VII. HYDROLOGY

Introduction

This section examines the hydrologic effects of the proposed Firefighter Project and discusses any potential changes to the chemical and physical nature of water due to that proposal.

Information Sources

Information sources used in this document include:

- Data gathered by personnel from the Flathead National Forest
- Natural resource databases maintained by the Flathead National Forest
- Data gathered and maintained by the U.S. Geological Survey – Water Resources Division
- Scientific literature developed locally and literature pertinent to the topic based on similar physical, chemical, biological or issue parameters were considered and cited.
- Background field information from the analysis area, literature and computer model results were reviewed to assess existing condition

Methods of Evaluation and Models Used

Models are used to simplify extremely complex physical systems and are usually developed from a somewhat limited database. Both models used in this analysis utilized data from northwestern Montana during their development. Although the models generate specific quantitative values for water yield and sediment, the results are only estimates used as a tool to interpret how the natural system may respond – they are not intended to predict exact quantities of water or sediment being produced or routed. A model's output is meaningful only when it is used to evaluate existing conditions in light of the area watershed and stream characteristics, field data, and best professional judgment. The modeling results are interpreted in combination with the physical channel stability measurements to determine the risk of channel erosion to an individual stream channel.

Montana Department of Natural Resources and Conservation (DNRC) hydrologist Tony Nelson developed an Excel worksheet titled “Water Yield Analysis” (WYA) in 2002 for the Flathead region. The WYA worksheets were used to estimate increased water yields in individual watersheds that have experienced past timber management or wildfires. The WYA worksheet uses the procedure discussed in “Forest Hydrology, Hydrologic Effects of Vegetation Manipulation, Part II” (USDA Forest Service 1976) and the principles and components of the WATSED model (USDA Forest Service 1990b). The procedure uses the equivalent clearcut area (ECA) concept to estimate water yield and this model is referred to by that acronym in the remainder of this document. Data inputs include the following: elevation, aspect, precipitation zones per watershed, and roads within each precipitation zone. These were used to estimate the water yield increase resulting from removal of over-story vegetation cover from an acre of forestland. Water yield decreases for a harvested area as the vegetation recovers. The rate of decrease is based upon vegetation habitat types (USDA Forest Service 1976).

Model Limitations

The ECA watershed response model was designed to address the cumulative effects of timber harvest operations, road construction, and to some extent, fire. The model estimates water delivered to the main channel because of forest management within the watershed, including headwater streams. No main channel hydrologic or hydraulic processes are modeled directly.

The ECA model does not factor in extreme or rare events, [e.g. very heavy rainfall on snow-covered ground or occurrences of unusually high rainfall (thunderstorms)], which could cause short-term, high water flows (peak-flows). This model relies on climatic conditions averaged over long periods and its accuracy is best when averaged over several years. Therefore, this model is less reflective of individual drought or flood years. Rain-on-snow precipitation events are discussed in the Effects section for Alternative 2 and 3.

It should be noted that the WYA model calculates the estimated water yield percent increases assuming a fully forested condition prior to disturbance. This assumption results in a slight over-estimation of the water yield increase due to the shallow rocky soils (with no vegetation) and talus slopes in the headwaters areas, and the presence of wet meadows, marshes, and ponds without forest cover. The ECA modeling results are interpreted in combination with the physical channel stability measurements to determine risk of channel erosion within a watershed.

The surface erosion potential for the proposed treatments was estimated using the Water Erosion Prediction Project (WEPP) computer model. The ROAD-WEPP interface of the model was used to estimate non-point sediment delivery from roads within the analysis areas. The model considers the amount and frequency of precipitation, and runoff from rainfall and snowmelt events. The model output predicts upland erosion rate, potential sediment yield, and the probability of erosion and sediment delivery during the time period. Road parameters input to the model include road width, slope, and ditch length to road-stream crossings. The potential sediment yield from each road crossing was calculated as an estimate of the background road associated sediment yield. The potential increase in road-associated sediment due to the proposed timber harvest was estimated by calculating the number of additional stream crossings that would have to be constructed, and the potential sediment from new temporary roads.

The Disturbed-WEPP model was used to estimate the potential erosion/sediment yield from landings needed for the proposed activities; it calculates the runoff and erosion from a hillslope for various disturbance activities. Outputs include inches of precipitation, number of rainfall events and the amount of runoff, number of snowmelt events and the amount of runoff, upland erosion rate, potential sediment yield, and probability of erosion and/or sediment delivery. The complete documentation of the WEPP model modules used in this analysis is available at the website http://forest.moscowfsl.wsu.edu/fswepp. This documentation states:

> "At best, any predicted runoff or erosion value, by any model, will be within only plus or minus 50 percent of the true value. Erosion rates are highly variable, and most models can predict only a single value. Replicated research has shown that observed values vary widely for identical plots, or the same plot from year to year"

The soil scientist and hydrologists using the model for this analysis found the calculated erosion rates to be very reasonable for these hillslopes and treatment conditions.

Analysis Area

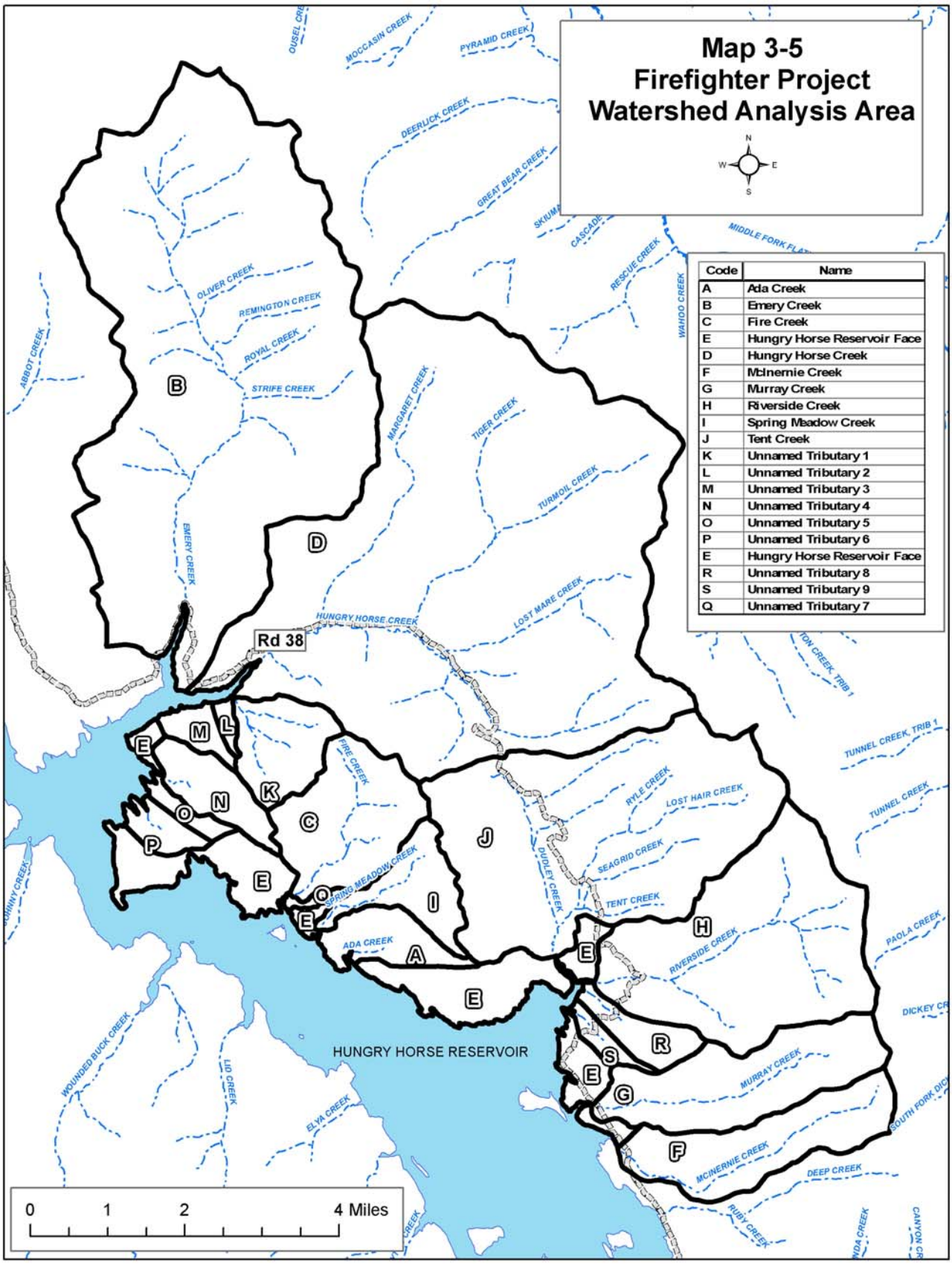
The analysis area used to conduct the hydrology effects analysis is bounded on the north by the northern boundary of the Emery Creek watershed, on the west by Hungry Horse Reservoir, on the east by the South Fork and Middle Fork Flathead River watershed divide, and on the south by the McInernie Creek watershed. The hydrology analysis area is somewhat larger than the Firefighter Project area, and all streams in the analysis area are tributary to the South Fork Flathead River watershed.

The temporal assessment of natural and man-caused disturbances in the analysis area begin with the first road building and timber management activities and continue to the present day.

The direct, indirect, and cumulative effects analysis area includes nineteen analysis watersheds, eighteen of which are true watersheds or basins, where the entire land area that collects and concentrates water to one pour-point. The final watershed is the assemblage of streams that flow directly into the South Fork Flathead River (Hungry Horse Reservoir) from glacial moraine landforms directly above the river. These are called face drainages and are typically first-order streams. Analysis watersheds are labeled with the primary stream name in the watershed, or labeled as a tributary if unnamed. Map 3-5 displays the analysis watersheds, and Table 3-23 lists the analysis watersheds, their size, and the corresponding label on Map 3-5.

Table 3-23. Analysis Watersheds and Acreage

Analysis Watershed	Watershed Area (Acres)	Map Label
Ada Creek	657	A
Emery Creek	13,578	B
Fire Creek	1,766	C
Hungry Horse Creek	15,318	D
Hungry Horse Reservoir Face Drainages	2,639	E
McInernie Creek	1,746	F
Murray Creek	2,001	G
Riverside Creek	4,372	H
Spring Meadow Creek	830	I
Tent Creek	6,236	J
Unnamed Tributary 1	928	K
Unnamed Tributary 2	95	L
Unnamed Tributary 3	269	M
Unnamed Tributary 4	674	N
Unnamed Tributary 5	189	O
Unnamed Tributary 6	303	P
Unnamed Tributary 7	77	Q
Unnamed Tributary 8	470	R
Unnamed Tributary 9	192	S
Total Acres	**52,418**	--


Map 3-5
Firefighter Project
Watershed Analysis Area
N
W
E
S
Code | Name
A | Ada Creek
B | Emery Creek
C | Fire Creek
E | Hungry Horse Reservoir Face
D | Hungry Horse Creek
F | McInernie Creek
G | Murray Creek
H | Riverside Creek
I | Spring Meadow Creek
J | Tent Creek
K | Unnamed Tributary 1
L | Unnamed Tributary 2
M | Unnamed Tributary 3
N | Unnamed Tributary 4
O | Unnamed Tributary 5
P | Unnamed Tributary 6
E | Hungry Horse Reservoir Face
R | Unnamed Tributary 8
S | Unnamed Tributary 9
Q | Unnamed Tributary 7
MOCCASIN CREEK
PYRAMID CREEK
DEERUCK CREEK
GREAT BEAR CREEK
CASCADE
RESCUE CREEK
WAHOO CREEK
MIDDLE FORK FL
OLIVER CREEK
REMINGTON CREEK
ROYAL CREEK
STRIFE CREEK
ABBOT CREEK
EMERY CREEK
MARGARET CREEK
TIGER CREEK
TURMOIL CREEK
LOST MARE CREEK
HUNGRY HORSE CREEK
Rd 38
FIRE CREEK
SPRING MEADOW CREEK
ADA CREEK
DUDLEY CREEK
RYLE CREEK
LOST HAIR CREEK
SEAGRID CREEK
TENT CREEK
RIVERSIDE CREEK
TUNNEL CREEK, TRIB 1
TUNNEL CREEK
PAOLA CREEK
DICKEY CR
MURRAY CREEK
MCINERNIE CREEK
DEEP CREEK
RUBY CREEK
SOUTH FORK DIC
CANYON CR
HUNGRY HORSE RESERVOIR
WOUNDED BUCK CREEK
LID CREEK
ELYA CREEK
0 1 2 4 Miles

Affected Environment

Introduction

Generally, there are four attributes used to characterize the existing condition of a watershed and water resource; upland/stream channel condition, upland/stream channel stability, water quality, and water quantity. Water quantity and water quality are a result of the geology, landforms, vegetation, climate, and disturbance regimes that characterize an area. Water quantity in mountainous areas is generally characterized by the amount and timing of the surface water flow (streams) and/or subsurface water flow (groundwater). Water quality is characterized by the chemical (nutrient yield) and physical (sediment yield) properties of the water.

The following is a discussion of the affected environment in and around the Firefighter Project analysis area. This section describes the general weather, geomorphology, stream channel, water yield, stream flow, and water quality/chemical characteristics within the analysis area, and past disturbances within the watersheds.

Site Description

Climate

The weather variations for the entire Flathead region are due to the influence of maritime patterns from the Pacific Ocean. The general easterly flows by lower layers of the atmosphere common at this latitude of the Pacific Northwest are modified by the mountain complexes of western Montana and central Idaho. The high mountains in the Continental Divide directly east of the Flathead region form an effective barrier against most cold Arctic patterns flowing south from Canada. During the winter months, the valleys experience many days with dense fog or low stratus cloud layers due to the trapping of dense, valley-bottom air by warmer Pacific air moving over the top.

Precipitation varies widely with season, elevation, and location. The greatest percentage of precipitation falls as snow during winter months. Some precipitation occurs every month of the year. Most winter precipitation in the mountains occurs as snow, although some rain-on-snow events are documented. Density of the mountain snow pack increases from about 20% water equivalency in early winter to about 35% in April. The weather station at Hungry Horse Dam, MT (station I.D. 244328) is used to characterize the precipitation of the South Fork Flathead (NOAA, 2006). Tables showing the average monthly climatic date for Hungry Horse are included in the Hydrology Report in the Project File.

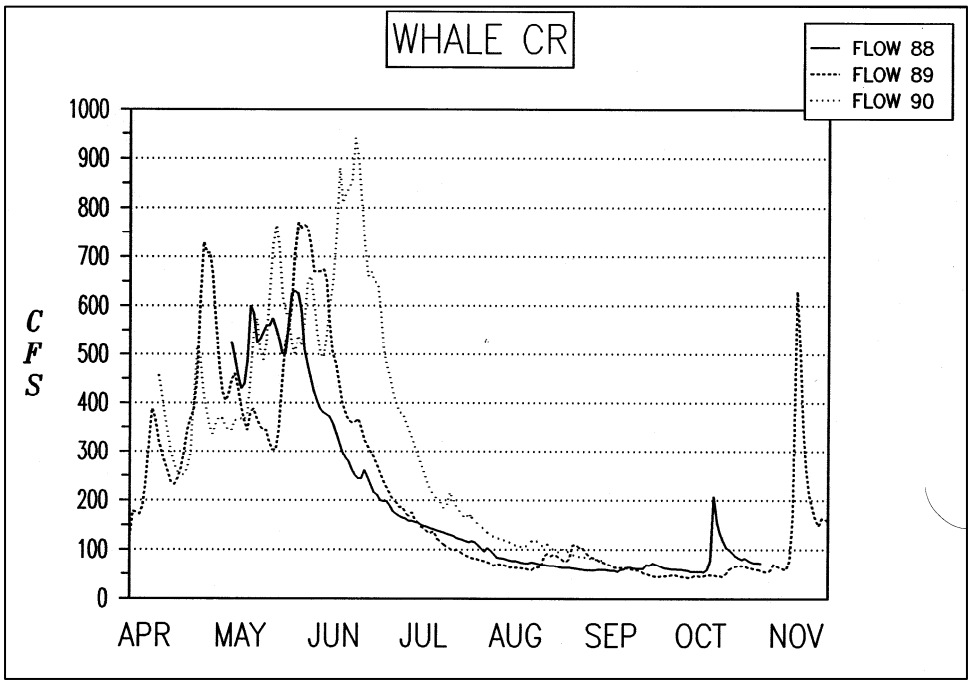
Streamflow

Streamflow begins to increase in April as the snow pack melts, and peak flow is usually reached in late May or early to mid-June. Not all snowmelt or rainfall immediately becomes surface runoff. The majority of the precipitation infiltrates the soil surface to become groundwater that percolates downward into the subsoil and bedrock, resurfacing in wet areas, small ponds, and perennial streams at various elevations below the point of infiltration. Slow release of

groundwater provides stream base-flow beginning in mid-July and continues until the fall rains, which typically begin in mid-September.

Peak streamflow usually occurs in late May or early June due to spring snowmelt within the analysis area. Flood flows rarely overtop the channel banks and erode adjacent land areas. High flows that erode the upper banks of the channel occur every three to five years. The last major high flow was in the spring of 1997 from the snowmelt of an unusually deep snow pack. Season-long hydrograph data is not available for a stream in the analysis area; however, Figure 3-1 displays the April thru November hydrograph for three years for Whale Creek, which is 44 air miles north of the analysis area. Typical runoff peaks occur in May to late June, with base flows occurring from late July to early November. Whale Creek has a slightly larger flow that the other analysis watersheds, but it should have a very similar hydrograph.

Figure 3-1. Whale Creek Waterflows (1988 – 1990) at the Bridge on Forest Road 486



Geology / Landforms

Glacial deposits or erosive surfaces dominate the landscapes in the entire South Fork Flathead River basin. There are extensive surface deposits of alluvium, glacial till, glacial outwash and lacustrine sediments in the valley bottoms and on mountain slopes. The glacial till was deposited by continental ice sheets or valley glaciers during the Pleistocene epoch. The underlying bedrock is Precambrian meta-sedimentary rock including argillites, siltites, quartzites, and limestone.

Climate, geology, and geomorphic processes combine to create various landforms. Landforms, soils and the associated vegetation are the dominant physical features that affect watershed processes by regulating how and where water flows across the landscape. These same physical

features influence the erosion processes that occur across the landscape. Landforms common in the analysis area are described in Table 3-24.

Disturbances such as fire and timber harvesting release nutrients from vegetation and soil. Many of the nutrients end up stored in soil and available for plants. Some of the released nutrients can end up in streams; nutrients are then routed downstream to the Flathead River and ultimately to Flathead Lake. Potential nutrient contribution for each individual landform is rated from low to high in Table 3-24. The nitrogen yield rating is based on the natural level of nitrogen in the soil, soil permeability, and precipitation. The phosphorus yield is based on the natural level of phosphorus in the soil and sediment hazard.

Stream Type Characterization

The Rosgen Stream Classification System provides a method for identifying streams according to morphological characteristics (Rosgen 1996). The morphological characteristics include factors such as channel gradient, sinuosity, width/depth ratio, dominant particle size of bed and bank materials, the entrenchment of channel, and the confinement of channel in the valley. A Rosgen Stream Type Classification (level –1) was developed for the Flathead National Forest in 1999 using digital elevation models (DEM). The model only reliably identifies A, B, C, and E stream types. Stream types in analysis watershed groups were extracted from the Rosgen coverage in the GIS library maintained by the Flathead National Forest. Stream types typically occurring on the various landforms are described in Table 3-24. Rosgen stream types are fully described in Rosgen 1996, and are summarized below:

- A-type: streams with gradients of 4 to 10%, characterized by straight, non-sinuous, cascading reaches with frequently spaced pools.
- B-type: streams with gradients of 2 to 4%, moderately steep, usually occupying narrow valleys with gently sloping sides.
- C type: streams with low gradients < 2% with moderate to high sinuosity and low to moderate confinement.
- E-type: streams with gradients < 2% with high sinuosity and moderate confinement; gravel and small cobble channel bottoms, and silt or clay banks.

Table 3-24. Summary of Typical Landforms, Stream Types, and Relative Nutrient Yield Potential in the Firefighter Project Area

Landform Class	Landform Acres in Analysis Watersheds	Most Common Stream Type	Nutrient Yield Potential Following Harvesting and Burning	
			Expected Nitrogen Yield	Expected Phosphorus Yield
Mass-Wasting Slopes	703	A	Moderate	Moderate -High
Valley Bottoms	1,202	C / E	Moderate	High
Breaklands	5,409	A	Moderate	High
Steep Alpine Glacial Land	12,423	A1/Aa+1 or A2/Aa+2	Moderate	High
Gentle to Moderately Sloped Glacial Land	13,671	A or B	Low	Moderate
Mountain Slopes and Ridges	13,240	A	Moderate	Low

Watershed Current Condition Assessment

Stream channel/upland condition, stream channel/upland stability, water quantity, and water quality (including sediment yield and nutrient yield) are the four major characteristics that describe the condition of a watershed. Following either natural or man-caused disturbances, there can be changes in water yield, sediment yield, and/or nutrient yield in runoff water from the affected basin. Past disturbances, including road building, timber management, wildfires, and floods, have the greatest potential to affect the current stream channel condition, water yield, and sediment yield in project area streams. Road construction is discussed in the sediment yield section, timber harvest and wildfires are discussed in the water yield section; flood events are discussed below.

Flood events are a primary natural disturbance processes affecting stream channels. A review of the U.S. Geological Survey's water flow records for the North Fork Flathead River near Columbia Falls indicates that there were two notable flood events in the flow records of 1911 to 1997. The June 9, 1964 flood was the highest recorded flow record at 69,100 cubic feet per second (USDI Geological Survey, 2007). This is an increase of 628% above the base flow of 11,000 cubic feet per second. This flow is greater than a 2,000-year return interval flood event (Personal communication, Charles Parret USGS). The 1964 flood had a major impact on most of the stream channels in the analysis area.

Stream Condition/Stability Surveys

The Pfankuch stream channel rating was developed to "systemize measurements and evaluations of the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from potential changes in flow and/or increases in sediment production" (USDA Forest Service 1978). This procedure uses a qualitative measurement with associated mathematical values (dimensionless units) to reflect stream conditions. The rating is based on fifteen categories: six related to the bottom of the stream channel (the part of the channel covered by water yearlong), five related to the lower banks (covered by water only during spring runoff), and four related to the upper banks (covered by water only during flood stages). Streams rated Excellent (<38) or Good (39-76) are less likely to erode during high flow than streams in Fair (77-114) or Poor (115+) condition. Prime fish habitat usually occurs in streams with a Good or Fair rating; streams in Excellent condition usually do not have adequate gravels for good spawning habitat.

The rating is evaluated along a stream reach, which is a section of stream with similar characteristics. Each rating represents one point in time, and a series of ratings must be made over several years to show the trend of stream stability. This method shows whether the stream is headed towards or away from dynamic equilibrium. Beginning in the late 1970s, the stream channels through the Flathead National Forest have had Stream Stability Ratings performed periodically; a significant shift of the ratings from Good to Poor can reveal a change in the stream channel stability. All the Stream Stability Ratings completed since the 1970s, on all the streams in the analysis area, fell into the Fair to Good category.

Pfankuch ratings were done for streams that had the potential to experience water yield increase from proposed timber harvest activities (refer to Table 5 in the Hydrology Report, Project File). Fifteen of the eighteen stream ratings performed in 2007 were in the Good class, or were borderline Good in the upper portion of the Fair class. Three streams reaches are classified as a Rosgen G3 stream type (G3 stream types are limited in this area), these are surveyed reaches #10, #15, and #17 (refer to Project File Stream Reach Survey Map). These G type, or gully stream types, typically would not be expected to have as high a stream stability rating as other stream types. In 1996, Rosgen developed stream stability classes for each stream type. Based upon his analysis the three stream-reaches in question would all be classified as having a Good stability rating. Refer to the table on page 6-30 in Applied River Morphology (Rosgen, 1996). There was an effort made during the development of Alternative 2 (Proposed Action) to minimize the timber harvest that could directly affect any of these stream reaches. The Pfankuch stream stability data sheets and a table displaying the Pfankuch stream stability ratings in the Firefighter Project area are contained in the Hydrology section of the Project File.

While stream reaches were being survey for stream stability ratings, stream width and depth were measured to develop a width-to-depth ratio. All of the streams are within the expected width-to-depth ratio range for the stream type surveyed.

Water Quantity (Water Yield)

The amount and timing of water flow from a basin is a major characteristic of a watershed. Water yields from a forested watershed change with an increase or decrease in forest canopy coverage due to timber harvest, wildfires, and/or natural vegetation growth. Watersheds exhibit great natural variability in flow and can accommodate some increase in peak flows without affecting stream channels and aquatic organisms. Increases in average high flows can cause a variety of channel effects, including channel widening and deepening, bank and bottom erosion, and sediment deposition on bars or islands. Substantial increases in peak flows generally lead to a subsequent increase in sedimentation. If the amount of water yield increase exceeds the capacity of the stream channel, there would typically be an increase in stream channel erosion.

The relationship between removal of vegetation by timber harvest and increases in water yield are well-established (USDA Forest Service, 1976). Snow accumulation and subsequent water yield are higher in open forest conditions, as would be created by timber harvest or fire (McCaughey and Farnes 2001; Skidmore et al. 1994; Molnau and Dodd 1995), and snowmelt may be advanced in time as well, moving peak flows to earlier in the spring (Farnes 2000). The majority of the increase in water yield occurs during the spring runoff (King 1989). Climate largely determines the magnitude of large flood events (Dunne and Leopold 1974), but land use practices have been shown to increase peak flows (Troendle and Kaufman 1987). A reduction in tree density and canopy cover results in decreased transpiration and canopy interception of rain and snowfall, increasing the amount of precipitation available for runoff. Water yield would return to pre-harvest levels with tree canopy regrowth. The stands types/habitat types that occur in the proposed units would be expected to have full vegetative-hydrologic recovery approximately 90 years after a clearcut or stand-replacing fire (USDA Northern Region 1976) (Galbraith 1973).

Timber management first occurred on National Forest System lands in the analysis watersheds beginning in 1943. The most recent timber management activity was the Firefighter Mountain Winter Range Project implemented from 1992 to 1996, and the Lower Emery sale completed in 2003. All types of silvicultural treatments have been used in the area, and since 1943, there have been silvicultural treatments on 10,782 acres. Regeneration cuts (clearcuts, seedtree, or shelterwood cuts) comprised 51.1% of the treatments, with the remainder being thinning, overstory removals, or miscellaneous salvage harvests. Prescribed fire was applied to 3,297 acres of the analysis watersheds during 2005 and 2006. Table 3-25 contains a summary of past forest management and road building activities in each of the analysis watersheds, the existing water yield increase above natural, and the road-associated sediment yield from past activities.

All sites with previously harvested areas are well vegetated with large and medium sized trees, poles, shrubs, and grasses. These harvest sites are not contributing any measurable sediment to the project area streams, and are well on their way to hydrologically recovering from the past vegetation treatments. Shrubs, forbs, and grasses have re-grown on the 3,267 acres burned in the wildlife prescribed fires, but these areas are not yet fully recovered hydrologically.

The ECA model was used to generate an estimate of the existing water yield increase above natural for all of the analysis watersheds in the Firefighter Project area. The existing water yield increase currently ranges from 0.5% to 11.3% in the analysis watersheds. When streams are approaching or exceeding 9 to 10% increased water yield, a stream stability rating is typically completed to ensure there would be no increased channel erosion (from additional water yield) were additional vegetation cover reduction to occur. All of the stream stability ratings completed in the analysis area were in the Good class for each stream reach.

Water Quality

Sediment Yield

The amount of sediment routed to, or eroded within, a stream channel could affect the beneficial uses of water; it is frequently used as a measure of overall water quality. Stream channel size and shape have evolved to carry the historical sediment load, and large increases in the sediment yielded to a stream may exceed the stream's ability to transport the load (Dunne and Leopold 1974). As a result, sediment deposition would occur in the stream channel, especially in low-gradient sections of a stream, as point bars and mid-channel bars. This leads to a wider, shallower, less stable channel than pre-deposition conditions, which may have a detrimental effect to fisheries by clogging spawning gravels. Increased sedimentation also impacts macro-invertebrates and other aquatic organisms. Bank erosion may be increased, thus adding even more sediment to the stream.

In managed forest areas, the main source of direct sediment is from road construction associated with timber harvest (Megahan and Kidd 1972). Channel alteration, road construction, other construction in or adjacent to live streams, and culvert or bridge installation may result in sediment being deposited directly into a stream. The construction of Forest Road 38 (Eastside Reservoir Road) was associated with the construction of Hungry Horse Dam in the early 1950s. The majority of the remaining forest roads were constructed to facilitate timber management

activities from the 1950s – 1990s. Beginning in the mid-1990s, the implementation of water quality Best Management Practices (BMP) for roads significantly reduced sediment input into streams from forest road systems. There are 150.2 miles of existing roads within the analysis watersheds. In the mid-1990s, the Forest Service began decommissioning roads for wildlife habitat improvement; since then approximately 44.6 miles of roads have been decommissioned within the analysis watersheds.

Stream crossings are the primary introduction point for sediment from the road system into a stream channel. There are 84 road/stream crossings on the existing road system in the analysis area watersheds. The potential sediment yield from each road/stream crossing was calculated as an estimate of the background road-associated sediment yield. The WEPP – Roads soil erosion model was used to estimate the potential sediment delivery from road/stream crossings. The total annual sediment yield from the existing road system in the analysis area is approximately 6.72 tons. The modeling results for the existing potential road associated sediment are summarized in Table 3-25 for each analysis watershed, and the WEPP model assumptions and results are in the Hydrology section of the Project File.

Tree falling is not usually considered a major cause of increased sediment, although methods for removing harvested timber (e.g. tractor yarding) can cause erosion due to the gouging of slopes and the reduction of soil infiltration rates from compaction. Logging causes a reduction in vegetation cover over the soil surface and skid trails may increase soil erosion potential. The erosion potential decreases rapidly over time following timber harvest as the site revegetates. The District Hydrologist observed no measurable amount of soil erosion occurring on past timber harvest or prescribed burn areas.

A statistical analysis of the relationship between suspended sediment and stream discharge was completed for samples collected from 1976 through 1986 on the Flathead National Forest (Anderson, 1988). Rating curves and regression analysis for the Spotted Bear and Hungry Horse Ranger Districts were reviewed to estimate background sediment carrying capacity for the analysis area. The estimated average background sediment concentration for watersheds in this geo-climatic region area, based on a review of the data, is 3.5 mg/l, with a range of 0.6 to 12.7 mg/l. For more information, including a table displaying a summary of the available data, refer to the Hydrology Report, Project File.

Table 3-25. The Firefighter Project Area Analysis Watersheds – Information Summary

Analysis Watershed	Water-shed Area (acres)	Total Acres of Past Timber Mgmt	Total Acres of Past Prescribed Fires	Existing Equivalent Clearcut Area (acres)	Existing Annual Water Yield Increase Above Natural	Total Miles System Road (miles)	Road Density (miles/ sq. mile)	Existing Background Sediment Yield - Road Associated (lbs/Year)
Ada Creek	657	138	0	88	5.6%	2.27	2.2	0
Emery Creek	13,578	4,219	1,694	3,018	11.3%	60.70	2.9	3,569
Fire Creek	1,766	283	0	92	2.3%	6.20	2.2	696

Analysis Watershed	Water-shed Area (acres)	Total Acres of Past Timber Mgmt	Total Acres of Past Prescribed Fires	Existing Equivalent Clearcut Area (acres)	Existing Annual Water Yield Increase Above Natural	Total Miles System Road (miles)	Road Density (miles/ sq. mile)	Existing Background Sediment Yield - Road Associated (lbs/Year)
Hungry Horse Creek	15,318	1,867	222	754	1.3%	29.57	1.2	2,974
Reservoir Face Drainages	2,639	746	182	417	6.7%	10.48	2.5	0
McInernie Creek	1,746	120	452	481	8.8%	1.93	.7	322
Murray Creek	2,001	97	505	523	8.7%	1.17	.4	322
Riverside Creek	4,372	232	16	96	0.5%	2.32	.3	760
Spring Meadow Creek	830	490	0	181	9.0%	3.91	3.0	464
Tent Creek	6,236	1,620	0	496	1.8%	19.78	2.0	2,190
Unnamed Tributary 1	928	173	115	155	6.7%	.70	.5	116
Unnamed Tributary 2	95	92	0	22	10.2%	1.16	7.8	231
Unnamed Tributary 3	269	217	0	46	9.0%	2.06	4.9	116
Unnamed Tributary 4	674	167	0	75	4.9%	4.69	4.5	580
Unnamed Tributary 5	189	26	0	17	3.8%	.49	1.7	116
Unnamed Tributary 6	303	30	0	20	2.9%	.86	1.8	116
Unnamed Tributary 7	77	7	0	4	2.4%	.21	1.8	0
Unnamed Tributary 8	470	147	81	57	4.2%	1.13	1.5	553
Unnamed Tributary 9	192	111	0	29	5.5%	.51	1.7	332
Total	**52,340**	**10,782**	**3,297**	**--**	**--**	**--**	**--**	**13,447 (6.72 tons)**

Nutrient Yield and Water Chemistry

Information about nutrient levels in the Flathead Basin is published in the Joint Water Quality and Quantity Committee Report – Flathead River International Joint Commission Study (Valiela and Thomas 1987). The study states "waters of the Flathead River system contain very low amounts of the major nutrients nitrogen and phosphorus. Autotrophic production in most lotic and lentic waters in the basin appear to be phosphorous limited, although nitrogen may not be

present in sufficient quantity or in required forms to support much productivity during late summer in some waters."

The "Nutrient Management Plan and Total Maximum Daily Load for Flathead Lake, Montana" (Montana Department of Environmental Quality 2001) publication identifies phosphorus and nitrogen as the primary nutrients of concern in the Flathead Lake basin; the South Fork Flathead River is a primary tributary to Flathead Lake. Any nutrient increase in the headwater streams that could increase nutrient levels in Flathead Lake, which would lead to increased algae growth in the lake, would be of concern. The relative estimated nitrogen and phosphorus yields for each common landform following harvesting/burning are displayed in Table 3-24. The estimated nutrient yield is based on the background levels of the pre-fire nutrients, and knowledge of how various soil types would leach or erode nutrients after a disturbance (e.g. fire, timber harvest).

Water quality was monitored at a station on Emery Creek (six miles east-southeast of Hungry Horse, Montana) from 1976 to 1981; this monitoring indicated that the levels of various nutrients are typical for the geologic parent material found in this portion of the South Fork Flathead River. The other analysis watersheds would be expected to have very similar water chemistry characteristics. Refer to Table 7 in the Hydrology Report (Project File) for water chemistry data for Emery Creek. There are no streams in the Firefighter Project area currently listed on the Montana Department of Environmental Quality - 303(d) Impaired Waterbody List. Refer to the Hydrology section of the Project File for more detailed information on water quality.

Summary and Interpretation of Existing Conditions

After the field review of many stream reaches, review of the water quality data, and the physical stream channel measurements taken during the past several years, the District Hydrologist concluded that all streams in the analysis area are in proper functioning condition[1]. The stream stability ratings are in the Good range or the higher portion of the Fair range for all streams in the analysis area. Harvested forest stands in this area have experienced rapid vegetation recovery with a somewhat delayed hydrologic recovery. The robust natural revegetation has helped to decrease the post-harvest water yield increase effects to the streams in the analysis area. Based upon field reviews of past timber management areas, no significant soil erosion exists on any of the sites, and harvested areas are not contributing sediment to analysis area streams. In general, after inspecting the analysis area stream channels and reviewing the applicable available water quality and physical stream data, the Hydrologist concluded that all of the streams and their associated characteristics (physical & chemical) are within their natural range of variation. These interpretations are based upon past monitoring reports, literature, field observations, and professional judgment.

[1] "***Proper Functioning Condition*** – Riparian-wetland areas are functioning properly when adequate vegetation, landforms, or woody debris are present to dissipate stream energy associated with high waterflows. This reduces erosion; improves water quality; filters sediment; captures bedload; aids floodplain development; improves flood-water retention and ground-water recharge; develops root-masses that stabilize streambanks against cutting; develops diverse pond and channel characteristics to provide the habitat, water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and supports greater biodiversity." (U.S. Department of the Interior, Bureau Of land Management 1993)

Environmental Consequences

Introduction

The effects indicators used to measure the potential effect of the Proposed Actions are:

- Potential changes to water yield
- Potential changes to water quality (sediment yield and nutrient yield).

The evaluation of direct, indirect, and cumulative effects to water used the most recent and available information, in addition to data related to past, present, and reasonably foreseeable events in the analysis area. Applicable past, present, and foreseeable events described in the introduction to Chapter 3 were considered during the evaluation of the affected environment. The condition of the affected environment together with applicable reasonably foreseeable events, were considered during the analysis of the environmental effects of the proposed alternatives.

Alternative 1 (No-Action Alternative)

Direct and Indirect Effects

There would be no direct effects to the water resource were Alternative 1 to be implemented, because no ground disturbing activities would occur.

There are two possible indirect effects to the water resource if Alternative 1 were chosen. First, if wildfires were to occur in the area, there would be an increased potential for high soil-burn severity on a significantly higher portion of the acreage than if the harvesting and/or prescribed burning were accomplished. Following a high-intensity wildfire, sites that experienced high soil-burn severity would have the potential for significantly increased post-fire soil erosion for 2 to 3 years. This would be especially true were a short-duration, high-intensity rainstorm to occur on the burn site. The resulting soil erosion event could transport significant amounts of soil materials to stream channels. This in turn would increase sediment and nutrient yields in the stream water, reducing water quality, and potentially affecting fish habitat.

The second possible indirect effect of implementing Alternative 1 would be an increased potential for culverts to fail (plugging and washing out the road prism) on perennial streams. There are 17 culverts proposed to be removed and 6 to be upsized in Alternatives 2 and 3. A culvert failure would have the potential to increase sediment and nutrient yield in stream water, thus reducing water quality and potentially affecting fish habitat.

Alternative 2 (Proposed Action)

Direct and Indirect Effects – Harvesting, Burning, and Temporary Road Construction

Forest timber harvesting, broadcast burning, and temporary road construction activities may affect both water quantity and water quality. Three effects to the water resource were analyzed

and discussed for the proposed Alternative 2 timber harvest and associated activities. These three effects are:

1) Potential water yield increase associated with the vegetation cover reduction due to timber harvest and/or broadcast burning, and the temporary road construction activities.
2) Potential soil erosion/sediment production increases associated with the proposed timber harvest yarding process, broadcast burning, temporary road construction, landing construction, culvert replacements, and culvert removals.
3) Potential water nutrient level increases associated with the timber harvest, broadcast burning, temporary road construction, landing construction, culvert replacements, and culvert removals.

Proposed activities under Alternative 2 would include timber harvest on 749 acres in 32 units, and broadcast burning 551 acres in 23 units following harvest treatments. Timber harvesting would require the use of approximately 38 landings. Yarding would be by ground-based skidding or ground-lead cable on 30 units, full suspension skyline and helicopter yarding would occur on the remaining two units. Approximately 30 miles of roads would be used for hauling in the project area, there would be about 3.0 miles of new temporary road construction, and 1.3 miles of historic/naturally revegetated roads restored to be used as temporary roads. Best Management Practices (BMP) road improvements (drive-thru-dips, water flappers, etc.) would be implemented on all haul routes and on an additional 4.5 miles of non-haul routes in the project area to decrease potential road-associated sediment yield. These activities would have the greatest potential to affect water quantity or water quality. The excavator piling of slash on approximately 198 acres would have no direct effect on water quantity or water quality. This interpretation was based upon past soil monitoring of excavator piling by the forest soil scientist, and the lack of observed post-treatment soil compaction and soil erosion associated with this practice. Refer to soil section of this chapter for more information.

Proposed road management changes would include: 13.8 miles of new road decommissioning; berming 17.9 miles of currently gated yearlong roads; gating yearlong 1.3 miles of currently open yearlong roads; berming .6 miles of road slated to be decommissioned; and opening yearlong .8 miles of road currently closed yearlong. The road management work would include the removal of seventeen culverts and the upsizing of six culverts.

Water Yield Effects

Harvesting, Burning, and Temporary Road Construction

A water yield analysis was performed to assess the effects of the proposed harvesting, burning, and temporary road construction on water quantity. The natural background water yield level, the present day water yield level, and the expected water yield under each alternative were modeled. ECA modeling was discussed previously in the Affected Environment section of this report; the results of the ECA modeling for the analysis watersheds are displayed in Table 3-26. Note: for water yield calculations, landing areas occur either on roads or within proposed cutting units; therefore, no additional area of land is impacted by the landing area and it is not accounted for twice in the water yield model.

An increase in water yield above natural background levels of greater than about 10% is used as an indicator of increased risk for stream channel erosion; this level is based upon past monitoring and professional judgment (Galbraith 1973). When a stream has a water yield increase of greater than 10% above natural background, and has a Fair or Poor stream stability rating, an assessment is made of the existing stream condition and potential increased stream erosion due to water yield increase. Generally, channels with a Pfankuch class of Good are capable of handling water yield increases with little risk of channel erosion or other major adverse effects. Those channels in the Fair class are at a higher risk of channel erosion from additional water yield; and channels with a Poor stability rating already show signs of active channel erosion, and any additional water yield could increase erosion potential.

A field review of stream channels in the analysis area (refer to Map 3-5) verified that the streams potentially affected by the proposed activities are rated as Good, or in the upper portion of the Fair class (Table 5 in Hydrology Report in the Project File). The water yield increase expected if Alternative 2 were implemented would range from 0% to 6.8% in the analysis watersheds (Table 3-26). The watershed with the largest increase would be Unnamed Tributary 7 (6.8%), and 8 of the 19 analysis watersheds would experience no change in water yield.

Only a small portion of the Hungry Horse Reservoir Face Drainages concentrates runoff water flow from precipitation into a single channel. The vast majority of the lands in these face drainages move precipitation in the form of groundwater, not as streams of concentrated surface water flow. Increased water yield in this type of watershed does not pose a significant risk of increased stream channel erosion. The lower reach of Unnamed Tributary 7 is a drainage that concentrates runoff water flow into a single channel, however this is a very small ephemeral stream channel and there should be no water yield increase to this channel.

Spring Meadow Creek currently has an existing water yield increases above natural of 9.0%, which would increase to 10% if Alternative 2 were to be implemented. The Pfankuch rating for the lower reach of this stream was 100, classified as Fair condition under the Pfankuch class breaks. Rosgen, in his book Applied River Morphology (1996), stratified Pfankuch condition classes by stream type in order to have better predictive response of a given stream reach due to changes in stream type. The stream type in lower Spring Creek is a G4, with a rating of 100; this would be considered in a Good condition class. Therefore, even though the water yield increase following the Alternative 2 harvest in Spring Meadow Creek is approximately 10%, there should be no increased channel erosion beyond the natural range for that stream-type, based upon professional judgment and experience on stream channels within the Flathead National Forest.

Table 3-26. Alternative 2 – Modeled Water Yield Data for Analysis Watersheds

Analysis Watershed	Watershed Area (acres)	Annual Natural Water Yield (acre-feet)	% Existing Annual Water Yield Increase Above Natural (ECA[1] acres)	Alt. 2 % Annual Water Yield Increase Above Natural (ECA acres)	Alt. 2 % Increase Annual Water Yield
Ada Creek	657	749	5.6 % (88 ac)	9.6 % (152 ac)	4.0 %
Emery Creek	13,578	25,299	11.3% (3,018 ac)	No Change	0%

Analysis Watershed	Watershed Area (acres)	Annual Natural Water Yield (acre-feet)	% Existing Annual Water Yield Increase Above Natural (ECA[1] acres)	Alt. 2 % Annual Water Yield Increase Above Natural (ECA acres)	Alt. 2 % Increase Annual Water Yield
Fire Creek	1,766	2,018	2.3% (92 ac)	6.1% (260 ac)	3.8%
Hungry Horse Creek	15,318	38,732	1.3% (754 ac)	No Change	0%
Reservoir Face Drainages	2,639	3,014	6.7% (417 ac)	9.1% (570 ac)	2.4%
McInernie Creek	1,746	4,803	8.8% (481 ac)	9.2% (505 ac)	.4%
Murray Creek	2,001	6,090	8.7% (523 ac)	9.4% (579 ac)	.7%
Riverside Creek	4,372	13,613	0.5% (96 ac)	No Change	0%
Spring Meadow Creek	830	946	9.0% (181 ac)	10.0% (202 ac)	1.0%
Tent Creek	6,236	14,697	1.8% (496 ac)	2.2% (635 ac)	.4%
Unnamed Tributary 1	928	1,058	6.7% (155 ac)	7.9% (182 ac)	1.2%
Unnamed Tributary 2	95	108	10.2% (22 ac)	No Change	0%
Unnamed Tributary 3	269	307	7.4% (46 ac)	No Change	0%
Unnamed Tributary 4	674	678	4.9% (75 ac)	6.4% (100 ac)	1.5%
Unnamed Tributary 5	189	215	3.8% (17 ac)	No Change	0%
Unnamed Tributary 6	303	345	2.9% (20 ac)	No Change	0%
Unnamed Tributary 7	77	88	2.4% (4 ac)	9.2% (17 ac)	6.8%
Unnamed Tributary 8	470	821	4.2% (57 ac)	No Change	0%
Unnamed Tributary 9	192	255	5.5% (29 ac)	9.6% (52 ac)	4.1%

[1]Equivalent Clearcut Area includes all area where vegetation cover has been removed or decreased including roads, timber harvest, thinning, and burned areas.

Based upon the recent field review of the affected stream reaches and the estimated water yield increase modeling of Alternative 2, changes to the current stream channel conditions is not expected in any analysis watershed due to the Proposed Action. The estimated water yield increase from the proposed Alternative 2 logging/broadcast burning units and temporary road construction should not significantly change the risk of stream channel erosion to any of the stream channels in the analysis watersheds from the existing situation. Refer to the Hydrology Report in the Project File for a discussion of water yield increase on some specific streams.

Rain-on-Snow Event Risk

In order to determine if there was a risk of additional water yield from the proposed harvesting/burning during a rain-on-snow (ROS) event, the United States Geological Survey (USGS) flow records for several streams were examined. The flow records (1964 – present) for South Fork Flathead River above Twin Creek near Hungry Horse (Station I.D. 12359800) indicated that one event occurred (November 11, 1989) that was not a ROS event, and another occurred on April 24, 1969 that may have been a ROS event, though earlier than the normal spring melt period. Flow records (1948 – 1976) at Sullivan Creek (Station I.D. 12361000) exhibited a normal spring snowmelt period (May through June) and one peak flow event that occurred on January 16, 1974, it was probably an ROS. The flow records (1929 – present) for the North Fork Flathead River near Columbia Falls (Station I.D. 1235500) were reviewed, and only one year's peak flow discharge was an ROS event. Flow records (1910 – present) for the

Middle Fork Flathead River near West Glacier (Station I.D. 12358500) indicated a peak flow event on March 2, 1972 that probably a ROS, but the highest peak flow for the Middle Fork occurred on June 9, 1964 when a major rainstorm occurred during the spring snowmelt period. The return-internal for this event at West Glacier is considered in excess of 200 years. On November 6, 2006, an ROS event occurred in some watersheds in Glacier National Park and the Flathead National Forest. Therefore, this type of event is rare for the location of the analysis area, but not unheard of.

A recent research paper discussing the causes of peak flow ROS and/or rain-on-spring-snowmelt events in six basins of northwestern Montana and northeastern Idaho concluded, "… there was no apparent correlation between the magnitude of peak flows and the amount of forest harvest." (MacDonald and Hoffman, 1995) In 1996, the Plum Creek Timber Company employed a consultant to model ROS events in the Swan River Valley. The basins they modeled were Goat and Squeezer Creeks. Based upon the research of the available local data on historic ROS events, the upper elevation limit for water to become available for runoff is approximately 5,100 to 5,200 feet. In other words, only the land below that elevation would yield runoff during a typical ROS event. That analysis estimated a 4.9% increase in runoff from a ROS event for a 25-year return interval storm, and 4.5% increase for a 100-year return interval storm (Plum Creek Timber Company, 1997). These modeled increased runoffs are the amount of increase above the level for a fully forested versus the current forested situation for Goat and Squeezer Creeks.

The amount and type of timber harvest/canopy removal in the lower elevations of Goat and Squeezer Creeks are qualitatively similar to the amount of canopy removal that would occur in the lower elevation portions of several of the analysis watersheds after the implementation of the proposed timber harvest and burning. The analysis watersheds that would approach the same level of managed land include Tent Creek, Fire Creek, and Ada Creek. Considering that these scenarios were modeled in close geographical proximity, it is reasonable to hypothesize that a similar response could be expected with an ROS event in the analysis watersheds. Because of the reduction in canopy cover from the proposed timber harvest and broadcast burns, there is the potential for an increase in snow deposition on those sites. This slight increase in snow deposition could theoretically increase the runoff slightly during an ROS event in the area, depending on the intensity/duration of the event. The additive peak flow increase due to the proposed harvesting/burning activities would have the potential for very slightly increasing the amount of channel erosion during a typical ROS event in the analysis area. However, discerning the amount of this potential risk to the channel is impossible. The potential effect of increased peak flow during a ROS event due to the proposed actions would decrease with the recovery of the canopy cover due to tree growth.

Sediment Yield Effects

Proposed Harvesting and Burning

In managed forest areas, the main sources of sediment directly input to stream networks results from road construction and skidding systems associated with timber harvest. The skidding of logs in the Firefighter timber harvest units would reduce the amount of natural vegetation cover (grasses, forbs, and shrubs) for a short time following treatment. The reduction in vegetative cover in the treatment units increases the potential for soil erosion, which increases the potential

sediment yield to streams. Ground-based skidding, without snow cover or down fuel layer, would result in the most vegetation reduction; winter tractor logging would result in the least.

The WEPP – Disturbed Land soil erosion model was used to predict both the background upland potential soil erosion and the amount of potential soil erosion associated with the proposed harvesting and broadcast burning. Typical hillslopes in the area would have no (0.0 tons/acre) potential soil erosion pre- or post-treatment. Post-harvest skid trail area would average 1.0 tons/acre of potential soil erosion until revegetation occurs. The skid trails would be water-barred and have slash piled on them right after skidding is completed. Because of the vegetation buffer distance from any stream channel and the proposed unit/skid trail locations, there is no potential for sediment from the skid trails to enter a stream channel.

Several of the units would be broadcast burned or under-burned following harvest to stimulate shrub production. These units would have 1.7 tons/acre of potential soil erosion with a 1.5-year return interval storm event, and 10.0 tons/acre potential soil erosion with a higher intensity 15-year return interval storm event. Over a 30-year period, the average potential soil erosion would be 3.8 tons/acre for this treatment type on typical hillslopes in the project area. Because a number of short-duration, high-intensity rainstorms are included in the 30-year precipitation/erosion modeling process, the soil erosion from broadcast burning is a worst-case scenario. For this amount of soil erosion to occur, a high-intensity rainstorm must impact the burned area shortly after treatment, a low probability event. Revegetation of the broadcast burn area typically occurs 3 to 5 weeks following a spring burn, which would be well before the late July to early September period when high-intensity thunderstorms usually occur. Of several hundred thousand acres of wildfires that occurred during the past decade in the Flathead River Basin, only a few hundred acres have experienced these post-fire erosion events.

Soil erosion occurring on a hillslope must be transported to a stream channel in order to become sediment yield. Vegetation buffers and other types of physical barriers are very effective in filtering out overland soil erosion before it can be deposited into a stream channel. Seven units are in proximity of an ephemeral or perennial stream channel; these include Units 7, 9b, 9c, 11, 20, 41, and 43. All other units are long distances from any stream channel, or there is a significant vegetation buffer that would not allow the transport of any eroded soil particles (during the logging process) to reach a stream channel. Due to the soil types, the landform slope, and the vegetation buffer distance to any live stream channel, there would be no potential for sediment production from the broadcast burning in the units or burning of burn slash piles to be delivered to a stream channel from any of these units either.

Two of the seven units that are near streams (Units 41 and 43) would be harvested and then would have post-harvest mechanical fuel treatments (excavator piling) and burning of the piles. The excavator piling of slash has a very, very low potential to produce any soil erosion (based upon past soil monitoring as discussed earlier). Implementation of Best Management Practices would require that slash piles be placed outside of the Streamside Management Zone, insuring that an adequate filtration zone would be between the stream channel and any burned slash pile which would prevent any sedimentation.

Five of the seven units near streams (Units 7, 9b, 9c, 11, and 20) are proposed to be logged and then be broadcast burned. Based on the WEPP 30-year average soil erosion potential for harvest/burn treatments applied to all of the acres, and applying 31% sediment delivery efficiency (WATSED model for typical Landtypes), the worst-case potential sediment yield from these five harvest/burn units would be 250.7 tons. This type of erosion has a very low probability of occurring and a great deal of any eroded materials would be filtered out prior to entering a stream channel. Units 11 and 20 have road prisms with a ditch directly below the unit, which would also be a very effective sediment trap. Refer to the Project File for the WEPP soil erosion modeling results and calculations. The results of the modeled potential broadcast burning associated sediment yields are summarized in Table 3-28 for each analysis watershed.

Temporary Roads

Alternative 2 would include the construction of about 3.2 miles of new temporary road and the use of about 1.1 miles of historic or naturally re-vegetated road prism. Seven of the nine new temporary road segments and the two historic road segments to Units 5 and 13 would have no potential to deliver sediment into a stream channel from either the construction/reconstruction or use of the road segment. This is due to soil types, landform slope, the distance to a live stream channel, and the use of drive-thru-dips to reduce amount of road surface runoff. Temporary road segments to Units 7 and 8 cross a stream channel, and the potential exists for sediment to be introduced into the stream at these crossings due to shorter buffer widths. These two stream crossings potentially could yield 315 pounds per year (.15 tons per year) of increased sediment yield during use. This estimate is based upon WEPP-Road soil erosion modeling.

All applicable forestry BMPs would be applied during the logging operations to reduce erosion from the temporary roads. When the use of these temporary roads is completed the new temporary roads would be recontoured, grass seeded, and brush/trees laid down on the road segments as soon as possible following the completion of timber harvest activities. The reused historic road prisms would be reseeded and brush/trees laid down on them as soon as possible following the logging. The results of the modeled potential sediment associated with temporary roads are summarized in Table 3-28 for each analysis watershed; refer to the Project File for WEPP model assumptions and results.

Landings

The proposed timber harvest units in Alternative 2 would require approximately 38 landings (refer to the Proposed Landing Map in the Hydrology section of the Project File). Only one of the landings (landing for Units 9b and 9c) would require significant excavation to be operational. The WEPP-Disturbed Land erosion model was used to estimate the erosion from a 150-foot-by-150-foot landing area considering local soil and climate conditions. The results indicate no potential for soil erosion from that landing (0.0 pounds per acre per year). The landing for Units 9b and 9c would be approximately 1.4 acres in size, and some soil excavation would be necessary. The WEPP-Road erosion model was used to estimate the potential erosion for this landing, and the modeled result was that the potential erosion would be 14,526 pound per year (7.3 tons). To prevent sediment from entering a stream in Unit 9b, there would be at least a 230-foot vegetation buffer between the lower end of the landing and the stream channel. Refer to the Hydrology section of the Project File for the WEPP model assumptions and results.

All applicable forestry BMPs would be applied during the logging operations to reduce erosion from the landings, including grass seeding and water barring as soon as possible following the completion of timber harvest activities.

BMP Improvements

Road segments remaining on the road system following project implementation may require improvements in the road surface drainage and stream drainage systems to meet current Montana State Best Management Practices and INFISH standards. There are approximately 34.4 miles of road requiring BMP improvements proposed in Alternative 2. Most improvement needs are directly associated with improving water drainage from the surface of roads and the filtering of sediment from the road surface and from ditch drainage. Improvements could include adding more road cross-drains (culverts or drive-thru-dips), and/or installing filter-windrows and sediment traps (culvert upsizing is addressed later).

The installation of various BMP treatments at stream crossings can significantly reduce sediment yield from the road surface. Using the WEPP-Road soil erosion model, an estimate was made of the potential sediment entering the stream from the three general types of stream crossings found in the analysis area. A flatter-narrow crossing (4% grade, 14-feet wide), a flatter-wider (double lane) crossing (4% grade, 28-feet wide), and a steeper-narrow crossing (6% grade, 14-feet wide) were modeled. The sediment estimate was completed with and without BMP improvement installed at each crossing type. See Table 3-27 for the estimated sediment yield from the various types of stream crossings with and without BMP treatments.

Table 3-27. Estimated Sediment Yield for Stream Crossings

Road-Stream Crossing Type	Number of Crossings to be Treated	Sediment Yield from Crossings Without BMPs (lbs/year)	Sediment Yield from Crossings with BMPs (lbs/year)	Total Reduction in Sediment Yield (lbs/year)
Flatter-Narrow	22	116	0	2,552
Flatter-Wide	11	322	0	3,542
Steep-Narrow	0	115	0	0
Total	**32**	**-**	**-**	**6,094 (3.05 tons/yr.)**

Drive-thru-dips would be installed approximately 25-50 feet prior to the start of a stream crossing, on the uphill side of the crossing, if the road has a continuous climbing grade through the stream crossing. A drive-thru-dip would be installed on each side of the stream crossing if the road grade dips downward into the stream crossing from both sides. Drive-thru-dips constructed near a stream crossing may allow some sediment to enter the stream channel. The construction of each drive-thru-dip could make approximately 250 square feet of newly exposed, unarmored road prism soil material available to produce sediment. The construction of each drive-thru-dip would have the potential to add 5.0 pounds/year of sediment to a stream until the road prism has been re-armored through the dip area. Based upon map reviews of proposed BMP road improvements, 32-stream crossing drive-thru-dips would be needed under Alternative 2. Construction would yield approximately 160 pounds/year of potential sediment for the first

year or two following construction. After the installation of drive-thru-dips, and additional cross-drain culverts at the stream crossings, there would be a significant reduction in road-associated sediment entering the stream. There would be potentially 3.0 tons/year net reduction in road associated sediment yield with the implementation of the BMPs proposed in Alternative 2. The results of the modeled BMP improvement potential sediment deceases are summarized in Table 3-28 for each analysis watershed (WEPP model assumptions and results are in the Hydrology section of the Project File). Note: Soil weight is approximately 110 pounds/cubic foot (depending on the percentage of stones/gravels) and it takes 18.1 cubic feet of soil to yield a ton of suspended sediment, or 2,970 pounds/cubic yard. One wheelbarrow full of soil weighs approximately 660 pounds.

Summary of Sediment Yield Effects

Table 3-28 displays all of the Alternative 2 sediment effects. The timeframe for the potential sediment yield values reported in Table 3-28 is from the disturbance activity to the first growing season following that disturbance. There would be a reduction in sediment potential of approximately 60-65% following the first growing season after disturbance, of about 80-85% after the third growing season, and a 100% reduction by the end of the fifth growing season after disturbance. The re-vegetation timeframe would be shorter on sites that are more productive.

Alternative 2 proposed timber harvesting, broadcast burning, BMP road drainage improvements, culvert upsizing, and culvert removals would have a short-term temporary negative impact to the water quality due to the increase in sediment yield; approximately 349.5 tons under a worst-case scenario. Seventy-two percent of the estimated sediment yield would be due to soil erosion from the four broadcast burning units if a high-intensity rainstorm were to occur shortly following the broadcast burning; there is a low probably of this event occurring. There would be no sediment yield effects due to timber harvest, slash pile burning, or landing construction. The culvert upsizing and removals would have a short-term effect to the water quality; however, there would be a long-term positive effect due to the reduction of culvert failure risk and the associated sedimentation. Alternative 2 actions should not cause a measurable increase to sediment yield outside the natural range of variation for the streams in the Firefighter Project area, unless the above mentioned post-fire soil erosion event were to occur. If the Alternative 2 worst-case scenario of an estimated 349.5 tons of sediment were all delivered to the Hungry Horse Reservoir, it would not be outside the range of natural variability for sediment yield into the South Fork Flathead River system. Downstream of the Reservoir, the sediment yield increase would probably not be discernible due the dilution effect and sediment settling that occurs in the Reservoir.

All applicable forestry BMPs would be applied during the proposed timber harvest and road construction activities in Alternative 2, which meets the intent of the Clean Water Act, the Montana Water Quality Law, and the Flathead National Forest Land and Resource Management Plan Standards and Guidelines. Due to streamside buffer zones and the large quantity of groundwater flow in analysis area streams, Alternative 2 proposed logging units should not cause a measurable change to stream water temperature. An extensive review of water temperature data can be found in the Fisheries section of this EA.

Table 3-28. Alternative 2 – Modeled Potential Sediment Yield for Analysis Watersheds

Analysis Watersheds	1st Year Culvert Upsizing Sedi-ment Yield (lbs)	1st Year Culvert Removal Sediment Yield (lbs)	Temp. Road Culvert Placement Sediment Yield (lbs)	Burning After Harvest Sediment Yield (lbs)	1st Year BMP Construc-tion Sediment Yield (lbs)	Sediment Re-duction From BMP Instal-lation (lbs)	Total 1st Year Sediment Yield – Alt 2 (lbs)
Unnamed Tributary 1	5,800	0	0	92,800	5	-116	98,489
Unnamed Tributary 2	0	26,400	0	0	5	-116	26,289
Unnamed Tributary 3	0	17,600	0	0	5	-116	17,489
Unnamed Tributary 4	0	46,000	0	0	20	-580	45,440
Unnamed Tributary 5	0	9,200	0	0	5	-116	9,089
Unnamed Tributary 6	0	9,200	0	0	5	-116	9,089
Fire Creek	0	17,600	0	330,600	20	-464	347,756
Unnamed Tributary 7	0	0	315	37,000	0	0	37,315
Ada Creek	0	0	0	0	0	0	0
Spring Meadow Creek	0	0	0	41,000	10	-232	40,778
Reservoir Face Drainages	600	0	0	0	0	0	600
Hungry Horse Creek	0	58,800	0	0	20	-1,288	57,532
Tent Creek	0	0	0	0	50	-2,190	-2,140
Riverside Creek	0	0	0	0	10	-760	-750
Unnamed Tributary 8	0	0	0	0	0	0	0
Unnamed Tributary 9	0	0	0	0	0	0	0
Murray Creek	0	0	0	0	0	0	0
McInernie Creek	0	0	0	0	0	0	0
Emery Creek	12,000	0	0	0	0	0	12,000
Total	**18,400 (9.2tons)**	**184,800 (92.4 tons)**	**315 (.15 tons)**	**501,400 (250.7 tons)**	**155 (.08 tons)**	**-6,094 (3.05tons)**	**698,976 (349.5tons)**

Nutrient Yield Effects

Within the Flathead Basin, phosphorus and nitrogen are the primary nutrients of concern that have been identified and studied in connection to timber harvest and fire activities. The primary concern with any nutrient increase in the headwater streams would be the potential for increasing

the nutrient levels in Flathead Lake that would lead to increased algae growth. This was specifically addressed in the Nutrient Management Plan and Total Maximum Daily Load for Flathead Lake, Montana (Montana Department of Environmental Quality 2001), which identifies phosphorus and nitrogen as the primary nutrients of concern in the Flathead Lake Basin.

The proposed harvesting/ burning treatments under Alternative 2 may cause a slight short-term increase in the nutrient levels in analysis area streams. This would be due to the increased leaching of nutrients from small limbs and needles on the ground following logging activities and from the increased nutrients made available for leaching and/or plant uptake following the burning of biomass on site. The potential nutrient leaching from needles and burn piles is very low due to the soil types in this area (volcanic ash silt loam surface layer) and these soils would rapidly absorb any nutrients made available after logging or broadcast burning in most situations. There would be the potential for surface soil erosion/sedimentation if a high-intensity rainstorm event were to occur on the steeper hillsides shortly (3 to 5 weeks) after broadcast burning. Were this to occur, there would be discernable levels of increased sediments and nutrients in the small analysis streams. The nutrient yield from a broadcast burn/erosion event would be significantly less than the levels observed after a wildfire, because of the higher burn severity that typically occurs with a wildfire. However, the likelihood of this scenario is low as most high-intensity rainstorms occur during the summer, not the spring and fall when broadcast burning occurs. Therefore, unless the rare post-burn rainstorm/soil erosion scenario occurs, there would be very low to no measurable increase in the stream-water nutrient levels following the harvesting, burning, and temporary road construction proposed under Alternative 2.

The greatest potential for sediment and the associated nutrients to enter a stream is due to soil erosion during the culvert removals associated with road decommissioning. The proposed 17 culvert removals would potentially yield 92.4 tons of sediment directly into the stream channels. The certainty of sediment and nutrient yield from the culvert removals would be much greater than from harvesting, burning, or road construction. The majority of the culvert removal sites are a relatively short distance from the Reservoir; therefore, the opportunity for suspended sediments to be deposited and nutrient loads to the stream channels would be much less than if a long, low-gradient channel existed below a removal site.

The amount of potential nutrient increase from Alternative 2 actions would not be discernable once the project area streams merge into the Hungry Horse Reservoir. The volume of water within the reservoir would effectively absorb and dilute beyond measurable amounts any incoming sediment and nutrient yield increases from the Proposed Action. Hungry Horse Reservoir has a very significant buffering effect on several of the water quality risk factors, including sediment and nutrient yield to the main stem of the South Fork Flathead River below Hungry Horse Dam. Most sediment would settle to the bottom of the Reservoir, and the amount of suspended sediment flowing out of the Reservoir would be significantly less than the amount flowing in. This settling also affects nutrient transport as many nutrients of concern bond to suspended soil particles and then settle to the bottom of the Reservoir. Therefore, there is a significant reduction in nutrient transport as water reaches the Reservoir.

Direct and Indirect Effects - Road Management

The following discussion reviews the different road management strategies used on the Flathead National Forest and their effects to the water resource. The various road management scenarios include roads open yearlong, seasonally restricted with a gate, closed yearlong with a gate, closed yearlong with a berm, and decommissioned. The road management scenario chosen for each road will affect water quality (sedimentation potential) and water quantity (water yield) in slightly different ways. The Firefighter Project proposes to change the road management scenario on several miles of the roads within the analysis area.

Seasonally Open and Gated Roads may have an increased or decreased sedimentation potential when compared to an open road. The seasonally closed road surface is exposed to the same rain and snowmelt events to erode the surface as a yearlong open road. The amount of sedimentation depends on the drainage structures built into the road prism and the amount of maintenance the road surface and the drainage structures receive. Typically, when the roads are used, but not graded, rutting occurs; this usually concentrates water flow and causes increased road surface erosion and sedimentation. Seasonally open roads usually receive less maintenance than roads open yearlong, and would have a slightly higher potential for sedimentation. In some situations, open yearlong roads that receive heavy use and regular road grading can have higher sediment yields because of the input of sediment following grading, especially when the ditches are cleared out with a grader. This type of road management easily allows for periodic inspection and maintenance of culverts, ditches, and cross-drain culverts, which reduces the risk of culvert plugging/failures and associated sedimentation potential. This road management scenario does not change the water quantity delivered to a stream from the road system.

Gated Yearlong Roads typically have some revegetation of the roadbed by grass and brush species. The amount of the revegetation on the roadbed would be determined by the amount of administrative road use, the type of vegetation on the site, and the soil moisture conditions in that locale. This scenario generally results in less erosion from road surfaces and ditches; however, when this category of road is used for administrative purposes rutting can occur, and if the road were not maintained, increased sedimentation could result. Gated yearlong roads allow for periodic inspection and maintenance of culverts, ditches, and cross-drain culverts, which reduces the risk of culvert plugging/failures and associated sedimentation potential. This scenario would not change the water quantity delivered to a stream from the road system.

Roads Bermed Yearlong typically would have waterbars installed on key road segments with high runoff potential, in order to reduce surface water flow distances and soil erosion. The density of waterbars would generally be significantly less than on a decommissioned road. Bermed roads with high-risk, stream-aligned culverts (a culvert prone to plugging and/or failure), would have the culvert removed or upsized. If a bermed road is used for winter access and it contains a high-risk culvert, the culvert would be upsized to minimize risk to the watershed and retain winter access. If a bermed road is not used for winter access and has a high-risk culvert, the culvert would be

removed and/or upsized prior to berming. Berming a road allows for monitoring and inspecting remaining culverts; however, both the monitoring and the mechanical maintenance of these culverts are more difficult and expensive than without a berm. Bermed roads eventually revegetate to a degree where it is impossible to access with machinery without first clearing vegetation. Consequently, the long-term risk of culvert plugging/failure and the associated sedimentation potential would be greater with a berm than with a gate. The amount of sediment produced by a culvert failure can range between tens of tons to more than two hundred tons of soil material, depending on the depth of the overburden on top of the culvert. However, once a bermed roadbed is allowed to revegetate, the potential for soil erosion and sediment transport to streams is significantly reduced. Berming roads would not change the water quantity delivered to a stream from the road system.

Decommissioned Roads reduce road access and road/culvert maintenance on roads that would not be needed for several years. Road decommissioning includes the following actions:

- Installing water bars to decrease road surface water concentration and movement.
- Culvert removal at perennial and intermittent streams to eliminate the possibly of a culvert failure.
- Seeding all or portions of the roadbed to initiate revegetation and reduce soil erosion.
- Placing erosion control matting, or straw mulch, at each excavated steam crossing.
- Planting shrubs at the excavated stream crossing sites to speed up revegetation.

There are three effects to the water resource due to road decommissioning. First, there is a decrease in water quantity delivered to stream networks from the road system. The installation of water bars with ditch blocks would intercept road-surface and ditch runoff; only very short ditch sections directly above stream crossings would continue to funnel ditch water into the stream. Decreasing ditch-intercepted groundwater reduces water volume reaching stream channels during peak flows, and less water flowing in the channel would reduce stream power and stream bank erosion.

The second effect would be the short-term (usually <4 hours) sediment yield that occurs during culvert removal, when fine streambed sediments under the culvert are washed downstream until natural streambed armoring is re-established. Additional short-term sediment yield increases would occur the first spring after decommissioning, when peak flow occurs in the channel, the lower stream banks would erode at the removal site until the natural streambed armoring is reestablished. Culvert excavation sites on steep slopes would result in more exposed soil from which erosion could occur; finer soil textures would also increase soil erosion potential.

The timing of culvert removals and application of BMP measures can minimize the effects of road decommissioning activities. Staggering culvert removals in a single watershed over several seasons would reduce the amount of sediment entering a stream in one season. The use of erosion control matting or mulching, and shrub planting for

streambank stabilization after removal would reduce the amount of erosion and sedimentation.

The third effect would be the long-term decrease in sediment yield after decommissioning (following the short-term increase directly associated with the culverts removal) due to less road surface and ditch erosion potential, and the reduced risk of sediment from the failure or plugging of a culvert. This would be a net, long-term positive effect to water quality and quantity.

Road Management Changes

Road management changes are discussed in detail in Chapter 2 of this document; the effects of these changes are discussed in this section.

Gating yearlong the 1.3 miles of currently open yearlong road (Forest Road 546) would slightly reduce the sediment yield from that road segment (less rutting and maintenance). There would be no change to the water yield from this road segment due to this management change.

Decommissioning 13.8 miles of roads currently closed yearlong would result in a slight positive effect to water quantity. This would be due to waterbars decreasing ditch intercepted ground water routed to stream channels. There would be a short-term sediment yield increase because of the culvert removals. Based upon the erosion estimates from Table 3-30 there would be approximately 91.5 tons of sediment produced from the culvert removals (discussed in following sections), and there would be a decreased risk of culvert failure. Therefore, the long-term sediment yield would be decreased from this road segment.

Berming about 14 miles of roads currently gated yearlong (Forest Roads 896, 1614, 1048, & 5317) would result in a slight decrease in sediment yield as the road prism revegetates. There would be an increased potential for culvert failures, and the associated sediment yield due to a failure, because of the increased difficulty of culvert maintenance on a bermed road. There would be a short-term sediment yield increase due to the upsizing of four culverts on the proposed bermed road segments. Based upon the erosion estimates from Table 3-29 there would be approximately 7.4 tons of sediment produced from the culvert upsizing.

Changes to road management proposed by Alternative 2 compared to the Paint Emery Project Decision would be as follows:

- Alternative 2 would increase the total miles of bermed roads by 6.74 miles.
- Alternative 2 would decrease by 7.78 miles roads gated yearlong.
- Alternative 2 would decrease by .5 miles roads open yearlong.
- Alternative 2 would increase by 1.53 miles roads decommissioned.

The overall effect due to road management changes in the Emery-Firefighter Grizzly Bear Subunit includes the following.

- There would be a slight positive effect to water quantity due to the decreased ditch intercepted ground water routed to stream channels, once the 1.53 miles of road are

decommissioned. There would be a short-term sediment yield increase due to culvert removals associated with the road decommissioning.

- 2) The 6.74 miles of road closed yearlong with a berm would result in a slight decrease in sediment yield as the road prism revegetates. There would be an increased potential for culvert failure and the associated sediment yield due to the increased difficulty of culvert maintenance on a bermed road.
- 3) The 0.5-mile reduction in open yearlong roads would reduce potential sediment yield from rutting of the road surface.

Culvert Replacement/Upsizing

The primary direct effects to the water resource under Alternative 2 would be increased sedimentation directly associated with the culvert replacement process. An estimate of the amount of erosion and associated sedimentation that occurs during the process of replacing and/or upsizing a culvert follows. Erosion material comes from two different sources: the area beneath a culvert in a streambed that is exposed to water-flow during the removal process, and the sideslopes of the road prism that would be excavated during the replacement process. Unless a stream is dry, there would be some erosion occurring in the streambed during the replacement process even with de-watering, due to the seepage of groundwater around or under the stream block. The road sideslopes would be bare ground following the excavation and even with erosion control and sediment reduction measures installed, some erosion could occur before these bare ground surfaces become revegetated (grasses usually revegetate the next growing season). These erosion areas would be within or directly adjacent to a stream and any fine eroded soil material would become suspended sediment.

The short-term increase in sediment varies with the soil and the slope of the land at the culvert site. Generally, the potential for erosion increases with the steepness of the slope and in soils with finer textures and few coarse fragments. This is particularly true with saturated soils that occur in the bottom of perennial streams.

The following assumptions were made to estimate the amount of erosion/sediment that would occur with a culvert replacement. These assumptions were based upon the combined experience of the interdisciplinary team soil scientist, hydrologist, and roads engineer. Refer to Table 3-29 for the estimated erosion/sedimentation model results for various culvert replacement scenarios.

1. The width of the excavated “stream bottom” that has potential for erosion is approximately twice the width of the culvert diameter to be put in the stream. For example, a 2-foot diameter culvert would have an excavated 4-foot wide stream bottom.
2. If there were any water, either surface or sub-surface flow, in the stream channel, de-watering would not capture 100% of the flow. There would be some amount of seepage water available for erosion in the streambed.
3. The depth of the road prism above the top of a flatter/shallow culvert would be about 2 feet, and the length of a flatter/shallow culvert would be about 28 feet.
4. The depth of the road prism above the top of a steeper/deep culvert would be about 15 feet, and the length of a steeper/deep culvert would be approximately 40 feet.
5. The amount of eroded fine soil material (sand, silt, clay) for a flatter/shallow culvert replacement, would average about .5 inches under a normal replacement scenario, and

approximately 1 inch under a worst-case scenario. The glacial till soils in this area contain fine soil material ranging from approximately 35 to 65% of the total soil volume.

6. The amount of eroded fine soil material (sand, silt, clay) with a steeper/deep culvert replacement would average approximately 1 inch under a normal replacement scenario, and approximately 2 inches under a worst-case scenario.
7. The potential erosion on the excavated road prism sideslopes is approximately .5 inches until the slope has revegetated. This assumes that grass seed and straw mulch would be applied to the excavated sideslopes.
8. The approximate weight of soil material is 110 pounds/cubic foot.
9. A dry normal scenario assumes no surface or groundwater flow during replacement with erosion originating only from road prism sideslopes. A wet normal scenario assumes the stream is dewatered but that some seepage would occur around the stream block. The wet worst-case scenario assumes that the stream is dewatered but there is a major flow under the stream block or the dewatering process fails during the replacement procedure.

Table 3-29. Estimated Erosion/Sedimentation during Culvert Replacement

Culvert Width – Erosion Scenario	Estimated Erosion/Sedimentation	
	Flatter/Shallow Site	Steeper/Deep Site
2 Foot – Dry Normal Resize	.3 Tons/Culvert	1.2 Tons/Culvert
2 Foot – Wet Normal Resize	.6 Tons/Culvert	1.9 Tons/Culvert
2 Foot – Wet Worst-Case Resize	.8 Tons/Culvert	2.7 Tons/Culvert
3 Foot – Dry Normal Resize	.4 Tons/Culvert	1.3 Tons/Culvert
3 Foot – Wet Normal Resize	.7 Tons/Culvert	2.4 Tons/Culvert
3 Foot – Wet Worst-Case Resize	1.1 Tons/Culvert	3.5 Tons/Culvert
4 Foot – Dry Normal Resize	.4 Tons/Culvert	1.4 Tons/Culvert
4 Foot – Wet Normal Resize	.9 Tons/Culvert	2.9 Tons/Culvert
4 Foot – Wet Worst-Case Resize	1.4 Tons/Culvert	4.4 Tons/Culvert

Culvert Removal

A sensitivity analysis was done to display the possible effects from a culvert removal and the potential soil erosion until the excavated site revegetates. The depth of roadbed over the top of a culvert would be directly proportional to the slope of the streambed at the installation site; steeper installation sites have more surface area exposed to erosion. For this comparison, three culvert installations were analyzed: the first occurring on nearly level ground; the second would be a very steep installation; the third would be a moderate slope installation. Actual field measurements of culvert installations and many erosion monitoring observation measurements were used in the calculations. Best-case and worst-case scenarios were analyzed for a culvert removal in non-erosive soil conditions, with all BMPs applied, and for a culvert removal in erosive soil conditions, with limited BMPs applied. The surface area exposed for each scenario was calculated and then multiplied by the erosion depth to obtain the volume of eroded material. The volume of eroded material in the typical glacial till soils of this area would yield about 60 percent suspended sediment and 40 percent bedload sediments (any particle larger that coarse sand size). Refer to Table 3-30 for a comparison of eroded soil material for each scenario.

Table 3-30. Eroded Materials Expected from Culvert Removals

Culvert Depth[1]	Culvert Removal Best-Case Scenario For Soil Erosion	Culvert Removal Worst-Case Scenario For Soil Erosion
Shallow Depth (4.1 ft.)	4.6 tons (3.1 cubic yards)	11.0 tons (8.1 cubic yards)
Moderate Depth (6.3 ft.)	4.4 tons (2.9 cubic yards)	13.5 tons (9.1 cubic yards)
Deep Depth (15.8 ft.)	12.5 tons (8.4 cubic yards)	50.7 tons (34.1 cubic yards)

[1]Depth is measured from the top of the outside shoulder of the road vertically to the bottom of the culvert.

There would be six proposed culvert upsizing sites, two on Road #1614, two on Road #546, one on Road #896, and one on Road # 5317. Four of the sites are on roads proposed to be bermed, one site is on a yearlong gated road, and one site is on an open yearlong road. There are seventeen culvert removal sites associated with the road decommissioning under Alternative 2. The best-case scenario culvert removal soil erosion from Table 3-31 was used in the calculation of sediment yield because of the soil types found in the Firefighter Project area. The number of culvert removals by depth class was multiplied by the erosion rate per site to give a total potential sediment yield. The potential sediment yield from the upsizing work would be 9.2 tons, and 92.4 tons from the culvert removal activities. See Table 3-31 for a more detailed breakdown of the culvert upsizing and removal proposal and potential sediment yield estimate.

Table 3-31. Alternatives 2 & 3 – Culvert Removals and Upsizings, and Sediment Yield.

Culvert Removal Depth	Alt. 2& 3 Proposed Removals	Culvert Removal Sediment Yield (tons)	Culvert Upsize Diameter	Alt. 2 & 3 Proposed Culvert Upsizing	Culvert Upsizing Sediment Yield (tons)
Shallow	7	32.2	2-Foot	1	.3
Moderate	8	35.2	3-Foot	1	1.3
Deep	2	25.0	4-Foot	4	7.6
Totals	**17**	**92.4**		**6**	**9.2**

Alternative 3

Proposed activities under Alternative 3 would include timber harvest on 355 acres in 20 units, and broadcast burning 7 acres in 1 unit following harvest treatments. Timber harvesting would require the use of approximately 22 landings. Approximately 26 miles of roads would be used for hauling in the project area, and there would be about 0.5 miles of new temporary road construction. Best Management Practices (BMP) road improvements (drive-thru-dips, water flappers, etc.) would be implemented on all haul routes and on an additional 6.2 miles of non-haul routes in the project area to decrease potential road-associated sediment yield. These activities would have the greatest potential to affect water quantity or water quality. The excavator piling of slash would have no direct effect on water quantity or water quality. This interpretation was based upon past soil monitoring of excavator piling by the Forest Soil Scientist, and the lack of observed post-treatment soil compaction and soil erosion associated with this practice. Refer to Soil section of this chapter for more information.

Direct and Indirect Effects

The road management direct and indirect effects of Alternative 3 would be the same as for Alternative 2 (culvert upsizing, culvert removals, BMP improvements), except as noted below.

Water Yield Effects

The acres of proposed harvesting and burning would be less for Alternative 3 than Alternative 2. Modeled water yield increase under Alternative 3 harvesting is displayed in Table 3-32. All other water yield effects are as described under Alternative 2.

Table 3-32. Alternative 3 – Modeled Water Yield for Analysis Watersheds

Analysis Watershed	Watershed Area (acres)	Annual Natural Water Yield (acre-feet)	% Existing Annual Water Yield Increase Above Natural (ECA acres)	Alt. 3 % Annual Water Yield Increase Above Natural (ECA acres)	Alt. 3 % Increase Annual Water Yield
Ada Creek	657	749	5.6 % (88 ac)	6.2 % (96 ac)	0.6%
Emery Creek	13,578	25,299	11.3% (3,018 ac)	No Change	0%
Fire Creek	1,766	2,018	2.3% (92 ac)	3.0% (121 ac)	0.7%
Hungry Horse Creek	15,318	38,732	1.3% (754 ac)	No Change	0%
Reservoir Face Drainages	2,639	3,014	6.7% (417 ac)	7.7% (478 ac)	1.0%
McInernie Creek	1,746	4,803	8.8% (481 ac)	No Change	0%
Murray Creek	2,001	6,090	8.7% (523 ac)	No Change	0%
Riverside Creek	4,372	13,613	0.5% (96 ac)	No Change	0%
Spring Meadow Creek	830	946	9.0% (181 ac)	9.1% (180 ac)	0.1%
Tent Creek	6,236	14,697	1.8% (496 ac)	2.2% (635 ac)	.4%
Unnamed Tributary 1	928	1,058	6.7% (155 ac)	No Change	0%
Unnamed Tributary 2	95	108	10.2% (22 ac)	No Change	0%
Unnamed Tributary 3	269	307	7.4% (46 ac)	No Change	0%
Unnamed Tributary 4	674	678	4.9% (75 ac)	5.3% (82 ac)	0.4%
Unnamed Tributary 5	189	215	3.8% (17 ac)	No Change	0%
Unnamed Tributary 6	303	345	2.9% (20 ac)	No Change	0%
Unnamed Tributary 7	77	88	2.4% (4 ac)	3.3% (6 ac)	0.9%
Unnamed Tributary 8	470	821	4.2% (57 ac)	No Change	0%
Unnamed Tributary 9	192	255	5.5% (29 ac)	No Change	0%

Sediment Yield Effects

Proposed Harvesting and Burning

The reduction in vegetative cover in the thinning/harvest units increases the potential for soil erosion, which increases the potential sediment yield to streams. As discussed under Alternative 2, due to the vegetation buffer, distance from any stream channel, and the proposed unit/skid trail locations, there would be no potential for sediment from the skid trails to enter a stream channel.

One unit (Unit 40) would be burned following harvest to stimulate shrub production. The WEPP 30-year period of precipitation events indicates the average potential soil erosion would be 3.8 tons/acre for the harvesting and burning treatments on typical hillslopes in this area. However, because of the significant distant of vegetation buffer between the broadcast burn area and any stream channel (more than a ½ mile), there would be no potential sediment yield from the timber harvest/broadcast burning under Alternative 3.

Due to the soil types, the landform slope, and the vegetation buffer distance to any live stream channel, there is no potential for sediment production from the burning of burn slash piles.

Temporary Roads

The proposed Alternative 3 harvesting would include the construction of .5 miles of new temporary road. There would be no potential to deliver sediment into a stream channel from either the construction or use of the road segment because there would be no proposed stream crossings (refer to discussion under Alternative 2). All applicable forestry BMPs would be applied during the logging operations to reduce erosion from the temporary roads. The road would be recontoured, grass seeded, and brush laid down on the road segments as soon as possible following the completion of timber harvest activities.

Landings

The proposed timber harvest units in Alternative 3 would require approximately 22 landings. As under Alternative 2, the WEPP-Disturbed Land erosion model estimated no potential for soil erosion from that landing in the project area. The landing for Unit 9b would not have to be enlarged as it would under Alternative 2; therefore, no extended buffer length would be needed to intercept sediment. All applicable forestry BMPs would be applied during the logging operations to reduce erosion from the landings, including grass seeding and water barring as soon as possible following timber harvesting activities The results of the modeled potential sediment associated with timber harvest, broadcast burning, and temporary road construction are summarized in Table 3-33 for each analysis watershed. (WEPP model assumptions and results, and Proposed Landing Map are in the Hydrology Project File).

Summary of Sediment Yield Effects

Alternative 3 proposed actions would have a short-term negative impact to water quality due to the increase in sediment yield of approximately 98.6 tons under a worst-case scenario. There would be no sediment yield effects due to timber harvest, slash pile burning, or landing construction. The culvert upsizing and removals would have a short-term negative effect to the water quality; however, there would be a long-term positive effect due to the reduction of culvert failure risk and the associated sedimentation. Alternative 3 actions should not cause a measurable increase to sediment yield outside the natural range of variation for the streams in the Firefighter Project area. If the Alternative 3 worst-case scenario of an estimated 98.6 tons of sediment were all delivered to the Hungry Horse Reservoir, it would not be outside the range of natural variability for sediment yield into the South Fork Flathead River system. Downstream of

the Reservoir, the sediment yield increase would probably not be discernible due the dilution effect and sediment settling that occurs in the Reservoir.

The effects to water temperature are the same as described in Alternative 2. All applicable forestry BMPs would be applied as described in Alternative 2.

Table 3-33. Alternative 3 – Modeled Potential Sediment Yield for Analysis Watershed

Analysis Watersheds	1st Year Culvert Upsizing Sedi-ment Yield (pounds)	1st Year Culvert Removal Sediment Yield (pounds)	Temp. Road Culvert Place-ment Sediment Yield (pounds)	Burning After Harvest Sediment Yield (pounds)	1st Year BMP Construc-tion Sediment Yield (pounds)	Annual Sediment Reduc-tion From BMP Instal-lation (pounds)	Total 1st Year Sediment Yield – Alt. 3 (pounds)
Unnamed Tributary 1	5,800	0	0	0	5	-116	5,689
Unnamed Tributary 2	0	26,400	0	0	5	-116	26,289
Unnamed Tributary 3	0	17,600	0	0	5	-116	17,489
Unnamed Tributary 4	0	46,000	0	0	20	-580	45,440
Unnamed Tributary 5	0	9,200	0	0	5	-116	9,089
Unnamed Tributary 6	0	9,200	0	0	5	-116	9,089
Fire Creek	0	17,600	0	0	20	-464	17,156
Unnamed Tributary 7	0	0	0	0	0	0	0
Ada Creek	0	0	0	0	0	0	0
Spring Meadow Creek	0	0	0	0	10	-232	-222
Reservoir Face Drainages	600	0	0	0	0	0	600
Hungry Horse Creek	0	58,800	0	0	20	-1,288	57,532
Tent Creek	0	0	0	0	50	-2,190	-2,140
Riverside Creek	0	0	0	0	10	-760	-750
Unnamed Tributary 8	0	0	0	0	0	0	0
Unnamed Tributary 9	0	0	0	0	0	0	0
Murray Creek	0	0	0	0	0	0	0
McInernie Creek	0	0	0	0	0	0	0
Emery Creek	12,000	0	0	0	0	0	12,000
Total	**18,400 (9.2 tons)**	**184,800 (92.4 tons)**	**0 (0.0 tons)**	**0 (0.0 tons)**	**155 (0.08 tons)**	**-6,094 (3.05)**	**197,261 (98.6 tons)**

Nutrient Yield Effects

The nutrient yield effects are the same as discussed under Alternative 2.

All Alternatives

Cumulative Effects

Cumulative Effects Analysis Area

The Hungry Horse Reservoir has a very significant buffering effect on several water quality risk factors. The amount of suspended sediment flowing out of the reservoir is significantly less than the amount flowing into the reservoir because most of the sediment settles to the bottom of the Reservoir. Many of the nutrients of concern to water quality are bonded to suspended sediment soil particles, which settle to the bottom of the reservoir, so there is a reduction in nutrient transport after the waters reach the Reservoir. In addition, Hungry Horse Dam managers dictate the volume of water flow downstream from Dam, not the water yield coming from the tributary watersheds. For these reasons, there is virtually no measurable effect of any proposed management activity to water quality or water quantity, once the individual streams flow into Hungry Horse Reservoir. Because of this, the downstream extent of the cumulative effects area for the Firefighter Project is the Hungry Horse Reservoir. The upstream extent of the cumulative effects area for this project is the headwaters divide of the nineteen analysis watersheds. All of these analysis watersheds have direct effects from the proposed timber harvest, temporary road building, road decommissioning, or road BMP improvements. Therefore, the combined cumulative effects analysis area is the nineteen analysis watersheds ending downstream at Hungry Horse Reservoir.

The temporal range of the watershed cumulative effects assessment begins with the initial man-caused disturbances to the uplands or streams in the analysis watersheds. These initial disturbances were timber management and road building activities, along with the construction of Hungry Horse Dam. The constructions of the dam and the roads have a continuous effect on the watershed; other activities such as timber harvest and road decommissioning have a shorter temporal affect. The temporal effect of timber harvest for total water yield recovery is approximately 80 to 110 years depending on the vegetation Habitat Type. (USDA 1976) The temporal timeframe of land disturbing activities that cause soil erosion/sedimentation are short-term usually until the grasses and shrubs re-establish on the disturbed site in 3 to 5 years, or in the case of a culvert removal until the streambed have re-armored itself during the following spring snowmelt runoff.

Cumulative Effects – Past Activities

Construction of Hungry Horse Dam

The construction of Hungry Horse Dam and filling of Hungry Horse Reservoir significantly changed the amount of lotic (flowing water habitat) and replaced it with lentic (standing water habitat). Many miles of nearly level to moderately sloping valley bottom stream were inundated

with several hundred feet of water, and many more acres of deep-water habitat were created. There were effects to the water quantity and quality due to the creation and management of the reservoir. The water yield (quantity of water) coming from the South Fork Basin in general has not been affected by the dam construction (some increase in evaporation has occurred). However, the timing of when the water flow occurs below the dam has changed. The construction of the reservoir created a large settling pond where large amounts of sediment and attached nutrients settle out of the water column rather than being transported downstream. Moreover, depending on how the water withdrawals are managed, there can be changes in the water temperature regime downstream compared to pre-dam construction. For the streams above the pool level of the reservoir (on National Forest System lands), there have not been any changes in the water yield, sediment yield, or nutrient yield cause by the dam construction.

Timber Management and Existing Road System

Past road building, and past timber harvest are the management actions that have had the most potential to affect on the current stream channel condition, sediment yield, and water yield in the analysis watersheds of the Firefighter Project Area. All past road construction and timber harvesting was analyzed to reflect the amount of man-caused disturbance in the project area. The impact of past management actions were considered in the hydrology/watershed affected environment section and used to describe the existing condition of the analysis watersheds. This information was used in three specific ways during the watershed assessment. First, during the water yield modeling (ECA modeling) all past harvest, past wildfires (larger fires in last 30 years) and existing non-decommissioned roads were used as input data during the analysis of the existing water yield amounts. Second, during the field review, the stream segments to be surveyed were partially determined based on the patterns of past timber harvest and road building. Third, the existing road network was analyzed to estimate the annual sediment yield from roads using the WEPP model.

Timber management activities in the project area started in the early 1940s, and have continued to the present as discussed earlier in the Affected Environment section of this report. The total area of all of past timber management is 10,782 acres within the 52,340 acre area of the analysis watersheds; 20.6% of the watershed area has had some type of silvicultural treatment. Since 2003, there has been 3,267 acres of broadcast burning for wildlife habitat improvement, which has occurred in seven of the analysis watersheds. Sediment yield, water yield, and nutrient yield were assessed for all of these areas.

There are 150.2 miles of existing system roads within the analysis watershed areas. The main system road, Forest Road 38, was associated with the construction of Hungry Horse dam. Road construction into the upper watershed areas started in the 1940s, with the majority occurring in the 1960s and 1970s; the last major road construction occurred in 2002 in Emery Creek.

Sediment contributions from roads are introduced into stream networks at road-stream crossings. The model WEPP–Road estimated that the annual sediment yield from the existing road system would be 6.72 tons/year. Past activities on roads include the routine grading of the road surface and culvert/bridge maintenance activities. A flood in June 2006 required some emergency culvert/bridge and stream channel work on Hungry Horse Creek and Lost Mare Creek in the

project area. The emergency rehabilitation work caused a small, short-term increase in sediment levels in the stream system.

There was a soil erosion inventory completed recently for all sites with past harvesting from Emery Creek south to Paint Creek, not including the area east of Forest Road 38 in the Firefighter Mountain Area. This inventory found that all of the harvest unit areas are well vegetated with medium sized trees, poles, shrubs, and grasses; they are not contributing any sediment to streams. There were three small sites identified associated with old landings and/or skid trail junctions that were contributing very small amounts of sediment (tens of pounds per year) to a stream; these sites need additional water-bars and grass seeding. In general however, virtually all of the past harvest areas in the analysis areas are revegetated, are not contributing sediment to streams, and are well on their way to hydrologically recovering from the past vegetation removal activities.

Road Decommissioning

There have been 44.6 miles of road decommissioned in analysis watersheds in the past decade. As discussed previously, the removal of culverts would, in the short-term, yield sediment from the active stream channel and removal area back-slopes. Sediment from the back-slopes would be ameliorated by the second growing season when grass revegetates the area. Stream channel erosion occurring after culvert removal generally happens after the first high-water event following removal. The estimated sediment yield from these culvert removals is 91.4 tons; refer to the Hydrology section of the Project File for more information on culverts to be upsized in this project. All culvert removals on decommissioned roads occurred more than two years ago, so these sites should be revegetated and stabilized, based upon a review of a majority of the removal sites. There would be no long-term cumulative effects (sediment yield or nutrient yield) from these past actions.

<u>Cumulative Effects – Ongoing and Reasonably Foreseeable Activities</u>

Recreation and Other Miscellaneous Activities

The activities/actions on National Forest System lands with no effects to the water quality or quantity include noxious weed treatments, recreational activities (camping, boating, hiking, fishing, mountain biking, snowmobiling, sightseeing, etc), firewood cutting and other product gathering (mushrooms, huckleberries, and miscellaneous poles, boughs, Christmas trees, etc), normal trail maintenance, tree planting, road closure device placement, and precommercial thinning. These would be no effect because ground disturbance associated with these activities would be minimal; there would be no long-term cumulative effects. This assumes that herbicides would be applied per label instructions; woodcutters adhere to the regulations detailed on wood cutting permits; roads used by planting contractors are not so wet that rutting would occur; and that no gasoline is spilled refueling motorboats.

Routine Road Maintenance

Routine road grading would occur on Forest Road 38, but there is no funding now or in the foreseeable future, for routine road grading on any other Forest Service road within the analysis

area. If any other grading were to occur, it would be part of a special project (e.g. a timber sale). In addition to the road grading, an estimated three major road maintenance efforts would be completed annually across seventeen stream crossings on Forest Road 38 in the analysis watersheds. The WEPP – Road Erosion Model was used to produce an estimate of erosion from the road surface and potential sediment entering a stream channel for this routine maintenance. The sediment yield for these stream/road crossings were modeled by treating them as a native surface road and comparing the sediment yield to a graveled road. After a road is graded, the fines in the road matrix are not compacted for a short period, and are mixed into the gravel surface acting as a native road surface would. There would be 19.6 pounds per year more sediment yield from a native surface road than from a graveled road. A worst-case scenario of additional sediment yield due to routine road grading would be 19.6 pounds per grading. Therefore, the total annual potential sediment estimated for routine road grading is 999.6 pound/year (0.5 tons) for the seventeen stream crossings along Forest Road 38 in the analysis watersheds (refer to the WEPP model runs are in the Hydrology section of the Project File).

Road Decommissioning

Under the 1999 Paint-Emery Decision (USDA Forest Service 1999c), there would be four road segments (Forest Roads 5365, 5366, 5328 & 1048) decommissioned in the Hungry Horse Creek watershed; nine culverts would be removed during decommissioning. There would be one road segment decommissioned (Forest Road 5367) in Emery Creek, which has one culvert to be removed. As discussed previously, the removal of culverts would yield sediment from the active stream channel and the removal area back-slopes. Using the estimated sediment yield values for culvert removal in Table 3-30, the estimated sediment yield from this activity is 44.4 tons. See Table 3-34 for the summary of the estimated sediment yield from these culvert removals.

Table 3-34. Potential Sediment Yield from Paint Emery Decision Culvert Removals

Paint-Emery Decision Culvert Removal Depth	Proposed Culvert Removals	Culvert Removal Sediment Yield (tons)
Shallow	0	0
Moderate	10	44.4
Deep	0	0
Total	**10**	**44.4**

Stream Crossing Rehabilitation

Stream channel stabilization work would be done at the Hungry Horse Creek Bridge on NFSR 896. During a flood event on June 15, 2006, this bridge was significantly damaged and was later removed. Minor stream channel rehabilitation work will occur at this crossing site, which will include some very short-term, minor suspended sediment producing activities.

Broadcast Burning

The 1999 Paint Emery Decision identified a series of broadcast burn units (for wildlife habitat improvement) in the headwaters of several watersheds in the Firefighter Project area. Two of these units have yet to be burned, one in Hungry Horse Creek and one in Fire Creek. There would be the potential for sediment yield were a high-intensity thunderstorm to occur following burning (see direct effects sediment yield section). Using the WEPP erosion model and the same procedure described earlier, the estimated worst-case scenario for sediment yield would be 3,401.6 tons for burning in Hungry Horse Creek, and 488.3 tons in Fire Creek.

Alternative 1 (No Action)

Summary Cumulative Effects

Past Actions

The existing 150.2 miles of road within the cumulative effects analysis area would have cumulative effects to water quality. There would be an annual sediment yield of approximately 6.7 tons per year, along with the increased nutrient yield associated with that sediment. Past timber harvesting and/or silvicultural treatments occurred on approximately 10,782 acres of Forest Service managed lands in the analysis watersheds. The existing water yield increase ranges from 0.5% to 11.3% in the analysis watersheds. Refer to Table 3-37 for the existing water yield increases for each analysis watershed. Lands where past timber management occurred are rapidly recovering pre-disturbance vegetation cover and the associated hydrologic recovery. Lands affected by the Paint Emery prescribe burning program have had good natural revegetation and there has been no post-fire sediment yield observed in the fire area. There has been some short-term sediment yield due to past road maintenance and road decommissioning work. The effects from these activities have been naturally ameliorated. The sediment yield from the existing road system is the primary long-term effect from past man-caused activities.

Present and Foreseeable Actions

There would be a foreseeable cumulative effect of routine road grading done approximately three times a year on Forest Road 38 in the analysis area. The estimated sediment yield from the road grading is 0.5 tons per year. There would also be potential short-term sediment yield increases from the burning in Hungry Horse Creek under the Paint-Emery Decision of 3,889.9 tons the first year if a high-intensity rainstorm were to occur shortly after the burn. There would be 44.4 tons of first year sediment yield increase following culvert removals associated with the remaining road decommissioning under the Paint-Emery Decision.

All of the other mentioned present and foreseeable actions have no effect to the water quality. The sediment yield increases from a broadcast burn/erosion event and the culvert removals would have a short-term detrimental impact to the water quality and potentially some short-term downstream effects to the stream channels directly below the fire/erosion area and/or the culvert removal sites. Table 3-38 displays the summary of the potential sediment yield by alternative.

Indirect Actions

A possible indirect effect of implementing Alternative 1 would be an increased potential for culvert failure (plugging and washing out the road prism) on perennial streams because they were not upsized or removed as under the other alternatives. Cumulatively, the past, present, and foreseeable future actions associated with the No-Action Alternative should not cause a measurable increase to water yield, sediment yield, and/or nutrient levels outside of the natural range of variation for the streams in the Firefighter Project cumulative effects analysis area. These interpretations are based upon past monitoring reports, literature, field observations, and professional judgment.

Alternative 2

Summary Cumulative Effects

The Past, Present, and Foreseeable Actions are as described for Alternative 1.

Proposed Actions

Water Quantity Effects

There would be an increase in the existing annual water yield in twelve of the analysis watersheds due to proposed timber harvesting and/or burning proposed in Alternative 2. The water yield increase due to the proposed activities (Firefighter and Paint Emery Projects) ranges from 0.4% to 10.2% in the analysis watersheds. Refer to Table 3-37 for the existing water yield and the changes for each analysis for each Alternative. There would be the potential for increased peak-flows due to proposed logging and/or burning, but these would be within the natural range of variability for these watersheds. The historic highest water yield increases in these watersheds are due to stand replacing wildfires, where a high percentage of the watershed burns. There have been more than ten major stand-replacement watershed-scale fires in this basin in the last decade. The estimated cumulative water yield for the analysis watersheds should not significantly change the potential for increased stream channel erosion due to water yield increase in any of the analysis watersheds.

Water Quality Effects

The effect of increased sedimentation, slightly decreased ground cover, and increased needles and fine branches on the ground associated with the proposed logging operations could cause a slight increase in the level of soluble nutrients in the stream water. The initial runoff following prescribed burning would elevate nutrient levels, but these levels would rapidly decrease after the initial flush. If a high-intensity rainstorm were to occur shortly after the prescribed burns, there would be the potential for a flush of sediment and associated nutrients. This potential increase in the background levels of nitrogen and phosphorus would be within the natural range of variability for the streams in the analysis area. This is due to the very high levels of nitrogen and phosphorus observed in the stream water following a wildfire (Spenser and Hauer, 1990, 1991) (Hauer and Spenser, 1998). The nutrient increase would not be discernable once the analysis area streams reach the Hungry Horse Reservoir because of the dilution effect.

The proposed culvert upsizings could potentially increase the sediment loading in three analysis watersheds by 9.2 tons, the first season following implementation. This activity would occur in Unnamed Tributary 1, Emery Creek, and a Hungry Horse Reservoir Face Drainage. (Table 3-28). The proposed culvert removals (Firefighter and Paint-Emery Projects combined) would potentially increase the sediment loading in seven analysis watersheds by 136.4 tons the first season following implementation (Table 3-35). There would be a small amount of nutrient yield associated with the sediments from the proposed culvert upsizings and culvert removals; however, due to the vast majority of suspended sediments settling out in Hungry Horse Reservoir there would be a very low potential for any significant nutrient yield increase to be transported downstream due to this activity.

Under Alternative 2, the potential total sediment yield from all Proposed Action activities in the Firefighter Project would be 349.5 tons (Table 3-28). This amount, when added to the other cumulative sediment producing activities (background sediment yield, Paint Emery activities etc.), brings the total to 4,290.6 tons of potential sediment yield. The proposed logging and temporary road/landing construction would potentially yield less than one-half ton of sediment. The routine road maintenance produces .5 tons/year of potential sediment yield. The proposed broadcast burning in combination with other foreseeable broadcast burning has the highest potential to produce sediment yield, if a high-intensity rainstorm were to occur shortly after burning, thus causing a post-burn erosion event. The vast majority of the 4,290.6 tons of potential sediment yield (97 percent) would be associated with a worst-case scenario, post-fire erosion event. As discussed earlier there is a very small probability of this scenario occurring. If this type of erosion event were to occur, the levels of suspended sediment in the affected streams and the reservoir would increase for a short time. The short-term suspended sediments and nutrient levels, once combined with the waters of Hungry Horse Reservoir, would be within the natural range of variability for these parameters observed every spring runoff period. Refer to Table 3-35 for the potential cumulative sediment yield due to the Alternative 2 proposed activities and other foreseeable activities. Implementation of road BMPs in the project area would result in a net benefit to water quality; there would be 3.05 tons/year sediment reduction. Table 3-38 displays a comparison of sediment yields by alternative.

There should be no measurable change to water temperature in the analysis area streams because there would be no activity within stream buffer zones. A rare high-intensity rainstorm shortly after burning could potentially initiate overland flow, resulting in some warmer temperature water entering streams, rather than the typical cooler subsurface flow.

Road Management Proposals

From a watershed perspective, the overall effects due to road management changes in the Emery-Firefighter Bear Management Unit include the following. 1) There would be a slight positive effect to water quantity due to the decreased ditch intercepted ground water routed to stream channels once the 1.53 miles of road are decommissioned. There would be a short-term sediment yield increase due to culvert removals associated with the road decommissioning. 2) The approximately 6.7 miles of road converted to closed-yearlong with a berm would have a slight decrease in sediment yield as the road prism revegetates. There would be an increased potential for culvert failure and the associated sediment yield due to the increased difficulty of

culvert maintenance on a bermed road. 3) The .5 mile of additional open yearlong road would not receive routine road maintenance; therefore, there may be some additional sediment yield should ruts develop in the road surface due to early season or late season use.

Summary

Cumulatively, the past, present and foreseeable future, and proposed activities should not cause a measurable increase to water yield, sediment yield, and/or nutrient levels outside of the natural range of variation for the streams in the Firefighter Project cumulative effects analysis area. These interpretations are based upon past monitoring reports, literature, field observations, and professional judgment.

Table 3-35. Alternative 2 – Cumulative Potential Sediment Yield for Analysis Watersheds

Analysis Watersheds	Annual Existing Roads Back-ground Sediment Yield (pounds)	Annual Sediment Yield Routine Road Maintenance (pounds)	1st Year Culvert Upsizing Sediment Yield (pounds)	1st Year Culvert Removal Sediment Yield (pounds)	Sediment Yield – Temp. Road Culvert Placement (pounds)	Sediment Yield From Broadcast Burning Firefighter & Paint-Emery Decision (pounds)	1st Year BMP Construction Sediment Yield (pounds)	Sediment Reduction From BMP Installation (pounds)	Alt. 2 1st Year Sediment Yield (pounds)
Unnamed Tributary 1	116	0	5,800	0	0	92,800	5	-116	98,605
Unnamed Tributary 2	231	0	0	26,400	0	0	5	-116	26,520
Unnamed Tributary 3	116	0	0	17,600	0	0	5	-116	17,605
Unnamed Tributary 4	580	0	0	46,000	0	0	20	-580	46,020
Unnamed Tributary 5	116	0	0	9,200	0	0	5	-116	9,205
Unnamed Tributary 6	116	0	0	9,200	0	0	5	-116	9,205
Fire Creek	696	0	0	17,600	0	1,307,224	20	-464	1,325,076
Unnamed Tributary 7	0	0	0	0	315	37,000	0	0	37,315
Ada Creek	0	0	0	0	0	0	0	0	0
Spring Meadow Creek	464	0	0	0	0	41,000	10	-232	41,242
Reservoir Face Drainages	0	0	600	0	0	0	0	0	600
Hungry Horse Creek	2,974	1000	0	138,000	0	6,803,136	20	-1,288	6,943,842
Tent Creek	2,190	0	0	0	0	0	50	-2,190	50

Analysis Watersheds	Annual Existing Roads Back-ground Sediment Yield (pounds)	Annual Sediment Yield Routine Road Maintenance (pounds)	1st Year Culvert Upsizing Sediment Yield (pounds)	1st Year Culvert Removal Sediment Yield (pounds)	Sediment Yield – Temp. Road Culvert Placement (pounds)	Sediment Yield From Broadcast Burning Firefighter & Paint-Emery Decision (pounds)	1st Year BMP Construction Sediment Yield (pounds)	Sediment Reduction From BMP Installation (pounds)	Alt. 2 1st Year Sediment Yield (pounds)
Riverside Creek	760	0	0	0	0	0	10	-760	10
Unnamed Tributary 8	553	0	0	0	0	0	0	0	553
Unnamed Tributary 9	322	0	0	0	0	0	0	0	322
Murray Creek	322	0	0	0	0	0	0	0	322
McInernie Creek	322	0	0	0	0	0	0	0	322
Emery Creek	3,569	0	12,000	8,800	0	0	0	0	24,369
Total	**13,447 (6.72 tons)**	**1,000 (0.5 tons)**	**18,400 (9.2 tons)**	**272,800 (136.4 tons)**	**315 (.16 tons)**	**8,281,160 (4,140.6 tons)**	**155 (0.08 tons)**	**-6,094 (3.05 tons)**	**8,581,183 (4,290.6 tons)**

Alternative 3

Summary Cumulative Effects

Past Actions and Present and Foreseeable Actions

The past actions and present and foreseeable actions are as described for Alternative 1.

Proposed Actions

Water Quantity Effects

There would be an increase in the existing annual water yield in eight of the analysis watersheds under Alternative 3. The water yield increase due to the Proposed Action ranges from 0.1% to 7.0% in the analysis watersheds where harvesting would be proposed. Refer to Table 3-37 for the existing water yield and the changes for each analysis watershed by alternative. There would be potential increased peak-flows due to proposed logging and/or burning, but these would be within the natural range of variability for these watersheds. The estimated cumulative water yield for the analysis watersheds should not significantly change the potential for increased stream channel erosion due to the water yield increase in any of the analysis watersheds.

Water Quality Effects

Water quality effects are as described under Alternative 2 with the exception of total potential sediment yield information as detailed below.

The potential total sediment yield from all proposed activities under Alternative 3 is 98.6 tons (Table 3-33). This amount added to the other cumulative sediment producing activities brings the total to 4,039.7 tons of potential sediment yield. The proposed logging and temporary road/landing construction would potentially yield less than one-half ton of sediment. The BMP improvements and routine road maintenance are as described in Alternative 2. The Alternative 3 proposed broadcast burning in combination with other foreseeable broadcast burning has the highest potential to produce any sediment yield. This would result only from a post-burn erosion event caused by a high-intensity rainstorm occurring shortly after the burning. The vast majority of the 4,039.7 tons of potential sediment yield (96 percent) would be associated with a worst-case post-fire erosion event. As discussed earlier there is a very small probability of this scenario occurring. If this type of erosion event were to occur, the levels of suspended sediment in the affected streams and the reservoir would increase for a short time. The short-term suspended sediments and nutrient levels, once combined with the other waters of Hungry Horse Reservoir, would be within the natural range of variability for these parameters that are observed every spring runoff period. Refer to Table 3-36 for the potential cumulative sediment yield under Alternative 3 and to Table 3-38 for a comparison of sediment yield by Alternative.

There should be no measurable change to water temperature in the analysis area streams because there would be no activity within the stream buffer zones. A rare high-intensity rainstorm

shortly after the prescribed burning could potentially initiate overland flow, resulting in some warmer temperature water entering streams, rather than the typical cooler subsurface flow.

Road Management Proposals

There are no differences in the proposed road management scenarios and potential watershed effects between Alternative 2 and Alternative 3

Summary

Cumulatively, the past, present, foreseeable future, and proposed activities should not cause a measurable increase to water yield, sediment yield, or nutrient levels outside of the natural range of variation for the streams in the Firefighter Project cumulative effects analysis area. These interpretations are based upon past monitoring reports, literature, field observations, and professional judgment.

Table 3-36. Alternative 3 – Cumulative Potential Sediment Yield for Analysis Watersheds

Analysis Watersheds	Annual Existing Roads Background Sediment Yield (pounds)	Annual Sediment Yield Routine Road Maintenance (pounds)	1st Year Culvert Upsizing Sediment Yield (pounds)	1st Year Culvert Removal Sediment Yield (pounds)	Sediment Yield From Temporary Road Culvert Placement (pounds)	Sediment Yield From Broadcast Burning Paint-Emery Decision (pounds)	1st Year BMP Construction Sediment Yield (pounds)	Sediment Reduction From BMP Installation (pounds)	Alt. 3 Total 1st Year Sediment Yield (pounds)
Unnamed Tributary 1	116	0	5,800	0	0	0	5	116	5,805
Unnamed Tributary 2	231	0	0	26,400	0	0	5	116	26,520
Unnamed Tributary 3	116	0	0	17,600	0	0	5	116	17,605
Unnamed Tributary 4	580	0	0	46,000	0	0	20	580	46,020
Unnamed Tributary 5	116	0	0	9,200	0	0	5	116	9,205
Unnamed Tributary 6	116	0	0	9,200	0	0	5	116	9,205
Fire Creek	696	0	0	17,600	0	976,624	20	464	994,476
Unnamed Tributary 7	0	0	0	0	0	0	0	0	0
Ada Creek	0	0	0	0	0	0	0	0	0
Spring Meadow Creek	464	0	0	0	0	0	10	232	242
Reservoir Face Drainages	0	0	600	0	0	0	0	0	600
Hungry Horse Creek	2,974	1,000	0	138,000	0	6,803,136	20	1,288	6,943,842
Tent Creek	2,190	0	0	0	0	0	50	2,190	50
Riverside Creek	760	0	0	0	0	0	10	760	10

Analysis Watersheds	Annual Existing Roads Background Sediment Yield (pounds)	Annual Sediment Yield Routine Road Maintenance (pounds)	1st Year Culvert Upsizing Sediment Yield (pounds)	1st Year Culvert Removal Sediment Yield (pounds)	Sediment Yield From Temporary Road Culvert Placement (pounds)	Sediment Yield From Broadcast Burning Paint-Emery Decision (pounds)	1st Year BMP Construction Sediment Yield (pounds)	Sediment Reduction From BMP Installation (pounds)	Alt. 3 Total 1st Year Sediment Yield (pounds)
Unnamed Tributary 8	553	0	0	0	0	0	0	0	553
Unnamed Tributary 9	322	0	0	0	0	0	0	0	322
Murray Creek	322	0	0	0	0	0	0	0	322
McInernie Creek	322	0	0	0	0	0	0	0	322
Emery Creek	3,569	0	12,000	8,800	0	0	0	0	24,369
Total	**13,447 (6.72 tons)**	**1,000 (0.5 tons)**	**18,400 (9.2 tons)**	**272,800 (136.4 tons)**	**0 (0.0 tons)**	**7,779,760 (3,889.9 tons)**	**155 (0.08 tons)**	**6,094 (3.05 tons)**	**8,079,468 (4,039.7 tons)**

Table 3-37. Modeled Potential Water Yield Increase for Each Alternative by Watershed

Analysis Watershed	Existing Annual Water Yield Increase Above Natural (%)	Alt. 1 Annual Water Yield Increase Above Existing (%)	Alt. 2 Annual Water Yield Increase Above Existing (%)	Alt. 3 Annual Water Yield Increase Above Existing (%)
Ada Creek	5.6	0	4.0	.6
Emery Creek	11.3	0	0	0
Fire Creek	2.3	4.1	10.2	7.0
Hungry Horse Creek	1.3	2.4	2.4	2.4
Reservoir Face Drainages	6.7	0	2.4	1.0
McInernie Creek	8.8	0	.4	0
Murray Creek	8.7	0	.7	0
Riverside Creek	0.5	0	0	0
Spring Meadow Creek	9.0	0	1.0	0.1
Tent Creek	1.8	0	.4	.4
Unnamed Tributary 1	6.7	0	1.2	0
Unnamed Tributary 2	10.2	0	0	0
Unnamed Tributary 3	7.4	0	0	0
Unnamed Tributary 4	4.9	0	1.5	0.4
Unnamed Tributary 5	3.8	0	0	0
Unnamed Tributary 6	2.9	0	0	0
Unnamed Tributary 7	2.4	0	6.8	0.9
Unnamed Tributary 8	4.2	0	0	0
Unnamed Tributary 9	5.5	0	4.1	0

Table 3-38. The Cumulative Potential Sediment Yield by Alternative

	Alternative 1	Alternative 2	Alternative 3
Potential 1st Year Sediment Yield (tons)	3,941.5	4,290.6	4,039.7

Regulatory Framework and Consistency

Clean Water Act

Section 313 of the Clean Water Act requires that Federal agencies comply with all substantive and procedural requirements related to water quality. Under Section 303 of the Clean Water Act, states have the primary responsibility to develop and implement water quality programs, which include developing water quality standards and Best Management Practices. State water quality standards are based on the water quality necessary to protect beneficial uses.

Environmental Protection Agency policy requires each state to implement a Non-degradation Policy. Under this policy, water quality must be maintained to fully support existing beneficial uses. Existing water quality that is higher than the established standards must be maintained at the existing level unless the board of health and environmental sciences determines that a change

in water quality is justifiable due to social and/or economic reasons (CFR Vol. 48, No. 217, 131.12, Nov. 8, 1983; Montana Water Quality Act, Section 75-5.)

Montana State Water Quality Law

The State of Montana has classified the waters in Firefighter Project area as B-1, as listed and described in ARM 17.30.608 (1). Waters classified as B-1 are suitable for drinking, culinary, and food processing purposes after conventional treatment. Water quality must also be suitable for bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply. Additional criteria specific to sediment are found within Section 17.30.623(2) (f) of Montana Water Quality Standards, where it is stated that "(N)o increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife." Naturally occurring is as defined by MCA 17.30.602 (17), and includes conditions or materials present during runoff from developed land where all reasonable land, soil, and water conservation practices (BMPs) have been applied. Reasonable practices include methods, measures, or practices that protect present and reasonably anticipated beneficial uses.

The state water quality law relates to the Clean Water Act and the maintenance of beneficial water uses using BMPs. BMPs are designed to prevent soil erosion and protect water quality, as well as help prevent soil damage. In a Memorandum of Understanding with the State of Montana, the Forest Service has agreed to follow Best Management Practices during timber harvest and road construction activities. The Firefighter Project would utilize all applicable BMPs during project design and implementation as described in Best Management Practices for Forestry in Montana – 1997. Forest Service - Soil and Water Conservation Practices (FSH 2509.22) would be combined with Montana State BMPs for incorporation into project design and implementation to ensure that soil and water resources are protected.

The Nutrient Management Plan and Total Maximum Daily Load for Flathead Lake, Montana, which identifies phosphorus and nitrogen as the primary nutrients of concern in the Flathead Lake Basin (Montana Department of Environmental Quality 2001). The relationship of phosphorous and nitrogen levels in runoff waters of watersheds that have had timber management or wildfire have been studied. As discussed in the direct effects section, there should be no nutrient yield increase associated with the proposed Firefighter Project outside of the natural range of variability for those chemical parameters in the normal runoff waters.

Montana Streamside Management Zone (SMZ) Law

By definition in ARM 36.11.312 (3), the majority of the streams in the Firefighter Project area meet the criteria for a class 1 stream. Some first order ephemeral streams meet the criteria of a class 2 or 3 stream based upon site-specific criteria. All alternatives would meet, at a minimum, SMZ buffer zone requirements. (Montana State University Extension, 1994) In several situations, because of the INFISH requirements, RHCA width requirements, and/or the expanded RHCA buffer width, the required SMZ buffer width is expanded significantly.

Consistency with Forest Plan Standards

The Flathead Forest Plan directs under Forest-wide Management Direction to: 1) develop watershed activity schedules for key watersheds; 2) maintain an inventory of non-wilderness areas needing soil and water restoration, and complete restoration projects as funds permit; 3) apply Best Management Practices during Forest Plan implementation to ensure that Forest water quality goals are met. Under Management Areas, specific water and soils direction to: 1) maintain long-term water quality to meet or exceed state water quality standards. To ensure meeting these standards, surface-disturbing activities would be monitored where this need is identified; 2) refer to Forest-wide standards under Water and Soils for Best Management Practices, Landtype Guidelines, and standards applicable to projects or activities within this Management Area; and 3) all Project proposals would be analyzed and evaluated to determine the potential water quantity and quality impacts. Mitigation measures would be developed to minimize adverse impacts. These water and soils standards were reviewed for all proposed management activities on management areas MA 7, MA 13, MA 15, and MA 16. All proposed management actions in all the alternatives meet these forest plan standards.

INFISH Standards

The INFISH (1995) Standards are discussed in detail in the fishery assessment. All units were designed to meet the RHCA requirements under INFISH to protect the stream channel and maintain water quality and the aquatic habitat.

Wetlands

Wetlands are protected under Executive Order 11990. This act directs federal agencies to "minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands..." There are no activities proposed in any alternative that directly encroach upon any lotic or lentic wetlands in the analysis area. There are several wetland and/or riparian areas within or adjacent to treatment units. As part of the project mitigation, all of the wetlands and/or riparian areas would have buffers around them to meet either INFISH or Montana State Streamside Management Zone Law, whichever is of the greatest buffer distance. Therefore, all alternatives would meet Executive Order 11990.

Regulatory Consistency

All of the proposed alternatives would meet Clean Water Act, Montana State Water Quality Standards, and Forest Plan Water Standards.