs and site specific mitigation, effects will be minimal. However, the cumulative effect of the sediment transported to these sensitive areas from proposed treatments, legislated treatments, and potential treatments on private land could lead to increased sedimentation in the short-term.
Table 25 summarizes alternative road densities within stream buffers and riparian areas. Alternative 3 shows the greatest decrease in road densities in these sensitive areas, but all action alternatives will have beneficial long-term cumulative effects. These long-term beneficial watershed effects are expected from maintenance and decommissioning of roads within these sensitive areas.

Cumulative Effects in the Analysis Area

Table 28 summarizes the number of acres proposed for treatment, for ongoing timber sales and legislated treatments, and the watersheds within which they occur.

Four watersheds within the analysis area totally outside the project area and are not connected hydrologically at the 6th or 7th field HUC level (Table 29). These watersheds will have no cumulative effects to soil and water with this project. In Table 30, the six shaded watersheds are either partially within the project area and have vegetative treatments outside the project that contribute to cumulative effects, or are hydrologically connected at the 6th field level. Watershed 10120111020105 is located completely outside of the project boundary but is connected at the 6th field level. The approximately 1948 acres of commercial treatments in this watershed represents approximately 18.2% of the watershed. Given the fact that most of these units are located high in the watershed, sediment generated by land management activities should be filtered out by vegetation before the confluence with 7th field 1012011101020104, downstream from the project area. Cumulative effects would not be apparent at the 6th level HUC.

Of the watersheds located partially within the project area, 10120111020301 has only 26 acres within the project area. None of these acres have been proposed for treatment under the proposed action or under legislation. The acres to be treated outside the project area, within this watershed, are primarily fuel breaks and noncommercial fuel reduction. Most of these treatments are along the margins of the watershed and will have minimal impact to streams. As result, there will be no additional cumulative effects due to land management activities in this watershed.

Watersheds 20305, 20103, 60106, and 70101(full watershed number in Table 28) all have activities within the project boundary and have legislated activities both inside and outside of the project boundary. Watershed 20305 has both commercial and noncommercial legislated activities associated with timber sales and fuel treatments. Within this watershed, direct effects related to prescribed burning and the construction of associated dozer line, would contribute sediment to Forbes Gulch. In addition, there would be at least a 50% basal area reduction within constructed fuel breaks due to the high volume of dead and dying trees. Increased sediment contributions are expected to go beyond the normal two to three year recovery period. However, Forbes Creek flows away from the project area. As a result, the effects are not cumulative spatially with the project area, although they may be temporally.

Watersheds 20103, 60106, and 70101 involve 2,752 acres of ongoing timber sales and legislated activities within the project area and 736 acres outside the project area (Table 28). Streams associated with these activities flow into the project area. However, vegetation treatments, including commercial harvest, noncommercial thins, and prescribed burns, would happen over a three to five year period. As a result, post-treatment vegetation recovery would filter out increasing amounts of sediment, reducing potential sediment sources adjacent to streams. This overlapping process, in addition to the application of BMP's and watershed conservation practices, will help reduce any short-term impacts associated with sediment. Approximately 0.5 miles of commercial treatments occur along the uppermost reaches of Deadman Gulch, and occasionally parallel Forest Highway 26. Soils in this area have moderate to very high erosion potentials once they are disturbed. As a result, there most likely will be increases in potential sediment sources located in the upper portions of this watershed. These increases may be additive in time as well as spatially. This may result in a cumulative effect to sediment levels and is of concern due to the downstream beneficial use of drinking water at the Fort Meade VA hospital. To address these concerns site specific mitigation measures are defined for this area under Appendix B.

Proposed treatments for commercial thinning and fuel breaks, in general, will be aiming for a 50% basal area reduction. Based on the modeling done for direct and indirect effects it is assumed that there will potentially be additional erosion and sediment available to streams. As timber harvest and vegetation recovery will overlap each other for several years, it is assumed that there could be short-term cumulative effects to erosion, sediment, and perhaps in some cases, water quality.