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EVALUATION OF WATER QUALITY
PROBLEMS AND MANAGEMENT NEEDS
ASSOCIATED WITH NON-USFS
SILVICULTURAL PRACTICES IN THE
MONTANA STATEWIDE 208 AREA

- FINAL DRAFT -

Prepared for:

Statewide 208
Water Quality Bureau
Dept. of Health and Environmental Sciences
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I. SUMMARY AND RECOMMENDATIONS

Certain silvicultural practices adversely affect water quality in the Montana Statewide 208 Area. The magnitude and duration of the impacts vary with types of practice, location, size of the operation, timing, and a number of other factors. A relatively small proportion of the total operations cause water quality problems that are long-term or result in substantial degradation of water quality. This is evident with the high water quality found in many areas that have been previously disturbed by forest management activities. This is not to discount the significant and long-term problems that do occur throughout the Statewide 208 Area. Previous and existing forest practices have caused and are causing water quality problems that could be prevented or mitigated to a great extent. Montana currently has no unified approach, either regulatory or non-regulatory to control water quality impacts resulting from silvicultural practices.

Recent legislation and enforcement, public pressure, assistance programs and self-regulation have reduced the number of problems in the last few years but have not totally solved the problem. Additional steps are necessary to further reduce the number, severity, and duration of water quality impacts resulting from forestry practices.

The following recommendations are offered to gain more information about the nature of the problem and, hopefully, to reduce impacts resulting from forest practices.

Recommendations

- (1) Encourage resource inventories and evaluations in commercial forest areas. Emphasize studies in critical areas (as defined in Section

V-C), highly impacted areas (as discussed in Section VI) and areas of potential intensive development. Resource inventories and evaluations should include:

- (a) soils (stressing limitations, hazards, and productivity);
- (b) hydrology - surface and groundwater;
- (c) revegetation potential (habitat types may be appropriate);
- (d) climate;
- (e) geology
- (f) such other information as may be necessary for specific areas to adequately characterize the site.

- (2) Encourage evaluations and analyses to assess impacts of various silviculture practices with goal of developing practices that prevent or minimize impacts to Montana's soil and water resources. For example, specific watersheds should be evaluated to determine relationship between harvesting and increased streamflow in receiving drainages. Section VI demonstrates that several streams have been impacted by increased flows resulting from harvesting. The U.S. Forest Service has developed models for evaluating this relationship on several National Forests, however, this system has been subject to some criticism. The Forest Service methodologies should be evaluated, refined, and expanded to develop a workable, comprehensive system to determine when harvesting should be limited in a specific drainage to minimize impacts due to increased flow. After this system has been proven, it should be implemented. It is recommended that development of this system be prepared by a joint Federal (FS, BLM), state (Div. of Forestry, WQB), and private task force.

Other evaluations and analyses should be conducted to assess problems outlined in Section IV, V and VI.

- (3) Develop programs to more specifically identify and quantitatively assess impacts to those drainages identified as highly impacted in Section VI. Follow up with corrective measures, if necessary or feasible.
- (4) Establish regional forestry committees to develop best management practices for areas with similar conditions. Each regional sub-committee should have a representative from the U.S. Forest Service, Bureau of Land Management, private industry, state Forestry Division, local Conservation District(s) and Water Quality Bureau as a minimum. Other agencies or interest groups may be appropriate in some regions.
- (5) Assess the state timber tax structure and make such modifications as necessary to prevent logging of private lands solely to reduce property taxes. Some private lands harvested because of the existing tax situation are a source of water quality problems.
- (6) Provide necessary funding and manpower to the Division of Forestry to adequately implement the existing Cooperative Management program. This program provides professional and technical assistance to private landowners but has been relatively ineffective because of manpower and funding constraints.
- (7) Support pending federal legislation to provide additional assistance to private forest landowners.
- (8) Intensify education program:
 - (a) hold public meetings with forest landowners, loggers, foresters, etc. to disseminate information on BMP's and assistance

programs (function of WQB, USFS, BLM, DNR&C, Conservation Districts and private industry);

(b) make available written guides to landowners, loggers, etc.

(c) Immediately fill the position of extension forester in the USDA Cooperative Extension Service.

- (9) In areas of checkerboard land ownership, encourage joint land use planning to avoid separate owners from independently and simultaneously disturbing a drainage beyond its capacity to absorb impacts from the treatment.
- (10) Encourage private forest industry, state and BLM, to use professional expertise in soils, hydrology and aquatic biology for planning, implementation, and monitoring of forest practices. Existing expertise in forestry can be complemented by:
- (a) hiring qualified professional people in soils, hydrology and aquatic biology and/or;
- (b) seeking additional training for existing personnel from government agencies and/or;
- (c) seeking assistance from agencies which have qualified personnel and/or;
- (d) hiring consultants.
- (11) Encourage the State, BLM, large private industry and others to develop and adopt as formal guidelines Best Management Practices. BMP's found in Section VII could be used as a basis.
- (12) Ask the Department of Fish and Game to do a detailed assessment of enforcement of the Streambed Preservation Act, to determine if implementation is effective as it relates to forest practices.
- (13) Encourage Conservation Districts or groups of districts to hire or have assigned professional personnel to give forest management

guidance to private landowners as well as provide information and education to individuals associated with the forest industry.

The Headwaters Resource Conservation and Development Project (which includes Beaverhead, Deer Lodge, Valley, Granite, Jefferson, Valley, Madison, Mile High, North Powell and Ruby Valley Conservation Districts) has identified assignment of a forester to the RC&D as a major action. North Powell and Deer Lodge Valley Conservation Districts have identified the need for a forester as woodland management specialist to assist in planning on private forest lands.

Beaverhead Conservation District is looking for assistance to reduce erosion on and revegetate clearcut areas by obtaining a research forester. (The Statewide 208 Project could provide assistance for these or similar projects).

- (14) Provide for coordinated utilization and administration of the numerous federal and state forestry assistance programs, as well as other applicable programs (SCS, ASCS, DHES, DNR&C, USFS, etc.). By coordinating these resources, the concepts of creating public awareness of forestry management and providing technical and financial assistance to forest landowners can be more effectively implemented. This could possibly be achieved through the Resources Planning Act as detailed in Section VIII.
- (15) Encourage studies to assess the natural limitations of watersheds to absorb impacts from silvicultural practices. Such studies should be done on as large a scale as practicable. Results should be utilized in preparing comprehensive management plans (coordinated between various landowners) and BMP guidelines for each watershed.
- (16) Encourage development and implementation of tax incentive programs that require the use of BMP's on forest lands for eligibility of

tax benefits. Such programs would necessitate coordination between the Department of Revenue and the DNR&C in order to design and administer effective and constitutional tax incentives.

- (17) Encourage small private forest landowners who are considering selling timber to seek professional assistance, through government agencies or consultants. Provide landowners with "model contracts" which outline the basin agreements with a logging contractor. Include water quality protection guidelines (equatible with BMP's) in these "model contracts".
- (18) Formulate plans to rehabilitate (reforest) areas that are eroding and causing sedimentation. Existing assistance programs, apportionment of taxes for corrective actions, etc. could be used to reforest or revegetate these areas.
- (19) In conjunction with the resource evaluations outlined in 1, it is recommended that the state reassess the classification of state forest lands to determine those areas that cannot be managed for timber production (because of critical site conditions or other limiting factors). Areas which, if managed for timber production, would result in adverse water quality impacts should be reclassified to a different, appropriate land use.
- (20) The Water Quality Bureau should hire a competent silviculturist to assist their existing staff in assessing non-point source water quality problems from silvicultural practices, to work closely with the Division of Forestry and other government agencies (including Conservation Districts) and to work with private landowners to prevent or mitigate adverse impacts from forest practices.

This person should be responsible for coordinating assessment and research relating to non-point source pollution from forest

practices and to evaluate the effectiveness of implementation of these recommendations to determine whether a regulatory framework is necessary.

- (21) Water quality information should be readily available. Existing and future collected data should be catalogued and entered in a retrievable computer system. Information should include watershed characteristics (baseline data, where available) and specific data on water quality impacts related to silvicultural activities. Coordinate data gathering methods and watershed designation systems between government agencies (USFS, DNR&C, WQB, DF&G, USGS, SCS, Conservation District). Provide for development of computer retrieval programs that will matrix specific water quality data with specific stream reaches (include options for historical listings of data).
- (22) Provide necessary funding and staffing (legal and field personnel) to adequately enforce existing regulatory statutes. Specific needs are identified in Section VIII (WQB, DNR&C, Conservation Districts).

The recommendations listed above essentially comprise a non-regulatory approach to controlling water quality problems arising from forest practices. It is recommended that this non-regulatory approach to be tried for two years and assessed for effectiveness at the end of 1980. If results are not consistent with water quality goals, it is recommended that a regulatory program, giving BMP's the force of law, be presented to the 1981 state legislature. Alternative regulatory approaches are discussed in Section IX.

As a final recommendation, Conservation Districts should be encouraged

(especially where problems have been pointed out) to assess (with state and federal assistance) the significance of water quality problems in their district and, where applicable, adopt ordinances similar to the Lewis and Clark County Conservation Districts Ordinance to control water quality problems resulting from forest practices.

II. INTRODUCTION

A. Scope of Study

The Montana Department of Health and Environmental Sciences (DHES) commissioned this report as part of its Statewide 208 project. DHES will integrate the results into a comprehensive management plan for all non-point source pollution in Montana.

Water quality problems in Montana's Statewide 208 Planning Area (Fig. II-1) were identified and evaluated from data provided by government agencies and private sources. Problem areas were assessed by the nature and severity of the problems, their relation to silviculture, and their potential for remedy.

Forestry management guidelines regarding stream water quality, presently used by Montana's forest industry, were appraised. Silvicultural practices (harvesting methods, road design and construction, use of pesticides, slash removal and seedbed preparation) and their attendant water quality problems were examined through literature review.

Existing legislation and regulation (federal, state and local) of forest practices and water quality was analyzed for effectiveness in controlling water pollution. Methods for mitigating or preventing water pollution were studied and best management practices (BMP's) for silvicultural activities were identified. Site-specific recommendations were made for selected problem areas.

B. Forest Industry in Montana

One fourth (23 million acres) of Montana's area is forested. Of this amount, about 14 million acres is commercial forest (Table II-1).

Figure II-1. Section 208 Planning Units

Statewide 208 Sub-Planning Areas

- A. Kootenai R.
- B. Lower Clark Fork R.
- C. Upper Clark Fork R.
- D. Upper Missouri R.
- E. Missouri-Sun-Smith R.
- F. Mid-Missouri R.
- G. Lower Missouri R.
- H. St. Mary R.
- I. Marias R.
- J. Milk R.
- K. Musselshell R.
- L. Upper Yellowstone R.
- M. Lower Yellowstone R.

Area-wide Planning Organizations

- 1. Yellowstone-Tongue APO
- 2. Mid-Yellowstone APO
- 3. Blue Ribbons APO
- 4. Flathead APO

Approximately 5½ million acres of state, private and BLM lands are covered by this report.

Annual harvest from forest lands is shown in Figure II-2.

Although no definitive figures exist on how many acres are subject to various forest management practices, it is estimated that 100-125,000 Montana acres are affected annually on state, private and BLM lands. This figure includes all types of forest practices including harvesting, site preparation, road construction, etc.

1. Large industrial forest lands

Three forest industry firms (Burlington Northern, Champion, and St. Regis) account for about 11 percent of the commercial forest lands in Montana. In 1976, these three firms produced, from their lands, about 30 percent of the timber harvested in the state.

Volumes harvested from industrial forest lands have increased from 194 MMBF in 1970 to 339 MMBF in 1976. This increase has been partially caused by intensified harvesting of old growth stands and efforts by the industrial firms to salvage timber affected by insects and disease.

2. Small private forest lands

The small private forest land owners control about 22 percent of Montana's commercial forests. These lands produced 21 percent of the total harvest in Montana during 1976.

About 19,000 individuals own Montana's private commercial forests. Twenty years ago 14,500 individuals owned the private commercial forest (Bolle et.al., 1966). The increase in the number of landowners can be attributed

Table II-1.

Commercial forest land in Montana

<u>Landowner</u>	<u>Acres</u>	<u>Percent</u>
Forest Service	7,944,700 (1974)	56.35
*BLM	315,000 (1975)	2.23
Misc. federal	53,000 (1970)	0.38
Indian	620,000 (1970)	4.40
*State	421,000 (1975)	2.99
*County and municipal	4,700 (1970)	0.03
*Private	4,740,000 (1976)	33.62
Small private	3,150,000	22.34
Large private (BN, St. Regis, Champion)	1,590,000	11.28
	14,098,400	100.00

* Assessed in this report (39.25% of commercial forest lands)

Data from USFS, 1973; BLM, 1975; EQC, 1976.

Figure II-2

MONTANA TIMBER HARVEST (1962-1976)

to the subdividing of these forestlands.

The percentage of the 3.14 million acres of small private commercial forest lands managed for timber production is not known. Private lands are usually at lower elevations, are readily accessible, and most have been previously logged (Schweitzer, Benson and McConne, 1975). Small farms, ranches and individual residences with small acreages may account for a considerable portion of these lands. Recent studies assessing landowner objectives in the United States show that less than 10 percent of individuals polled expressed an interest in wood or fiber production or in making investments necessary to increase production of forestlands (Jones and Paxton, 1977).

Many of the logged stands (especially those harvested in the late 1800's and early 1900's) currently support saw timber; however, most of these stands have not been intensively managed. Road systems are generally well developed in logged stands and on smaller private tracts.

3. State forest lands

The State of Montana controls about three percent of the commercial forest land in Montana (421,000 acres). These lands are administered by the Forestry Division of the Department of Natural Resources and Conservation, although decisions regarding state lands are made by the Board of Land Commissioners. The state originally controlled sections 16 and 36 in each township. Land exchanges, however, have resulted in consolidation of state forest lands into contiguous blocks. West of the Continental Divide about 200,000 acres are grouped into seven state forests (Bolte, et.al., 1966).

Since 1962 state forest lands have supplied about two percent of the total Montana timber harvest. Since 1974 the state forest lands have supplied about one percent of the total timber harvest.

Approximately 70 percent of state forest lands have been developed in some respect.

4. Bureau of Land Management forest lands

The BLM manages 314,700 acres in Montana as commercial forest land. To a large extent this land occurs as scattered parcels interspersed with private, Forest Service or state lands.

BLM forest lands are managed under the principles of multiple use, sustained-yield and environmental quality. Forest management is defined by the BLM (1975) to include the management of land along with wildlife, water, minerals, timber, recreation, forages, and other resource values associated with it. The major laws governing management of BLM forest lands are the Federal Water Pollution Control Act, Clean Air Act, Fish and Wildlife Coordination Act, Federal Environmental Pesticide Act, Taylor Grazing Act, Multiple Use Act, National Environmental Policy Act, and the Federal Land Policy and Management Act.

III. SILVICULTURAL PRACTICES IN MONTANA

Silviculture is an applied science concerned with the establishment, growth and composition of forest communities for commodity output.

As an applied science, silviculture is based upon fundamental natural and social sciences. The immediate natural science foundation of silviculture is the field of silvics, involving environmental factors controlling the growth and development of individual tree species and the forest as an ecological unit. Silviculture is also based on and influenced by economics (supply and demand, cost effectiveness, etc.). For the purposes of this report silvicultural practices include:

- (1) Forest harvesting and regeneration techniques (including slash disposal);
- (2) On-site road construction and maintenance;
- (3) Stand maintenance (thinning, use of pesticides, fertilization, burning, etc.).

Theoretically, harvesting methods employed in a silvicultural system vary depending on a number of factors including:

- (1) Silvics or ecology of the species;
- (2) Site characteristics (steep slopes, erosion, potential, etc.);
- (3) Nature of the stand (even-aged, uneven-aged, maturity, species diversity, insect damage, etc.);
- (4) Management objectives (desired regeneration; maintenance of seral or climax species, etc.);
- (5) Economics;
- (6) Social constraints or desires;
- (7) Legal constraints.

Harvesting methods most commonly used in Montana forests include:

- (1) The selection system is the removal of mature and immature trees singly or in groups at intervals. The objective of this system is to maintain an uneven-aged stand with regeneration established almost continuously;
 - (a) Individual tree selection involves removing individual trees rather than groups of trees. This method tends to favor shade-tolerant species;
 - (b) Group selection is the removal of small patches (less than two acres) to create a mosaic of even-aged groups within an uneven-aged forest;
- (2) The shelterwood system involves a series of cuts removing mature trees over a relatively short portion of the rotation. This system encourages establishment of an essentially even-aged stand under partial shelter of the remaining trees;
- (3) The seed tree system entails removing nearly all trees in one cut. A few desirable seed-producing trees are left, distributed over the area, to naturally reseed the stand.
- (4) The clearcutting system is the harvesting in one cut of all trees in an area to create an even-aged stand.

An important part of many silvicultural systems is site preparation. The objective of site preparation is to create conditions necessary for establishment of a new forest stand (Packer, 1971). Factors often considered with site preparation are:

- (1) Disposing of logging residue;
- (2) Reducing or eliminating plant competition;

- (3) Preparing mineral soil seedbeds;
- (4) Providing favorable microenvironment (pitting, furrowing, terraces, etc.).

Various methods are used to prepare sites in Montana including:

- (1) Fire - one of the principal means of site preparation in Montana - used for reducing slash, eliminating competition and creating mineral soil seedbeds; often used in combination with mechanical treatment (dozer pile and burn);
- (2) Chemical - rarely used in Montana; main purpose is to reduce plant competition;
- (3) Mechanical - can be used to dispose of logging residue, eliminate plant competition, prepare mineral soil seedbeds and create favorable microenvironments. Most common mechanical site preparation techniques are:
 - (a) scarification - commonly used in Montana when logging residue is machine piled for burning; involves exposing mineral soil by removing vegetation and litter;
 - (b) stripping and scalping - involves removing strips or small patches of vegetation by machine or hand to reduce competition and expose mineral soil;
 - (c) terracing - construction of contour benches (usually the width of tractor). This practice is not common on most state, BLM, or private lands but has been used by the U.S. Forest Service especially in the Bitterroot National Forest (not employed at this time).

Road construction and maintenance activities, although not generally considered with silvicultural practices, are included because of their complementary relationship with forest practices in Montana and their notoriety for creating water quality problems. The literature is replete with references to road construction and maintenance as a primary source of water quality problems when discussed in the context of silvicultural practices. Road construction is an integral part of managing Montana's forests and several thousand miles of roads have been constructed for access to forest lands.

Precommercial and commercial thinning (reducing the number of trees per acre to allow remaining trees to grow with less competition) is practiced in Montana on better sites. No water quality problems have been tied to thinning projects in Montana and relatively little potential exists for these problems in the future.

Use of pesticides and fertilizers on state, BLM, and private forest lands has been limited in Montana and current plans do not call for substantial increases in use of these chemicals.

A. Large Private Industry

Silvicultural practices vary depending on management objectives, silvics, slope, aspect, habitat types, etc. In general, forest industry firms do less clearcutting than the U.S. Forest Service (EQC, 1976), using cutting methods that rely more on natural regeneration.

1. Champion International

Champion International has developed a guide to silvicultural practices that it uses to manage the company's 640,000 acres of commercial timberland.

The primary goal of these silvicultural guides is "controlling the establishment, composition, and growth of forests stands on Champion's timberlands in a manner that will ensure a permanently productive source of goods and benefits". Average annual harvest from Champion's lands for the period 1972-1976 was 186 MMBF.

Champion's lands are classified as A) intensive culture areas, B) low productivity areas and C) special impact areas. Recommended silvicultural practices vary with each classification. Silvicultural guidelines for Champion's timberlands are found in Appendix A.

2. Burlington Northern

Burlington Northern manages its 750,000 acres of commercial forest lands in Montana through five year plans. These plans give management direction to unit foresters who are responsible for implementing the plans (BN has unit headquarters at Kalispell, Seeley Lake, Missoula and Bozeman). BN "does not attempt to issue detailed formal instructions to its managers because continuous flexibility is needed to respond to the local conditions which are never static and are always subject to nature, the public interest and market demand" (Merryman, 1975).

Long term goals include intensifying forest management practices to maintain a sustained future timber supply. Current annual harvest is 70-75 MMBF/year (BN, pers. comm., 12/21/77). Although BN is evaluating various intensive forest management activities such as precommercial thinning, commercial thinning, fertilization and genetic improvement, economic pressures are narrowing the margin between costs and benefits of many intensive management methods (Merryman, 1975).

Burlington Northern uses harvest methods other than clearcutting in nearly all situations in Montana. In their Rocky Mountain District (which includes Idaho and portions of Washington), 150,000 acres have had harvest activities during the last ten years; 137,800 acres by various partial cutting methods and 12,200 acres clearcut (Merryman, 1975).

Burlington Northern lands are classified in one of seven major classes according to their available resources, topography, soil, location and environmental constraints. Land use classes are listed in Appendix B.

3. St. Regis

St. Regis Paper Company harvests about 35-45 MMBF annually from its 200,000 acres of forest land in Montana. Operations are guided by direction established in their 1969 Forest Management Plan. This plan is in effect through 1979 after which it will be revised to reflect existing conditions and available information on timber management.

Silvicultural practices used by St. Regis are based on species and site or productivity class as well as management objectives. Both even-aged and all-aged silvicultural systems are used. Silvicultural policy for St. Regis' timberlands is included as Appendix C.

B. Small Private

Generally, the small private forestland owner practices the least intensive forestry management in Montana (EQC, 1976). Management objectives are variable and silvicultural practices cover a wide range. Harvesting methods range from selective cutting to clearcutting.

Inspections of silvicultural practices on private lands indicated some of

the worst and some of the best silvicultural practices used in Montana. Important factors in operation quality included (Many of these points also apply to large private, state and BLM operations):

1. Management objectives of the landowner

Some landowners harvest to reduce the tax base, convert to another land use or for quick income. Other landowners manage their timber for long-term productive uses.

2. Contractor

As with any profession, there is a wide range in performance between operators. Some loggers take no precautions to protect water quality. Other operators are very conscientious about doing a quality job. Monitoring of the job by concerned landowners usually results in better operations.

3. Professional assistance available to the landowner

4. Size of the operation

5. Location of the operation

This is an important factor as many private lands are located along drainages (homestead lands). Proximity to public lands can be important when both public and private lands in the same drainage are harvested simultaneously because of the mutual aspect of access.

6. Timing of the operation

The time of the year (spring and early summer vs. fall or winter) influences impacts on water quality. In addition, the timing of the operation in relation to other silvicultural practices or other land uses in the same drainage may influence water quality impacts.

7. Methods used by contractor

8. Existing access

Most private lands are well roaded. In those cases where roads are constructed, substantial possibilities exist for increasing sedimentation.

Precommercial thinning, use of pesticides, and fertilizers is not a significant problem because of limited use.

Slash disposal is normally accomplished by burning, or, in some cases, by making the debris available for firewood.

C. State

The primary harvest method on state lands is selection cutting and over-story removal. Clearcutting is preferred in highly diseased stands or old growth, even-aged stands (15-20 percent of harvesting).

Because most state lands (about 70 percent) have been developed in the past, new road construction is generally limited to the remaining undeveloped areas.

Pesticides and fertilizers have not been used extensively on state forest lands and current plans do not call for expansion of this practice.

D. Bureau of Land Management

The Bureau of Land Management has recently defined operational practices on BLM lands (BLM, 1975, pages I-27 though I-66). These practices include protection, site preparation, seeding, planting, site and stand improvement, intermediate and final harvests, and the development of transportation systems. Most of these practices are carried out by private parties. usually on a contract basis, under BLM supervision.

Harvesting operations vary from individual tree selection to clearcutting. Two recent BLM Environmental Assessments (BLM, 1976 and BLM, 1977) state that over 90 percent of harvesting on the Missoula and Dillon sustained yield units will be by partial cutting (which results in harvesting in stages, with at least 10 years between stages). These two sustained yield units contain most of the BLM's commercial forest land.

Road construction is often necessary to gain access to BLM timber. Road design varies with amount and type of use, topography, and other variables. Roads range from 10-14 feet in width with road clearing from 25-50 feet. Design criteria are part of the timber sale contract.

Slash treatment is also a part of timber sale contracts. In Montana, burning, mechanical treatment, and lop and scatter are principal slash treatment methods. Burning has been the principal treatment; however, the BLM (1976) considers lopping and scattering of slash to be a feasible treatment in stands harvested by partial cutting.

Use of pesticides has been limited on BLM lands in Montana and current plans do not call for largescale applications (BLM, 1975,1976,1977).

IV. WATER QUALITY PROBLEMS ASSOCIATED WITH SILVICULTURAL PRACTICES

There is an increasing interest in the effects of silvicultural practices upon water quality. Researchers from public agencies and universities are pursuing more detailed projects in an effort to more accurately define such relationships. Private research projects are limited. This section will provide the layperson with an understanding of water quality impacts that may occur during silvicultural activities. References are cited for further study of specific research projects.

Due to the variability of watershed characteristics, there are some problems with general application of results from a particular study area. This fact emphasizes the need for watershed inventories and related research to determine the limitations, requirements, and impacts of land uses in forested watersheds. Further research pertinent to Montana's forestlands and problems should be encouraged by appropriate agencies and individuals.

A. Sedimentation and Turbidity

Sedimentation has been considered one of the most serious water quality problems associated with forestry practices. Suspended solids may directly affect fish, prevent development of fish eggs and larvae, modify movements or migrations of fish, and reduce available food for fish. Other affects of high suspended solids include degradation of drinking water (and increased treatment costs) and impacts to recreational uses. Settleable materials which blanket the bottom of water bodies, may damage invertebrate populations, block gravel spawning beds, and if organic material, remove dissolved oxygen from overlying waters.

Roads are the primary cause of accelerated erosion and sediment increases from forestry practices (2,4,13,25,27,34,48,50,53,57,69,71). Sediment problems may result from construction activities, poor road design and location, and road use and maintenance practices.

Vegetation removal can also lead to increased sediment loads in forest streams (13,27,46,52,61,62). The associated methods of vegetation removal (skidding, yarding, etc.) may also contribute to accelerated erosion, depending upon the degree of soil disturbance (43,53).

Sediment increases may also result from the effects of fire upon the soil mantle. These effects vary depending upon the severity of the fire; natural forest fires may affect the soil mantle differently than certain prescribed burning methods (1,3,4,18,27,28,35,52,60,66).

Research specific to Montana is outlined below:

Weisel and Newman (67) studied the Blackfoot River drainage in Montana and concluded that irrigation practices have a greater sediment effect than forestry practices on the area's streams.

A study done in northwestern Montana by Packer and Williams (52) found that clearcutting and slash burning result in erosion and stream sedimentation. They noted that erosion stopped after three years on north facing slopes, but south facing slopes were not healed for seven years.

B. Channel Morphology

Some silvicultural activities may affect stream channel morphology, including: harvesting practices, road construction, and burning. Changing channel morphology may accelerate erosion, creating sedimentation problems (as outlined previously).

Logging debris left in stream channels can cause damming, channel changes, and channel scouring (27).

Vegetation removal (either by harvesting or fire) can cause increased streamflows resulting in channel adjustments (35, other citings in following discussion on flow regimes).

Road construction and skidding operations may also directly affect channel morphology.

C. Water Balance and Flow Regime

Watershed flow regime and water balance may be affected by forestry practices such as harvesting methods, burning, and road construction.

Vegetation removal, particularly by clearcutting, reduces interception and evapotranspiration losses. Snow accumulation may also be enhanced. Increased water yields usually result in watersheds where such activities occur (7,8,16,26,30,31,36,38,39,40,53,54,55,58,59,64,68,71).

Burn areas (natural and prescribed) maintain a higher soil water content due to reduced evapotranspiration (1,5,10,23,31,35,58,63). This can affect streamflow due to reduced runoff response time to precipitation events and increased water yield.

Infiltration will improve in harvested and burned areas as revegetation progresses; however, roads retain their impervious character (32,63).

The following text outlines related studies done in Montana:

Bateridge (8) observed more water flowing from clearcut basin streams than from forested basin streams in the Bitterroot National Forest.

It was noted that peak runoff from clearcut basins averaged 11.5 times as great as the mean daily flow while peak runoff on an undisturbed basin was 8.7 times as great as normal mean daily flow.

It was also noted by Foggin and Forcier (26) that clearcut drainages near Missoula had a larger discharge than uncut drainages.

Packer (55) studied clearcuts in Montana's Flathead National Forest and found the clearcut areas receive four more inches of water from melting snow than unforested areas.

In a snowmelt study in northwestern Montana, Packer (54) found that on south facing slopes the rate of melt decreased as slope increased and on north facing slopes the opposite occurred - the rate of snowmelt increased as slope increased.

A five year study of the Coram Experimental Forest in Montana was done by Tackel (63). He noted that for the first year after logging the infiltration capacity of skid roads, scarified areas and broadcast burned areas averaged 4.1 percent, 15.4 percent, and 62.5 percent respectively of the infiltration capacity of undisturbed soil. During the next four years, the burned and scarified areas improved (increasing infiltration capacity), but the skid roads remained impervious.

D. Temperature

The species composition and activity of any aquatic environment is partially regulated by temperature. Water temperature affects the ability of organisms to survive and reproduce effectively (EPA, 1976).

Silvicultural activities that can influence stream temperature include

degree of vegetation removal and proximity to streams, burning and increased sedimentation. Clearcutting practices have been shown to cause increases in stream temperature (12,15,41,42,45,46). Vegetation removal adjacent to streams can increase solar radiation, thereby raising stream temperatures (6,12,19,42). Fires, either prescribed slash burning or natural, may affect stream temperatures due to vegetation removal and/or the actual heat generated by the fire (10,41,45). When forestry practices generate increased sediment loads and turbidity, stream temperature may also increase due to the higher absorption capacity of the turbid waters.

There has been no research done in Montana that relates stream temperature fluctuations with silvicultural practices.

E. Nutrients

Forestry practices may result in nutrient losses from soils which in turn cause increased levels of nutrients in stream water chemistry. Such changes may affect the aquatic life communities of streams, as well as degrade soil fertility. Harvesting methods, prescribed burning, and road construction are activities which may influence nutrient cycling.

Clearcut harvesting has been correlated with high nutrient levels in streams (8,11,26,29). Nutrient losses may be accelerated depending upon soil types or prescribed burning in the clearcut area.

It has been demonstrated that fire can release many soil nutrients, leading to increased nutrient levels in streams (11,22,28,35,61,64,70). Such effects and their duration depend upon the type of fire (natural, broadcast burn, pile burn, etc.) and the rate of revegetation.

Use of fertilizers in silvicultural activities may also contribute to increased nutrient levels in streams of the treatment area (35).

Any soil disturbance, whether from harvesting, road construction, or burning, will contribute to increased nutrient losses from the disturbed area (70).

Several studies have been conducted in Montana and are identified here:

In studying watersheds on the Bitterroot National Forest, Bateridge (8) found that clearcutting can stimulate nitrification, resulting in significant losses of NO_3^- (nitrate) from forested watersheds, particularly those with coarse-textured soils. However, effects of clearcutting may be distorted by effects of parent materials. Foggin and Forcier (26) noted that dissolved nutrient loads in clearcut basin streams near Missoula, Montana are generally higher than those of their forested counterparts. They found that these differences were more closely related to parent material than to the degree of clearcutting. Parent material could possibly account for inconsistencies in the following studies. Weisel and Newell (67) studies the Blackfoot River drainage in Montana and found no measureable nitrate in Gold Creek or Belmont Creek although both had been heavily logged in the past ten years.

Bateridge (8) also noted that nutrient losses were greater from roaded watersheds than from unroaded watersheds in the Bitterroot National Forest.

BeByle and Packer (22) found that a maximum nutrient concentration of 44 ppm occurred in summer runoff from burned clearcuts in western Montana. In studying the effects of logging and burning on water quality (Coram Experimental Forest in western Montana), Stark (pers. comm.) concluded that the low level treatments (partial cutting, skyline

logging, minimal surface disturbance) had a minimal and short term effect on water quality. It is Stark's opinion that more severe treatments (more surface disturbance) on different habitat types would show higher levels of cations and ions in receiving waters.

F. Chemical Changes

Several characteristics of stream water chemistry may be affected by silvicultural activities, including: specific conductivity, pH, various anion and cation concentrations, dissolved oxygen, etc. Harvesting methods, fire (natural and prescribed), and use of pesticides are the primary activities responsible for such chemical changes.

Most research has dealt with the effects of clearcutting and/or burning practices upon stream water chemistry (8,11,26,28,35,61). Specific relationships cannot be generalized due to conflicting results, but it appears that the combined effects of these practices are a primary factor in such chemical changes.

Pesticides may affect stream water chemistry when the chemical substances are applied to, or drift into, stream courses. Overland flow and leaching of pesticides are less significant mechanisms of transporting such applied chemicals into the stream of the treatment area (20,29).

Studies conducted in Montana include the following results: Bateridge (8) noted higher specific conductivity in uncut watershed streams than in clearcut watershed streams in the Bitterroot National Forest. He found no relationship between clearcutting and sodium (Na) and potassium (K) ion concentrations.

Foggin and Forcier (26) noted that while clearcut basins near Missoula have larger discharges than matched forested areas, cation concentrations and specific conductances of streams in clearcut basins are not significantly reduced. Dissolved nutrient loads from clearcuts are generally higher than loads in forested counterparts.

G. Biological Changes

The dissolved oxygen content of stream water is a primary determinant of aquatic life composition. This factor can be influenced by several silvicultural activities including: use of pesticides, harvest methods, and burning.

Research shows that logging debris left in streams can have a high enough biological oxygen demand (B.O.D.) to reduce the stream's dissolved oxygen content below the minimum required for fish development (newly hatched fry or developing embryos) (6). Another study found dissolved oxygen levels below that needed to sustain fish life in a watershed that was clearcut and burned (41).

There are no studies which directly address the biological impacts of silvicultural activities in Montana.

V. POTENTIAL PROBLEMS

Potential water quality problems exist whenever silvicultural practices are implemented without proper controls.

Most opportunities for problems will occur in response to increasing demands for wood products that must be supplied by the small private forest land owner. Timber harvested from public lands has decreased substantially since 1971. To ameliorate this loss, harvests from industrial forest lands have increased. Private corporations have intensified their harvest of old growth stands where annual production is relatively low. The large private corporations are currently attempting to manage their lands on a sustained yield basis (while at the same time allowing enough flexibility to meet variable annual demand). As a result, it can be expected that harvests will increase on small private forest lands. Generally, there are fewer self-imposed controls on silvicultural practices for the small private forest land owner than for public or industrial land owners.

A. Planned Development Activities

Planned development activities are shown in tables V-1 & V-2. These planned activities do not imply that water quality problems will result on every acre affected or mile of road constructed. Rather, it is an attempt to show the magnitude of planned development and where opportunities for problems may exist.

TABLE V-1

PLANNED SILVICULTURAL ACTIVITIES

<u>Landowner</u>	<u>Comm. Forest Base</u>	<u>Acres affected in next 10 years (estimated)</u>	<u>Road Construction</u>	<u>Herbicides Fertilizers</u>	<u>Estimated Cut (annual) MMBF</u>	<u>Principal Harvesting Method</u>
BLM	315,000	60,000-70,000	<5 miles/yr.	Minimal Use	14	Selection cutting
State	421,000	85,000-100,000	12-16 miles/yr.	Minimal Use	21	Selection cutting
Large Private	1,590,000 <u>1/</u>	500,000-750,000	500-700 miles next 5/yr.	Minimal Use	300-400	Selection, shelter, wood, seed tree, salvage
Small Private	3,150,000 <u>1/</u>	250,000-400,000	Unknown	Minimal Use	150-250	Variable

1/ Only 2,200,000 acres of private timber showed up on county tax records for 1970 (Schweitzer et.al, 1975).
The Forestry Division of DNR&C shows 5,260,440 acres (1976) of private forest lands having 10% + crown cover.

2/ Sustainable harvest for State Forest lands is 35MMBF, projected cut based on existing administrative capabilities is 26.5 MMBF - acres affected in next 10 years is based on a cut of 26.5 MMBF.

TABLE V-2

BLM - SUMMARY OF PLANNED DEVELOPMENT

	<u>comm. forest (acres)</u>	<u>acres under timber mgmt. (10 year plan)</u>	<u>acres affected in 10 years</u>	<u>silvicultural practices</u>	<u>sustainable¹ harvest (MMBF/decade)</u>
Missoula SYU Sustained Yield Unit	144,000	100,000	25,000	over 90% by shelter- wood cutting (23,350 acres selectively cut; 1,150 acres clearcut)	70
Dillon SYU	171,733	99,010	21,588	over 94% by partial cutting (15,508 acres selectively cut; 1,400 acres clearcut; 4,680 acres commercially thinned)	54.6
Central Montana SYU	106,632	not available	not available	98% by selection cutting and partial cuts; small clearcuts up to 5 acres in mature lodgepole; about 60 acres/year thinned	9.5
Eastern Montana SYU	acreages and sustained harvest will not be available until after the forest inventory to be completed in 1982-83. Current harvesting is minimal and consists of small post and pole sales				

¹ sustainable harvest reflects potential - actual harvest is scheduled at lower volumes.

1977 - 5 MMBF
1978 - 7 MMBF
1979-80 - 8 MMBF
under 10 MMBF until 1983

B. Cumulative Effects

In areas of checkerboard ownership (usually alternate Forest Service and private), independent land use planning may cause simultaneous disturbance of large areas within the same drainage, creating more impacts than if only one ownership were involved. Federal land use plans and environmental impact statements rarely treat cumulative impacts of silvicultural practices on public and private lands. Practices on private lands are normally not coordinated with practices on public lands (except for cooperative road construction programs).

Silvicultural practices coupled with other land uses such as grazing often lead to additional water quality impacts. Throughout our survey, it was apparent that land uses other than timber management contributed to water quality problems. Often it is impossible to distinguish the source of water quality problems in areas of multiple land uses. (Another complicating factor is the role played by natural processes contributing to the system, i.e., slumps, bank instability, etc.).

C. Critical Areas

Silvicultural practices acceptable to one area may not be acceptable in another area because of differences in the capability of each area to absorb impacts. Such differences may result from the natural limitations and hazards of an area, the historical land use activities in an area, or a combination of these factors. The following listing describes several parameters that should be considered when planning silvicultural activities.

1. Natural Limitations and Hazards

a. Geology

Lithology - Poorly consolidated materials provide greater potential for erosion and sedimentation.

Structure - Bedrock structures may contribute to sensitivity of an area (i.e. dip slopes).

Geologic hazards - Landslides, slumps, etc. may contribute to sensitivity of an area.

b. Soils

Erosion potential - Dependent upon soil type, slope, disturbance, and other factors.

Moisture content - Relative to soil stability and capacity for forest regeneration.

Thickness - Relative to soil stability and capacity for forest regeneration.

Fertility - Relative to soil capacity for rapid revegetation and forest regeneration.

c. Topography

Slope - Steeper slopes are more susceptible to erosion, especially impacts from road construction or skidding.

Aspect - Greatly influences potential for forest regeneration in some areas.

d. Regeneration Potential

Habitat type - Physical requirements for regeneration will vary among habitat types.

Soils - Primary factor in potential for site to support regeneration (moisture, thickness, fertility).

Topography - Greatly influences capacity for regeneration in an area.

e. Groundwater

Water table - Areas of high water table (some marshes, etc.) may be more sensitive to harvest activities.

f. Watershed Hydrology

Regime stability - Condition of channels

Precipitation events - Expected intensity, duration, and frequency; relationship of vegetation manipulation and runoff.

Capacity of receiving water to absorb changes - Increased sediment loads, increased water yields, temperature changes, chemical changes, nutrient changes, other pollutants.

2. Man-Caused Limitations

a. Historical land use activities

Type of activities - Timber harvest, grazing, road construction, etc.

Extent of activities - Acreage involved within watershed.

Coordination of activities - Location, timing, duration

b. Condition of Receiving Waters

Cumulative effects of land use activities - Impacts to stream water quality.

Tolerances for additional impacts - Increased sediment load, increased water yields, chemical and nutrient changes, other

Watershed management objectives - Defined by state agencies (Fish and Game, Health and Environmental Sciences).

Silvicultural activities should be modified to reflect the limitations and hazards of the specific site, as well as the entire watershed. Such modifications may include changes in location and construction of road systems, harvesting technique, size and location of cutting units, timing of activity, and subsequent land use. In cases where severe impacts to water quality are anticipated (or already exist), silvicultural activities may necessarily be completely avoided.

D. Changes In Silvicultural Practices

Changes in silvicultural practices that could lead to additional water quality problems without proper controls include:

1. Using harvesting, road construction, slash treatment or other methods that create more soil disturbance.
2. Harvesting areas where volumes/acre are low (for example, to harvest 1 million board feet in an area averaging 50,000 board feet/acre would involve 20 acres; to harvest 1 million board feet in an area averaging 10,000 board feet/acre would involve 100 acres - generally sites with lower volumes per acre are harder and slower to revegetate). In some cases, however, more productive sites have greater potential for problems because of higher annual precipitation.
3. Practices in critical areas.
4. Intensifying management to include large scale applications of herbicides, pesticides, and fertilizers.
5. Failing to revegetate areas (this is especially critical in some private lands where landowners sell their timber without provisions for revegetation).

VI. WATER QUALITY PROBLEMS RELATIVE TO SILVICULTURAL PRACTICES IN MONTANA

Presented in this section is a comprehensive inventory and evaluation of specific water quality problems related to silvicultural practices in Montana's Statewide 208 Study Area. Approximately 170 known, suspected, or anticipated "problem" areas were identified. This survey was completed with cooperation and assistance from state and federal agencies, private corporations, citizen groups, and individuals associated with timberlands and their management. Personal field contacts with district offices of government agencies and the local private sector provided substantial information regarding water quality impacts. Other information sources which were utilized included: specific publications regarding water quality and its management (DHES, DF&G, others); statistics compiled by the Conservation Districts (DNR&C) regarding erosion problems on commercial forestlands; and a DF&G inventory of impacts to fisheries habitat from logging practices.

In most cases, reported problems were difficult to document. This is due to the nature of non-point pollution and the lack of adequate stream monitoring systems. Therefore, information from several sources was gathered to most accurately assess problem areas. The text and tables of this section emphasize problem identification, reported types and causes of problems, and suggested measures for mitigation or prevention of problems. Plate I shows the geographic locations of the identified problem areas.

In some cases, silvicultural practices are one of several land management activities contributing to non-point pollution of a watershed; isolating the impacts of these activities may be difficult. Coordinated planning of

management activities should be pursued on a basin-wide basis to adequately mitigate or prevent water quality degradation. The following prioritization of problem drainages reflects the severity of the watershed's cumulative non-point problems where forestry activities have been a major contributor. The order of listing individual watersheds does not necessarily indicate prioritization within each group.

Currently impacted watersheds needing immediate evaluation and mitigation/prevention planning:

- Fisher River
- Shields River
- Fish Creek (tributary to Clark Fork River)
- Thompson River
- Tobacco River
- Smith River

Watersheds of potential impacts needing evaluation and prevention planning:

- Blackfoot River
- Yellowstone River
- Clearwater River
- Lolo Creek (tributary to Bitterroot River)
- Mainstem Clark Fork River (Middle)
- Upper Swan River
- Clark Fork River (Upper) - Little Blackfoot

Description of these drainages is developed in the following text and tables.

A. Kootenai River Basin

The Kootenai River drainage basin is in the northwest corner of Montana. Its headwaters are located in Canada. The boundaries of this area are the Whitefish Range and Salish Mountains to the east, the Cabinet Mountains to the south, and the Purcell Mountains to the north. The mouth of the Kootenai River is on the Columbia River in British Columbia.

There are 2.4 million acres within the Montana segment of the Kootenai watershed. Approximately 2.3 million acres are forest lands under federal, state, industrial and small private ownership, with the USFS being the largest landowner. About 53 percent of this acreage is commercial forest land. All but four streams in the basin are classified as B-D₁ streams by DHES.

Forestry practices are the largest contributors to non-point stream pollution in the Kootenai River drainage basin (DHES, 1974). The Lincoln County Conservation District (1977) estimated that less than two percent of commercial timberlands (2,084 acres) can be classed as contributing to non-point pollution due to soil erosion. Of these problem areas, approximately 70 percent were considered correctible.

The USFS and DF&G have also identified several drainages where silvicultural activities have either created water quality problems or aggravated and contributed to an existing problem. There have been no detailed investigations of long-term effects from timber harvesting in these watersheds. To simplify discussion of water quality problems, the following designations were made:

Upper Kootenai River

Tobacco River

Canadian border to Fisher River

headwaters to mouth

Fisher River	headwaters to mouth
Lower Kootenai River	Fisher River to Idaho border
Yaak River	headwaters to mouth

Natural conditions may contribute to water quality degradation, particularly when aggravated by silvicultural activities. Slope and soil conditions are the primary limiting factors in the Kootenai River drainage.

Soils developed on glacial till and glaciofluvial deposits occur in the narrow valleys. These soils are used primarily for timber production and present a severe erosion hazard when mismanaged. Glaciolacustrine material and shallow soils on steep slopes also present severe erosion hazards (DHES, 1974).

1. Upper Kootenai River Drainage

Between the Canadian border and the mouth of the Fisher River (approximately 45 miles), there are numerous small tributary drainages. All drainages but Sullivan Creek (A-Closed) are classed as B-D₁ streams (DHES), and constitute a segment of drainage basin 76D (DNR&C). Most of this area is under USFS ownership, but private and other ownerships exist in some drainages. Intermingled ownership (USFS and private) occurs west of Lake Koocanusa near the Canadian border, in the Pinkham Creek drainage, and along the main stem of the Kootenai River for approximately 15 miles north of the Fisher River tributary. In areas of mixed ownership, there have been some coordinated road building programs that provide access for both private and USFS timber harvests; however, further coordination of forestry activities has been limited. Due to this historical lack of coordination between land managers, these areas must be identified as potential problems for water quality impacts from silvicultural activities.

To date, both USFS and private timber harvests have been extensive in the Upper Kootenai drainage segment. Related impacts to water quality are delineated in Table VI-A1 and located on Plate I.

2. Tobacco River Drainage

The Tobacco River drainage lies between the Salish Mountains and the Whitefish Range, and is designated as part of drainage basin 76D (DNR&C). All streams are classed as B-D₁ waters, except for Deep Creek which is A-Open-D₁ (DHES). The headwater areas are primarily USFS ownership, but the valley bottoms and lower reaches contain much private land distributed in many small ownerships. These areas of mixed ownership create a significant problem in coordinating forestry management activities. There are several areas where small private harvesting is occurring as a prelude to subdivision development. The potential for water quality degradation in these areas is high.

Silvicultural activities have occurred in the Tobacco River drainage since the 1920's. Extensive harvesting has been pursued on both private and USFS lands and effects on stream water quality have been multiple and long-term. Personnel and reports from the USFS, DF&G, and DHES identified problem areas within the drainage. In some cases, forestry practices have aggravated natural conditions (erosive soils, etc.) or combined with poor agricultural practices (streambank grazing, etc.) to create a water quality problem. Table VI-A2 outlines problem areas and Plate I locates the problems.

3. Fisher River Drainage

The Fisher River, tributary of the Kootenai River, is bounded by the Salish Mountains to the east and the Cabinet Mountains to the west. The

mouth of the Fisher River is located approximately 12 miles southeast of Libby, Montana. The drainage basin identification number for the Fisher River is 76C (DNR&C) and the entire watershed is classified as B-D₁ (DHES) streamwaters.

The Fisher River watershed is owned by the USFS, St. Regis, Champion, Burlington Northern, State, and other private concerns. Intermingled ownership on lands of expansive commercial timber resources has been a contributing factor in the degradation of the Fisher River, due to the historical lack of management activity coordination in such ownership patterns.

Extensive timber harvesting is an historical and continuing land use within the Fisher River drainage. The area is heavily roaded with the largest remaining unroaded areas less than township size. It is difficult to identify water quality impacts associated solely with silvicultural practices. However, extensive harvesting and road building have combined with other factors to significantly degrade the quality of streams in the drainage.

Pleasant Valley, in the southeast portion of the Fisher River basin, is mostly owned by Champion, and to lesser extents, private owners and the state. Extensive harvesting and road building has occurred in the Pleasant Valley Creek and Pleasant Valley Fisher River watersheds producing moderate increases in sediment loads and water yields (USFS - Fisher River, pers. comm.; DF&G - Kalispell, pers. comm.). These factors, combined with poor grazing practices within Pleasant Valley (stock have grazed and trampled streambanks) have resulted in high sediment loads and channel degradation in the Pleasant Valley drainage.

The middle Fisher River (from the mouth of Wolf Creek to U.S. Highway No. 2) has been channelized and shortened by road construction associated with silvicultural activities. Combined with increased water yields from upstream silvicultural and grazing practices, the river is sustaining streambank scouring and addition of sediment to the river (USFS - Fisher River, pers. comm.; DF&G - Kalispell, pers. comm.).

Within the Wolf Creek drainage (northeast portion of the Fisher River watershed), timber harvest has been extensive on all ownerships (USFS, State, and private). Increased water yield has most probably been caused by these operations, enhanced by grazing activities. However, the major stress factor placed upon the hydrologic regime is the shortening (by 2-3 miles) and channelization of the stream (Army Corps of Engineers) during construction of the railroad. Severe bank erosion, high sediment loads, and increased water temperatures have resulted from these activities (USFS - Fisher River, pers. comm.; DF&G - Kalispell, pers. comm.; Lincoln County Conservation District, 1977).

The upper Fisher River between Miller Creek and Loon Lake has also been shortened and channelized, during construction of U.S. Highway No. 2 (DF&G - Kalispell, pers. comm.).

The southwest corner of the Fisher River drainage (T25-26N, R29-30W) is an area of checkerboard ownership (USFS and BN) where the potential for future water quality problems is high. These drainages (Silver Butte Creek and East Fisher Creek) are particularly sensitive to forestry activities because some stream channels are unstable, resulting from fires within the watersheds.

Problem areas are delineated in Table VI-A3 and located on Plate I.

Prevention and mitigation measures must be applied on a basin-wide basis to effectively deal with the previously identified problems. The most comprehensive measures include: 1) restriction of silvicultural (and other) activities that could further impact existing problem areas; 2) conduct basin-wide inventories to assess physical limitations of the watershed and identify water resource needs; 3) coordination of silvicultural (and other) activities among various land managers in accordance with watershed limitations, particularly in drainages already impacted; 4) pursue watershed rehabilitation and protection measures (i.e., reforestation, road reclamation, streambank stabilization); 5) promote or require use of BMP's in both silvicultural and agricultural activities.

4. Lower Kootenai River Drainage

Between the mouth of the Fisher River and the Idaho border (approximately 45 miles) there are many tributary streams to the Kootenai River. These streams drain the Purcell Mountains to the north and the Cabinet Mountains to the south. The DNR&C has designated all streams (except the Yaak River) within drainage basin 76D. The DHES has classified all streams as B-D₁ waters, except Rainy Creek (A-Open-D₁, C-D₁) and Flower Creek (A-Open-D₁).

Ownership is predominantly USFS, although private holdings dominate the narrow stream valleys. Intermingled ownership patterns (USFS and multiple private) are prominent in Pipe Creek, Libby Creek, Lake Creek, O'Brien Creek, and Ruby Creek drainages. These areas are likely to sustain future water quality impacts if timber harvesting is not pursued on a coordinated basis involving the land managers of the watersheds.

Extensive timber harvesting and road building has occurred in several drainages; the northern tributaries between Libby and Troy are heavily roaded.

Municipal water supplies are taken from Flower Creek (for Libby) and from O'Brien Creek (for Troy). Silvicultural activities have been pursued on both private and USFS lands within these drainages. Current harvesting is done carefully and with supervision from DHES (Kalispell). Although no water quality problems (related to forestry practices) have developed to date, complete land use control is limited due to the multiple ownership patterns.

Table VI-A4 identifies existing and potential problem areas within the Lower Kootenai watershed segment. These problems are located on Plate I .

5. Yaak River Drainage

The Yaak River drainage in the northwest corner of Montana is tributary to the Kootenai River. The headwaters area is in Canada, while the Purcell Mountains define the watershed in Montana. The mouth is approximately five miles east of the Montana/Idaho border. The DNR&C drainage basin identification number is 76B and the drainage is classed as B-D₁ water (DHES).

Ownership within the Yaak River drainage is predominately USFS. However, narrow strips of private ownerships are located in the valley bottoms of the main stem, some of its tributaries, and near the mouth.

Timber harvesting has been extensive in the southern and western portions of the drainage, predominantly on USFS lands. Silvicultural activities on private lands have been pursued in the past and will be continued. Impacts to stream water quality have resulted from some of these operations. Table VI-A5 outlines these water quality problem areas within the Yaak River watershed. Locations are shown on Plate I.

There is a limited potential for future water quality problems associated with forestry practices on private lands. Most of the merchantable timber on private ownership has already been harvested, thus eliminating potential problems until second growth tree stands become merchantable. However, most private ownerships are adjacent to streams and any harvesting activities in these areas must be pursued with extreme caution and regard for protection of stream water quality. One such area of proposed timber harvest is located along the Yaak River in T35N, R33W (predominantly Section 2).

TABLE VI-A1 UPPER KOOTENAI RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76D	Lincoln	T37N, R28W Sec. 28, 29	Dodge Creek (perennial)	High sediment load; change in flow regime; unstable banks	Poor road design (lack of drainage structures), poor road location (caused stream diversion); cumulative effect of harvests within drainage; slash debris in stream	Rehabilitate roads (seeding, drainage structures, erosion structures); remove slash debris from stream; limit further harvesting in drainage until hydrologic equilibrium restored
76D	Lincoln	T35N, R27W	Pinkham Creek (perennial)	High sediment load; change in flow regime; unstable banks	Poor road design (lack of drainage structures), poor road maintenance; cumulative effects of harvests within drainage; steep slope and erosive soil conditions	Rehabilitate roads (seeding, drainage structures, etc.); maintain roads (closures when necessary); limit further harvesting in drainage until hydrologic equilibrium restored; identify critical areas (slope and soil conditions) and manage accordingly
76D	Lincoln	T37N, R28W Sec. 14-16	Young Creek (perennial)	High sediment loads; increased water yield	Heavily roaded; large area harvested; inadequate coordination of harvest activities between ownerships	Rehabilitate roads (seeding, drainage structures, etc.); maintain roads (closures when necessary); limit further harvesting in drainage until hydrologic equilibrium restored; coordinate management activities between ownerships within watershed
POTENTIAL PROBLEMS -----						
76D	Lincoln		Kootenai River and tributaries	Aggravation of existing problems; aggravation of naturally erosive conditions	Further harvesting activities; inadequate site planning in critical areas	Basin-wide inventory of watershed characteristics to give basis for management activities within watershed; use of BMP's
76D	Lincoln	Areas of mixed ownership	Kootenai River and tributaries	Creation of similar problems in other drainages	Lack of coordination in planning activities between mixed ownerships	Coordinate location, type, and timing of forestry activities with regard to assessed limitations of watersheds

TABLE VI-A2		TOBACCO RIVER DRAINAGE			Reported type of Impact			Reported cause of Impact			Suggested Measures of Mitigation/Prevention		
Drainage Basin	County	Location	Stream Affected	Reported type of Impact			Reported cause of Impact			Suggested Measures of Mitigation/Prevention			
76D	Lincoln	T32-36N, R25-27W	Tobacco River and Fortine Creek (perennial)	Bank degradation; increased sediment load; flow alterations			Log transport in river (1920-30's); stream channelization (railroad construction); extensive harvesting in drainage			Minimize further bank degradation (restrict grazing on banks, seeding); limit timber harvest until hydrologic equilibrium restored; rehabilitate poor logging roads (seeding, drainage); rehabilitate watershed (enhance revegetation and forest regeneration)			
76D	Lincoln	T34-35N, R26W	Meadow Creek (perennial)	Increased sediment yield; alteration of flow regime			Poor road construction; skidding in stream channel; logging debris left in stream channel			Rehabilitate roads (seeding, drainage, erosion control) and maintain; remove debris and re-establish channel			
76D	Lincoln	T35N, R25W Sec. 29-31	Deep Creek (perennial)	Increased sediment load; alternation of flow regime			Harvest activities within stream channel; logging debris left in channel			Remove debris from stream and re-establish channel; stabilize banks where necessary (seeding)			
76D	Lincoln	T33N, R27W, Sec. 27-28	Swamp Creek (perennial)	Increased sediment load; bank instability			Harvest activities within and immediately adjacent to stream			Remove any debris from channel; stabilize banks where degrading (seeding)			
POTENTIAL PROBLEMS													
76D	Lincoln	T24N, R26W	Meadow Creek and tributaries	Increased sediment load; increase in water yield			Continuing harvest on small ownerships (some for subdivision)			Restrict harvesting to be within limits of watershed equilibrium; coordination of harvesting, employ BMP's in harvesting			

TABLE VI-A3 FISHER RIVER DRAINAGE			Reported type of Impact			Reported cause of Impact		Suggested Measures of Mitigation/Prevention	
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>						
76C	Flathead and Lincoln	T28-29N, R25-27W	Pleasant Valley Creek (perennial)	Increased water yield and associated sedimentation	Extensive harvesting and road construction (also grazing)	Restrict harvesting activities in line with capacity of drainage to absorb changes			
76C	Flathead	T27-28N, R25-27W	Pleasant Valley Fisher River (perennial)	Increased water yield and associated sedimentation	Extensive harvesting; poor road design (steep grades, no erosion controls); grazing	Restrict harvesting activities in line with capacity of drainage to absorb changes; rehabilitate roads (seeding, closures, erosion control measures)			
76C	Lincoln	T27-28N, R29W	Middle Fisher Rv. (U.S. Highway #2) to Wolf Creek (perennial)	High sediment load	Stream cutting its banks (due to channeling and increased water yield)	Restrict harvesting activities; stabilize banks (restrict grazing, seeding)			
76C	Lincoln	T29-30N, R29W	Lower Fisher Rv. (Wolf Creek to mouth)(perennial)	High sediment load	Stream cutting its banks (due to channeling and increased water yield)	Restrict harvesting activities; stabilize banks (restrict grazing, seeding)			
76C	Lincoln	T29-31N, R26-28W	Wolf Creek (perennial)	High sediment load; increased water yields; temperature increase	Extensive harvesting; (channelizing from railroad construction)	Restrict harvesting activities; stabilize banks (restrict grazing, seeding)			

POTENTIAL PROBLEMS									
76C	Lincoln	T25-26N, R29-30W	East Fisher Creek and Silver Butte Creek (perennial)	Potential impact	Potential for poorly coordinated land management in checkerboard ownership	Coordination of silvicultural activities between USFS, BN, other			
76C	Lincoln	T28-31N, R26-28W	Wolf Creek (perennial)	Potential impact	Potential for poorly coordinated land management in checkerboard ownership	Coordination of silvicultural activities between USFS, BN, other			
76C	Lincoln and Flathead	T25-31N, R25-30W	Fisher River watershed	Complicate existing impacts		Assessment of physical status and capabilities of entire watershed; employ BMP's in accordance with assessment			

TABLE VI-A4 LOWER KOOTENAI RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76D	Lincoln	T30N, R33-34W	North Fork Keeler Creek (perennial)	Flooding, channel adjustments, sedimentation	Extensive harvest; poor road management	Restrictions of additional harvests until equilibrium of flow regime is attained, watershed rehabilitation (forest regeneration, streambank stabilization); road reclamation (seeding, erosion structures); road maintenance (if in use)
76D	Lincoln	T31-32N, R33-34W	Iron Creek (perennial)	High sediment load	Poor road design and maintenance	Road reclamation (seeding, erosion structures); maintenance (if road in use)
76D	Lincoln	T29-31N, R33W	Lake Creek (perennial)	Periodic high sediment loads, silting in reservoir at Troy Dam (primarily from Iron Creek and Keeler Creek)	Extensive harvests in watershed, poor road design and maintenance	Restrictions of additional harvests until equilibrium of flow regime is attained, watershed rehabilitation (forest regeneration, streambank stabilization); road reclamation (seeding, erosion structures); road maintenance (if in use)
76D	Lincoln	T32N, R30W, Sec. 7, 17	Blue Creek (perennial)	Erosion and sedimentation	Poor road design (inadequate drainage); steep slope logging, skidded in stream	Reconstruct (with adequate drainage) or eliminate stream crossings; prevent further steep slope soil disturbance and stabilize existing erosion (seeding); further harvesting should give more regard to stream protection
POTENTIAL PROBLEMS -----						
76D	Lincoln	T31-34N, R31W	Pipe Creek (perennial)	Potential problem	Uncoordinated management activities on multiple ownerships	Evaluation of watershed characteristics, silvicultural activities; coordinate USFS and land managers to develop harvesting plan that will protect stream water quality
76D	Lincoln	T31-33N, R33W	O'Brien Creek (perennial)	Potential problem (municipal water supply)	Uncoordinated management activities on multiple ownerships	Evaluation of watershed characteristics, silvicultural activities; coordinate USFS and land managers to develop harvesting plan that will protect stream water quality

TABLE VI-A4(cont.)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76D	Lincoln	T30N, R30-31W	Flower Creek (perennial)	Potential problem (municipal water supply)	Uncoordinated management activities on multiple ownerships	Evaluation of watershed characteristics; silvicultural activities; coordinate USFS and land managers to develop harvesting plan that will protect stream water quality
76D	Lincoln	T32N, R34W	Brush Creek and Ruby Creek (perennial)	Potential problem	Uncoordinated management activities on multiple ownerships	Evaluation of watershed characteristics; silvicultural activities; coordinate USFS and land managers to develop harvesting plan that will protect stream water quality

TABLE VI- A3 YAAK RIVER UNPAIRED

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76B	Lincoln	T33N,R33W, Sec. 4	Wampoc Creek (perennial)	Siltation; change in channel geometry (no defined channel); (may not significantly affect Yaak River)	Skidded on steep slopes and across streams; poor road design and maintenance; debris in stream	Remove stream obstructions and return streamflow to natural channel; rehabilitate eroding areas (erosion barriers, seeding, closure or maintenance of roads)
76B	Lincoln	T37N,R31W, Sec. 25	East Fork Yaak River (perennial)	Erosion	Gully channels created by skidding; slash debris in stream	Rehabilitate skid trails (fill gullies seed); remove debris from stream channel to allow normal flow

POTENTIAL PROBLEMS

76B	Lincoln	T35N,R33W, Sec. 2	Yaak River (perennial)	Potential sedimentation	Streamside harvesting	Utilize harvest methods protective of stream (BMP's)
76B	Lincoln	Other private timberlands adjacent to streams	Yaak River watershed	Potential sedimentation	Streamside harvesting	Utilize harvest methods protective of stream (BMP's)

B. Clark Fork River Basin

The Clark Fork River receives waters from most of Montana west of the Continental Divide; it is tributary to the Columbia River. The northern portion of the watershed (Flathead and Lake Counties) is within the Flathead Designated 208 study area and was not considered in this report. To simplify discussion of water quality problems, the following designations were made:

Upper Clark Fork River Basin	Headwaters to mouth of Blackfoot River
Middle Clark Fork River Basin	Mouth of Blackfoot River to mouth of Flathead River
Lower Clark Fork River Basin	Mouth of Flathead River to Idaho stateline

Various drainage reaches and problems areas are discussed within each designated basin:

Upper Clark Fork River Basin

The Upper Clark Fork River has its headwaters along the Continental Divide. There are significant forest resources contained within the basin, surrounding broad sediment filled valleys. Much of the timberland is administered by the USFS. Silvicultural activities on the basin's timberlands have resulted in some degradation of water quality. Those problem areas occurring on non-USFS lands are discussed in the text. Other land uses that contribute non-point pollution include agriculture, mining, and urbanization.

Local Conservation Districts have estimated that approximately seven percent of the commercial forest acreage is contributing to non-point source sediment pollution within the basin (1977).

1. Mainstem Clark Fork River Drainage (Upper)

This drainage segment of the Clark Fork River extends from the headwaters area near Butte, Montana to the mouth of the Blackfoot River at Bonner, Montana. The watershed is defined by the Continental Divide to the east, a high divide to south, the Flint Creek Range to the west, and the Garnet Range to the north. The DNR&C basin designation is 76G. Several stream classifications (DHES) are applied in this drainage, primarily due to mining and related industrial activities.

Forestland ownership in the Deer Lodge Valley is predominantly USFS with limited private and state ownerships along the foothills. In the Garnet Range, however, there are extremely intermingled ownership patterns that include: BLM, Champion, Burlington Northern, state, and small private ownerships.

Water quality problems resulting from silvicultural practices are limited in the Deer Lodge Valley. However, some streams in the Garnet Range and upper reaches of the Little Blackfoot River have sustained degradation. Streambank disturbance and poorly constructed roads by logging operations have created sediment problems in the basin (DHES, 1975). Related water quality problem areas are outlined in Table VI-B1 and located on Plate I.

The headwaters area of the Clark Fork River drainage experienced substantial timber harvests in the early 1900's. An area south of Anaconda, Montana, primarily in the Mill Creek watershed, was extensively logged for a coking operation. Natural revegetation has been hampered by fume kills from the Anaconda Company smelter and by fire. Erosion and sedimentation is

still a problem in this drainage, particularly near Sugarloaf Mountain (USFS - Deer Lodge, pers. comm.).

Highway and railroad construction along the Clark Fork River have altered channel geometry, especially near Bearmouth, Montana. This channel straightening enhances the potential for erosion downstream, thus limiting the capability of the stream to absorb impacts from forestry activities (DHES, 1975). This clearly illustrates the need for basin-wide inventory, impact evaluation, and planning of land management activities.

TABLE VI-81 MAINSTEM CLARK FORK RIVER DRAINAGE (UPPER)						
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
766	Lewis and Clark	T11N,R6W	Hope Creek (perennial)	Sedimentation; possible water yield increases	Road construction; clearcut harvesting	Rehabilitate roads (seeding, erosion and drainage structures); enhance revegetation
766	Lewis and Clark	T11N,R6W	Dog Creek (perennial)	Sedimentation; possible water yield increase	Road construction; clearcut harvesting	Rehabilitate roads (seeding, erosion and drainage structures); enhance revegetation
766	Powell	T8N,R6W, Sec. 10,11	Telegraph Creek (perennial)	Sedimentation; channel impacts and instability	Streamside harvest activities; debris in stream; channel rehabilitation	Remove debris; assist revegetation and other streambank stabilization measures
766	Powell and Deer Lodge	T6N,R8W, Sec. 9,10, 15,16	Peterson Creek (perennial)	Sedimentation; channel impacts	Road construction; lack of erosion control measures	Reclaim roads not in use (regrading, seeding); assist in revegetation and stabilization of disturbed slopes (seeding, fill in skid trails); maintain road in use
766	Deer Lodge	T5N,R8W, Sec. 19	Perkins Gulch (perennial)	Soil movement; sedimentation	Road construction; improper skid trails	Reclaim roads not in use (regrading, seeding); assist in revegetation and stabilization of disturbed slopes (seeding, fill in skid trails); maintain road in use
766	Missoula	T12-13N, R18W	Deer Creek (perennial)	Increased sediment loads	Road construction; clearcut harvesting	Rehabilitate roads (seeding, erosion and drainage structures); enhance revegetation and bank stabilization
766	Deer Lodge	T4N,R11-12W	Mill Creek (perennial)	High sediment loads; channel degradation	Initial logging and subsequent lack of vegetation (fire, fume kills)	Rehabilitation measures (assist revegetation, streambanks stabilization, etc.); coordinate future land management activities
766	Powell	T9-10N, R6-9W	Little Blackfoot River (perennial)	Not defined by DF&G	Watershed abuse due to logging	Identify and evaluate impacts; take appropriate measures

TABLE VI-B1 (cont.)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
POTENTIAL PROBLEMS -----						
76G	Deer Lodge	T5-6N, R11-12W	Lost Creek (perennial)	Potential problem (large area of commercial timber under contract)	Extensive harvest and road construction without use of BMP's may create impacts	Evaluate watershed characteristics and develop management plan with regard to watershed limitations
76G	Powell	T9N, R7-8W	Trout Creek (perennial)	Possible problems	Numerous harvests	Identify whether or not problems exist and take appropriate measures
76G	Granite	T11N, R14-15W	Tributaries to Clark Fork River (perennial and ephemeral)	Potential problem	Non-coordination of forestry activities in area of mixed ownership may lead to water- shed abuse	Evaluate watershed characteristics and impacts; coordinate future management activities between owner- ships with regard to watershed limitations; use of BMP's

2. Blackfoot River Drainage

The Blackfoot River watershed west-central Montana is defined by the Continental Divide to the east, the Garnet Range to the south, and the Mission, Swan, and Continental Ranges to the north. The drainage is tributary to the Clark Fork River at Bonner, Montana. The DNR&C basin designation is 76F, and the entire drainage is classified B-D₁ (DHES).

The Blackfoot River basin is characterized by numerous ownerships including: USFS, BLM, Burlington Northern, Champion, the state (under several administrative agencies), other federal, and small private. Areas of pronounced intermingled ownership are: the upper Blackfoot (near Lincoln), the Garnet Range, and the southern extension of the Mission Range.

USFS lands cap the Continental Divide and provide the northern limits of the watershed. Timber harvesting has been pursued in the Blackfoot drainage for many years. Near Missoula, extensive harvesting and roadbuilding has occurred, particularly on Champion, Burlington Northern, and USFS ownerships. The Garnet Range has sustained extensive removal of commercial timber on BLM, Champion, and state ownerships. In addition, the headwaters area of the Blackfoot River is currently being harvested on several ownerships.

Water quality impacts from silvicultural practices have been numerous throughout the watershed. These are outlined in Table VI-B2 and located on Plate I. The local Conservation Districts have estimated that about six percent of the commercial timber acreage within the Blackfoot River watershed (including the Clearwater River) is contributing to non-point source sediment pollution (1977). Past and present mining activities as well as agricultural practices, are also contributing to the sediment

load of the watersheds (DHES, 1975; Spence, 1975).

Natural conditions also contribute to water quality degradation, particularly in the Lincoln area where soil conditions are unstable (DHES, 1975).

Management activities may initiate or additionally complicate non-point pollution from natural conditions. Despite these affects, the Blackfoot River generally has good water quality for its entire length (DHES, 1975; Spence, 1975). However, seasonal impacts (siltation during spring runoff) are reportedly a result of logging and agricultural activities (Dale, 1970). Though only seasonal, these impacts can significantly affect fisheries habitat condition.

TABLE VI-B2		BLACKFOOT RIVER DRAINAGE			Reported type of Impact	Reported cause of Impact	Suggested Measures of Mitigation/Prevention
Drainage Basin	County	Location	Stream Affected				
76F	Lewis and Clark	T14N, R8W	Keep Cool Creek (perennial)	Minor sedimentation; possible increased water yields; soil movement	Extensive clearcut	Assist revegetation, particularly in areas of disturbed soil	
76F	Lewis and Clark	T14-15N, R9W	Beaver Creek (perennial)	High sediment load	Extensive roads and harvests; steep gradient of stream	Reclaim or rehabilitate roads; assist revegetation; maintain streambank stability	
76F	Powell	T14N, R10W	Arresta Creek (intermittant)	Excessive soil disturbance; sedimentation	Heavily logged (lack of coordination with adjacent mixed ownership); poor road construction; poor skidding practices	Assist revegetation of disturbed areas; evaluate watershed impacts and coordinate future activities (if any) within watershed limitations	
76F	Lewis and Clark	T14-15N, R8W	Landers Fork and North Fork (perennial)	High sediment load; unstable streambanks; soil movement	Logging practices, grazing practices, and a natural fire	Assist streambank rehabilitation; evaluate watershed impacts and coordinate future management activities within watershed limitations	
76F	Lewis and Clark	T14N, R7W, Sec. 15-17, 21	Hogum Creek (perennial)	Possible accelerated erosion	Harvested on steep slopes	Identify whether or not problem exists, then proceed (if necessary) with mitigation measures (enhance revegetation, etc.)	
76F	Missoula	T14-15N, R16-17W	Gold Creek	Increased water yield probable; sedimentation	Large areas of harvest, extensive road building (over last 30 years)	Evaluate watershed characteristics and impacts; coordinate forest management activities with regard to limitations of watershed (may require harvest restrictions); watershed rehabilitation (vegetation, streambank stabilization)	
76F	Missoula	T14-15N, R16W	Belmont Creek (perennial)	Increased water yield probable; sedimentation	Large areas of harvest, extensive road building (over last 30 years)	Evaluate watershed characteristics and impacts; coordinate forest management activities with regard to limitations of watershed (may require harvest restrictions); watershed rehabilitation (vegetation, streambank stabilization)	

TABLE VI-B2 (cont.)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76F	Missoula	Lower reaches	Blackfoot River (mainstem) (perennial)	Not defined by DFG	Watershed abuse due to logging	Identify and evaluate specific problems; take appropriate mitigation/prevention measures.
76F	Powell	T15-17N, R12-13W	Monture Creek (perennial)	Not defined by DFG	Watershed abuse due to logging practices	Identify and evaluate problem area; employ necessary mitigation measure
76F	Lewis and Clark	T15N, R7E	Alice Creek (perennial)	Mud slide washing into stream, high sediment load	Improper placement of logging road	Assist stabilization of slide (seeding, etc.); do not relocate road in same critical area
76F	Lewis and Clark	T14N, R9W, Sec. 19	Blackfoot River (perennial)	Accelerated erosion	Poor skidding practices in steep terrain	Assist revegetation and stabilization of disturbed slopes
76F	Powell	T12-13N, R8-11W	Nevada Creek (perennial)	Not defined by DFG	Watershed abuse due to logging	Identify and evaluate specific problems; take appropriate mitigation/prevention measures
76F	Missoula	T14N, R17W	Twin Creeks (perennial)	Sedimentation; alteration of flow regime	Extensive harvest and road construction activities	Assist revegetation of disturbed areas; evaluate watershed impacts and coordinate future activities (if any) within watershed limitations
76F	Powell	T14N, R13-14W	Chamberlain Creek (perennial)	High sediment loads	Past logging (1950's) and subsequent over-grazing	Restrict grazing activities and rehabilitate watershed (enhance revegetation, streambank stabilization)
76F	Lewis and Clark	T13-14N, R9W	Willow Creek (perennial)	Sediment contribution	Poor road construction	Rehabilitate roads (grade, seeding, etc.)
<u>POTENTIAL PROBLEMS</u>						
76F	Powell	T12N, R10W, Sec. 3, 4, 10	Nevada Creek tributary (perennial)	Possible accelerated erosion	Harvested on steep slopes adjacent to stream; improper skidding practices	Identify whether or not problem exists, then proceed (if necessary) with mitigation measures (enhance revegetation, fill in gullied skid trails, etc.)

TABLE VI-B2 (cont.)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Type of Impact</u>	<u>Cause of Impact</u>	<u>Mitigation/Prevention Measures</u>
POTENTIAL PROBLEMS	Lewis and Clark	T14N,R8W	South Fork Blackfoot River (perennial)	Potential for sedimentation increased water yield	Non-coordination of forestry activities in area of mixed ownership; may lead to watershed abuse	Evaluate watershed characteristics and impacts; coordinate future management activities between ownerships with regard to watershed limitations; use of BMP's
76F	Missoula	T13-14N, R14W	Elk Creek (perennial)	Possible problem	Mainly due to mining but may be some effects of harvesting	Identify whether or not problems exist and take appropriate measures
76F	Missoula	T13N,R17W	Bear Creek (perennial)	Possible problems	Extensive harvest and road construction	Identify whether or not problems exist and take appropriate measures
76F	Lewis and Clark	T14N,R9W, Sec. 7,17	Lincoln Gulch (ephemeral)	Suspect accelerated erosion	High road density; improper skidding practices in steep terrain	Reclaim roads not in use (regrading, seeding); assist in revegetation and stabilization of disturbed slopes
76F	Lewis and Clark	T14N,R8W	Sucker Creek (ephemeral)	Possible sediment contribution	Old gullied skid trails	Reclaim trails (fill in and seed)

3. Clearwater River Drainage

The Clearwater River is tributary to the Blackfoot River near Clearwater Junction, Montana. The watershed is defined by the Swan Range to the northeast, the Mission Range to the west, and lesser divides to the north and east. The Clearwater River and tributaries are included in the DNR&C basin 76F and are classified as B-D₁ waters by the DHES.

Forestland ownership patterns are extremely varied in the Clearwater River drainage. The USFS has contiguous ownership in the extreme head-water areas, as does Burlington Northern (BN) in the Mt. Henry area. Elsewhere, a very intermingled pattern of ownership exists which includes Champion, BN, USFS, state, BLM, and small private landowners.

The watershed has sustained heavy logging and road building activities on parts of most ownerships; the USFS, BN, and Champion have most actively pursued silvicultural activities. Related impacts to water quality have been reported by the USFS, DF&G, DNR&C (Forestry Division), and in other research on water quality. Non-USFS lands contributing to water quality degradation are outlined in Table VI-B3 and located on Plate I.

Other management activities also affect water quality in the Clearwater River. Agricultural practices (grazing) have caused deterioration of some streambanks and shorelines (DHES, 1975). Recent urbanization activities have also contributed to non-point pollution.

Natural conditions within the watershed contribute to seasonal water quality variations. Unconsolidated clay-to-gravel-sized material (Quaternary) is present in the valley bottom and is a source of sediment during periods of high flow. Silvicultural activities can directly

TABLE VI-B3 CLEARWATER RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Type of Impact</u>	<u>Cause of Impact</u>	<u>Mitigation/Prevention Measures</u>
76F	Missoula	T17-18N, R15-16W	West Fork Clearwater River (perennial)	High sediment loads; increased water yields; channel degradation	Extensive harvesting and road construction	Watershed rehabilitation (revege- tation, streambank stabilization, etc.); coordination of land use activities with regard to watershed limitations (may necessarily res- trict harvest activities; BN-USFS cooperative planning)
76F	Missoula	T17N, R15W	Deer Creek (perennial)	High sediment loads; increased water yields; channel degradation	Extensive harvesting and road construction	Watershed rehabilitation (revege- tation, streambank stabilization, etc.); coordination of land use activities with regard to watershed limitations (may necessarily res- trict harvest activities)
76F	Missoula	T18N, R15W	Richmond Creek (perennial)	High sediment loads; increased water yields; channel degradation	Extensive harvesting and road construction	Watershed rehabilitation (revege- tation, streambank stabilization, etc.); coordination of land use activities with regard to watershed limitations (may necessarily res- trict harvest activities; BN-USFS cooperative planning)
76F	Missoula	T16-17N, R15-17W	Placid Creek (perennial)	Sedimentation, other impacts to Placid Lake	Harvesting and road construction; water diversion associated with Jocko reservoirs	Evaluate watershed characteristics and impacts; coordinate future manage- ment activities (BN, USFS, Champion, State) within watershed limitations; apply rehabilitation measures to existing impact areas
76F	Missoula	T15N, R14-15W	Lost Prairie Creek (perennial)	High sediment loads; increased water yields; channel degradation	Extensive harvesting and road construction	Watershed rehabilitation (revege- tation, streambank stabilization, etc.); coordination of land use activities with regard to watershed limitations (may necessarily res- trict harvest activities)

TABLE VI-B3 (cont.)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Type of Impact</u>	<u>Cause of Impact</u>	<u>Mitigation/Prevention Measures</u>
76F	Powell and Missoula	T17-18N, R14-15W	Morrell Creek (perennial)	High sediment loads; increased water yields; channel degradation	Extensive harvesting and road construction	Watershed rehabilitation (revegetation, streambank stabilization, etc.); coordination of land use activities with regard to watershed limitations (may necessarily restrict harvest activities)
76F	Missoula	T14-15N, R14-15W	Blanchard Creek (perennial)	Increased sediment loads	Harvesting and road construction	Watershed rehabilitation (revegetation, streambank stabilization, etc.); coordination of land use activities (Champion, state, USFS) within watershed limitations
POTENTIAL PROBLEMS -----						
76F	Missoula	T15-16N, R16-17W	Boles Creek (perennial)	Potential for sedimentation; increased water yield; impacts to Placid Lake	Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse; logging in Boles Creek is starting (BN, USFS)	Evaluate watershed characteristics and impacts; coordinate future management activities between ownerships with regard to watershed limitations (USFS, Champion, BN, state)
76F	Missoula		Clearwater River watershed	Potential for sedimentation; increased water yield; completion of existing impacts	Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse	Evaluate basin-wide characteristics and impacts; coordinate future land management activities between ownerships in regard to watershed limitations; apply watershed rehabilitation measures to existing problem areas; harvest restrictions may be necessary

aggravate these erosive conditions through soil disturbance. Increased water yields or alteration of runoff flow timing (from forestry practices) may initiate channel instability and high sediment loads.

Prevention and mitigation measures must be applied on a basin-wide basis to effectively deal with non-point pollution in the Clearwater River drainage. The most comprehensive measures include: 1) restriction of silvicultural (and other) activities that could further impact existing problem areas; 2) conduct basin-wide inventories to assess physical limitations and natural hazards of the watershed and identify water resource needs; 3) coordination of silvicultural (and other) activities among various land managers in accordance with watershed limitations, particularly in drainages already impacted; 4) pursue watershed rehabilitation and protection measures (i.e., reforestation, road reclamation, streambank stabilization); 5) promote or require use of BMP's in silvicultural activities.

4. Flint Creek Drainage

The Flint Creek drainage in western Montana is a tributary of the Clark Fork River. Its area (490 square miles) is defined by the Flint Creek Range to the east, the John Long Mountains to the west, and the Anaconda Range to the south. The mouth of Flint Creek is near Drummond, Montana. The DNR&C drainage basin identification number for Flint Creek is 76GJ. The DHES has classified most streams as B-D₁, except for South Boulder Creek (A-Open-D₁) and the Fred Burr Lake watershed (A-Closed).

Approximately eight years ago (1969) the U.S. Forest Service instituted a moratorium on timber harvests within the Philipsburg Ranger District. As a result of this circumstance, the private timberlands in the Flint Creek drainage have been logged to a great extent. However, due to land ownership patterns, there was not a great deal of merchantable timber on non-USFS lands.

Reported impacts to water quality from timber harvesting have never been quantified. There is a general lack of concern for stream protection and a lack of knowledge regarding protective harvesting methods on the part of contractors operating on the private timberlands (USFS - Philipsburg, pers. comm.). Water quality impacts from such practices could range from one-time to seasonal to continual. Table VI-B-4 delineates reported problems; Plate I indicates locations.

In the Flint Creek drainage there is a limited future potential for impacts to stream water quality from silvicultural practices on non-USFS lands. This is due in part to the physical characteristics of these timberlands (gentle slopes, fairly dry watersheds). Since recent years

have witnessed extensive harvesting on these lands, the available merchantable timber is continually decreasing, thus the potential for impacts decreases. However, if demand for forest products continues, currently marginal timber will become merchantable. This could expand the harvestable timberland acreage under non-USFS ownership.

Another factor aiding in the prevention of water quality problems is the fact that landowners in the area are gradually becoming aware of better land management practices and thus, requiring harvesting contractors to employ more land-compatible harvesting methods.

TABLE VI-B		FLINT CREEK DRAINAGE		Reported type of Impact	Reported cause of Impact	Suggested Measures of Mitigation/Prevention
Drainage Basin	County	Location	Stream Affected			
76GJ	Granite	T9N,R13W	Douglas Creek (perennial)	Watershed abuse	Not delineated (DF&G)	Investigation of type and severity of problem, management according to results
76GJ	Granite	T8N,R13W	Boulder Creek (perennial)	Watershed abuse	Not delineated (DF&G)	Investigation of type and severity of problem, management according to results
POTENTIAL PROBLEMS -----						
76GJ	Granite	T10N,R14W	Cow Creek (perennial)	Potential problem	Uncoordinated activities occurring on multiple ownership	Assess watershed characteristics and develop watershed management plan accordingly
76GJ	Granite	T9N,R14W	Willow Creek (perennial)	Potential problem	Uncoordinated activities occurring on multiple ownership	Assess watershed characteristics and develop watershed management plan accordingly

5. Rock Creek Drainage

Rock Creek is tributary to the Clark Fork River in western Montana. It's area is defined by drainage divides in the John Long Mountains to the east, the Sapphire Mountains to the west, the Anaconda Range to the south, with the mouth near Clinton, Montana. Its drainage basin identification number is 76E (DNR&C), and the waters are classed as B-D₁ streams (DHES). Rock Creek is also a designated Blue Ribbon trout stream (DF&G).

The headwaters of Rock Creek are in the USFS's Philipsburg Ranger District of the Deer Lodge National Forest. Approximately eight years ago, the USFS placed a moratorium on timber sales within this District. As a result, the private (and other non-USFS) timber lands in the upper reaches of Rock Creek have been extensively logged. However, due to land ownership patterns, the merchantable timber acreage on non-USFS lands is limited. Impacts to water quality (if any) from these harvests have not been quantified, although the USFS has cited some inadequate harvesting methods (poor skidding, poor slash disposal, poor road construction) used on private lands (USFS - Philipsburg, pers. comm.). In some areas of gently sloping terrain and in dry drainages, these practices would have a minimal effect upon stream water quality. However, these same poor harvesting practices when occurring in close proximity to perennial streams, could severely impact water quality. Such sensitive areas include Upper Willow Creek (T7,8, 9N, R15W) and Rock Creek (T7N, R16W).

The middle section of the Rock Creek drainage contains very little non-USFS land ownership. Some clearing has occurred in the past, associated with patented mining claims along Rock Creek proper.

In the lower reaches of the Rock Creek drainage a checkerboard pattern of land ownership exists among the USFS, Champion International, Burlington Northern, the State, and other private interests. Although these harvest activities (some of which are large clear-cuts) have not caused significant impact to date, there is a high potential for cumulative impacts in the future. This is evident in the history of poor coordination of harvesting activities (as they relate to water quality) among mixed ownerships.

Until now, most timber harvests in the Rock Creek drainage have occurred on tributary streams with little impact to the water quality of Rock Creek proper (DF&G - Missoula, pers. comm.). The DF&G is actively advocating a watershed management policy that will continue to protect the water quality of Rock Creek.

The Granite Conservation District has indicated that no soil erosion problems exist on commercial forestland within the drainage (1977).

Areas of potential impact from silvicultural activities (ownership of merchantable timber along perennial streams, checkerboard ownership of timberlands, etc.) should be managed with particular regard to protection of stream water quality. Table VI-B-5 outlines problem areas within the Rock Creek drainage; these are located on Plate I .

INDIC V1-DJ	NOVA GREEN URMAYMAC				
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>
					<u>Suggested Measures of Mitigation/Prevention</u>

POTENTIAL PROBLEMS -----

76E	Granite	T8-9N, R15W	Upper Willow Creek (perennial)	Possible channel impacts and sedimentation	Streamside harvest activities	Identify whether or not problems exist and take appropriate measures
76E	Granite	T7N, R16W	Rock Creek (perennial)	Possible channel impacts and sedimentation	Streamside harvest activities	Identify whether or not problems exist and take appropriate measures
76E	Missoula	T11N, R17W	Gilbert Creek (perennial)	Potential for sediment- ation increased water yield	Non-coordination of forestry activities in area of mixed owner- ship; may lead to water- shed abuse	Evaluate watershed characteristics and impacts; coordinate future management activities between owner- ships with regard to watershed limitations

Middle Clark Fork River Basin

From the mouth of the Blackfoot River to the Flathead River confluence, the Clark Fork receives waters from large areas of forestland. The USFS is, by far, the largest forest landowner in this drainage segment (Bitterroot, Lolo, and Kaniskys National Forests). There are also areas of non-USFS forestland ownership. Timber harvesting has occurred and will continue throughout the drainage. Numerous related water quality impacts have been identified.

6. Bitterroot River Drainage

The Bitterroot River is tributary to the Clark Fork River approximately five miles west of Missoula, Montana. The elongate drainage (north-south) is defined by the Sapphire Mountains to the east, the Bitterroot Range to the west and southwest, and the Anaconda Range to the southeast. The DNR&C drainage basin identification number is 76H; all streams are classed as B-D₁ waters (DHES).

Forestland ownership within the Bitterroot River drainage is predominantly USFS. In the headwater areas (East and West Forks of the Bitterroot River) private and state ownership is limited to the narrow valley bottoms (predominantly patented mining claims) and Ross Hole. In the lower reaches there are minor amounts of non-USFS forestlands located along the foothills. The Lolo Creek and Miller Creek watersheds contain mixed ownerships (USFS, private, state).

The Bitterroot drainage has sustained extensive timber harvesting, road construction, and other silvicultural treatments on USFS lands. The impact of these forestry practices was the stimulus for national controversy regarding the administration of public lands (late 1960's to early 1970's). Some of the affected watersheds may contain non-USFS lands where additional

silvicultural activities may complicate existing impacts.

The DF&G has listed the Bitterroot River and the West Fork Bitterroot River as experiencing habitat deterioration due to logging practices. Local Conservation Districts have estimated that approximately 36 percent of the commercial forest acreage within the watershed (USGS basin 17010205) contribute to non-point source sediment pollution. It is not defined how non-USFS silvicultural activities are reflected in above statistics.

An EPA study (July, 1975) reports that cumulative timber harvests within the Bitterroot River drainage have led to increased stream flows and timing alteration of peak flows. (This assessment includes both USFS and non-USFS harvest activities). Extensive clearcut areas (USFS) are probably the major cause of increased peak flows (EPA, 1975), however, private and state timber harvests have also contributed to this change in the hydrologic regime. A lack of timber harvest regulation on private lands was noted as a determining factor in the employment of poor management practices on these lands.

The Sleeping Child burn (1961) along with timber harvest activities (primarily USFS and Burlington Northern) have resulted in streamflow increases and altered timing of peak flows in several drainages. Presently, these changes continue to cause stream degradation in the lower reaches of the Sleeping Child drainage, complicated by erosive materials and streambank abuse from grazing practices. Other impacts to water quality (temperature increases, sediment load) undoubtedly occurred 5-10 years after the fire, but baseline data was not available for comparison.

Lolo Creek enters the Bitterroot River at the town of Lolo (approximately six miles south of Missoula). A checkerboard pattern of ownership

dominates this watershed (USFS, Champion, other). Timber harvesting and associated road building has occurred in many areas, mainly on lands of Champion and the Forest Service. Water quality impacts from these activities are not known to exist (USFS - Missoula, pers. comm.; DF&G - Missoula, pers. comm.). The construction of U.S. Highway 12 has significantly altered the stream geometry and flow regime of Lolo Creek; approximately 80 percent of the stream has been channelized (DF&G - Missoula, pers. comm.). Further timber harvest activities in the Lolo Creek watershed could produce additional water yields that would contribute to stream degradation (Dept. of Fish and Game - Missoula, pers. comm.). Coordination of future harvest activities (and use of associated BMP's) will be necessary to prevent further water quality degradation in Lolo Creek.

Environmentally critical areas are also a factor to consider in assessing water quality of the Bitterroot River drainage. Erosive conditions are prevalent on soils developed from the Idaho batholith, as well as the unconsolidated valley fill material of the watershed's lower reaches. Steep slopes and land features (slumps, etc.) are also common forestland conditions of the Bitterroot. Some helicopter logging has been done in such areas.

Other land uses in the Bitterroot River drainage also contribute to non-point source pollution. The Conservation Districts believe that agricultural practices (streambank grazing, irrigation) and subdivision expansion are larger problems than silvicultural practices.

There is little merchantable timber remaining on the private forestlands of Ravalli County (Brandborg, 1975); however, where little or no planning

is required for timber harvesting, the potential for negative impacts to water quality is great.

The Water Quality Bureau has given a high priority to the water quality problems of the Bitterroot River drainage and will develop guidelines that will abate or eliminate non-point source pollution from road building and logging practices (in cooperation with other agencies) (DHES, 1975).

TABLE VI-B6		BITTERROOT RIVER DRAINAGE				
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76H	Ravalli	T3-4N, R18-20W	Sleeping Child Area (Cameron, Martin, Rye, Lyman and Bertie Lord Creeks) (perennial)	Sedimentation; increased water yield; channel degradation (effects still felt in lower reaches)	Natural fire and timber harvests	Restrictions of additional harvests until equilibrium of flow regime is attained; watershed rehabilitation (forest regeneration, streambank stabilization)
76H	Ravalli	T2-3N, R17W	Moose Creek (perennial)	Sedimentation	Road construction in natural hazard area	Stabilize cut and fill slopes; adequate erosion and drainage structures; restrict additional disturbance
76H	Ravalli	T8N, R19W Sec. 1-2, 11-12	Claremont and Haacke Creeks (perennial)	Soil movement; sedimentation	Harvest practices; steep slopes; soil type	Site rehabilitation (seeding, fill in skid trails, erosion structures, etc.)
76H	Ravalli	T9N, R18W, Sec. 20, 29	Ambrose Creek (perennial)	Sedimentation; channel degradation	Road construction; logging in stream; debris in stream	Rehabilitate channel (remove debris, re-establish channel, stabilization measures)
POTENTIAL PROBLEMS -----						
76H	Ravalli and Missoula		Bitterroot River watershed	Potential for sedimentation; increased water yield	Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse	Evaluate watershed characteristics and impacts; coordinate all land management activities between owners with regard to watershed limitations; use of BMP's
76H	Missoula	T11-12N, R20-24W	Lolo Creek (perennial)	Potential for sedimentation; increased water yield	Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse	Evaluate watershed characteristics and impacts; coordinate future management activities between owners with regard to watershed limitations; use of BMP's
76H	Ravalli	T8N, R18-19W	Burnt Fork Creek (perennial)	Potential for sedimentation; increased water yield	Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse (municipal water supply)	Evaluate watershed characteristics and impacts; coordinate future management activities between owners with regard to watershed limitations; use of BMP's

7. Mainstem Clark Fork River Drainage (Middle)

As the Clark Fork River winds between the Bitterroot Mountains and Ninemile Divide, it receives tributary flows from numerous small streams, as well as larger flows from Ninemile Creek and the St. Regis River. All drainages are within the DNR&C basin designation 76M. Stream waters are classified as B-D₁, except for Packer and Silver Creeks (A-Open-D₁) of the St. Regis River watershed and Rattlesnake Creek (A-Closed) near Missoula (DHES).

The Fish Creek drainage is addressed in a separate section.

Although most ownership in this area is USFS, there is significant intermingled ownership along the Clark Fork River and adjacent slopes (Champion, Burlington Northern, Montana Power, the state, and other small private). Timber harvesting and road construction have occurred on many of these parcels.

Several water quality impacts resulting from forestry practices have been identified by the DHES, DF&G, and local USFS Ranger Districts and other problem areas are suspected. Table VI-B7 delineates these areas; locations are shown on Plate I. Local Conservation Districts estimate that approximately 12 percent of the commercial forestland acreage within the mainstem Clark Fork River (middle) drainage is contributing to non-point source sediment pollution (1977). Approximately 70 percent of these problems were considered correctable within the basin (USGS basin 17010204).

In some areas, several land management activities may be contributing to non-point stream degradation. Ninemile Creek has experienced severe erosion, sedimentation, and habitat deterioration caused by road construction, dredge mining, and logging within the watershed (DF&G in DHES, 1976). Agricultural practices and expanding urbanization may also contribute to

watershed impacts.

Rattlesnake Creek is a public water supply for Missoula, Montana. Ownership within the watershed is a checkerboard pattern of USFS and Montana Power Company (MPC) lands. Past timber harvests (1960's) in the headwaters area (MPC) have caused sediment problems in the drainage (DF&G - Missoula, pers. comm.). Current land management within the watershed is controlled due to the A-Closed classification (DHES). However, if Missoula changes its water supply (to groundwater wells), Rattlesnake Creek could be developed for additional timber harvest. The USFS and MPC have agreed to cooperate in planning future management activities within the drainage. This planning should include the following measures for protection of water quality: 1) conduct basin-wide inventories to assess physical limitations of the watershed and identify water resource needs; 2) coordination of silvicultural (and other) activities among land managers in accordance with watershed limitations; 3) pursue watershed rehabilitation and protection measures (if any are needed); 4) require use of BMP's in silvicultural activities.

The St. Regis River is tributary to the Clark Fork River at St. Regis, Montana. The watershed contains little private or state ownership. Timber harvest and road construction has been extensive on USFS lands. The DF&G has identified areas of watershed abuse due to logging practices in the St. Regis River drainage. Since research for this report showed no problem areas on non-USFS lands, the identified impacts (DF&G) probably occur from activities on USFS lands.

In some cases, further investigation will be necessary to more accurately identify impact causes (USFS or non-USFS lands) before corrective measures

can be taken. The cumulative effects of small tributary flows with high sediment loads (or other impacts) should be considered when planning land management activities along the mainstem of the Clark Fork River.

TABLE VI-B7 MAINSTEM MIDDLE CLARK FORK RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76M	Missoula	T15-16N, R21-22W	Sixmile Creek (perennial)	High sediment load; flooding	Large area harvested (non-coordination between ownerships)	Evaluate watershed characteristics and impacts; coordinate forest management activities with regard to limitations of watersheds (may require harvest restrictions); watershed rehabilitation (vegetation streambank stabilization)
76M	Missoula	T13-14N, R22-23W	Petty Creek (perennial)	High sediment loads	Harvest and road building activities; other land uses (development, grazing)	Evaluate watershed characteristics and impacts; watershed rehabilitation (revegetation, streambank stabilization); coordinate all land management activities with regard to limitations of watershed (may necessitate harvest restrictions)
76M	Missoula, Mineral, Sanders	Blackfoot River to Flathead River	Clark Fork River (perennial)	Not defined by DFG	Watershed abuse due to logging	Identify and evaluate problems; employ necessary mitigation/prevention measures
76M	Missoula	T15-16N, R20-21W	Mill Creek (perennial)	High sediment load; channel degradation	Extensive harvest; road construction; non-coordination of management activities between mixed ownerships	Evaluate watershed characteristics and impacts; watershed rehabilitation (revegetation, streambank stabilization); coordinate all land management activities with regard to limitations of watershed (may necessitate harvest restrictions)
76M	Missoula	T14-15N, R18-19W	Rattlesnake Creek (perennial)	Not defined by DFG	Past logging resulting in general watershed abuse	Identify whether or not problems currently exist and take appropriate measures; evaluate watershed characteristics; coordinate future management activities between ownerships with regard to watershed limitations; use of BMP's

TABLE VI-87 (cont.)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76M	Missoula	T13-14N, R21-22W	Deep Creek (perennial)	High sediment loads; increased water yields; channel degradation	Extensive harvest and road construction debris in streams	Evaluate watershed characteristics and impacts; watershed rehabilitation (revegetation, streambank stabilization); coordinate all land management activities with regard to limitations of watershed (may necessitate harvest restrictions)
76M	Missoula	T15-17N, R22-24W	Ninemile Creek (perennial)	Severe erosion, sedi- mentation, and habitat deterioration	Combined abuse of watershed (logging, dredge mining, road construction)	Identify and evaluate impacts; coordinate watershed rehabilitation and future management activities between ownerships
POTENTIAL PROBLEMS -----						
76M	Missoula, Mineral, Sanders	Bitterroot River to Flathead River	Clark Fork River and tributaries	Potential problems (sedimentation, increased water yield, channel degradation)	Non-coordination of forestry activities in area of mixed ownership may lead to water- shed abuse	Evaluate watershed characteristics and impacts; coordinate future management activities between ownerships with regard to water- shed limitations; use of BMP's
76M	Missoula	T21-22N, R14W	Albert Creek (perennial)	Possible existing or future impacts	Non-coordination of forestry activities in area of mixed ownership may lead to water- shed abuse	Identify whether or not problems exist and take appropriate measures; evaluate watershed characteristics and coordinate future management activities with regard to watershed limitations
76M	Missoula	T21-22W, R14W	Rock Creek (perennial)	Possible existing or future impacts	Non-coordination of forestry activities in area of mixed ownership may lead to water- shed abuse	Identify whether or not problems exist and take appropriate measures; evaluate watershed characteristics and coordinate future management activities with regard to watershed limitations

8. Fish Creek Drainage

The Fish Creek watershed drains a portion of the Bitterroot Mountains and is tributary to the Clark Fork River about 10 miles west of Alberton, Montana.

Forestland ownership within the drainage is extremely varied. Although the headwaters area is mostly USFS ownership, the lower reaches are dominated by a checkerboard pattern of ownership that includes: Champion, the state, Burlington Northern, and the USFS. Timber harvest and associated road construction has occurred on parts of all ownerships; these activities have been especially heavy on Champion and USFS lands.

Significant water quality problems have developed on Fish Creek, resulting from these silvicultural operations (DHES, 1976; USFS - Ninemile, pers. comm.; DF&G - Missoula, pers. comm.). Increased sediment loads, increased water yields, and channel modifications have been the most obvious problems. Table VI - B8 delineates specific problem areas; these are located on Plate I.

Measures for problem mitigation and prevention must be applied on a basin-wide basis to effectively deal with the previously identified problems. The most comprehensive measures include: 1) restriction of silvicultural (and other) activities that could further impact existing problem areas; 2) conduct basin-wide inventories to assess physical limitations of the watershed and identify water resource needs; 3) coordination of silvicultural (and other) activities among various land managers in accordance with watershed limitations, particularly in drainages already impacted; 4) pursue watershed rehabilitation and protection measures (i.e., reforestation, road reclamation, streambank stabilization); 5) promote or require use of BMP's in silvicultural activities.

TABLE VI-B8 FISH CREEK WATERSHED

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76M	Mineral	T12-14N, R26-24W	Fish Creek (perennial)	High sediment loads	Road construction; extensive harvest; other poor logging practices	Road reclamation (seeding, erosion structures); maintenance (if road in use); watershed rehabilitation (revegetation, streambank stabilization, etc.); coordination of land use activities (many necessitate harvest restrictions)
76M	Mineral	T13N,R25W	Thompson Creek (perennial)	High sediment load; flooding; channel degradation	Road construction; stream-side harvest; improper skidding; poor road design and maintenance (drainage problems)	Road reclamation (seeding, erosion control structures); watershed rehabilitation (revegetation, streambank stabilization)
76M	Mineral	T13N,R24W	Deer Creek (perennial)	High sediment load; flooding; channel degradation	Placement of log landing in creek	Relocate log landing; rehabilitate area (revegetate, additional bank stabilization measures if necessary)
76M	Mineral	T14-15N, R25W	Bear Creek (perennial)	High sediment load; flooding; channel degradation	Poor road design and maintenance (inadequate drainage and erosion structures)	Road reclamation if road not in use; road maintenance if road in use (install drainage and erosion control structures, seeding, etc.)
POTENTIAL PROBLEMS -----						
76M	Mineral	T12-14N, R26-24W	Fish Creek watershed	Potential for additional sedimentation, increased water yield	Non-coordination of forestry activities in area of mixed ownership; continued poor practices	Evaluate watershed characteristics and impacts; coordinate future management activities between ownerships with regard to watershed limitations; watershed rehabilitation measures (revegetation, streambank stabilization, etc.); possible harvest restrictions

Lower Clark Fork River Basin

From the mouth of the Flathead River to the Idaho stateline (approximately 90 miles), the Clark Fork River receives tributary flows from the Bitterroot Range to the southwest and the Cabinet Mountains to the northeast. The DNR&C basin designation is 76N. The DHES has classified all streams as B-D₁, except Ashley Creek (A-Closed) and Pilgrim Creek (A-Open-D₁).

USFS ownership dominates the area, except in the Thompson River drainage. Timber-harvest activities have been extensive, both on USFS and other forestlands; related water quality impacts are discussed.

Along the Clark Fork River and in the area of the Flathead River, highly erosive (silt and clay) glacial lake deposits contribute to non-point water pollution. These areas are especially susceptible to impacts from forestry activities. The steep terrain found in this area also contributes to the sensitivity of watersheds. Local Conservation Districts (1977), estimated that three percent (11,500 acres) of the commercial forestland acreage contributed to sediment pollution of streamcourses (USGS drainage basin 17010213). Approximately 75 percent of these problems were considered correctible.

9. Mainstem Clark Fork River Drainage (Lower)

This drainage segment is characterized by the narrow valley of the Clark Fork River. Tributary flows drain the adjacent slopes. Ownership within the drainage is predominantly USFS; private and state holdings are concentrated in the valley bottoms. Significant checkerboard ownership patterns exist in the Thompson River drainage (discussed in following section), Weeksville Creek, Lynch Creek (and tributaries), and in the Vermillion River watershed.

This drainage segment has sustained extensive timber harvest and road building activities, mostly on USFS lands. Forestry activities also occur on non-USFS ownerships; these operations were evaluated for their effects on stream water quality. Problem areas are delineated in Table VI-B9 and located on Plate I. The Clark Fork River proper has sustained some water quality degradation (low to moderate) from silvicultural activities (DHES, 1976). The cumulative effects of continued harvesting on multiple ownerships should be considered in future management decisions.

TABLE VI-89 MAIN STEM CLARK FORK RIVER DRAINAGE (LOWER)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76N	Sanders	T27N,R34W	Elk Creek (perennial)	Sedimentation; channel alteration	Skidding logs in stream; felling logs in stream; some channelization	Remove debris from stream; rehabilitate streambank (fill in skid trails, seed disturbed areas, etc.)
76N	Sanders	T21N,R27W	Weeksville Creek (perennial)	Channel modifications; sedimentation	Streamside road construction; skidding in stream	Streambank stabilization (grading, seeding, possible road relocation)
76N	Sanders	T21N,R30W Sec. 31	Dry Creek (perennial)	Channel modifications	Streamside harvests; skidding logs in streambed	Streambank stabilization (erosion control, seeding, etc.)
76N	Sanders	Flathead River to Idaho border	Clark Fork River (perennial)	General impacts of harvesting (low to moderate)	Cumulative effects of USFS and other harvest activities	Evaluate watershed characteristics and impacts; coordinate future management activities between ownerships with regard to watershed limitations; use of BMP's
POTENTIAL PROBLEMS -----						
76N	Sanders	T23N,R31W	White Pine Creek (perennial)	Potential erosion and sedimentation	Streamside harvest; logging debris piled along stream	Remove debris from streamside; rehabilitate disturbed area (fill in skid trails, seed disturbed area)
76N	Sanders	T25N,R29-30W	Vernillion River (perennial)	Potential problem	Non-coordination of forestry activities between ownerships	Assess watershed characteristics, then develop plan in accordance

10. Thompson River Drainage

The Thompson River drains a portion of the Cabinet Mountains and is tributary to the Clark Fork River about five miles east of Thompson Falls, Montana. It is within the designated basin 76N (DNR&C) with a stream classification of B-D₁ (DHES).

Ownership patterns within the drainage are extremely intermingled. Some USFS ownership is consolidated on the east and west sides of the watershed. However, the northern headwaters and central portion of the watershed are administered in a checkerboard fashion under Champion, Burlington Northern, the state, and USFS.

Timber harvesting and associated road building have been pursued extensively in the Thompson River drainage (USFS and non-USFS lands), resulting in detrimental impacts. The construction of two roads along the river, effectively channelizing the stream, is probably the major impact in the watershed (USFS - Thompson Falls, pers. comm.). The steep terrain of the area contributes to the watershed's sensitivity to silvicultural practices. Problem areas are outlined in Table VI-B10 and located on Plate I.

Some naturally unstable areas (slumps, slides, etc.) are contributing to high sediment loads in the Thompson River drainage (Honeymoon Creek). Grazing practices also contribute to non-point source water pollution.

Prevention and mitigation measures must be applied on a basin-wide basis to effectively deal with the identified problems. The most comprehensive measures include: 1) restriction of silvicultural (and other) activities that could further impact existing problem areas; 2) conduct basin-wide

inventories to assess physical limitations of the watershed and identify water resource needs; 3) coordination of silvicultural (and other) activities among various land managers in accordance with watershed limitations, particularly in drainages already impacted; 4) pursue watershed rehabilitation and protection measures (i.e., reforestation, road reclamation, streambank stabilization); 5) promote or require use of BMP's in all land management activities.

TABLE VI-B10 THOMPSON RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76N	Sanders	T20-27N, R25-28W	Thompson River (perennial)	High sediment loads; channel degradation	Extensive harvest; stream-side road location; steep area harvested	Watershed rehabilitation (forest regeneration, streambank stabilization); road reclamation (seeding, erosion structures); road maintenance (if in use); coordination of management activities between ownership; possible restrictions of additional harvests until equilibrium of flow regime is attained
76N	Sanders	T22-23N, R26-27W	Little Thompson River (perennial)	Not defined by DFG	Watershed abuse due to logging	Identify and evaluate problems; employ necessary mitigation/prevention measures
76N	Sanders	T25N, R27W, Sec. 29-31	Lazier Creek (perennial)	High sediment load; increased water yield	Extensive harvest in basin	Evaluate watershed characteristics and impacts; watershed rehabilitation (revegetation, streambank stabilization); coordinate all land management activities with regard to limitations of watershed (may necessitate harvest restrictions)
76N	Sanders	T23-25N, R27-28W	Fishtrap Creek (perennial)	Potential for further degradation (present USFS impacts)	Additional forestry activities without coordinated planning between ownerships	Evaluate watershed characteristics and impacts; coordinate future management activities between ownerships with regard to watershed limitations; use of BMP's
76N	Sanders	T26N, R26W	McGregor Creek (perennial)	Sedimentation	Construction and silvicultural activities	Identify and evaluate specific problems; employ necessary mitigation/prevention measures
POTENTIAL PROBLEMS -----						
76N	Sanders		Thompson River and tributaries (perennial)	Further watershed abuse and water quality degradation	Extensive harvest and road construction without coordination between land owners	Evaluate watershed characteristics and impacts; watershed rehabilitation (revegetation, streambank stabilization); coordinate all land management activities with regard to limitations of watershed (may necessitate harvest restrictions)

11. Upper Swan River Drainage

The Swan River drainage (northwest Montana) is defined by the Mission Range to the west, the Swan Range to the east and a lesser divide to the south. The mouth of the drainage is at Bigfork, Montana. Only the upper reaches (Missoula County) are addressed in this study; the Flathead Designated 208 study addresses the drainage segment within Lake County. The DNR&C basin designation is 76K and the headwater areas are classed as B-D₁ waters (DHES).

An extensive checkerboard ownership pattern (USFS and Burlington Northern) dominates the upper Swan River valley. Logging activities have been pursued on both land onwerships and are expected to increase in the future (USFS - Bigfork, pers. comm.). Some coordination of harvests and road building has occurred between adjacent ownerships.

Reported water quality problems were surprisingly few when considering the extent of harvest which has occurred. However, as additional timber harvest and road construction occur, the watershed will come closer to its capacity for absorbing impacts from forestry activities. Existing and potential problems are delineated in Table VI-B11 and located on Plate I.

Coordination of silvicultural activities between the USFS and BN are necessary if the Swan River is to retain its present water quality. There are also agricultural and urban development activities that must be considered.

TABLE VI-B12 UPPER SWAN RIVER

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported Cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
76K	Missoula	T17-18N, R16-17W	Swan River (perennial)	Not defined by DFG	Watershed abuse due to logging practices	Identify problem and employ appropriate mitigation measures

POTENTIAL PROBLEMS

76K	Missoula	T19-21N, R16-18W	Swan River and tributaries	Potential for sedimentation; increased water yield	Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse	Evaluate watershed characteristics and impacts; coordinate future management activities between ownerships with regard to watershed limitations; use of BMP's
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C. Missouri River Basin

In order to effectively identify and evaluate water quality problems of the Missouri River Basin, the following stream basin groupings were utilized:

Upper Missouri River Basin	Headwaters to Three Forks
Middle Missouri River Basin	Three Forks to mouth of Marias River
Lower Missouri River Basin	Marias River to North Dakota border

The Blue Ribbon Designated 208 Study Unit is within the Upper Missouri River Basin and was not considered in this report.

Upper Missouri River Basin

Trends in timber harvesting within the Upper Missouri River basin have gradually changed. Until recently, most harvest activities occurred on USFS lands. At present, private timber resources are supplying up to 75 percent of mill production (Stoltze Land and Lumber - Dillon, pers. comm.). As demand for private timber increases and stumpage prices increase, costly BMP's are more likely to be disregarded; this is particularly true due to the lack of guidelines in effect on private lands. However, there is a growing awareness amongst landowners of the advantages in seeking professional assistance for the design and contracting of a timber sale (B. Hand, pers. comm.).

Dyrness (1967) and Swanston (1970) identified the Upper Missouri River drainage as an area where risk of mass movement is high. Timber harvesting in such environments may seriously affect water quality if adequate site planning is not employed.

1. Big Hole River Drainage

The Big Hole River drains a large portion of southwest Montana. The watershed is defined by the Bitterroot Range to the west, the Anaconda Range to the north, and the Pioneer Mountains to the south (which the river skirts around). The Big Hole River, part of the Missouri River drainage, flows into the Jefferson River near Twin Bridge, Montana. The DNR&C drainage basin identification number is 41D. The drainage is classified as A-Open-D₁ above the town of Divide, Montana, and as B-D₁ from Divide to the mouth.

Although most timberland in the area is under USFS administration, there is also private, State, and BLM ownership of merchantable timber. Timber harvesting on non-USFS lands is relatively small scale. The principal management objective on private ownerships in this area is to increase grazing capacity. Under this situation, timber regeneration is discouraged.

Most timberland in this area is moderately sloping with dry soils; therefore, impacts to water quality have been minimal (USFS - Wise River, pers. comm.). The five Conservation Districts in the Big Hole drainage have estimated that less than five percent (26,260 acres) of the commercial forest land can be considered as contributing to soil erosion and non-point water pollution (1977); over 50 percent of these problems are considered correctable. Although impacts to water quality have not been monitored, poor harvesting practices have been observed or reported (USFS - Wisdom, pers. comm.; USFS - Wise River, pers. comm.; DHES, 1974). Such practices include skidding across stream channels, leaving debris in streams, cutting adjacent to streams, and poor sizing of cutting units (too large). In some of the dry areas, such practices may not

influence water quality; however, there are several wet areas in the valley that are particularly sensitive to poor timber harvesting practices. There is also an area of erosive bentonitic soils in the area of California and Oregon Creeks (T3N, R11W). Past logging in this area has enhanced erosion and sediment contribution to these streams; natural beaver dams have helped to prevent extensive downstream deterioration of water quality (DF&G - Butte, pers. comm.).

There is active timber harvesting in the Mt. Haggin area northwest of Wise River, Montana. In a recent land sale, the DF&G and USFS have purchased an area of former checkerboard ownership (private and USFS). Although former timber contracts must be honored (Louisiana Pacific), DF&G has placed some BMP's into effect. These measures should protect stream water quality in most cases; however, DF&G has limited control of how much acreage will be harvested before 1988 (contract termination). Due to these circumstances, this area should be considered as a potential problem.

Agriculture-related activities have probably had the largest impact upon the Big Hole River drainage (DHES, 1974; DF&G - Butte, Bozeman, pers. comm.).

Table VI-C outlines known or suspected water quality problems associated with silvicultural activities in the Big Hole River Valley; Plate I shows locations of problem areas.

At present, the Big Hole River retains a high water quality rating. However, it is threatened by several aspects of agricultural and forestry operations within the watershed. A comprehensive basin-wide management plan employing appropriate practices for silvicultural activities will help maintain the water quality of the Big Hole River.

TABLE VI-C1 BIG HOLE RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
41D	Beaverhead	T3S,R18W, Sec.22-27	Nugget Creek and Pioneer Creek (perennial)	Sedimentation; channel alteration	Logging debris in stream; skidding across stream; streamside harvesting	Rehabilitate channel (remove debris, stabilize banks, seed where necessary)
POTENTIAL PROBLEMS -----						
41D	Beaverhead	T5S,R14W, Sec. 24,25, 36	Bull Creek (perennial)	Potential problem	Extensive harvest in area	Investigate to determine if problem exists; implement measures in response to severity of problem
41D	Beaverhead	T1S,R14W, Sec. 5	Unnamed ephemeral stream	Potential problem	Logging debris in channel; skidded across drainages; streamside harvesting	Investigate to determine if problem exists; rehabilitate channel (remove debris, etc.)
41D	Deer Lodge	T3N,R12-13W	California and Oregon Creeks (perennial)	Potential problem	Naturally erosive soil conditions; could be complicated by timber harvest and road building	Restriction of silvicultural activities until assessment of watershed and coordinated site specific plans are completed
41D	Deer Lodge	T3N,R12W	Drainages in area of Mt. Haggin land purchase (DF&G (perennial and ephemeral))	Potential problem	Extensive harvest activities	Closely monitor activities and stream water quality; enforce existing contract stipulations; encourage contractor to use additional BMP's

2. Red Rock River Drainage

The Red Rock River drainage contains approximately 1,600 square miles in extreme southwestern Montana. The watershed is defined by the Beaverhead Mountains to the west, the Centennial Mountains to the south, and the Gravelly Range to the east. Clark Canyon dam marks the mouth of the drainage. The DNR&C drainage basin designation is 41A, and the DHES has classed all streams as B-D₁.

The Centennial Valley contains some of the better timber in the Dillon area; however, site factors (steep slopes, soil conditions) may limit its economic merchantability.

Forestland ownership within the Red Rock River drainage is predominantly USFS and BLM, with lesser amounts of state and private ownership. Although USFS ownership is well consolidated, some areas have significant mixed ownership patterns amongst several landowners. Harvest activities not coordinated between various land ownerships increases the potential for water quality impacts; this is of particular importance in the Medicine Lodge Creek watershed. Problems are shown in Table VI-C2 and on Plate I.

The physical characteristics of the land are especially susceptible to impacts from silvicultural activities. Several soil groups within the drainage are highly erosive, particularly those associated with fine-grained volcanic materials, loosely consolidated sandstones and shales, or unconsolidated sands and gravels.

The Red Rock and Horse Prairie Conservation District estimated that nearly 25 percent of the watershed's commercial forestland contribute to non-point source sediment pollution (1977). Site planning is of extreme importance in such environments; preclusion of conventional logging may be necessary in some areas.

TABLE VI-C-2 RED ROCK RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
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41A	Beaverhead	T14S,R3W Sec.21,26, 27	Winslow Creek and Tipton Creek (perennial)	Accelerated erosion	Excessive soil disturbance due to harvesting in wet soil conditions	Rehabilitate area (fill in tire ruts, seed, etc.); adopt harvest practices and timing with regard to site conditions
41A	Beaverhead	T9S,R14W, Sec.31	Bloody Dick Creek (perennial)	Increased sediment load; channel alteration	Road construction (steep gradient, poor drainage structures, stream crossing)	Reclaim road if not in use (regrade, seed); reconstruct road if still in use (less steep grades, drainage and erosion control features, seed shoulders and slopes)

POTENTIAL PROBLEMS -----						
41A	Beaverhead	T11-13S, R11-12W	Medicine Lodge Creek (perennial)	Potential problem	Uncoordinated harvest activities	Inventory watershed characteristics and develop watershed management plan in accordance with identified physical limitations; coordinate management activities of mixed ownerships.
41A	Beaverhead		Red Rock River drainage	Potential problem	Uncoordinated or poorly planned activities in critical areas	Basin-wide evaluation of watershed characteristics; coordinate forest management activities of mixed ownerships with regard to identified critical areas and other watershed impacts (overgrazing, etc.).

3. Ruby River Drainage

The Ruby River drainage is tributary to the Beaverhead River. The Ruby River watershed is defined by the Gravelly Range to the southeast, the Snowcrest Range to the southwest, the Tobacco Root Mountains to the northeast, and the Ruby Range to the west; the mouth is near Twin Bridges, Montana. Its drainage basin identification number is 41C (DNR&C); all streams are classified as B-D₁ except a portion of Indian Creek which is A-Open-D₁ (DHES).

Non-USFS land ownership in the Ruby drainage is divided among the BLM, the State and the private sector and dominates the broad valleys and foothills. There is little merchantable timber on these lands, being limited by climate and aspect.

High turbidities have been noted in the Ruby River drainage. The likely causes of these conditions are highly erosive soils, slumping, and other naturally occurring erosion processes (DNES, 1974; DF&G - Bozeman, pers. comm.). Poor agricultural practices (overgrazing) may also complicate this situation (DHES, 1974).

There has been limited recent harvesting of merchantable timber along the foothills northeast of Sheridan, Montana. Although most of this area is immature second growth timber, there still remain scattered patches of merchantable timber. There is also current harvesting activities on Idaho Creek (T7S, R3W). It is reported that this patented claim is being clear-cut along the stream bank in preparation for placer mining activity (USFS - Sheridan, pers. comm.). No water quality data is available relative to the impact of this operation. However, since Idaho Creek is

a rearing area for trout (USFS - Sheridan, pers. comm.; DF&G - Bozeman, pers. comm.), this area should be evaluated on-site for possible water quality impacts.

The potential for timber harvests are quite limited on the non-USFS lands of the Ruby River drainage, primarily due to the lack of merchantable timber. However, parts of the watershed are particularly sensitive to any surface modifications (road construction, vegetation modification, etc.) because of the natural conditions. Proper road construction in these unstable areas increases the cost of the operation to the point where harvesting the marginal timber available is not economical. Even without such economic constraints, timber harvests should be curtailed in areas where such activities would enhance the naturally occurring erosion processes. Table VI-C3 delineates existing and potential impacts of water quality in the Ruby River watershed; Plate I shows location of these areas.

TABLE VI-C-3 RUBY RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
41C	Madison	T7S, R4W, Sec. 29, 30	Idaho Creek (perennial)	Sediment increases	Streamside harvest; debris in stream	Rehabilitate channel (remove debris, seed and stabilize banks)
POTENTIAL PROBLEMS -----						
41C	Madison	T3S, R4W, Sec. 32, 33, 28	Noble Fork of Wisconsin Creek (perennial)	Potential problem	Streamside harvest	Utilize BMP's in harvest activities (re: skidding, debris, felling, shape, etc.)
41C	Madison		Ruby River and tributaries	Potential for increased sediment loads and other impacts	Naturally unstable areas; activities could aggravate situation	Basin-wide evaluation of watershed characteristics; define critical areas and apply harvest restrictions accordingly; coordinate all management activities (forestry, agriculture, etc.)

4. Beaverhead River Drainage

The Beaverhead River drainage (southwest Montana) is defined by the Pioneer Mountains to the west, the Ruby Range to the east, and extends from Clark Canyon Reservoir to the mouth of the Ruby River. The DNR&C basin designation is 41B. All waters are classified as B-D₁ (DHES) streams except the upper portion of Rattlesnake Creek (A-Open-D₁).

Forestland ownership in the Beaverhead River drainage is predominantly USFS with additional BLM, state, and private ownerships. In certain areas, intermingled ownership creates an opportunity for uncoordinated management activities which may result in water quality impacts. This situation exists in the Blacktail Deer Creek drainage, where future harvesting is anticipated.

Timber harvesting has occurred on all ownerships, however, recent activities have been concentrated on small private ownerships. Few impacts to water quality were reported as resulting from forestry activities. The local Conservation Districts (1977) estimated that over 12 percent of commercial forestland within the Beaverhead River drainage (8,000 acres) are contributing to non-point sediment pollution. Approximately 85 percent of this acreage was considered to have rehabilitation potential. Many areas within the drainage are characterized by highly erosive soil conditions, due to fine-grained volcanic material and loosely consolidated sediments. Identified water quality impacts are shown in Table VI-C₄; locations are shown on Plate I.

TABLE VI-C 4 BEAVERHEAD RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
41B	Beaverhead	T4S,R12W, Sec. 15	St. Louis Creek (perennial)	Increased sediment load; channel degradation	Logging debris in stream channel	Remove debris from stream; rehabilitate streambanks as necessary (seeding, etc.)

POTENTIAL PROBLEMS -----

106	41B	Beaverhead	Blacktail Deer Creek (perennial)	Potential problem	Uncoordinated harvest activities which may accelerate erosion in sensitive areas (poorly consolidated sediments)	Evaluate watershed characteristics and impacts; coordinate future management activities between ownerships with regard to watershed limitations
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5. Jefferson River Drainage

The Jefferson River drainage is considered a headwater stream of the Missouri River, extending from Twin Bridges to Three Forks and bounded by the Continental Divide to the west, the Tobacco Root Mountains to the south, and the Bull Mountains to the north. Designated as drainage basin 41G (DNR&C), the Jefferson River watershed is classified as B-D₁ (DHES).

Most forestland in this basin is under USFS ownership; however, there is also BLM, state, and private ownership. Timber harvest on non-USFS lands has been limited, due to the fact that there is relatively little merchantable timber available on these lands. No impacts to water quality from these activities have been identified.

Moderate turbidities have been recorded in the Jefferson River drainage. The primary causes for these problems are natural erosion, hydrographic modifications, and agricultural practices (DHES, 1974). Local Conservation Districts estimated that about two percent of the commercial forestlands contribute to non-point sediment pollution. Weathered granitic and volcanic materials within the drainage are susceptible to accelerated erosion.

Potentials for future water quality problems (from forestry practices) are limited. However, there are two areas of mixed ownership (Bull Mountains, Tobacco Root Mountains) where non-coordination of management activities could result in water quality degradation. These are outlined in Table VI-C5 and located on Plate I .

TABLE VI-C5 JEFFERSON RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
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POTENTIAL PROBLEMS -----

416	Jefferson	T3-4N, R4W	Headwaters (Whitetail Creek) (perennial)	Potential problem	Non-coordinated harvest activities; possible critical area	Coordinate management activities in mixed ownership; site evaluation relative to physical characteristics
416	Madison	T2S, R4W	Wychham Creek, Spring Creek, and Mill Creek (Perennial)	Potential problem	Non-coordinated harvest activities; possible critical area	Coordinate management activities in mixed ownership; site evaluation relative to physical characteristics

6. Boulder River Drainage

The Boulder River is tributary to the Jefferson River near Cardwell, Montana. The watershed is defined by the Elkhorn Mountains to the north and east, and the Boulder Batholith and Bull Mountains to the west. The DNR&C drainage basin designation is 41E. The watershed is classified as B-D₁ (DHES), except for the upper reaches of Basin Creek.

Forestland ownership in the Boulder River drainage is predominantly USFS with additional BLM, private and state ownerships. Silvicultural activities on non-USFS lands have been very limited and only one problem area was reported. There are two areas of checkerboard ownerships (USFS and private) where harvest activities should be coordinated. At present, the USFS has curtailed its harvest activities in the Bull Mountains due to private harvesting on adjacent lands.

The drainage has low sedimentation rates. The Jefferson Valley Conservation District (1977) estimated that only 100 acres of commercial forestland (from a total of 50,000 acres) contributes to non-point sediment pollution. Local agricultural practices have accelerated geologic erosion (Jefferson Valley Conservation District, 1976). Severe mining impacts have also occurred (DHES, 1976).

Table VI-C6 delineates existing and potential areas of water quality impacts in the Boulder River drainage; Plate I shows locations of these areas.

TABLE VI-C6 BOULDER RIVER DRAINAGE
Drainage Basin County Location

			<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
41E	Jefferson	T3-4N, R3W	Headwaters area of several streams	Physical damage to channel; accelerated erosion	Felling and skidding in streams	Remove debris from stream channel; rehabilitate banks (fill in skid trail ruts, seed disturbed areas.)

POTENTIAL PROBLEMS -----

41E	Jefferson	T6N, R2W	Headwaters of Dry Creek	Potential problem (extensive harvest)	Non-coordination of harvest activities between mixed ownership	Coordinate planned harvest and road building activities between various land managers in alignment with physical limitations of watershed
41E	Jefferson	T3-4N, R3-4W	Headwaters area of several streams	Potential problem (extensive harvest)	Non-coordination of harvest activities between mixed ownership	Coordinate planned harvest and road building activities between various land managers in alignment with physical limitations of watershed

Middle Missouri River Basin

7. Main Stem Missouri River Drainage

This segment of the Missouri River drainage extends from Three Forks, Montana to the mouth of the Marias River near Loma, Montana. The DNR&C drainage basin designations included under this section are 41I, 41QJ, and 41Q. Water quality classifications (DHES) gradually degrade from B-D₁ to B-D₃ in this watershed segment.

Forestland ownership is dominated by the USFS; however, there is also significant private timberland ownership, including: Burlington Northern, Champion, and several large ranch companies. Silvicultural activities have been pursued in many areas; related water quality impacts are outlined in Table VI-C7 and located on Plate I. Some water quality impacts are minimized due to the dry climatic conditions. However, other impacts may be aggravated due to slow regeneration rates on some sites.

Of particular interest are Conservation District estimates of commercial forestland contributions to non-point sediment pollution. Belt Creek and the Smith River are adjacent watersheds, however, their sediment contributions are radically different: Belt Creek yields sediment pollution from 40 percent of its forestland, Smith River yields sediment pollution from only four percent of its commercial forestland. This difference is probably due to natural characteristics of the basins (soft shale and siltstone sediments and Tertiary volcanics), as well as degree of other management activities (USFS logging, agriculture, etc.).

TABLE VI-C7 MAIN STEM MISSOURI RIVER DRAINAGE				Suggested Measures of Investigation/Prevention		
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	
411	Broadwater	T8N,R3E	Duck Creek (and general area) (perennial and ephemeral)	Possible accelerated erosion	Road construction	Reclaim roads if not used (seeding, etc.); rehabilitate roads if still in use (regrade steep sections, seed shoulders)
411	Broadwater	T11N,R1E	Gabish Gulch (ephemeral)	Sedimentation; channel impacts	Road located in stream bottom	Close road to use and stabilize streambeds (seeding, filling old ruts, etc.)
411	Lewis and Clark	T11N,R5W	East Skelly Gulch (perennial)	Sedimentation; channel impacts	Streamside harvest; logging across stream	Rehabilitate channel and stabilize streambanks (fill in skid trails, seeding)
410J	Lewis and Clark	T15N,R5W	Wolf Creek (perennial)	Sedimentation; channel impacts	Logging debris in stream (possibly complicated by streamside grazing activity)	Remove debris from stream channel and rehabilitate streambanks as necessary
410J	Lewis and Clark	T13N,R5-6W	Rattlesnake Creek and Hill Creek (perennial)	Possible accelerated erosion	Generally poor harvest practices	Identify specific problems and mitigate accordingly
410J	Lewis and Clark	T15N,R2W	South Fork Stickney Creek (perennial)	Not defined by DFG	Watershed abuse due to logging practices	Investigate problem and implement necessary measures
41Q	Cascade	T15N,R7E	Belt Creek (perennial)	Not defined by DFG	Watershed abuse due to logging practices	Investigate problem and implement necessary measures; may result from private and/or USFS activities
411	Jefferson	T8N,R4W, Sec.5-6	Bufalo Creek (perennial)	Accelerated erosion; possible water yield increase	Clear-cut on steep slopes; inadequate road drainage and grade	Assist revegetation on streambanks and steep slopes; rehabilitate roads (proper erosion and drainage structure regrade where necessary)
411	Jefferson	T8N,R2W, Sec.29-30	Middle Fork Warm Springs Creek	Possible accelerated erosion	Poor road construction	Rehabilitate roads to meet BMP's; periodic road maintenance

8. Rocky Mountain Front Drainages

The Rocky Mountain Front of northern Montana contains several watersheds within the Statewide 208 study area. Between the Blackfeet Indian Reservation and the town of Craig, Montana, there are four major watersheds that drain the east flank of the Rocky Mountain Front. All these drainages are tributary to the Missouri River and include: Dearborn River, (41U); Sun River, (41K); Teton River, (41O); and part of the Marias River (41P).

East of the Teton and Sun River Ranger Districts (USFS) lie private, state and BLM land ownerships. However, there is little, if any, commercial saw-timber on these lands. Small post and pole operations have harvested some private timber in the past, but there are no harvesting activities at this time. The post and pole mills in Choteau and Fairfield are obtaining their timber primarily from the Lincoln area with a small portion coming from the Sun River District of the USFS. Ranches may also be harvesting some timber for their own purposes (fences, corrals, increase grazing area), but none of these activities involve commercial silviculture.

The Dearborn River contains significant forestland, including some commercial saw-timber. This area of USFS, state, private, and BLM ownership could also support some post and pole type harvest. Therefore, coordination of harvest activities should be pursued to prevent any water quality impacts from harvesting too large an area within a short time or from poor road design.

Timber harvests on the Teton Ranger District were ended approximately five

years ago (1972) due to unstable soils and associated costs of road construction. This action had little, if any, impact upon harvests of private timberlands due to the marginal nature of the timber resource. Due to these physical limitations of the environment, as well as economic conditions, there is little potential for future silvicultural activities on most non-USFS lands along the Rocky Mountain Front.

Table VI-C8 delineates existing and potential water quality impacts; Plate I shows location of these areas.

TABLE VI-C8 ROCKY MOUNTAIN FRONT DRAINAGES

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
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41U	Lewis and Clark	T16N, R6W	Green Creek (perennial)	Accelerated erosion	Road construction (steep slopes, erosive soil conditions)	Reclaim roads if not used (regrade, seed); rehabilitate and maintain roads if in use (reduce slope, install erosion control structures, seed shoulders and fills)
41U	Lewis and Clark	T16N, R6W	Middle Fork Dearborn River (perennial)	Accelerated erosion	Road construction (steep slopes, erosive soil conditions)	Reclaim roads if not used (regrade, seed); rehabilitate and maintain roads if in use (reduce slope, install erosion control structures, seed shoulders and fills)

POTENTIAL PROBLEMS -----

41U	Lewis and Clark	T18N, R7W	Dearborn River	Potential problem (accelerated erosion)	Non-coordination of harvest and road building activities among mixed owner-ship	Plan silvicultural activities with regard to physical limitations of site and watershed; coordinate planning with adjacent landowners
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9. Smith River Drainage

The Smith River drainage is tributary to the Missouri River southwest of Great Falls, Montana. The watershed is defined by the Big Belt Mountains to the west, the Little Belt Mountains to the east, and the Castle Mountains and Elkhorn Ridge to the south. The DNR&C basin designation is 41J, and the entire drainage is classified as B-D₃ streams (DHES).

Ownership patterns within the Smith River drainage are extremely intermingled. USFS ownership (Helena, Lewis and Clark) dominates the headwater areas, but other ownerships are mixed along the foothills and valley bottoms. Other prominent landowners include: Rankin Ranch Co., Sieben Livestock Co., 71 Ranch, Burlington Northern, the state, and BLM. The numerous areas of checkerboard ownership make cooperative land management decisions very difficult.

The Smith River has sustained cumulative man-caused impacts to water quality. Temperature increases have resulted from irrigation return flows (DF&G, 1973). Although annual sediment yield is moderately low (SCS, Conservation Districts), several local sources of sedimentation have been identified. These include hydrographic modifications (irrigation diversions, rechanneling for a railroad route and other roads), heavy livestock use adjacent to streambanks and overgrazing, logging practices, old placer tailings, and cabin site development (DF&G, 1973).

Past and present silvicultural activities are affecting stream water quality in the drainage. Extensive USFS harvests have occurred in the headwaters area; impacts from non-USFS harvesting and road building have occurred in several drainages. These problem areas (non-USFS

related) are delineated in Table VI-C9 and identified on Plate I . Although forestry practices are not the primary source of water quality degradation in the Smith River drainage, such activities certainly contribute to non-point pollution and complicate detrimental effects of other land use activities.

Prevention and mitigation measures must be applied on a basin-wide basis to effectively deal with the previously identified problems. The most comprehensive measures include: 1) restriction of silvicultural (and other) activities that could further impact existing problem areas; 2) conduct basin-wide inventories to assess physical limitations of the watershed and identify water resource needs; 3) coordination of silvicultural (and other) activities among various land managers in accordance with watershed limitations, particularly in drainages already impacted; 4) pursue watershed rehabilitation and protection measures (i.e., reforestation, road reclamation, streambank stabilization); 5) promote or require use of BMP's in both silvicultural and agricultural activities.

TABLE VI-C9 SMITH RIVER DRAINAGE						
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
41J	Meagher	T11N, 3E	Benton Gulch (perennial)	Not defined by DFG	Watershed abuse due to logging practices (may possibly relate to USFS land)	Identify problem and utilize necessary measures
41J	Meagher	T10-11N, R6-7E	Newland Creek (perennial)	Not defined by DFG	Watershed abuse due to logging practices (probably extensive clearcut harvests)	Identify problem and utilize necessary measures; coordinate private and USFS management activities within watershed (forestry and other)
41J	Meagher	T10-11N, R8-9E	North Fork Smith River (perennial)	Stream channel degradation; sedimentation	Extensive clearcut harvesting	Rehabilitate headwaters area (enhance revegetation and second growth timber, stabilize streambanks); stabilize lower streambanks (seeding, restrict grazing)
41J	Meagher	T12N, R5-8W	Sheep Creek (perennial)	Stream channel degradation; sedimentation	Extensive clearcut harvesting; road construction (channeled stream segments)	Rehabilitate headwaters area (enhance revegetation and second growth timber, stabilize streambanks); stabilize lower streambanks (seeding, restrict grazing; maintain roads if in use (seed shoulders and fills)
41J	Meagher and Cascade	T11-17N, R3-4E	Smith River (perennial)	Not identified by DFG	Watershed abuse due to logging practices	Identify problem and employ appropriate measures
41J	Meagher	T12N, R6E	Moose Creek (perennial)	Possible sedimentation	Clearcut harvest along streambanks	Rehabilitate streambanks; enhance revegetation and reforestation
41J	Meagher	T9-10N, R4-5E	Thompson Gulch (perennial)	Possible sedimentation	Clearcut harvest along streambanks	Rehabilitate streambanks; enhance revegetation and reforestation

TABLE VI-C9 (cont.)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
41J	Meagher	T10N, R3-4E	Elk Creek (perennial)	Possible sedimentation	Poor road construction	Rehabilitate roads (seeding, install drainage and erosion structures); maintain roads
41J	Meagher	T11N, R2E	Beaver Creek (perennial)	Sedimentation	Numerous stream crossings	Reduce number of crossing or close to road use

POTENTIAL PROBLEMS

41J	Meagher and Cascade	Smith River and tributaries	Aggravation of existing problems; creation of similar problems in other drainages	Continued use of poor forestry practices (and agricultural practices) in an uncoordinated manner	Basin-wide inventory of watershed characteristics; coordinate location, type, and timing of land management activities with regard to physical limitations of watershed; this may necessarily restrict certain activities in order to improve and maintain water quality
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Lower Missouri River Basin

Minor timber resources are found in the Lower Missouri River basin. However, there are no valid inventory figures available regarding volume or acreage of this resource (YTAPO, 1976). Commercial saw timber is found in the headwater areas of the Musselshell and Judith River basins. Occasional post and pole type operations occur on both public and private lands throughout the area.

There are also broadleaf forests which occur in the area. Cottonwood forests are found along several streambanks, on islands in the river, and on other riparian tracts. No figures are currently available which describe the acreage estimates for this timber resource. Commercial development of cottonwood forests was attempted along the Yellowstone River in the early 1970's "It was the opinion of the agency personnel at three federal offices that if a large, modernly equipped company (Georgia-Pacific) couldn't develop a commercial operation to utilize this resource, probably no other company would in the future." (YTAPO, 1976).

10. Judith River Drainage

The Judith River drainage (central Montana) is defined by the Judith Mountains to the east, the Big Snowy Mountains and Little Belt Mountains to the south, and minor drainage divides to the west. The DNR&C drainage basin number is 41S. The upper reaches are classified as B-D streams and the lower reaches are B-D₂ (DHES).

The headwater areas contain commercial timber. Although most forestland is under USFS ownership, there are also private, state, and BLM forestland ownerships. There are current harvesting activities in the area, expected to expand as a new mill moves to the area (Judith Gap, Montana). Related water quality impacts are listed in Table VI-C10 and located on Plate I.

Non-point source sediment pollution has been traced to several activities within the basin, including: agriculture, silviculture, and urbanization (DHES, 1975). Natural soil conditions also contribute to the sediment loads of some streams; man-caused impacts may aggravate these erosive areas.

TABLE VI-C10 JUDITH RIVER DRAINAGE

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
41S	Fergus	T16N,R16E	Big Spring Creek (perennial)	Sedimentation; decreased oxygen; increased stream-flow	Logging and associated road construction	Reclaim roads if not in use (regrade, seed, close); rehabilitate roads if in use (seed fills and shoulders, utilize erosion control structures, maintain); stabilize streambanks; enhance revegetation in cut areas
41S	Judith Basin	T12-13N, R9-15E	Judith River headwaters (perennial and ephemeral)	High sediment load	Poor logging practices	Identify and evaluate more specific problem areas; apply necessary mitigation measures
POTENTIAL PROBLEMS						
41S	Judith Basin and Fergus	Northern slopes of Little Belt Mtns. and Big Snowy Mtns.	Judith River headwaters	Potential problem	Future harvest potential	Utilization of BMP's; coordination of activities within watershed

11. Musselshell River Drainage

The Musselshell River is tributary to the Missouri River in central Montana. The southern drainage divide extends between the Bull Mountains and the Crazy Mountains, while the northern divide extends from the Castle Mountains through the Little Belt and Snowy Mountains, to the Judith Mountains. The drainage contains approximately 8,000 square miles and contains the following DNR&C designated basins: 40A, 40B, 40C. Stream classification ranges from B-D₁ to B-D₃ (DHES).

Forestland ownership in the basin is predominantly USFS. Private (and other) ownerships of merchantable timber occur along the lower slopes of the basin's drainage divides. Non-USFS logging occurs in the Bull Mountains and the Crazy Mountains, as well as other locations.

Due to the dry climatic conditions and scarcity of perennial streams in the region, timber harvesting generally has only a minor effect on water quality (DHES, 1976). Impacts from these activities are outlined in Table VI-C11 and located on Plate I .

Most erosion occurring in the Musselshell River basin is due to natural geologic conditions (BLM, 1971). Timbered areas usually produce sediment at a comparatively low rate (BLM, 1971) and this is generally true in the Musselshell basin. However, the local Conservation Districts (1977) have estimated that 42 percent of the commercial timber acreage (within the USGS sub-basin 10040202) is contributing to non-point sediment pollution. This may indicate the presence of an environmentally critical area (i.e., erosive soil conditions developed on Upper Cretaceous and Tertiary sediments), in this drainage segment.

Land management activities can aggravate these conditions; rangeland, the dominant basin land use, has also contributed to non-point sediment pollution.

TABLE VI-C 11 MUSSELSHELL RIVER DRAINAGE						
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
40A	Meagher	T6N,R10E	Forest Lake	Sedimentation; increased water yield	Large areas harvested; poor road construction	Reclaim or rehabilitate roads (grading, seeding); rehabilitate channels (encourage revegetation of banks); restrict harvesting until watershed limitations are assessed
40B	Fergus	T12-13N, R21-24E	N. Fork Flat-willow Creek/ S. Fork Flat-willow Creek	Not defined by DF&G	Watershed abuse due to logging practices	Identify problem and employ necessary mitigation measures
40A	Meagher	T6-8N, R10-11E	Cottonwood Creek (perennial)	Sedimentation; possible water yield increases	Extensive harvest in headwaters area	Curtail harvest activities until watershed impacts and limitations are assessed, then coordinate activities between ownerships with regard to limitations; rehabilitate watershed (stabilize banks, enhance revegetation and regeneration in cut areas

POTENTIAL PROBLEMS -----

40A	Wheatland	T11N,R14E	Roberts Creek (ephemeral)	Potential problem	Future harvest potential	Utilization of BNP's; coordination of activities within watershed
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D. Yellowstone River Basin

1. Upper Yellowstone River Drainage

The Upper Yellowstone River drainage is in south-central Montana, entering the state from Yellowstone National Park. The drainage segment extending downstream from the Montana/Wyoming border to the Sweetgrass County line (boundary of Mid-Yellowstone designated 208 study area) was evaluated for this study. The DNR&C drainage basin identification number is 43B, and the DHES classifies this drainage segment as a B-D1 stream.

The Paradise Valley is within the Upper Yellowstone drainage, between Gardiner and Livingston, Montana. This valley receives tributary flows from the Absaroka Range to the east and the Gallatin Range to the west. Within the valley there is a significant checkerboard land ownership pattern, predominantly west of the Yellowstone River. Most land ownership is either USFS or Burlington Northern, with significant small private ownership. There is also scattered BLM and state ownerships. Much of the private land was harvested for timber approximately ten years ago, but merchantable timber still remains in most drainages. Several drainages have sustained extensive clear and selective cutting of their forest cover (DF&G, 1975).

Logging and associated road building are a contributing factor to water quality degradation in the Upper Yellowstone River drainage (DF&G, 1975; DF&G, Bozeman, pers. comm.). These activities have caused increased water yields and sediment loads in several drainages.

Preliminary DF&G studies on tributary systems where extensive logging or road building has occurred have shown considerably higher turbidity levels during spring runoff periods (DF&G, 1975). Specific problems are delineated in Table VI-D1 and located on Plate I.

Important considerations in assessing these impacts are the natural characteristics of the watersheds. Much of the Upper Yellowstone drainage contains highly unstable soils derived from volcanic material and fine-grained sedimentary rocks; loose alluvial soils also present water erosion hazards (DHES, 1976).

Forestry practices can easily aggravate these potentially erosive conditions and such practices may necessarily be restricted in some areas.

Mitigation measures should be applied on a basin-wide basis to adequately deal with the identified problems.

Effects of past and present harvest activities in the area should be carefully evaluated before any additional areas are committed to timber harvesting or associated road construction (either private or USFS).

In a coordinated basin-wide approach of forestland management, further aggravation of existing problems and creation of new problems will be prevented.

TABLE VI-D1. UPPER YELLOWSTONE RIVER DRAINAGE						
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
43B	Park	T8S, R8E	Bassett Creek (perennial)	High sediment load	Naturally unstable area (erosive volcanic material - Tertiary)	Critical area designation; restrict timber harvest (or other soil disturbance) completely
43B	Park	T8S, R8E	Cedar Creek (perennial)	High sediment load	Naturally unstable area (erosive volcanic material - Tertiary)	Critical area designation; restrict timber harvest (or other soil disturbance) completely
43B	Park	T7S, R6E	Stoughten Creek (perennial)	High sediment load; increased water yield	Naturally unstable area; impact aggravated by poor road design and construction; skidding logs in stream	Critical area designation; reclaim roads (seeding, etc.); adjust roads (relocate/closures); restrict harvest activities until watershed impacts are evaluated
43B	Park	T7S, R6-7E	Donahue Creek (perennial)	High sediment load; increased water yield	Naturally unstable area; impact aggravated by harvest activities	Critical area designation; assist revegetation; reclaim roads (seeding, etc.); adjust roads (relocate/closures); restrict harvest activities until watershed impacts are evaluated
43B	Park	T6S, R7E	Little Donahue Creek (perennial)	High sediment load; increased water yield	Naturally unstable area; impact aggravated by harvest activities	Critical area designation; assist revegetation; reclaim roads (seeding, etc.); adjust roads (relocate/closures); restrict harvest activities until watershed impacts are evaluated
43B	Park	T5S, R7-8E	Fridley Creek (perennial)	High sediment load; increased water yield	Naturally unstable area; impact aggravated by harvest activities	Critical area designation; assist revegetation; reclaim roads (seeding, etc.); adjust roads (relocate/closures); restrict harvest activities until watershed impacts are evaluated
43B	Park	T4S, R8E	Pine Creek (perennial)	High sediment load; increased water yield	Poor road location; poor stream crossings	Critical area designation; reclaim roads (seeding, etc.); adjust roads (relocate or redesign crossings); restrict harvest activities until watershed impacts are evaluated

TABLE VI-D1 (cont.)						
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
43B	Park	T3-4S, R7E	Trail Creek (perennial)	High sediment load; increased water yield	Poor road location; poor stream crossings; harvesting along streams	Critical area designation; reclaim roads (seeding, etc.); adjust roads (relocate or redesign crossings); restrict harvest activities until watershed impacts are evaluated; assist revegetation
43B	Park	T3S, R8E	Morrison Gulch (perennial)	High sediment load; increased water yield	Poor road location; poor stream crossings; harvesting along streams	Critical area designation; reclaim roads (seeding, etc.) adjust roads (relocate or redesign crossings); restrict harvest activities until watershed impacts are evaluated; assist revegetation
43B	Park	T3S, R9-10E	S. Fork Deep Creek (perennial)	High sediment load; increased water yield	Poor road location; poor stream crossings; harvesting along streams	Critical area designation; reclaim roads (seeding, etc.) adjust roads (relocate or redesign crossings); restrict harvest activities until watershed impacts are evaluated; assist revegetation
43B	Park	T7S, R6E	Rock Creek (perennial)	High sediment load; increased water yield	Naturally unstable area; impacts aggravated by extensive timber harvesting	Critical area designation; watershed rehabilitation (forest regeneration); road reclamation (seeding, etc.); restrict harvest activities until watershed impacts are evaluated
43B	Park	T7-8S, R6E	Tom Miner Creek (perennial)	High sediment load; increased water yield	Naturally unstable area; impacts aggravated by extensive timber harvesting and grazing	Critical area designation; watershed rehabilitation (forest regeneration); road reclamation (seeding, etc.); restrict harvest activities until watershed impacts are evaluated
POTENTIAL PROBLEMS						
43B	Park		Upper Yellowstone River Drainage (and tributaries)	Aggravation of existing problems; creation of similar problems in other drainages	Continued harvesting activities in critical areas without coordination between land managers	Basin-wide evaluation of watershed impacts and watershed characteristics; coordinate activities with regard to physical limitations of watershed

2. Shields River Drainage

The Shields River drainage in south central Montana is a tributary of the Yellowstone River. The watershed is delineated by the Crazy Mountains to the east, Elkhorn Ridge to the north, and the Bridger Range to the west, with the mouth of the river about seven miles northeast of Livingston, Montana. The drainage basin contains 875 square miles and the DNR&C basin identification number of 43A. DHES classifies the drainage as a B-D1 stream.

A checkerboard ownership pattern (USFS/private) dominates the forest land within the Shields River drainage. Private ownership in these areas is predominantly Burlington Northern along the east flank of the Bridger Range, and the 71 Ranch which has extensive holdings in the northern Crazy Mountains.

Timber harvesting has been fairly extensive in the Shields River watershed. The headwaters area in the Crazy Mountains was harvested heavily in the 1960's (USFS), however, additional merchantable timber (private) remains that is currently being harvested. Harvesting activities also continue on the east slopes of the Bridger Range.

Silvicultural activities have been, and continue to be, the major contributing factor in water quality degradation of the Shields River watershed (DF&G - Bozeman, pers. comm.). Detrimental agricultural practices also contribute to watershed problems. These man-caused activities may aggravate natural conditions within the watershed: some soils developed from fine-textured sedimentary rocks (soft siltstone and sandstone) are highly erosive; loose alluvial soils present water erosion hazards (DHES, 1976). Specific problems related to forestry practices are outlined

in Table VI-D2 and located on Plate I.

The DF&G has identified the entire Shields River drainage (headwaters to mouth) as suffering from watershed abuse due to logging practices (DF&G, 1978). This classification illustrates the far reaching effects of poor silvicultural practices combined with other man-related activities and natural conditions. Water yields and sediment loads have increased to the point where much of the watershed is experiencing changes in flow characteristics, streambank erosion, and impacts of aquatic resources. The DHES has recommended water quality surveillance, particularly sediment monitoring, for the Shields River (DHES, 1976).

Prevention and mitigation measures must be applied on a basin-wide basis to effectively deal with the previously identified problems. The most comprehensive measures include: 1) restriction of silvicultural (and other) activities that could further impact existing problem areas; 2) conduct basin-wide inventories to assess physical limitations of the watershed and identify water resource needs; 3) coordination of silvicultural (and other) activities among various land managers in accordance with watershed limitations, particularly in drainages already impacted; 4) pursue watershed rehabilitation and protection measures (i.e., reforestation, road reclamation, streambank stabilization); 5) promote or require use of BMP's in both silvicultural and agricultural activities.

TABLE VI-02SHIELDS- RIVER DRAINAGE						
<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
43A	Gallatin and Park	T1N, R7-8E	Brackett Creek (perennial)	Increased water yield; high sediment load; channel adjustments	Large area of timber harvested	Restrictions of additional harvests until equilibrium of flow regime is attained; watershed rehabilitation (forest regeneration, streambank stabilization)
43A	Gallatin	T1N, R7E	Skunk Creek (perennial)	Increased water yield; high sediment load; channel adjustments	Large area of timber harvested; road along creek	Restrictions of additional harvests until equilibrium of flow regime is attained; watershed rehabilitation (forest regeneration, streambank stabilization); road reclamation (seeding, erosion structures); road maintenance (if in use)
43A	Meagher and Park	T5N, R10-11E	Shields River (upper reaches) (perennial)	Increased water yield; high sediment load; channel adjustments; high nutrient levels	Road construction; large area of timber harvested	Restrictions of additional harvests until equilibrium of flow regime is attained; watershed rehabilitation (forest regeneration, streambank stabilization); road reclamation (seeding, erosion structures); road maintenance (if in use)
43A	Park		Shields River (lower reaches) (perennial)	Channel adjustments; high sediment load	Combined abuse of watershed (forestry, agriculture)	Watershed rehabilitation (revegetation, streambank stabilization, etc.); coordination of land use activities; use of BMP's
43A	Park	T3N, R10E	Horsefly Creek (perennial)	High sediment load	Road construction	Road reclamation (seeding, erosion structures); maintenance (if road in use)
43A	Park	T3N, R10E	Middle Fork Pitch Creek (perennial)	High sediment load	Road construction	Road reclamation (seeding, erosion structures); maintenance (if road in use)
43A	Park	T2-3N, R10E	Cottonwood Creek (perennial)	High sediment load	Road construction	Road reclamation (seeding, erosion structures); maintenance (if road in use)

TABLE VI-D2 (cont.)

<u>Drainage Basin</u>	<u>County</u>	<u>Location</u>	<u>Stream Affected</u>	<u>Reported type of Impact</u>	<u>Reported cause of Impact</u>	<u>Suggested Measures of Mitigation/Prevention</u>
POTENTIAL PROBLEMS						
43A	Park, Gallatin, Meagher		Shields River and tributaries	Aggravation of existing problems; creation of similar problems in other drainages	Continued use of poor forestry practices (and agricultural practices) in an uncoordinated manner	Basin-wide inventory of watershed characteristics; coordinate location, type, and timing of land management activities with regard to physical limitations of watershed

VII. BEST MANAGEMENT PRACTICES

Best Management Practices (BMP's) have been heralded as the salvation of water quality, whether dictated by law or implemented on a voluntary basis. They are particularly applicable as control measures for non-point source water pollution. State, federal and local agencies, 208 projects, and to some extent, private industry, have prepared various compilations of BMP's for their particular practices. In addition, the Environmental Protection Agency has added to this proliferation with the publication of their own BMP's.

The following BMP's are summarized from these previous lists with an attempt to include only those that are appropriate for the Montana Statewide 208 Area (see Sec. X for references). The problem inherent in BMP's covering an entire state is that they are too broad to cover the range of conditions found at the extremes. For maximum effectiveness, BMP's should be geared to local conditions reflecting limitations, hazards, and potentials of the site. A statewide listing can only serve as a guide for later refinement.

Pre-operation Planning

Planning is an important management tool that, properly utilized, can prevent or at least allow for mitigation of adverse water quality impacts. Planning is inherent in silviculture and a forester plans his harvest method based on desired regeneration, silvics, stand characteristics, economics, etc. Unfortunately, this planning process often ignores an assessment of potential impacts of the proposed action. Federal agencies (as required by NEPA), state agencies (as required by MEPA), and some private corporations (internal policy), prepare environmental analysis of

proposed silvicultural practices that may be adversely affect water quality. Some of these environmental analyses prepared as part of the planning process are excellent, others are pathetic.

The entire planning process (and environmental analysis) is predicated on an adequate knowledge of the baseline conditions of the area to be affected. This data (including soils, geology, hydrology, etc.) is not available for most areas and must be identified as an important NEED. Public and private groups should be encouraged to gather sufficient baseline data to discuss potential impacts of implementing silvicultural practices. As a minimum, those factors discussed in Section VI-C (Critical Areas) should be addressed.

Possessing adequate baseline data will allow prediction of some impacts of implementing silvicultural practices. The amount of research done in the Montana Statewide 208 Area addressing impacts is minimal, however, and adequate baseline data does not necessarily imply that impacts can be accurately predicted. The U.S. Forest Service and the University of Montana have some programs evaluating the impacts of silvicultural practices on water quality. More work in this area is needed; federal, state, and private groups should be encouraged to support or conduct this type of evaluation and analysis.

BMP's for the Montana Statewide 208 Area

1. Develop general drainage and timber management plans jointly with other owners in vicinity of the operation to minimize cumulative impacts of several operations.

2. Know site-specific hazards and limitations of the area.
Modify plans to accomodate potential problems.
3. Choose silvicultural system (where such flexibility exists) which minimizes water quality impacts.
4. Choose the type and size of logging equipment to minimize soil disturbance.
5. Consider limiting activities to periods when weather conditions provide protection (i.e., road building during dry weather, logging on snow, etc.).
6. Assess the potential impacts of the proposed practices.
7. Favor operations BMP's which prevent or avoid impacts over BMP's which mitigate or correct impacts.

Road Location, Construction, Design and Maintenance

A. Road Location

1. Locate roads on natural benches, ridge tops, flatter slopes, etc. to minimize the area of road disturbance.
2. Fit location to the topography so that minimum alterations of natural conditions will be necessary (i.e., minimize cut and fill situations).
3. Avoid high erosion hazard sites (steep narrow canyons, slide areas, slumps, swamps, etc.). If necessary to locate across slump, do so just above slump shoulder. Slight location changes can often eliminate major erosion problems.
4. Locate road a safe distance from streams when running parallel to stream channels to provide an adequate buffer area or be prepared to catch sediment moving downslope below the road.

5. Where alternative locations are not available, incorporate corrective action into plans.
6. Maintain streambank vegetation; avoid crossing streams when possible; if not, minimize approach cuts and fills and channel disturbance.
7. Minimize number of roads constructed through comprehensive road planning, recognizing foreseeable future uses.
8. Do not locate stream crossing strictly on a grade basis. Choose stable site and adjust grade to it, where possible.
9. On stream crossings where placement of a culvert or bridge is not desirable, locate crossing on a stable, rocky portion of the stream.
10. Avoid using unimproved stream crossing whenever possible.
11. If necessary, include short road segments with steeper gradients (if consistent with traffic needs and safety) to avoid problem areas or to take advantage of terrain features.
12. Avoid midslope locations on long, steep, unstable slopes, especially where bedrock is highly weathered or soils are plastic.
13. Locate roads on well-drained soils and rock formations that tend to dip into the slope; avoid slide prone areas characterized by seeps, clay beds, concave slopes, hummocky topography, and rock layers that tend to dip parallel to the slope.
14. For timber harvest roads, take advantage of natural log landing areas (flatter, better drained, open areas) to reduce soil disturbance associated with log landings and temporary work roads.

15. Avoid undercutting unstable, moisture laden toe slopes when locating roads in or near valley bottoms.
16. Vary road grades where possible to reduce concentrated flow in road drainage ditches and culverts and to reduce erosion on the road surface.

B. Road Design and Construction

1. Build minimum adequate road commensurate with traffic speed, safety requirement and erosion hazards. Reduced speeds and alternative safety measures (restricted road use) may be desirable in erosion hazard areas. Reduce road density where possible.
2. Design road to make seasonal use needs and maintenance activities compatible with minimizing erosion from the road.
3. Incorporate corrective action into plans. Use available soils information as a guide.
4. Balance cuts and fills to provide a minimum amount of disturbance, erosion and/or water turbidity. Compact fills to avoid loss of fill material. Slope cuts and fills to minimize erosion. Revegetate (mulch if necessary) cuts and fills to minimize erosion. Design drainage ditches, waterbars, culvert placement, etc. in such a manner as to disperse runoff and minimize cut and fill erosion.
5. Use full bench construction (no fill slope) where stable fill construction is impossible. Haul excavated material to safe disposal areas. Include waste areas in soil stabilization planning for the road.
6. Where full bench construction is impractical, properly designed retaining walls provide an effective but costly alternative to hold fill material.

7. Use the steepest slopes possible on cut and fill slopes commensurate with the strength of the soil and bedrock material as established by an engineering geologist or other specialist in soil mechanics. Benching cut slopes in areas of weak or erodible bedrock (e.g. weathered granites) into a series of properly drained terraces provides opportunity for vegetation establishment and may even require less excavation.
8. Deposit excess material in stable locations well above the high water level and never into any stream channel. Do not allow any material, including sidecast soil, stumps, logs or other material to be deposited into a stream.
9. When building across slump areas, do not dispose excess material on the slump, as added weight may cause further slumping.
10. Design fill at an angle less than the normal angle of repose.
11. A thorough job of clearing is required to insure proper construction of fills. Overcasting onto brush and timber or incorporating brush and timber into the fill material can lead to serious surface and mass erosion problems. In addition, provide a good base for fills and assure proper compaction as fills are constructed.
12. Where possible, the cleared vegetation should be spread evenly over the soil surface beneath the toe of the road fill. The vegetation material should be cut up or somehow crushed into the surface to assure close contact with the soil. This practice should enhance the buffering qualities of the slope beneath the road.
13. Do not permit earth moving activities when soils are saturated. Disturb roadside vegetation only the necessary width to maintain slope stability and serve traffic needs.

14. Rough grade a new road only as far as that road can be completely finished during the current construction season. Construct water-bars on decking roads to prevent erosion.
15. Keep slope stabilization work as current as possible with road construction.
16. When installing culverts, avoid channel changes and place culverts so they conform to the natural stream channel as closely as possible. Design culverts for maximum streamflows; overdesign rather than underdesign when peak flows are not known. Remove as much debris from the channel above the culvert as possible. Carefully compact the fill material around all culverts to prevent seepage and ultimate culvert failure.
17. Keep stream disturbance to an absolute minimum; prevent any disturbance during high flow periods.
18. Vagaries in weather conditions are an important factor leading to erosion during construction. In areas where the climate permits, plan jobs for completion during dry periods. Elsewhere, limit the work area to small sections that can be completed before proceeding further. This exposes a minimum of disturbed area to erosion forces in the event the weather changes. Light rains usually have limited erosional impacts. However, if obvious impacts occur during larger storms, be prepared to cease operations after installing emergency drainage as needed. It is advisable to install all designed drainage from the downstream end of the job to the upstream end in areas of unpredictable weather.

19. Outsloping (i.e., sloping toward the downhill side of the road) from 3-5 percent is preferable to insloping because it eliminates the need to develop facilities to dispose of the water draining down the inside of the road. Outsloping can be unsafe in some situations because of particular traffic requirements or unusual site conditions such as clayey road surfaces that are very slippery when wet. In addition, outsloping should only be used where runoff will flow off the road onto stable surfaces. normally, this precludes the use of outsloping on fill portions of the road unless fill slopes are small and low in erodibility or are well protected by mulches, vegetation, or both.
20. Insloping (i.e., sloping toward the uphill side) of the road surface is preferred to outsloping in areas of unstable fills, except in the case of a contour road where there is no chance for lateral flow along the road. Water draining from the road is carried along the inside of the road either on the road surface itself or more commonly in a ditch. Culverts are installed periodically to carry the water under the road. Some points to consider when designing an insloped road are:
- (a) Avoid using ditches or keep ditches to a minimum width and increase the number of cross drains to reduce the total area disturbed by construction.
 - (b) Plan ditch gradients steep enough (generally greater than 2 percent) to prevent sediment deposition.
 - (c) Install culverts frequently enough to avoid accumulations of water that will cause excessive erosion of the road ditch and the area below the culvert outlet. Surface the ditch in areas of erodible material (e.g., weathered granitics).

- (d) Use a culvert size of at least 40 to 50 cm, depending on expected debris problems.
 - (e) Install culverts at the gradient of the original fill slope if possible: otherwise provide anchored downspouts to carry the water safely across the fill slope. Skew culverts 20° to 30° toward the inflow to provide better inlet efficiency and flow characteristics. Provide rock or other splash basins at the downstream end of culverts to reduce the erosion energy of the emerging water.
 - (f) Protect the upstream end of culverts from plugging with sediment by using sediment catch basins, drop inlets, changes in road grades, headwalls, and recessed cut slopes.
 - (g) Install the culvert deep enough to assure that it will not be crushed by traffic loads. This requires a depth of about 1.2 m for metal culverts subjected to loads from large, loaded logging trucks.
21. In some areas, alternating inslope and outslope sections can be built into the road, especially if road grades are "rolled" (provide alternating adverse and favorable grades). In such instances, install dips or cross drains on the surface of the road to control erosion of the roadway.
22. It is usually necessary to construct cross drains in the road surface on either insloped or outsloped roads to help prevent erosion caused by water concentrations in ruts. Various types of cross drains are used, including open-top culverts and intercepting dips. Some points to consider when installing cross drains are:

- (a) Spacing requirements - spacing depends on a number of factors such as road grade, and type of material. Guides for spacing are presented in Megahan (1977).
 - (b) Open-top culverts are usually constructed of wood. They should be installed at a 30° angle downslope to promote self cleaning and make crossing easier. Culverts of this type must be properly maintained to prevent plugging and damage by traffic.
 - (c) Intercepting dips, when properly constructed, are cheaper to maintain and more permanent than wood, open-top culverts. Dip design depends on the kind and speed of the traffic using the road. Dip designs allow road use by passenger autos travelling at speeds of approximately 30 kilometers per hour. On steeper roads it may be necessary to install open-top culverts (using the same design) in addition to dips to meet the cross-drainage spacing criteria.
 - (d) In addition to cross drain spacing, location of cross drains is an important factor to consider in minimizing sediment delivery to stream channels from either insloped or out-sloped roads.
23. Berms are required on the outside edge of the road at specific locations where alignment and grade characteristics cause excessive runoff from the road tread over the fill slope. Use compacted soil, soil cement, or asphalt mixtures to construct stable berms. Where necessary, use downspouts in the berm to safely carry water to the bottom of the fill slope. Locate downspouts at safe water discharge points and provide energy dissipators (rock basins, etc.) to further reduce erosion hazards.

C. Road Drainage

Crossing Natural Drainageways

There are three methods for crossing natural drainageways: fords, culverts, and bridges. Factors influencing the appropriate crossing include construction and maintenance cost, equipment and supplies available, debris potential, stream size, contemplated road use and life, foundation conditions, and vertical position of the road relative to the stream.

1. Fords are attractive alternatives for crossing small streams, particularly in areas where large amounts of rock, sediment, and organic debris tend to plug bridges or culverts. Fords cause minimal disturbance to the stream channel (when properly located and designed), are inexpensive, and avoid many of the problems associated with bridge and culvert installation. Fords require stable channel bottoms able to support vehicles or channels that can be protected by gabions or paving.
2. Culverts (metal or wood) or bridges are required for channels where fords are impractical. Availability of construction equipment and materials, size of stream, potential for debris, terrain steepness, and reliability of the calculation for determining culvert capacity are some of the points to consider when deciding whether to use a culvert or a bridge at a given location. Bridges, are preferable, particularly in areas with debris or excessive sediment because the chances of failure are less.

Structures should be large enough to carry the flows to which they are subjected within acceptable limits of risk. Costs increase rapidly with size, so adequate local hydrological studies are needed.

3. Roads should climb away from channel crossings in both directions wherever practical so high water will not flow along the road surface. Surface sloped sections of the road if necessary to reduce sediment movement directly into the stream.
4. Where adequate maintenance can be assured, install open top culverts or dips in the road surface to direct road runoff on to filter strips rather than directly into the stream.
5. Use rip-rap (placed rock), masonry headwalls, or otherwise protect embankment and and channel sides at drainage structures.
6. Increase the capacity of bridges or culverts in areas where debris, sediment, or both types of problems exist. In extreme situations, this may mean doubling the capacity of the structure.
7. Frequently maintained trash racks (grates) over the inlet end may be useful where floating debris tends to plug culverts.
8. If at all possible, use bridges in areas where debris problems are severe and fords are impractical. Otherwise it may be necessary to construct rock - or gabion-protected fills with a dip to allow overflow in the event that culvert capacity is lost.
9. Submit design to appropriate governmental agencies and obtain all necessary permits for stream crossing before beginning any activities; utilize trained personnel available to help with plans (S.C.S. and Montana Fish and Game).

Drainage Along the Roadway

Drainage is needed along the roadway to remove water before it has a chance to concentrate and cause erosion. To help accomplish this,

slope road surfaces laterally either outward or inward, depending on traffic needs and erosion hazards. Unfortunately, traffic can cause some rutting in the road surface that concentrates flow along the road in spite of the outsloping or insloping. Thus, in many situations, additional cross-drainage measures are needed to interrupt this flow and divert it laterally before it has a chance to cause erosion problems.

D. Slope Stabilization Measures

Slope stabilization includes revegetation and other measures to control surface erosion on road cut and fill slopes and on waste and borrow areas. Usually the objective is to establish a dense vegetative cover to reduce forces available for erosion and increase surface protection.

1. Apply stabilization practices immediately following construction. Some stabilization practices may be desirable during construction. Use practices that provide rapid benefits.
2. Site factors governing air and soil temperature, soil moisture, and fertility are important influences on revegetation success. Large variations in these factors can occur throughout the length of a road, particularly in low precipitation zones or in areas with prolonged dry seasons. Such differences are often magnified in mountainous areas. It is important to tailor revegetation measures to the specific site factors. Consider elevation, aspect, rain shadow effects, groundwater seepage, soil and bedrock properties, etc. in evaluating site differences. Include vegetation in the evaluation, both as an indicator of site potential and to serve as a guide for species selection.

3. Site preparation is often an important prelude to seeding and planting. This might include various practices such as: (a) spreading previously stockpiled topsoil; (b) chaining, harrowing, disking, or rolling to roughen the seedbed and break surface crusting; and (c) fertilizing.
4. It is desirable to conduct seeding operations before mulching to attain maximum benefit from the mulch. However, this is not possible in some locations (e.g., areas with pronounced dry seasons) because the time of seeding or transplanting is critical. Seeding and planting operations during the drought period are usually failures; operations must take place during appropriate seasons for the area. Transplanting through a previously applied mulch is often successful in these situations. Sometimes wattling (installing low barriers of soils and brush along the contour up and down the slope) is a successful substitute for mulching. Seeding, planting, or both, between the wattles can then be carried out at the proper time.
5. Species selection must be designed to meet local needs. Grasses have been most commonly used; however, forbs, shrubs, and trees alone or in combinations should be considered. Legumes have particular benefits as nitrogen fixers as do some other plants. Deep-rooted plants including both trees and shrubs can help increase mass stability as well as reduce surface erosion. Rapid-growing, short-lived species (e.g., some of the ryes and oats) are often desirable for nurse crops for slower growing vegetation.
6. Fertilization should accompany most revegetation operations. Proper types and amounts of fertilizer should be based upon soil analyses or experience in the area. Additional amounts may be required if organic mulches are used.

7. In some areas, vegetation response is rapid enough to provide slope protection during the initial high erosion period. However, it is usually necessary to supplement the protection during the interim with mulches. Mulching provides additional benefits by reducing surface soil temperatures, water losses from the soil, and soil crust formation.
 - a. Select type and amount of mulch to control erosion.
 - b. On steeper areas it is often necessary to anchor the mulch into the soil by covering it with netting material that is pinned in place, spraying adhesive chemicals (e.g., liquid asphalt, various polymers) onto the mulch, or rolling it with a spike roller.
 - c. Machines have been developed that combine mulching material (straw or wood fibre are commonly used) with water, an adhesive, or both, and spray the mixture onto the slope. Usually, seed and sometimes fertilizers are added to the mixture to provide multibenefits in one operation.

E. Road Maintenance

1. Maintain roads immediately after logging and whenever necessary by cleaning ditch lines, blading debris from empty landings, trimming damaged culvert ends and cleaning out culvert openings. Culverts, cross drains, and dips should be cleaned regularly to assure proper functioning, especially before winter or expected rainy seasons. Debris should be removed from live drainages upstream from the inlet. Cross drains and dips are often damaged during high use periods or sometimes even removed for more efficient traffic flow; this should be replaced before rainy seasons or snowfall. Ditches should be cleared of debris and sediment accumulations with care being taken to avoid undercutting the roadcut

when removing slide debris. Know potential problem situations and monitor these during periods of precipitation.

2. Grade the road surface as often as necessary to retain the original surface drainage (either insloped or outsloped). Take care to avoid side-casting graded material over the fill slope. Carefully monitor surface drainage during wet periods and close the road if necessary to avoid undue damage. Restore surfacing on the road tread and in the road ditch if necessary following damage caused by operation in wet periods.
3. Haul all excess material removed by maintenance operations to safe disposal areas. Apply stabilization measures on disposal sites if necessary to assure that erosion and sedimentation do not occur.
4. Prior to and during large storms or excessive snowmelt it is beneficial to patrol roads to assure that road drainage facilities are functioning.
5. Control roadside brush only to the extent required for good road maintenance.
6. Close unused roads.

F. Road Surface Applications

(De-icers and dust abatement measures)

1. Properly prepare and be prepared to implement a spill prevention and counter measure plan where necessary to prevent chemicals from entering streams.
2. Choose a safe site for pumping oil from supply trailers to distribution tankers to prevent oil spills that might occur from entering any stream or watercourse.

3. Apply dust oils only when the roadbed has been properly graded, watered, shaped and compacted. Construction of a temporary small berm or wrinkle made on the downside road shoulder will assist in preventing the material from running off the road during application.
4. Oil should be shut off when crossing all streams.
5. In lieu of salts for ice and snow control, snow plowing, chains and sanding should be utilized where possible and appropriate. The use of salt-sand mixtures should also be promoted in lieu of straight salt applications.
6. The use of salt for snow and ice control on logging roads should be limited to minimum essential needs. This would include limiting salt application to those areas necessary to provide a safe driving surface (i.e., steep grades, major intersections and stop points).
7. Avoid application of de-icers near streams or lakes.
8. Locate storage areas where the threat to groundwater and surface water contamination is minimal.

G. Road Closure

Many roads, especially work roads associated with timber harvesting, are designed for use only for a short time. These roads should be closed along with any other roads that are needed only for intermittent travel to minimize maintenance expense and erosion hazards.

1. Block the road to vehicles.
2. Remove all temporary culverts including brush and wood types.
3. Remove all temporary bridges.
4. Remove all other culverts and bridges that cannot be maintained.
5. Except on large fill slopes, outslope the road surface and remove all berms, taking care not to spill graded material over the fill

slope. The best way to accomplish this is to grade material toward the cut bank. Outslope only enough to divert water over the bank (approximately 2 to 3 percent plus the slope gradient of the road in percent).

6. When removing culverts and bridges, be sure all fill material is removed from below the high water line of the stream. All material that is removed should be placed in a safe disposal area. The remaining fill material should be left at a stable angle.
7. Cross ditch the road tread in accordance with cross ditch designs and cross-drain spacing guides applicable to the area.
8. Revegetate the road surface and areas disturbed by road closure operations along with any other areas of exposed soil. Use all revegetation procedures necessary (including mulching) to stabilize the site. Break up road surface by ripping where compaction may deter revegetation.
9. Remove fill material from any area where mass failure is possible in the future.

Harvesting and Reforestation

A. Harvest Design

1. Analyze and design harvesting based on:
 - (a) Soil characteristics
 - (b) Rainfall characteristics
 - (c) Topography
 - (d) Plant cover (forest type, understory, silvics)
 - (e) Critical components (aspect, watercourses, landforms, other activities)
 - (f) Silvicultural objectives
2. Leave buffer strips of brush, alder, or low-value conifers wherever possible along streams supporting fish populations. This must be followed up either by logging away from the stream or by tight-lining sufficiently to preserve this protective cover.
3. As an alternative to buffer strips, make settings small enough so as to minimize water temperature rise.
4. Avoid logging across any stream supporting resident fish, or any stream where a downstream water system might be affected.
6. Time logging activities to the season in which soil damage can be kept to acceptable limits. Modify as required.
7. Use the logging method that best suits the soil type and season in order to minimize soil disturbance and accomplish silvicultural objectives.
8. Plan logging layouts to avoid across-ridge or across-drainage skidding.
9. Match equipment to job, site, and silvicultural objectives.
10. Design and locate skid trail and skidding operations for minimum disturbance.

11. When possible use uphill yarding with cable systems.
12. Use yarding system with longest reach to keep road densities at a minimum (economic feasibility a factor).

B. Falling and Bucking

1. Do not fall trees into any stream and/or streambed without permission from proper authorities (Streambed Preservation Act).
2. Do not limb or top trees where limbs or tops would fall or be dragged into a stream. Such logs should be topped and limbed after being pulled away from the stream.
3. Wedge away from stream.
4. Where stream blockages or windfalls exist in the form of log jams, make necessary cuts in preparation for removal by yarding crews.
5. Do not allow any gasoline or oil to spill in such a location that it will enter any stream.

C. Yarding and Loading

1. There will be no yarding through streams except by permit (Streambed Preservation Act).
2. Avoid soil slumps and slides when building tractor skid roads and landings.
3. Avoid yarding across ends of culverts, ditchlines and roads. If necessary to yard across end of culvert, chunk up over end to prevent damage to culvert end. Remove when finished.
4. Install water bars on tractor skid trails when logging is finished. Modify spacing between bars to fit slope and soil type.
5. Avoid trapping and turning of small streams out of their natural

beds into tractor trails and landings.

6. Never tractor skid in any streambed.
7. Where stream crossings are necessary, pick locations requiring a minimum of streambank disturbance and soil displacement. Chunk upstream crossings with logs when necessary. Remove logs when finished. Cross only at right angles.
8. Remove unlimbed logs and tops from streams for limbing and bucking on landings.
9. Deposit excess material from landing and skid trail construction in such locations that it will not get into or be washed into streams.
10. Shut down tractor logging during periods of heavy prolonged rain when permanent soil damage or stream water turbidity may be the direct result. Modify as required by soil type.
11. Do not dump waste oil in such a location that it can find its way into any stream.
12. Use extreme care to avoid fuel spillage during refueling.
13. Leave-strips shall be provided along all streams. The leave-strips on each side of the stream shall be at least equal in width to the width of the stream channel. Only merchantable timber shall be harvested within the leave-strips. Yarding from within the leave-strips shall occur as soon as possible after felling.
14. While transporting logs across streams, logs shall be fully suspended above the stream.
15. If debris should enter any stream, such debris shall be removed concurrently with the yarding operation and before removal of equipment from the project site. Removal of debris shall be accomplished

in such a manner that natural streambed conditions and stream bank vegetation are not disturbed. .

16. Clean up landing to permit seeding. If necessary, reseed to accelerate revegetation.
17. Where large areas of mineral soil have been exposed and natural revegetation is inadequate to prevent accelerated erosion, seeding of skid trails (in addition to water bar construction) should be carried out before the next growing season. Placing hay or straw on skid trails (where soils are highly erosive) before snowfall will retard erosion in the spring.
18. Dozer skidding on steep slopes with the blade attached to slow descents should not be used because of the creation of vertical erosion channels.
19. Whenever possible, suspend the head end of the log to minimize soil gouging.

D. Post Harvesting Activities

1. Remove temporary crossings.
2. Establish or re-establish stream-side vegetation.
3. Install water bars or other drainage structure in skid roads, landings or fire trails, where needed.
4. Remove all logging machinery debris (broken or discarded cable or chokers, oil barrels, discarded filters, empty cable spools, discarded broken machine parts, etc.) to county dump or proper disposal area. Properly dispose of all refuse.
5. Remove temporary streambank protective measures.

E. Shop and Maintenance Areas Management

1. Provide for waste disposal of shop debris either by using central disposal area or commercial service. Burning of waste must meet applicable air quality regulations. Avoid burning if possible.
2. Provide proper container for holding all waste oil. Avoid oil seepage into any water course.
3. Do not discard old filters, grease and oil containers, etc., at place of use. Return to shop for disposal.
4. Remove worn parts and other old materials to shop for disposal.

F. Revegetation

1. Vegetation adequate to protect soil is required.
2. Utilize methods that minimize compaction and movement of topsoil - if the rehabilitation is done mechanically.
3. Rapid reforestation of harvested areas is encouraged to rapidly re-establish long-term protective vegetative cover on the area. Short-term low vegetative cover, which does not unduly hinder the establishment of trees, should be considered.

G. Scarification and Slash Treatment

1. Scarify only to the degree necessary to regain control of the site and return it to timber production.
2. Scarify during the dry season if possible. Be guided by the character and texture of the soils in your area. Refer to any soils data available.
3. On steeper slopes, scarification should be done in a manner to keep erosion to a minimum.

4. Tractor scarification should be limited to slopes consistent with costs, safety and soil erodability.
5. Patches of advanced reproduction should be preserved, if possible.
6. Movement and compaction of topsoil should be kept to a minimum.
7. Scarified areas should be revegetated (seeding, planting, etc.) as soon as possible.
8. Adequate vegetative buffer strips should be maintained between site preparation areas and water.
9. Brush blades should be used on cats piling slash.
10. An unburned buffer strip should be provided between prescribed burned areas and all water bodies. Burning activities should be timed to minimize impact to water quality.

H. Chemical Site Preparation, Fertilizers and Insect Control, Herbicides and Silvicide Application Methods

1. Chemicals applied to forest lands should not include direct applications to water bodies. Suitable buffer strips should be provided. Weather and runoff conditions should be considered.
2. During mixing and disposal of chemicals, entry of chemicals into drainages should be prevented.
3. Selective, non-persistent pesticides should be favored whenever possible.
4. Existing Montana regulations regarding use of chemicals should be strictly adhered to regarding mixing, application and disposal.

I. Intermediate Stand Treatments

1. Prevent deposition of debris from thinnings, release cuttings, improvement cuttings and prunings from accumulating in drainages.

2. Avoid significant removal of streamside trees and vegetation.
3. Prevent deposition of fertilizers in water bodies or drainageways, particularly during aerial application of fertilizers.

VIII. EVALUATION OF EXISTING STATUTES

Silvicultural practices in Montana are regulated by a number of laws, regulations, and guidelines. Such federal, state, and local acts relevant to water quality will be reviewed and evaluated in the following text.

The most applicable federal laws deal with flood prevention and control, public water supplies, and forestry management. There are several programs that provide technical and financial assistance to public agencies and private landowners for mitigation and/or prevention of water quality impacts from forestland management.

The Department of Natural Resources and Conservation (DNR&C) and the Department of Health and Environmental Sciences (DHES) are the agencies responsible for administering state laws relevant to water quality and forestland management. Erosion control and maintenance of public water supplies are stressed in the applicable state laws. Several regulations and guidelines are administered on a local level through the Conservation Districts. Public education, technical services, and financial assistance are available to forestland managers. There are few laws instituted by local government that affect forestry practices and water quality.

A fairly comprehensive framework exists for regulating silvicultural activities within Montana. However, the mechanism for implementing these statutes does not operate adequately. The primary deficiencies are in the areas of problem/violator identification and legal enforcement; these aspects could be improved with additional staffing of field and legal personnel. Public

education and assistance programs are not being implemented on a scale large enough to effectively guide the use of BMP's in the forests. Additional staffing of field personnel and increased cost-share funding would make these programs more accessible to a greater number of landowners.

Federal Water Pollution Control Act

Public Law 92-500

In 1965 Congress passed the Federal Water Pollution Control Act (FWPCA). This law was primarily designed to regulate discharges of pollutants from point sources and provided for administration of detailed regulatory rules at the state level. Since control of point source pollution alone would not lead to the interim water quality goals (fishable and swimmable water by 1983), Section 208 was included in the 1972 Congressional amendments to the FWPCA. Section 208 establishes a procedure under which states and regional agencies are required to establish regulatory programs to control non-point source pollution. The Environmental Protection Agency (EPA) administers this law through the states and has encouraged the 208 agencies to adopt plans which embody preventive or best management practices (BMP's), utilizing both non-structural and structural techniques for land management, rather than permit type controls.

Definition of 208 regulatory controls for silvicultural practices is still in the formative stages. Successful implementation and enforcement of the final 208 program will provide the needed regulation of non-point source water pollution from silvicultural activities.

Certain silvicultural activities are described as potential point sources of water pollution and are required to be permitted under the FWPCA, through the federal and state Pollution Discharge Elimination Systems (NPDES, MPDES). Such activities include "any discernable, confined and discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities from which pollutants are discharged into navigable waters".

Montana Water Pollution Control Act (MWPCA)

(Title 69, Chapter 48, R.C.M. 1947)

The MWPCA is the basic water pollution law for the state. The act requires the Board of Health and Environmental Sciences to establish standards for water quality and provides a mechanism for enforcement of the standards (through DHES). Contamination or other alteration of the physical, chemical, or biological properties of any state water, in excess of the Montana Water Quality Standards, is prohibited. The act also states that it is unlawful to place or cause to be placed any wastes in any location where they are likely to cause pollution of state waters. This is applicable to both point and non-point sources of water pollution. Enforcement may be pursued through litigation for a civil or criminal penalty, injunctions, compliance orders, or notices of violation (through a hearing process). A non-degradation provision is included in the MWPCA. This requires that:

Any state water, whose existing quality is higher than the established water standards, be maintained at that high quality unless it has affirmatively been demonstrated to the Board that a change is justifiable and as a result of necessary economic social development and will not preclude present and anticipated uses of these waters.

This means that high quality waters shall not be allowed to degrade to meet minimum standards.

Although much of the MWPCA relates to point source pollution control, it also has application for non-point source pollution. However, enforcement of MWPCA with respect to non-point silviculture related water pollution has been negligible. Extensive monitoring (including baseline data) is necessary to accurately delineate the problem and the responsibility of the defendant before the courts. Currently, DHES does not have the

personnel or the funding to pursue this type of monitoring program.

Another problem is that the DHES (Water Quality Bureau) depends upon "complaints" to identify violations of water quality standards. Acting on this basis, the Bureau has investigated very few reported violations attributed to forestry practices. Again, funding and manpower limit enforcement to this "complaint" mode (Rasmussen, pers. comm.).

The MWPCA is not being adequately enforced with respect to silviculture related non-point water pollution.

The Water Quality Bureau should request funding and personnel to implement an aggressive enforcement program to promote compliance with the Montana Water Quality Standards.

Montana Water Quality Standards (MAC 16-2.14(10)-S13380)

The Montana Water Quality Standards have been developed pursuant to the Montana laws regarding water pollution. These standards classify all waters in the state of Montana with respect to their quality and beneficial uses. Most waters in Montana are classified as being suitable either as a public water supply and for propagation and growth of salmonid fishes or for use as a water supply and growth and propagation of non-salmonid fishes. There are a number of other water quality categories with suitability for aquatic life, irrigation, industrial water supply and public water supply being the key in these classifications.

The water quality standards establish maximum allowable changes in water quality and establish limits for pollutants which affect the prescribed beneficial uses of state waters. The rule specifies minimum levels for dissolved oxygen, temperature, coliform bacteria, dissolved chemical substances, toxic materials, radioactivity, turbidity, color, odor, and other deleterious substances. In addition to specific water quality requirements, these standards also have general water quality criteria. These general criteria provide for short term exceedence of specific water quality criteria due to necessary activities such as dredging, channel or bank alterations, stream diversions or other construction activities where turbidities may exceed the criteria.

The standards for each classification of waters should provide for protection and non-degradation of stream water quality (a draft of revised water quality standards has been completed by the Water Quality Bureau). Enforcement of the standards is discussed under the MWPCA.

Domestic Water Supply Act

(16 U.S.C. 552a-552d)

In May, 1940, Congress passed the Domestic Water Supply Act which allows the Department of Agriculture to enter into cooperative agreements with a municipality (upon application of the municipality) for the protection of the public water supply. This act has application when a municipality obtains its water from a watershed within a National Forest. Under the provisions of this act, the Department of Agriculture is authorized to adopt and prescribe rules and regulations necessary to effect the adequate protection of the watershed; this may include withdrawal of the land from other development uses. If the municipality concerned objects to the utilization of timber or other resources within the reserved watershed, and the Department of Agriculture agrees to withhold such resources from utilization, the municipality shall pay to the Forest Service the amount necessary to reimburse the United States for revenue lost from non-utilization of the resource.

Although enacted to prevent water quality degradation in public water supplies, the act may actually discourage adequate watershed protection because of the resource utilization clause. This is especially true in rural areas and small towns where the tax base may not be large enough to cover the reimbursement costs of non-utilization. This act should be revised to allow for adequate water supply protection without requiring municipalities to "buy" the resource development rights of a publicly owned (National Forest) watershed.

Public Water Supply Law

(Title 69, Chapter 49, R.C.M. 1947)

The Public Water Supply Law involves protection, maintenance, and improvement of the quality and potability of water for public water supplies and domestic use. DHES (Water Quality Bureau) has supervision over all waters used for public water supply or domestic purposes. Departmental responsibilities include adopting rules and standards, investigating complaints, monitoring water quality, and issuing orders to prevent or abate pollution of public water supplies. The law prohibits the pollution of state waters and particularly public water supplies.

The construction of logging roads and logging camps within a watershed of a public water supply system is prohibited unless a permit has been issued by DHES after approving detailed plans and specifications for protection of water quality. Considering this regulation of logging operations, the DHES has the legal framework with which to control or prevent impacts to public water supplies from silvicultural activities. The law has been utilized successfully in this respect (Yellowstone Pine Co. operation on Hyalite Creek, Gallatin National Forest, 1974).

The Water Quality Bureau (WQB) should pursue the following steps: 1) require the use of BMP's for plan approval; 2) actively monitor forestry activities in such watersheds; the WQB should not rely on a "complaint" procedure for problem identification; and 3) aggressively enforce the law to provide adequate protection of public water supplies.

Flood Control Act

(33 U.S.C.A. 701-701(U))

Soil erosion and flooding are closely related and contribute significantly to water quality degradation. The Flood Control Act deals with the improvement of watershed areas, retardation of runoff, water flow, and soil erosion. "Works of improvement" include critical area tree planting and acceleration of technical forestry assistance. These programs can be instituted on non-federal lands on a cost-share basis (federal share according to watershed and authorization). The act is administered by the Soil Conservation Service in cooperation with the U.S. Forest Service, state foresters, and other public agencies.

Although this act applies to forestry measures and water quality maintenance, there have been no projects in this regard in Montana. Most projects that have occurred or been planned are construction type projects (impoundments, diversions, etc.) (Hatterly, pers. comm.). These may be necessary for mitigating existing problems, but greater emphasis should be placed on prevention of flooding and soil erosion problems through land use measures. The following aspects should be considered in this regard: 1) In forested watersheds, the conservation districts administering the act should pursue aggressive public awareness campaigns to encourage landowners to use the services available to them. This should include an emphasis on forestry land management techniques; 2) The DNR&C should encourage more land treatment measures, as opposed to construction measures, when prioritizing project applications from the local districts.

Watershed Protection and Flood Prevention Act

Public Law 566 (16 U.S.C. 1001-1008, 33 U.S.C. 701b)

Due to erosion, floodwater, and sediment damages in the Nation's watersheds, Congress passed the Watershed Protection and Flood Control Act in August, 1954. The act authorizes the Department of Agriculture to cooperate with states (and their political subdivisions), soil or water conservation districts, flood prevention or control districts, and other local public agencies, for the purpose of preventing such damages and thereby preserving and protecting the Nation's land and water resources.

The act is oriented towards "works of improvement", which include:

1) flood prevention (structural or land treatment measures), and 2) conservation, development, utilization, and disposal of water in watersheds not exceeding 250,000 acres (with other restrictions). The Department of Agriculture is authorized to assist local organizations (upon application of the organizations) in making investigations and surveys of watersheds as a basis for the development of coordinated programs.

Non-federal, as well as National Forest lands, are affected by the act. Cost-sharing programs are available for critical area tree planting and technical assistance for implementing forestry measures oriented toward the goals of the act. Administration of the law is handled by the Soil Conservation Service in cooperation with the Forest Service, state foresters, and other public agencies.

Implementation of Public Law 566 has been very similar to the Flood Control Act, discussed previously. (Most programs have been oriented toward construction-type projects.). Methods for improving program

effectiveness are also the same as presented earlier. One aspect of Public Law 566 is a provision for conducting watershed surveys as a basis for development of coordinated programs. This type of action should be pursued by the local organizations to promote coordinated land management activities within the physical limitations of particular watersheds.

Timber Access Road Hearings

(Title 23, U.S.C. Section 211)

This section of the Federal Highways Law provides the opportunity for the Forest Service to seek public input regarding the construction of timber access roads on National Forests. This provision allows interested persons to present their views on the practicability and feasibility of such road construction

Some roads constructed on National Forest lands are cost-share roads build for access to federal, private, and/or state lands.

This hearing process is a potential method for prevention of water quality impacts from such timber access roads. Qualified persons may provide technical analyses of road location, design, and maintenance with regard to water quality impacts. However, this procedure would have limited application for several reasons: 1) qualified persons may not be available for review and comments on a proposed road system; and 2) the Forest Service may hold such hearings, but is not required to hold them under the provisions of this section.

Agriculture and Consumer Protection Act of 1973

Title X

The Rural Environmental Program established under this act provides for federal forestry assistance to private and non-federal farmlands. Activities include establishment of tree stands for soil protection, forestry purposes, environmental improvement, and to improve woodlands. Federal assistance includes cost-sharing for initial establishment of conservation practices (tree planting, site preparation, erosion control, etc.) and technical assistance at no cost to landowners. The program is administered by the Agricultural Stabilization and Conservation Service (ASCS) in cooperation with the Forest Service and state foresters.

The Rural Environmental Program could be a vehicle for mitigation of water quality problems resulting from forestry practices on non-federal farmlands. There are many cases in Montana where contracts between the logger and landowner were written without adequate regard for protection of stream water quality. In such cases where impacts have occurred, the landowner could use the assistance provided in this program to rehabilitate the harvested area and mitigate the impacts. However, the landowner must be made aware of the services available to him and encouraged to use them.

Cooperative Forest Management Act

64 Stat. 473, as amended; (16 U.S.C. 568c, 568d) .

In August, 1950 Congress adopted the Cooperative Forest Management Act. This act authorizes the Dept. of Agriculture (Forest Service) to cooperate with state foresters (or other appropriate officials) in providing technical services to private landowners, forest operators, wood processors, and public agencies. These services include multiple-use management, environmental protection, and improvement of forest lands. The program is administered by state foresters in cooperation with the Forest Service. Federal financial assistance cannot exceed the net state expenditures for the program (maximum 50 percent cost-share).

Analysis of this program is included in the discussion of the state CFM program which follows.

Cooperative Forest Management Program

(Section 81-1409, R.C.M. 1947)

This program authorizes the DNR&C, through the Forestry Division, to cooperate with forest landowners in regard to forest management on private lands in Montana. There are also provisions for cooperation with the U.S. Forest Service in implementation of the related federal statute (described previously). The program's objectives include the conservation and perpetuation of forest and watershed lands and their resources, including prevention of soil erosion and regulation of stream flow. The Division is currently cooperating with public and private agencies and individuals through this program. Participation is completely voluntary by both parties, the state and the landowner. The landowner is under no obligation to follow any recommendations provided by the state.

Lack of funding and manpower constraints limit the effectiveness of this program, and only about 5 percent of the total private timber owners are affected. Many landowners are not aware of the technical and financial assistance available to them. The state is reluctant to advertise the program due to the lack of personnel to implement it effectively.

The CFM program could be an effective vehicle for prevention and mitigation of forestry related water quality impacts. However, several aspects should be stressed: 1) an aggressive public awareness campaign should be undertaken to adequately inform private forest landowners of the services (technical and financial) available to them; 2) services should stress management of a sustaining timber resource, protection of water quality and utilization of BMP's, on-site evaluations of proposed harvest

areas, contract arrangements, and cost-share alternatives and other incentives for good forest management; 3) funding and staffing should be commensurate with the demand for services resulting from the above campaign. This may require additional financial assistance from the federal CFM program; 4) currently, the state provides approximately two-thirds to three-fourths of the CFM program costs. Increased federal funding may only give justification to reduce the state's financial commitment to the program (Mangum, pers. comm., 2/15/78). The Division of Forestry should actively object to any funding cutbacks, and demonstrate its need for additional funding and personnel to adequately implement the CFM program; 5) current federal funding is based on a nationally standardized rate which does not necessarily match the funding needs of individual states. The RPA program (described next) could revise this schedule of federal cost-share funds.

Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974

This Congressional act provides for long range planning of the Nation's natural resources. Administered by the USDA, Forest Service, the act requires periodic resource assessment and program recommendations.

States were given the option of preparing their own RPA plan or having the Forest Service prepare one for them. Montana is preparing its own statewide plan under the aegis of the DNR&C, Division of Forestry.

Goals and objectives have been defined and include:

1. Increase timber production through proper forest management and forestry assistance (state and private forest lands).
2. Maintain or improve water quality and quantity without impairing land productivity.
3. Increase and improve fish and wildlife habitat through appropriate land management practices.

Under this proposed plan, federal funding for cost-share programs will be expanded at a rate of approximately 50 percent per year for five years (beginning with implementation in 1980).

Relative to forestry practices and water quality maintenance/enhancement, this act seems to re-iterate the goals of many already existing federal and state statutes. To prevent this proposed program from becoming as ineffective as some of the other cooperative assistance programs, the following recommendations should be considered: 1) actively promote public awareness of available services; 2) emphasize land treatment measures that mitigate or prevent water quality problems; 3) provide

local assistance to landowners; 4) coordinate all public education and assistance programs so that administrative costs are reduced and implementation does not overlap; 5) encourage improvement of legal action system for dealing with violators of federal, state, and local laws and regulations; 6) encourage the state to continue its level of financial support for such programs, despite increasing federal support; 7) encourage federal funding to be allocated on a basis of need; 8) develop programs that deal with coordinated management of watershed resources, based on physical limitations of particular watersheds; 9) encourage tax incentive programs that promote sound resource management; 10) support proposed federal legislation that would assist in implementation of this act (see Appendix F.).

Conservation Districts Law

(Title 76, Chapters 1 and 2, R.C.M. 1947)

In 1939 the Conservation Districts Law was enacted, providing for the formation of conservation districts to regulate primarily agricultural use of land and water. Although the law is administered by the Department of Natural Resources and Conservation, the districts become independent political bodies upon their formation. The law allows the districts to study soil erosion, flood water and sediment damages, and conservation of soil and water, as well as carry out preventative land and water use practices for such problems. Responsibilities also include administration of the Natural Streambed and Land Preservation Act of 1975, as it applies to private lands.

Districts have authority to formulate regulations governing land use (within the district) in the interest of conserving soil and water resources. Enforcement of adopted regulations may be difficult: 1) court injunctions may be requested to stop the non-complying activity, but this may not alleviate the problem or make reparation for damages; 2) the district could petition the court to require the defendant to comply with the land use regulation and perform whatever work is necessary; the court could either dismiss the petition, require the defendant to perform the work, or authorize the district to perform the work and recover the incurred costs from the defendant. (An analysis of the enforcement procedure, as applied to the Natural Streambed and Land Preservation Act, is discussed in that section.). To date, the Sediment Control Ordinance of Lewis and Clark County is the only land use regulation to be adopted by a conservation district (described later). The effectiveness of this

enforcement is unknown due to the short time since implementation.

The districts provide information, technical assistance, and public education programs, particularly in regard to agricultural land use practices. Landowners seem responsive to this local approach of encouraging good land management techniques.

Institution of similar programs relative to forestry BMP's could be a major factor in prevention of associated water quality problems. To ensure the effectiveness of such programs, several aspects should be considered: 1) professionals with forestry and watershed management experience should be utilized in program design and implementation; 2) enforceable land use regulations should be passed to provide penalties for those who do not implement BMP's and to provide for mitigation of resultant water quality degradation; 3) funding should be made available on a cost-share basis to implement the BMP's without creating financial hardship for the small landowner.

Stream Preservation Act

(Title 26, Chapter 15, Sections 1501-1504 R.C.M. 1947)

The Stream Preservation Act authorizes the Department of Fish and Game (DF&G) to review any project proposed by a state agency or political subdivision which would obstruct, damage, or modify the existing form of any stream. Plans and specifications of such action must address the adverse impacts to fish or game habitat that may result from the proposed project. Department of Fish and Game approval is necessary before commencement of any activities.

This act provides for protection of water quality from impacts caused by road construction, drainage systems, and other stream modifications, associated with silvicultural (and other) activities on non-federal public lands. This act has been successfully utilized in several cases; the DF&G has initiated four or five restraining orders and has successfully prosecuted one county which was in violation (Bolan, pers. comm., Feb., 1978). It is apparent that the legal framework exists to properly enforce the Stream Preservation Act, however, other aspects of implementation could be improved: 1) follow-up activities are necessary to ensure that approved plans are being properly followed; this would require additional field personnel; 2) evaluate the existing procedure of problem identification and make necessary changes to provide adequate coverage of violations.

Natural Streambed and Land Preservation Act of 1975

(Title 26, Chapter 15, Sections 1510-1523)

In July, 1975 the Board of Natural Resources and Conservation adopted rules setting minimum standards and guidelines for projects affecting any natural, perennial flowing stream within its mean high-water line. The purpose of this law is to protect natural streams, particularly the streambanks and streambeds, and prevent soil erosion and sedimentation. It is administered by the Department of Fish and Game (DF&G) through local conservation districts or county commissioners in areas where there is not a conservation district. This act has application when any individual or corporation plans action which would modify or alter any perennially flowing stream. Local conservation districts must be notified of proposed activities that will affect streams (stream crossings, bridges, culverts, etc.) and the district supervisors must review and approve such activities before their commencement.

Implementation of this act has provided a measure of control regarding water quality degradation. Estimated public participation is approximately 90 percent and assistance from conservation districts has been very good (Euland, pers. comm., 2/10/78). However, there are several areas of implementation that require improvement for adequate protection of water quality: 1) enforcement of the act (beyond voluntary compliance) has been variable. Prosecution of violators through the County Attorneys has been problematic for several reasons: a) County Attorneys may not be full-time positions, and must prosecute criminal cases before civil cases; b) some County Attorneys have private law practices which require time; c) locally elected Attorneys may be reluctant to take legal action

against members of their constituencies; d) some County Attorneys need assistance in interpreting and effectively applying the act to specific violations; e) although DNR&C is authorized to assist local Attorneys with violation cases, the Department has very little staff time available for this. Enforcement could be improved by several means: i) appropriate more funds to enable the Conservation Districts to hire private legal counsel to act against violators; ii) appropriate funds to increase DNR&C's legal staff so that adequate assistance can be provided to the County Attorneys; iii) initiate a legislative mandate requiring the County Attorneys to enforce the act on a priority basis. Although voluntary compliance has prevented or mitigated many water quality problems, effective legal enforcement is also necessary; 2) programs for public awareness of the act's requirements should be encouraged through the Conservation Districts, particularly with regard to forestry practices. The DNR&C has allocated additional funding to the district for such purposes; 3) follow-up activities are necessary to ensure that approved plans are being properly followed; this would require additional personnel; and 4) evaluate the existing procedure of problem identification and make necessary changes to provide adequate coverage of violations.

Fire Hazard Reduction or Management Law

(Section 28/403.1-408, 410-415, R.C.M. 1947)

Montana's Fire Hazard Reduction Law was enacted with the intention of reducing or managing forest fire fuels resulting from the harvesting or thinning of timber, timber stand improvement, or timber clearance from right-of-ways (powerlines, pipelines, roads). It is applicable to such activities on private lands within the state and requires that the person conducting the activity enter into an agreement with the DNR&C (Forestry Division) regarding a program of fire hazard reduction or management. The law also requires the person to post a bond to be held by the state until the terms of the agreement are met.

The State Division of Forestry and the U.S. Forest Service follow similar programs when developing timber sales on state and federal lands, respectively. Contracts include arrangement for fire hazard reduction or management, as well as bonding.

Although this law does not deal directly with stream water quality, certain aspects may have either positive or negative influences upon water quality. Slash disposal methods vary with regard to piling, burning, etc. Currently, the Division of Forestry does not prescribe slash disposal methods for particular sites, but provides a list of recommended methods. This procedure does not prevent piling of slash in streams, dozer piling on steep slopes or unstable soils, broadcast burning in sensitive areas, or other disposal activities that may negatively impact water quality. If fire hazard reduction methods were applied with due consideration of the physical nature of the site and protection of stream water quality (refer

to section on BMP's), this law could be used as an effective tool for prevention of water quality impacts. The posted bond should adequately cover the costs required to complete the prescribed method of slash disposal, in the event that the operator did not fulfill the contract terms.

Timber Sales Law

(Title 81, Chapter 16, R.C.M. 1947)

The Department of Natural Resources and Conservation (DNR&C), through the Forestry Division, may sell timber on state lands and may prescribe rules for forest practices on these lands. For each proposed timber sale, the DNR&C requires information regarding harvest areas, their location with respect to water bodies and stream, and a statement of their value for watershed protection. State timber sales require contracts with the operator and posting of bond until contract terms are met. (Timber sale contract terms relative to water quality maintenance are detailed in Appendix D).

This procedure can provide an effective control method for preventing water quality impacts on state forest lands. However, contracts must be written to incorporate site-specific best management practices resulting from on-site evaluation of sale areas. The DNR&C is responsible for contract enforcement and should provide funding and personnel to adequately review sales and field check for compliance of each contract. The procedure for legal enforcement (through DNR&C attorneys) should be maintained for efficient processing and prosecution of contract violators.

Montana Pesticides Act

(Title 27, Chapter 2, Section 213-145, R.C.M. 1947)

Damage to plants and loss of vegetation from chemical applications can result in soil erosion, debris, sedimentation, and other causes of water pollution. The federal government has enacted several measures to reduce water pollution from the intrusion of these chemicals into surface and groundwaters, and to reduce the destruction or damage to plant life which can result from misuse of such chemicals. State law (enacted in 1971) provides for the administration of the Federal Insecticide, Fungicide, and Rodenticide Act. This function is implemented through the State Department of Agriculture and includes licensing of dealers and applicators of chemical treatments. Competency tests are given to persons applying for licenses and include specifics on forest pest control, seedbed preparation, etc.

Since there is little use of pesticides in silvicultural activities of Montana, this law has a limited effect. However, it does provide a regulatory framework for the use of pesticides, and has alleviated some water quality problems related to misuse of such chemicals (La Rue, personal communication).

Open-Space Land and Voluntary Conservation Easement Act

(Sections 62-602 - 618, R.C.M. - 1975 Supplement).

Basically, this act enables private landowners to voluntarily enter into conservation easements (with public bodies and qualifying private organizations) to preserve the open space integrity and natural resources of their land. Conservation easements are granted in perpetuity and run with the land; all subsequent purchasers or heirs are legally bound to the restrictive terms of the easement. There are also beneficial tax consequences (federal and state) for the landowner giving an easement.

In some cases, protection of stream water quality could be enhanced by application of conservation easements to Montana's forest lands. More specifically, such easements could prevent the following activities:

Vegetation - removal or destruction of trees, shrubs, or other vegetation;

Surface use - surface use except for such purposes permitting the land or water area to remain predominantly in its existing condition;

Acts detrimental to conservation - activities detrimental to drainage, flood control, water conservation, erosion control and soil conservation, or fish and wildlife habitat and preservation.

When applied in a reasonable manner, such easements could prevent stream degradation from forestry practices without significantly reducing the state's timber resources. Such application could include restrictions of road construction and timber harvesting along streamcourses and other critical areas.

Additional benefits resulting from the use of conservation easements on

forest lands include tax deductions for the landowner. Property tax benefits are realized when commercial timberland is removed from potential development. (The acreage under easement must be assessed at a lower value when development potential is removed.). Income tax benefits are realized as a deduction for donating the development potential of the land to a qualifying agency. (The deduction is based on the difference in appriasal value of the property before and after the development rights are donated.).

To utilize this act in the prevention of water quality impacts, the state should undertake a public education campaign to inform forest landowners of the benefits available under the act. This could be done in conjunction with the slash disposal and CFM programs currently administered by the DNR&C Division of Forestry.

Lewis and Clark Conservation District Soil Erosion Sediment Control Ordinance

#77-01

Enacted in 1977, this ordinance is the first land use regulation to be adopted by a conservation district (as authorized in the Conservation District Law). The ordinance provides a comprehensive and coordinated erosion and sediment control program that includes application to forestry activities (Section 8). Best management practices related to forestry activities are presented in the ordinance as guidelines for development of erosion and sediment controls. Each land occupier must have an approved (by the district supervisor) conservation plan (with woodland management section) or timber harvest plan before commencing any timber harvesting activities. Enforcement of the ordinance is pursued through the Lewis and Clark County Conservation District. Voluntary compliance is stressed, but the District also has the authority to initiate orders for mandatory corrective measures or cease and desist orders through the district court.

The state Division of Forestry assists the conservation district in education and assistance to the public and evaluation of forestry management plans. To date, 14 timber harvest applications have been field checked and approved. Two violations have been documented (associated with violation of the streambed preservation act), and are pending action by the county attorney. Other statistical evaluation of the ordinance's effectiveness are not available (due to its recent implementation).

With respect to forestry activities, the Lewis and Clark County sediment control ordinance provides the potential for effective local control of associated water quality problems. There are two aspects necessary for successful implementation of the ordinance: 1) Funding

and personnel must be increased commensurate with the demands for assisting the public in preparation and implementation of timber harvesting plans, as well as the demands of processing and adequately evaluating (on-site field checks) the applications received. 2) Ordinance enforcement must be effective, both on a voluntary compliance basis and through the district court.

Timber Taxation

Forest lands in Montana are taxed under a statewide property tax system instituted in 1963. Tax assessments are derived from a timberland classification system and timber valuation schedule. The classification system, developed in 1961 (no update), incorporates parameters of: 1) species; 2) stand size; 3) stocking, and; 4) access and topography. Valuation schedules are calculated differently for timber east or west of the Continental Divide. These schedules were updated in 1972 and will be updated again in 1978 to reflect present day market prices and operational costs of timber harvesting. In addition, all commercial forestland is also taxed as grazing land (John Clark, pers. comm., 12/77).

Such tax structures can influence management of forestland. Many landowners have reduced their land's assessment value by selling the timber and/or deferring reforestation. This situation is reducing the state's timber base, but is not directly responsible for water quality problems. However, combined with the poor utilization of public assistance programs by landowners and the resultant lack of BMP's in use on private lands, the tax structures do encourage practices which may negatively affect water quality. The following actions are necessary to alleviate this situation: 1) restructuring of taxation policies to encourage management for timber, particularly reforestation; 2) active forestry assistance programs that reach forest landowners with information and technical advise for employing BMP's in forest management programs; 3) tax incentives for encouraging use of BMP's in forestland management.

Recent tax measures in the state legislature reflect an increasing awareness of tax incentives as a potential method of reducing undesirable land

management practices (Klinger, 1977). However, no tax incentive provisions relative to the use of BMP's have been legislated to date. A bill to revise timber taxation in Montana was introduced in the State Legislature in 1977 (H.B. 83). This bill would eliminate property taxation of private timber lands and replace it with a yield tax and a surtax on all timber harvested from public and private lands. The revenue generated under this program would be distributed to local governments to offset the revenue lost from property tax reduction. A roll-back tax was also stipulated, in order to discourage conversion of forestland to other uses. The bill is in the Revenue Oversight Committee where amendment or substitutions may be made before it is returned to the Legislature for action (expected in 1979).

Evaluation of Existing Guidelines

The state, large private corporations, and the Bureau of Land Management have operating guidelines pertaining to the protection of water quality. These guidelines, along with the Streambed Preservation Act and other existing controls, have undoubtedly helped prevent some water quality problems.

Examples of these guidelines can be found in Appendix D. (water quality protection on timber sales on state forest lands), and to a lesser extent in Appendices A , B , and C .

Although these guidelines are a step in the right direction, it is evident by the number of problems discussed in Section VI that additional steps are necessary to further reduce the number, magnitude, and duration of problems. Either the guidelines are inadequate or administration of the guidelines is inadequate.

IX. ALTERNATIVES FOR PREVENTION/MITIGATION

The goal of preventing or mitigating adverse water quality impacts resulting from silvicultural practices can best be solved by implementing best management practices. The question then arises as to how to implement these practices. A variety of regulatory and non-regulatory options exist, each with its own benefits and drawbacks.

A. Regulatory Alternatives

The regulatory approach is being used in adjacent states (Idaho, Washington, and Oregon) and attempts have been made to pass a Forest Practices Act in Montana. All attempts have been unsuccessful. Montana currently has no unified approach, either regulatory or non-regulatory, to control water quality impacts resulting from silvicultural practices. Existing legislation (such as the Streambed Preservation Act) offers only piecemeal control.

Regulatory programs can be implemented at the national, state, or local level or at a combination of levels.

Klinger (1977) has assessed laws affecting water quality and lists regulatory alternatives, advantages and disadvantages.

Implied in any of the regulatory alternatives is the commitment to adequately fund, staff, and enforce the program.

STATEWIDE NON-POINT SOURCE WATER POLLUTION CONTROL ACT

A statewide non-point water pollution control law could be developed to regulate all land use activities which could affect water quality, including silvicultural practices. Implementation could be designed at the state and/or local level. Such a law would have the advantage of uniform control measures for those land uses potentially causing water quality problems and would not single out specific uses as does a Forest Practices Act. Best Management Practices (rules promulgated pursuant to the Act) could be developed for each land use activity depending on severity of problems and specific control measures pertinent to the activities.

Existing state or local agencies do not have adequate staffing or funding to implement a non-point source water pollution control law.

A major disadvantage of a comprehensive control law is that opponents representing various land users could combine their efforts to lobby against the proposed legislation if control standards were too stringent to suit them.

STATEWIDE SOIL EROSION AND SEDIMENT CONTROL ACT

A statewide soil erosion and sediment control law could be considered which included silvicultural practices. The law could be similar to a statewide non-point source water pollution control act except that it would regulate only those land use activities where erosion and sedimentation were the primary problems. This assumes that other water quality problems such as increased temperatures, changes in flow regimen, nutrient changes, etc. are not of sufficient magnitude to require regulation or will be covered in another manner. Best Management Practices (as rules and regulations) could be adopted which specified sediment control measures for those land uses defined in the Act. Besides regulating only erosion and sedimentation, this law would have disadvantages similar to a statewide non-point source water pollution control law.

STATEWIDE FOREST PRACTICES ACT

Statewide forest practices acts (FPA) have been passed in adjacent states and unsuccessful attempts have been made to pass similar legislation in Montana. Assessments of the Oregon FPA and the Idaho FPA have shown some problems:

- 1) Lack of adequate budgeting has caused insufficient staffing in the regulatory agency to enforce the law and rules and regulations. In Idaho about 25 percent of the operations are inspected in a year (correspondence from Idaho Department of Lands, December 19, 1977). It has been estimated that enforcement and administration of a Montana FPA will require ten additional full-time employees (pers. comm., Forestry Division, DNR&C, December 21, 1977).
- 2) Cumbersome enforcement provisions result in delays in processing violations.
- 3) While rules and regulations (which are equivalent to BMP's) are adequate, administrative problems dealing with the implementation of the rules on the ground have arisen. Three main categories of operational improvement were identified in an assessment of Oregon's FPA (Brown et.al, 1977): 1) training of inspectors, 2) supervision of operations, and 3) enforcement.

A Forest Practices Act could be implemented:

- 1) only on a statewide basis with uniform administration and enforcement or;
- 2) on a local basis with Conservation Districts or other agencies required to implement the law or;

- 3) on a local basis with Conservation Districts having the option to implement a program. The state would retain jurisdiction for any areas where local agencies did not have adequate programs. An operator with activities in several Conservation Districts could be allowed the option of going to the various districts or only to the state agency.

A model Forest Practices Act is found in Appendix G.

LOCAL NON-POINT SOURCE WATER POLLUTION CONTROL ORDINANCES
(AND LOCAL SOIL EROSION AND SEDIMENTATION CONTROL ORDINANCES)

Montana Conservation Districts have the authority to "formulate regulations governing the use of lands within the district in the interest of conserving soil and water resources and preventing and controlling erosion" (Section 76-109, RCM 1947). Lewis and Clark County Conservation District has passed (through a referendum) a Soil Erosion and Sediment Control Ordinance (see Section VIII for discussion of this ordinance).

Conservation Districts could consider a range of alternatives including ordinances that:

- 1) control soil erosion and sedimentation from various land uses. This would be similar to the Lewis and Clark Co. Cons. District ordinance. No assessment of the effectiveness of the L & C ordinance is available (because of its recent implementation).
- 2) regulate non-point sources for other water quality parameters in addition to sedimentation.
- 3) control only for those water quality impacts resulting from silvicultural practices. (Similar to a statewide Forest Practices Act, except administration and enforcement would be at the local level with assistance from the state or federal government.)

MODIFICATIONS OF EXISTING STATUTES

Montana has several existing statutes that could be modified to control water quality impacts of silvicultural practices. Brief summaries of some of these laws are found in Section VIII.

1) The State Conservation Districts Law could be modified to:

- a) hold referendums on ordinances designed to control water impacts (this could include various land uses or solely forest practices). Currently such referendums are at the discretion of the district and entirely voluntary. This option allows the eligible voters in the districts to decide whether a control program is in their best interests. Direction could be provided by the state in cooperation with the Montana Association of Conservation Districts to detail elements of a desired program specific to each district.
- b) formulate regulations (adopt by resolution) without a referendum to control water quality impacts. This would be similar to a above except that eligible voters do not decide the ultimate fate of the program. Unless Section 76-114, RCM 1947, was modified, voters could decide to discontinue the district or part of the district if they were unhappy with the regulations adopted by resolution without adequate public input.

2) Section 81-1409, RCM 1947, provides for cooperation between the state (Dept. of Natural Resources and Conservation) and public or private land-owners to prevent soil erosion. The section could be modified to require such cooperation and provide for rules and regulations to implement this program.

3) The Montana law regarding water pollution (Section 49-4801 et seq., RCM 1947) could be modified to make it clear that non-point sources are covered, to provide for rules and regulations (BMP's) for various land uses, and to provide for effective implementation.

B. Non-regulatory Program

Water quality problems caused by silvicultural practices in Montana are usually the result of a small portion of the total operations. Many of these water quality problems are unintentional. A non-regulatory program emphasizing education and assistance to forest managers may alleviate most of these problems. Although forestry assistance programs have been available in Montana for years, less than 1 out of 20 forest land owners take advantage of them. About 70 percent of forest landowners do not know where to go for assistance (Forestry Division, DNR&C, pers. com., December 21, 1977). In addition, with current staffing and funding levels, the Forestry Division cannot provide substantial increases in assistance to forest land owners.

The non-regulatory program is basically the recommendations found in Section I.

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Appendix A.

SILVICULTURE AND ROAD GUIDELINES
CHAMPION INTERNATIONAL

I. Silviculture Guidelines

Champion's lands are classified as A) intensive culture areas, B) low productivity areas and C) special impact areas. Recommended silvicultural practices vary with each classification.

A. Intensive culture areas - These are timberlands with more than 40 cubic feet growth capability/acre/year based on an 80 year average. Harvesting methods are at the discretion of the District Land Manager and subject to review by the Rocky Mountain Operations' Silviculturist. Recommended factors to be considered by the District Land Manager in selecting the harvest method include species composition, aspect, slope, age of the stand, soil type, habitat type, and proximity to aquatic and riparian zones. For sawtimber stands the following guidelines are used (taken directly from Champion's guidelines):

Because forest stands may vary in component composition and ecological characteristics within a relatively short distance, harvesting of the stand should not be limited to a single, strict method, rather should reflect the dynamic condition of the stand. The forester should consider; species composition, aspect, slope, age of the stand, soil type, habitat type and stream protection guidelines, using these characteristics to select the best combination of harvesting alternatives for accomplishing the management goal.

1. Commercial Thinning

This harvest method is employed to encourage continuation of maximum growth of a stand through removal of undesirable trees when economically feasible. Only healthy, vigorous trees will be left at a spacing for optimum stocking.

The following guidelines may be used to accomplish these objectives:

- a. Remove all high risks, diseased and dead trees (including pulpable material),
- b. Leave dominant or co-dominant trees, capable of release, with at least 40% crown,
- c. Leave trees should be spaced as near equidistant as possible,
- d. Logging should be done in a manner least damaging to the residual stand.

2. Clearcutting

This harvesting system involves the removal of all utilizable material from within the cutting boundaries and provides for proper slash disposal and site preparation to encourage regeneration of the area with desirable species. The understory is usually removed in order to provide a seedbed and reduce competition.

The size and shape of clearcut areas must be flexible enough to: consider the economy of the logging; the ease and quality of slash disposal; permit scarification of the area to prepare a seedbed; to have an adequate seed source; with due consideration for visual impacts on the landscape.

Specifications for clearcut blocks:

a. Size

- 1) Shade Tolerant Species (Douglas-Fir, Englemann spruce, grand fir, sub-alpine fir)

Clearcut units should be narrow, less than 200 feet, to reduce the chances of insolation loss. The units should be orientated to afford the least exposure time to direct sunlight.

- 2) Shade Intolerant Species (lodgepole pine, western larch, ponderosa pine)

Clearcut units should be over 200 feet wide and greater than 1/2 acre in size. The maximum size should not exceed 40 acres if the unit is essentially square. No point in the unit should be more than 10 chains (660 feet) from the nearest seed source.

b. Boundaries

Logging roads and ridges make desirable boundaries for fire control. When a ridge is used, the cutting boundary should be placed slightly over the crest as slash fires are very difficult to stop right on top of a ridge. Whenever a ridge cannot be a boundary, boundaries should be blended to the physiographic features.

c. Site Preparation

Site preparation activities should be performed as soon as possible following harvest. Depending on regeneration objectives, either mechanical, chemical or burning techniques should be utilized. Timing and method used should provide for minimal soil disturbance and compaction to meet the required objectives.

d. Habitat Types

Do not clearcut on any of the ponderosa pine habitat types or on the Douglas fir/rough fescue type.

e. Soil types

Do not clearcut on the following soil types: Krause, Totelake, Coldcreek, Winkler, Sharrot, Rachert, Ashborn, Nemote or Drexel.

3. Seed Tree Cutting

Seed trees, as the name implies, are trees left to regenerate a cutover area by producing and dispersing seeds. Trees left as seed trees should be vigorous, genetically desirable and of an age to produce adequate quantities of viable seed. The understory may or may not be removed after logging, depending upon species, condition, size, age and stocking.

a. Specifications for Seed Tree Cutting

1) Size: No restriction on size; however, economics of logging and slash disposal must be considered.

2) Boundaries: Logging roads and ridges make desirable boundaries for fire control. When a ridge is used, the cutting boundary should be placed slightly over the crest as slash fires are very difficult to stop right on top of a ridge. Whenever a ridge cannot be a boundary, boundaries should be blended to the physiographic features.

3) Site Preparation: At least 50% of the cut area, distributed uniformly over the harvest unit, should be scarified, preferably by mechanical methods. If the area is harvested during the winter, site preparation should be done the following summer, when soil moisture is low, so as to minimize soil compaction.

4) Habitat Types: Do not use this system on any of the ponderosa pine habitat types nor on the Douglas fir/rough fescue type.

5) Soil Types: Do not use this system on the following soil types; Krause, Totelake, Coldcreek, Winkler, Sharrot, Rachert, Ashborn, Nemote or Drexel.

b. Individual Seed Tree

This method is applicable to those types where trees of seed tree specifications are left standing uniformly throughout the cut area. An average of seven trees per acre should be left for seed source.

Individual seed trees must be wind firm to remain standing following the cutting of the rest of the stand. Ponderosa pine and western larch are particularly adapted to the individual seed tree cutting method. Thin-barked species such as Douglas-fir, lodgepole pine and Englemann spruce have difficulty surviving slash fires and Englemann spruce is subject to windfall, making these species less desirable to cut by this method.

c. Seed Tree Groups

Instead of individual seed trees, it is often more desirable to leave seed trees in groups of from one-fourth to one-half acre in size, scattered uniformly through the harvest area. The seed trees in these groups should exhibit the same characteristics as individual seed trees. Seed tree groups may be advantageous in the areas where diseased trees are interspersed with clean or resistant groups. Seed tree groups should be left as undisturbed as possible and a good fire break built around them. Trees adjacent should be felled away from these groups.

4. Shelterwood Cutting

This harvesting method is most often used on the more severe south and west exposures in stands that we desire to regenerate tolerant species. It involves the removal of the entire merchantable stand with a series of partial cuts extending not over 20% of the rotation period; the final harvest being an overstory removal.

An adequate number of trees should remain to protect the site as well as provide seed. At least 10 vigorous dominant or co-dominant seed bearing trees per acre should be left following logging.

5. Tree Selection

In areas where the present all or uneven-aged stand composition is desirable, the selection system should be used.

Two common methods in this system are individual tree selection and group selection. In each method the purpose for cutting the mature trees is to perpetuate the all or uneven-aged condition. The amount of timber removed from the area depends upon the distribution of the age classes comprising the stand.

6. Overstory Removal

This involves the application of a partial cut to two-storied stands for removal of the overwood and perpetuation of the understory.

This method is practical if the following conditions are met:

- a. The understory should consist of healthy and desirable tree species for the particular site,
- b. The area must have desired stocking after logging,
- c. The understory must be younger than 80 years, and able to maintain a satisfactory rate of growth after removal of the overwood,
- d. If the understory is patchy, some overstory trees should be left near the open areas as a seed source and protection to regain full occupancy of the site by a new seedling crop, and
- e. During the overstory removal operation, care should be taken to avoid unnecessary damage to the young residual stand. This should be emphasized for both falling and skidding operations.

7. Salvage Cutting

This harvesting method is used to recover dead or dying merchantable timber which may have been killed by disease, fire, old age, etc. Sufficient volume of higher risk live timber may be included in order to effect an economic operation.

8. Sanitation Cutting

All foresters should be aware of disease and insect damage and designate those trees for removal. High risk trees (injured, unhealthy, decadant and suppressed) should also be considered for removal.

In addition, Champion's guide states that consideration should be given to converting old growth sawtimber stands into healthy, vigorous stands of less than 80 years old. Any of the previously described harvesting methods may be employed. The forester should again consider species composition, aspect, slope, age of the stand, stand vigor, soil type and habitat type when prescribing a harvest system.

B. Low productivity areas are timberlands with less than 40 cubic feet growth capability/acre/year based on an 80 year average (about 15% of Champion's Montana timberlands). In contrast to intensive culture areas, only natural regeneration is recommended. Pre-commercial thinning is not recommended on these sites. A goal of managing these lower capability sites is to "realize maximum economic return while leaving enough residual to protect the site". Salvage cutting (removing dead or dying timber) and selection cutting are the primary recommended treatments on these lower capability sites.

C. Special impact areas include lands that receive special management considerations, because normal silvicultural practices could adversely affect a more sensitive forest resource. Management varies from non-entry to intensive. Some special impact areas listed by Champion include:

1. All waterways and lakes;
2. Important wildlife winter range, spring elk calving grounds;
3. Residences in or near cutting areas;
4. High visual impact areas along highways and main logging roads, i.e., Thompson River road, Fish Creek, Gold Creek, etc.;
5. Areas adjacent to wilderness or other preserved lands;
6. Areas adjacent to powerlines, irrigation ditches and pipes, underground cables, etc.
7. Historical areas and main hiking trails.

II. Road Guidelines

Roads constructed on Champion's timberlands are classified as main, secondary, branch, or spur. The following description is taken directly from Champion's guidelines:

1. Main Roads

Main logging roads are those constructed to serve transportation needs from a major drainage. The Gold Creek and Thompson River roads are examples of main logging roads. Engineering and construction standards will provide good alignment to insure a rapid and safe transportation. Bridges, culverts, and ditches will be permanent type construction in order to withstand heavy use by traffic and to handle the most severe effects of weather. Main logging roads will be either double lane or single lane with intervisable turnouts and double-lane curves (over 50) in order to allow a smooth flow of traffic. Turnouts will be constructed to provide easy access and to be a minimum length of 50 feet. Sufficient gravel surfacing will be provided to give a smooth roadway easy to maintain. Double-lane roads will be at least twenty-four (24) feet in surface width; single -lane roads will be fourteen (14) feet in surface width. Maximum grades will be 8% favorable and 6% adverse, except in special cases.

2. Secondary Roads

Secondary logging roads are built to serve transportation in a tributary of a major drainage. Fishtrap Creek and Mollett Park roads are examples of secondary roads. Engineering and construction standards will not be as detailed as in the case of main logging roads; however, good alignment is still necessary. Bridges and drainages (ditches and culverts) will be of a permanent type. Secondary roads will be single lane with double-lane curves (over 50). Turnouts will be at intervals that will allow traffic to move with little delay (minimum length 50'). Spot surfacing will be provided to weatherproof the road, but will not necessarily be done to make a smooth roadbed. Single lane should be at least fourteen (14) feet surface width and curves at least twenty-four (24) feet. Maximum grade should not exceed 8% favorable or 6% adverse, except in special cases.

3. Branch Roads

Branch roads are permanent roads used to allow removal of timber from small acreages. Engineering and construction will be sufficient to allow safe and economical transportation without regard for surfacing. Branch roads will be single lane (minimum width of 12') with enough turnouts to allow traffic to pass but at a slow speed. There will be no surfacing except to make roads passable. Permanent drainage structures will be required. Ditches will be required to adequately drain the road. Maximum grades will be 8% favorable and 6% adverse, except in special cases. Branch roads will be outsloped and diagonal drainage barriers constructed when timber removal is completed to minimize damage from erosion. The roadway will be turnpiked on flat ground to provide drainage. Good alignment is often possible and desirable on branch roads for both safety and hauling speed.

4. Spur Roads

Spur roads will be temporary roads constructed to log a small area. Roads will be spaced at least 600 feet for cable logging and $\frac{1}{2}$ mile for tractor logging. Engineering and construction will be sufficient to allow safe transportation. Bridges and culverts will be of temporary construction and will be removed when logging is completed. Turnouts and "jay holes"

will be used to allow traffic to safely pass. Maximum grade will be 12% favorable and 8% adverse, except in special cases. Spur roads will be cut off from the permanent road system upon completion of logging and erosion control barriers constructed.

5. Road Clearing

All merchantable timber (minimum is 16-foot log to a 6" top diameter) will be sawed from the road right of way and the logs removed from the road prism prior to construction. Slash and debris will be piled in openings or covered at the toe of the slope to keep it away from the standing timber and facilitate disposal. All merchantable trees whose root system will be badly undercut during road construction will be removed. Additional clearing may be necessary on main and secondary roads to provide better visibility on curves and intersections.

6. Backslopes

All roads will be constructed to provide stable backslopes and minimize erosion and soil movement.

7. Drainage and Erosion Control

All roads will be constructed with adequate drainage facilities which will be of a permanent nature on main, secondary, and branch roads. Drainage facilities utilized will be such as to not damage fisheries. On fishable streams, bridges are preferred over culverts; however, if a culvert must be used, it will be installed so as to not impede fish movement. On temporary road crossing fisheries, drainage facilities utilized will be such as to avoid any damage to said fishery. In order to allow for adequate drainage, gravel and dirt berms will not be permitted on the outside edge of roads. When constructing low standard roads in areas of unstable soils, a system of shallow dips sloping to the outside, will be built at the time of road construction. These dips should be approximately 100 feet in length and should be one to two feet below road grade at the lowest point. Because of the resulting drainage problems zero grades roads should be avoided when possible and roads built on flat ground will be turnpiked.

All permanent roads will be reconditioned upon completion of current logging operations, and all temporary roads will be blocked or destroyed and reforested.

Appendix B.

LAND USE CLASSES
BURLINGTON NORTHERN

1. Multiple use class - commercial forest lands comprising the base for sustained annual production of forest products. Management objectives are oriented toward maximized production of social and economic goods and services.
2. Water resource class - lands abutting bodies of water which are important for recreation, water quality and fisheries. Management direct is to protect and enhance water resource values while utilizing other valuable resources to the extent possible.
3. Scenic area class - lands adjacent to heavy use areas (roads and trails) and lands which can be viewed for long time periods from major public roads. Silvicultural systems are designed to limit unfavorable visual impact.
4. Limited use class - non-forest, non-productive, non-operable, and unstable lands. This class also includes lands with valuable wildlife habitat or unique ecosystems. Silvicultural practices are allowed in these areas only if adequate resource protection is assured. Recreation, grazing and wildlife are primary uses of these lands.
5. Prescribed use class - lands that are legally designated or proposed as wilderness, scenic highways, wild and scenic rivers, shoreline management areas, parks, municipal reservoirs, historic sites or national trails.
6. Existing development class - lands presently being used on a commercial basis for cabin sites, camping areas, ski developments, communication sites and the like.
7. Quarry mining class - areas of active mining and areas where future mineral development is considered the best land use.

SILVICULTURAL POLICY

ST. REGIS PAPER COMPANY

GENERAL SILVICULTURAL OBJECTIVES

1. To develop maximum production of wood volume from all the ownership.
2. To obtain intensive utilization practices.
3. To prevent erosion and site deterioration.
4. To provide protection against and control of insects, diseases and wildfire.
5. To obtain a stabilized flow of raw material from the ownership.

SILVICULTURAL METHODS

PONDEROSA PINE MANAGEMENT

(60,000 Acres)

The policy in the ponderosa pine type will be to perpetuate the pine on these areas. Although the spread in price of stumpage between species has closed materially in the last ten years, the ponderosa pine still is more valuable than the Douglas fir which invades these sites in natural succession. The yield tables also show a considerable margin of merchantable volume for ponderosa pine per acre over Douglas fir on these same sites for all rotation ages.

The general plan in the ponderosa pine type will be to develop the 25,000 acres of virgin stands remaining as soon as practical and cut them down to seed trees or small sawtimber stands if the understory is reasonably vigorous. As most of these remaining virgin ponderosa stands are on the poorer sites, these stands will best be retained without starting over again by burning or scarification. Even with seed trees the residual will be saved and managed by thinning and cleaning to push it along for the earliest re-cut possible. These stands will generally be managed as uneven aged stands.

(Note: Reproduced from Forest Management Plan, St. Regis Paper Co., 1969).

The cutover stands on the better sites which have been selectively cut in the last 20 years will be re-cut down to seed trees consisting of some six dominant trees per acre. The least vigorous stands will be re-cut first. The merchantable species other than ponderosa pine will be removed to keep these species from seeding the area. If the understory is reasonably vigorous and not mostly lodgepole pine, it will be retained and managed. Otherwise, it will be destroyed by laydown and burning or dozer piling to prepare the seed bed for the ponderosa pine. The seed trees will be removed as soon as the reproduction of desirable species has reached 30% stocking by milacre plots. The seed trees should be removed in the winter with at least one foot of snow on the ground to give a measure of protection to the small seedlings. These stands will generally be managed as even aged stands.

In ponderosa pine stands, complete elimination of other species is not the goal. Rather, the ponderosa will be favored on these areas and other species discouraged by control of seed source, cleaning operations with dozers or power saws, site preparation, and opening up the stands at least 50% by crown closure to favor the ponderosa seedlings.

FIR AND LARCH MANAGEMENT (110,000 Acres)

The old growth larch stands will be gone within the next several years due to the heavy cutting in this type for the plywood plant. These remaining stands will be cut down to some six dominant larch seed trees per acre; all other merchantable timber will be removed. If the understory is reasonably vigorous, it will be retained and managed, otherwise, it will be laid down and burned to prepare site for the larch regeneration. The seed trees will be removed as soon as the reproduction is established up to 30% stocking of desirable species by milacre plot surveys.

In younger stands and ones where Douglas fir predominates, the stands will be opened up by partial cutting, removing 50% to 75% of the merchantable volume. The younger and more vigorous stems will be retained for the next cut in 20 to 30 years. These stands will be thinned, using dozers and/or power saws if the logging does not reduce the stems per acre to the density needed for good growth.

MIXED IDAHO MANAGEMENT
(14,000 Acres)

This type is found primarily in the Troy area and is comprised mainly of cedar, Douglas fir, larch, hemlock, white fir, spruce, and white pine. These stands were logged heavily some 30 years ago, leaving mostly cull and suppressed stems. These have now developed into areas of dense reproduction mixed with patches of small timber of which a good percentage is cull.

Where there are sufficient vigorous stems to make a stand, the undesirable stems will be logged and the cull will be destroyed by dozers or power saws. The resulting stand will be thinned with power saws to the spacing necessary for good growth. Because of the blister rust, white pine will not be picked for crop trees.

Where there are not sufficient numbers of vigorous stems for a stand, the area will be logged of all merchantable material. The remaining material will be laid down and burned. The area will be either seeded or planted with seedlings to get it back into production. Large areas (over 200 acres) will be favored over small clear cut areas because of the danger of seeding by inferior species on the perimeter.

As this type is the most productive timberland in the ownership, every effort should be made to get it back in good growing condition as soon as possible.

LODGEPOLE PINE MANAGEMENT
(10,000 Acres)

The remaining lodgepole pine stands on St. Regis lands are found in relatively small acreages mixed in with other types. This is because an effort has been made to change this type to other timber by planting and seeding over the last 15 years.

The increase in value of stud size timber and the excellent growth for this species shown on the 1966 re-cruise indicates that a reappraisal of our position on eliminating this species is in order.

This species must be managed as an even aged stand. Regeneration is generally no problem but overstocking must be guarded against. Burning broadcast without laying down the residual and dozer piling both result in too much reproduction. Laydown and burning lightly or laydown without burning produce the most manageable new stands. These new stands should be thinned at a relatively early age (15 years or less) in order to keep them from stagnation. Release after stagnation is very difficult, if not impossible, in these lower elevation stands of lodgepole pine.

THINNING AND CLEANING

These operations which are designed to open up and improve the composition of stands have proven to be not only economically feasible but most desirable in shortening rotations and increasing yields from timberlands. One pre-commercial thinning can double the growth rate of the crop trees for 20 years and shorten the rotation by ten years or more according to preliminary information on our 1955 experimental plots. Over the rotation period, with one pre-commercial thinning and two commercial thinnings, the total yield of the stand can be more than doubled compared to an unthinned stand.

The 3230 acres of pre-commercial thinning done on these lands over the last four years have cost an average of \$15.22 per acre. By doubling the growth rate, which means raising the board foot per acre per year growth from 100 board feet to 200 board feet, an increase in merchantable volume of 2000 board feet is accumulated in 20 years. At current stumpage rates, this is worth \$100 gained as compared to the \$15.22 expenditure.

The immediate goal is to thin 2000 acres annually of stands under merchantable size, with the goal of reaching 4000 acres annually by the end of this ten year period. Initially, this work will be done in stands in the advanced reproduction stage to push them along at a faster rate of growth to provide volumes for cutting in the critical period 30 to 40 years from now. As these stands are completed, the new reproduction from the 20,000 acres of present seed trees will be large enough to thin and clean and will all be thinned by the time they reach 20 years of age.

Commercial thinning of all stands now in the small sawtimber size will be pushed as rapidly as possible and wherever sufficient stud log volume is developed to make the operation commercially feasible. At present, stands needing removal of 1000 board feet per acre if roaded, or 2000 board feet per acre if requiring roading, will be considered operable for commercial thinning

SITE PREPARATION

- (a) Scarification will be done wherever necessary to re-establish ponderosa pine and larch on this type of timberland. Dozer piling in conjunction with slash disposal will be the usual method, although dozer stripping may be used to peel off grass sod areas where required.
- (b) Broadcast burning for site preparation will be used only where it is necessary to destroy the entire understory in order to get a new stand

started. This type of burning will be used in only the ponderosa pine and larch seed tree areas and in clear cuts where seeding or planting is required. South facing slopes on dry sites will only be burned as a last resort because of the difficulty of re-establishing reproduction on these areas after burning.

- c. Dozer stripping will be done to remove grass sod and shrubs for seeding and planting operations where required. Also, it may be used in seed tree areas where sod has formed after the initial scarification or burning. This stripping will entail peeling off the entire sod for the width of the dozer blade and stripping 33% to 50% of the ground area.
- d. Laydown of cull or decadent understory will be the general practice prior to any broadcast burn. This treatment results in a hot burn which is necessary to bare up mineral soil for regenerating the stand. Also, standing burning of understory containing lodgepole stimulates this type of reproduction because of the serotinous cones on these trees. This type of treatment may be done either by dozers or by slashing with power saws. The steeper ground and thinner stands will be the areas for power saw slashing. Laydown without burning may be done where there is sufficient small reproduction present of quality species to regenerate the area.
- e. Chemical spraying for brush eradication is not necessary on most company timberlands. It has proven effective on several smaller areas along streams and will be used in these locations to remove brush for regenerating the stand or to release reproduction under the brush.
- f. Poisoning rodents with 1080 poisoned grain has proven very effective in curtailing rodent populations. This method will be employed prior to all seeding operations to protect the seed during the germination period.

TREE PLANTING

The present program of planting 100,000 to 150,000 seedlings annually will be continued as long as there are areas requiring this method to get new stands started. The seedlings will be obtained from the company tree nursery located in Libby. The need for restocking company timberlands and the value of this program in providing employment for loggers during the break-up period in the spring makes tree planting doubly attractive.

Christmas tree stock will be planted where feasible with the timber type seedlings to provide a more rapid return from planting areas.

Machine planting will be done wherever possible because of the cheaper cost and better survival over hand planting, as experienced in the last ten year period.

DIRECT SEEDING

Due to the fact that seeding costs per acre amount to about 20% of planting costs, work on this method of regenerating stands will be continued. Of the 3780 acres seeded in the last seven years, about one-third of this seeding resulted in adequate stocking.

Helicopter seeding in the winter on the snow gave the best results and using Panama seeders on spring seeding gave the poorest results. Broadcast-seed by hand gave results similar to helicopter seeding but was more expensive. Areas under 200 acres cost more with helicopter because of dead-head time.

All areas seeded must have adequate site preparation to give at least 33% bare mineral soil. Burning, dozer scarification or scalping may be used for this purpose.

Rodents must be poisoned prior to or with the seed application (monocrotophos), in order to insure the safety of the seed through the germination period.

Seeding should be done just before snowfall in October or November or on the snow in the winter for the best results. Spring broadcasting does not generally result in the seeds being covered sufficiently by soil to result in good germination.

SLASH DISPOSAL

- a. Hand piling and burning of slash will be kept to a minimum because of the excessive cost. This method will be used only along main highways and along main haul roads.
- b. Dozer piling and burning will be used wherever the slope permits. Breaking up slash areas with piled strips will be favored over complete disposal because of cost. Cleanup along roads and around landings will be sufficient in many areas. The minimum amount of slash disposal will be done consistent with state requirements.
- c. Broadcast burning will be done where it fulfills other requirements for regeneration of stands and may be used to burn out safety strips in place of dozer piling the strips.

SALVAGE OF DEAD TIMBER

Every effort will be made to salvage all dead and dying timber occurring in company timberlands as soon as possible and at least annually.

Rubber-tired skidders will be used for this type of operation as much as possible. Small contractors with self-loading trucks will be encouraged to do salvage work. These contractors will be kept busy the year around as much as is practical to keep them available.

Annual surveys of company timberlands will be made by the block foresters in the late spring and early summer to determine areas and volumes requiring salvage.

With 3,800,000 board feet of merchantable timber dying annually on company timberlands, as shown by the 1966 cruise, the importance of recovering this volume is imperative.

WATER QUALITY PROTECTION ON TIMBER SALES ON STATE FOREST LANDS

Erosion Control (from Timber Sale Agreement) .

1. Operations shall be conducted to prevent damage to roads, trails, meadows, streambanks, lakeshores or other natural features of the sale area.
2. Tractors and other heavy equipment will not be operated in stream courses except at designated crossings and as essential to construction or installation of culverts and bridges. Debris resulting from logging or construction operations which may affect the natural flow of any stream course shall be immediately removed.
3. Logs shall not be hauled, skidded, or yarded across stream courses unless fully suspended.
4. Tractor skidding will be restricted to use of winches wherever it is necessary to remove logs from timber felled within forest reproduction on boggy areas or streams.
5. Equipment shall not be operated when ground conditions are such that excessive damage will result to soil, vegetation, skid trails or roads.
6. The kinds and intensity of erosion control work shall be adjusted to ground and weather conditions as directed by the forest officer in charge. Erosion control shall be kept current immediately preceeding expected season periods of precipitation and runoff, and maintained as required throughout the contract period or extensions thereof.
7. Where logging or road construction operations are in progress, but not completed, and before operations cease at the end of the operating season, temporary erosion barriers, dips, water bars, or ditches will be constructed to prevent erosion, as directed by the forest officer in charge.

Sawing and Logging Operations (from Timber Sale Agreement)

Operations shall comply with all applicable state laws, rules and regulations concerning sanitation in operations. Refuse resulting from the operation will be removed, buried, or otherwise disposed of. The operation shall not service tractors, trucks, and similar pieces of equipment on lands at or adjacent to lakes, streams, or recreation facilities.

Roads

1. Slash and debris shall not be placed in lakes, meadows, or streams where the flow of water may be obstructed and shall be removed if placed therein.
2. Slash resulting from road construction that would adversely affect road stability shall be disposed of as directed by the forest officer in charge.
3. Placement of windrows will not be allowed against trees or where there would be interference with draining structures, blockage of stream channels, or in general cause watershed damage.

Appendix E.

List of Contacts

U.S. Forest Service

Beaverhead National Forest

Supervisors Office, Dillon, MT.
Dillon Ranger District, Dillon, MT.
Wise River Ranger District, Wise River, MT.
Wisdom Ranger District, Wisdom, MT.
Sheridan Ranger District, Sheridan, MT.

Bitterroot National Forest

Supervisors Office, Hamilton, MT.
Darby Ranger District, Darby, MT.
Stevensville Ranger District, Stevensville, MT.
Sula Ranger District, Sula, MT.
West Fork Ranger District, Darby, MT.

Deerlodge National Forest

Supervisors Office, Butte, MT.
Deer Lodge Ranger District, Deer Lodge, MT.
Jefferson Ranger District, Whitehall, MT.
Philipsburg Ranger District, Philipsburg, MT.
Butte Ranger District, Butte, MT.

Flathead National Forest

Swan Lake Ranger District, Bigfork, MT.
Condon Work Cnter, Condon, MT.

Gallatin National Forest

Big Timber Ranger District, Big Timber, MT.
Bozeman Ranger District, Bozeman, MT.
Gardiner Ranger District, Gardiner, MT.
Livingston Ranger District, Livingston, MT.

Helena National Forest

Supervisors Office, Helena, MT.
Townsend Ranger District, Townsend, MT.
Helena-Canyon Ferry Ranger District, Helena, MT.
Lincoln Ranger District, Lincoln, MT.

Kootenai National Forest

Fortine Ranger District, Fortine, MT.
Libby Ranger District, Libby, MT.
Rexford Ranger District, Eureka, MT.
Cabinet Ranger District, Trout Creek, MT.
Fisher River Ranger District, Libby, MT.
Troy Ranger District, Troy, MT.
Yaak Ranger District, Troy, MT.

Lewis and Clark National Forest

Supervisors Office, Great Falls, MT.
Teton Ranger District, Choteau, MT.
Sun River Ranger District, Augusta, MT.
Belt Creek Ranger District, Neihart, MT.
Judith Ranger District, Stanford, MT.
Musselshell Ranger District, Harlowton, MT.
White Sulphur Springs Ranger District, White Sulphur Springs, MT.

Lolo National Forest

Supervisors Office, Missoula, MT.
Missoula Ranger District, Missoula, MT.
Ninemile Ranger District, Huson, MT.
Plains Ranger District, Plains, MT.
Seeley Lake Ranger District, Seeley Lake, MT.
Superior Ranger District, Superior, MT.
Thompson Falls Ranger District, Thompson Falls, MT.

Regional Offices

Northern Region, Missoula, MT.
Rocky Mountain Region, Denver, CO.
Intermountain Region, Ogden, UT.
Pacific Northwest Region, Portland, OR.

Forest and Range Experiment Stations

Intermountain, Ogden, UT.
Intermountain, Logan, UT.
Intermountain, Moscow, ID.
Intermountain (Forestry Sciences Lab), Missoula, MT.
Pacific Northwest, Portland, OR.
Pacific Northwest, Corvallis, OR.
Pacific Northwest, Seattle, WA.
Rocky Mountain, Ft. Collins, Co.
Rocky Mountain, Bottineau, ND.
Rocky Mountain, Tempe, AZ.

Bureau of Land Management

State Office, Billings,
District Offices, Lewistown, Dillon, Butte, Missoula and
Billings, MT.

Department of Natural Resources and Conservation

Division of Forestry, Lewistown, Hamilton, Plains, Anaconda,
Greenough, Helena, Missoula, Bozeman and Billings, MT.

Division of Conservation Districts, Helena, MT.

Department of Fish and Game

Fish and Game, Great Falls, Bozeman, Missoula, Kalispell,
Deer Lodge, Lewistown, Townsend, White Sulphur Springs,
Butte and Helena, MT.

Other Contacts

St. Regis Paper Co., Libby, MT.
Champion International Corp., Missoula, Bonner, MT.
Burlington Northern, Inc., Missoula, MT.
Stoltze Land and Lumber Co., Dillon, MT.
Evans Products Co., Missoula, MT.
Brand - S Lumber Co., Livingston, MT.
Yellowstone Pine Co., Belgrade, MT.
Bill Hand, Dillon, MT.
Don Wood, Lolo, MT.
Environmental Information Center, Helena, MT.
University of Montana, School of Forestry, Missoula, MT.
Department of Health and Environmental Sciences, Water
Quality Bureau
Montana Association of Conservation Districts
Lewis and Clark County Sediment Control Project

Appendix F.

PENDING FEDERAL LEGISLATION

Congressman James Weaver (Oregon), Chairman of the House Subcommittee on Forests, has introduced three bills to implement and expand objectives of the Forest and Rangeland Renewable Resources Planning Act. These bills are:

House Bill 8020, the Forest and Rangeland Renewable Resources Cooperative Assistance Act, which would expand federal cooperative assistance to state and private landowners.

House Bill 1821, the Forest and Rangeland Renewable Resources Research Act, which would expand forest research to use the best scientific capabilities to support the protection, management and utilization of forest resources.

House Bill 8022, the Forest Resources Extension Act, which would expand forest resources extension programs to help make private landowners aware of the opportunities and techniques for increasing production of forest resources on their lands.

House Bills 8020 and 8022 are currently in the House Forest Subcommittee and have been since June, 1977 with no action. House Bill 1821 is currently in the Ways and Means Subcommittee with no action since January 14, 1977 (Sharon Brown, pers. comm.).

MONTANA FOREST PRACTICES ACT

Section 101 Short title. This chapter shall be known and may be cited as "The Montana Forest Practices Act."

Section 102 Policy of the State - Purpose of Chapter.

(A) Recognizing that it is the declared policy of this State and its people to provide a healthful environment, to prevent degradation and improve the environment for present and future generations, this act directs the promulgation and adoption of rules regulating forestry practices on State and private forest lands.

Forest lands provide jobs, tax base, other social and economic benefits, headwaters for many of Montana's surface and groundwater sources, air, soil and water resources, and provide habitat for terrestrial and aquatic wildlife. It is the declared policy of this State to require forest management practices on these lands which protect and enhance their benefits and resources.

(B) The Legislature hereby finds and declares:

That in order to achieve the aforementioned declared policy of this State, promote the health and welfare of its citizens, protect domestic stock, wildlife resources, preserve and enhance agricultural, silvicultural and recreational productivity and assure a long-range dependable tax base, it is reasonable to require that all subject forest operations be limited to those for which permits have been granted, that no operation be permitted until the operator has presented a comprehensive plan describing the project, together with payment of a permit fee, and the plan is done, that certain remedies are available, and that certain minimum air, soil and water quality standards as specified in rules and regulations adopted pursuant to this act are met.

This act further provides that if basin-specific standards agreed upon by representatives of State resource agencies, forest management personnel and private citizens are violated, this act empowers the department to investigate, provide findings, levy fines and provide redress for damage caused to the State's air, soil or water resources by forest practices.

Section 103 Definitions. Unless the context requires otherwise, in this chapter:

- (1) "Operation" means a commercial activity relating to the growing, harvesting, or processing of forest products on forest lands.
- (2) "Forest lands" mean those lands growing forest tree species which furnish, or could at maturity furnish, raw material used in the manufacture of lumber or other forest products. This definition does not include those lands which have been converted from growing trees to uses other than commercial forest production.
- (3) "Operator" means a person engaged in conducting an operation.
- (4) "Person" means a person, partnership, corporation, association or other legal entity, or any political subdivision, or agency of the State.
- (5) "Harvesting" means an activity related to the removal of forest tree species including the clearing of forest tree species from land for conversion to a non-forest use such as grazing, agriculture, road development, subdivision activity.
- (6) "Rules" means those rules adopted by the board pursuant to this act.
- (7) "Landowner" means a person, partnership, corporation, association or other legal entity, or any political subdivision or agency of the State, that holds an ownership interest in forest land.
- (8) "Timber owner" means a person, partnership, corporation, association or other legal entity, or any political subdivision or agency of the State, that holds an ownership interest in forest tree species.

(9) "Forest regions" mean those regions of forest land which the Department of Natural Resources and Conservation, Division of Forestry, has used to divide the State. These regions are recognized to be possibly separate and distinct in terms of minimum standards regarding air, soil and water resources. It shall be the duty of department personnel, state resource agency representatives, forestry management spokesmen and concerned citizens to develop specific minimum standards through the rules adopted pursuant for this act within each region. Be it further recognized that standards may be different within regions, if surface water basin differences so require.

(10) "Director" means the director of the Department of Natural Resources and Conservation.

(11) "Department" means the Department of Natural Resources and Conservation.

(12) "Board" means the Board of Natural Resources and Conservation.

(13) "State" means the State of Montana or any political subdivision thereof.

*Note: Need small operator designation for cost-sharing projects for monitoring, road surveys, etc..

Section 104 Duties of the board. The board:

(1) Shall adopt rules for forest regions establishing minimum standards for forest practices on forest lands. These rules shall be related to the following:

- a. Reforestation;
- b. Road construction and maintenance;
- c. Harvesting of forest tree species;
- d. Application of chemicals and fertilizers;
- e. Disposal of slash.

It is recognized that operations on forest land are already subject to other laws and regulations of other agencies which deal primarily with the consequences of such operations rather than the manner in which they are conducted. It shall be the purpose of this act and its rules to address both the method of operation as outlined in (1) above, and the consequences of such actions. The board shall incorporate the existing standards and policies of other State resource agencies when developing rules to protect and enhance the air, soil and water resources of its forest lands.

(2) Guidelines may be developed for each watershed based on, but not limited to, its:

1. Geology
2. Soil erosion hazards
3. Mean annual runoff
4. Stream order
5. Hydrologic recovery rate
6. Stream channel stability
7. Hydrologic response
8. Type of vegetation manipulation
9. Past influence of man
10. Wildfire 11. flood history

Section 105 Duties, powers of the department. The department:

- (1) Shall administer and enforce this chapter;
- (2) Shall through the director and the board appoint a forest practices advisory council for the purpose of providing technical advice to the board in carrying out the board's powers and duties as set forth in Section 104. There shall be representation from each of the division's

forestry regions, state resource agencies, forestry management personnel and citizens of the State. Members of the council shall be qualified by education and experience to provide technical advice related to reforestation, road construction and maintenance, harvesting of forest tree species, application of chemicals and fertilizers and slash disposal on forest lands. It shall be the duty of the council to further assist in the authorship of rules and regulations to be proposed for adaption pursuant to this act. These rules and regulations are to contain specific minimum standards for regional air, soil and water resources.

(3) Shall advise and assist the board in the discharge of its duties as set forth in this chapter;

(4) Shall achieve coordination among State agencies which are concerned with the forest environment;

(5) Shall cooperate with and provide advice to landowners and timber owners in the management of forest lands;

(6) May enter into cooperative agreements or contracts which may be necessary in the administration of this chapter.

(7) Shall direct County Conservation districts, within 365 days after the effective date of this act, to adopt best management practices acceptable to the department, and which provide for forest management plans for private landowners consistent with the intent of this act.

Section 106

(1) An operator may not engage in commercial forest practices, including, but not limited to, development, road construction or harvesting, without having first obtained from the department a permit designating the area of land to be affected during the applicable permit period.

(2) In order to obtain a permit the operator must file with the department, within 90 days prior to any action described in (1) above, an operating plan to describe proposed actions and locations.

(3) The department shall then effect an inspection of the proposed site. This inspection will specifically determine, at a minimum, fundamental resource information needs as they relate to the site itself. Resource information needs shall include, but not be limited to, descriptions of existing air, soil and water resources and an estimation of the effect of the proposed forestry action upon those resources. If it is decided that monitoring systems will be needed to ensure the non-degradation of these resources, such systems will be developed at the direction of the department.

(4) The permit application shall be on forms prescribed and provided by the department and shall include the name and address of the operator, timber owner, and landowner, the legal description of the operating area, and other information the department considers necessary for the administration of the rules adopted by the board.

(5) Any changes in the original application material must be reported to the department within thirty (30) days of the change by the operator, timber owner or landowner which filed the original application. Within fifteen (15) days of receipt of the notice of change, the department shall mail a copy of the notice of change to whichever party, landowner, timber owner, operator, that did not submit the notice of change.

(6) (a) An application fee of twenty-five dollars (\$25.00) shall be paid before the permit required in this section shall be issued. The operator shall file with the department a bond payable to the State of Montana with surety satisfactory to the department in the penal sum to be determined by the board (on the recommendation of the director) of not

less than fifty dollars (\$50.00) nor more than twenty-five hundred (\$2500.00) for each acre or fraction thereof of the area of land affected. The level of bonding shall be relative to the degree of disturbance projected to result from the proposed operation.

(b) In determining the amount of the bond within the above limits, the board shall take into consideration the character and nature of the area of the proposed location, the nature of the proposed operation, and those actions which will be required to insure the nondegradation of existing resources. In no event shall the bond be less than the total estimated cost to the State of completing the work described in the operating plan.

(7) Forest practices conducted in accordance with the provisions of a forest management plan approved by the County Conservation District in which the practices occur shall be exempt from the provisions of this act.

Section 107 Violation by operator; notice of noncompliance; finds of fact; order to cease operation; order to repair damage; penalties; levy of fines; placing of liens.

(1) If any of the requirements of this act or rules or orders of the department and the board, or of the local County Conservation District, have not been complied with within the time limits set by the department or by the board or by this act, the department shall serve a notice of noncompliance on the operator, timber owner or landowner, whoever has obtained the permit to operate. Where found necessary, the director shall order the suspension of a permit. The notice or order shall be handed to the operator in person or served by registered mail to the permanent address shown on the application for operating permit. If the operator has not complied with the requirement set forth in the notice of non-

compliance on the operator, timber owner or landowner, whoever has obtained the permit to operate. Where found necessary, the director shall order the suspension of a permit. The notice or order shall be handed to the operator in person or served by registered mail to the permanent address shown on the application for operating permit. If the operator has not complied with the requirement set forth in the notice of noncompliance or order of suspension within time limits set therein, the permit and bond may be revoked by order of the board. The department may not issue any additional permits to an operator who has been repeatedly in noncompliance or violation of this act.

(2) When it has been found by the department that damage has resulted from an operation, a determination shall be made of the estimate of the cost to repair the damage or the unsatisfactory condition as directed by the order of the department. The department shall notify the operator, timber owner and landowner in writing by registered mail of the amount of the estimate. Upon agreement of the operator, timber owner and landowner to pay the cost, the department shall proceed to repair the damage.

In the event that agreement to pay has not been reached between the operator, timber owner and landowner within thirty (30) days, the department shall present to the board its finding of fact, and the estimate of the cost to repair the damage and an explanation of the estimate.

The board may then present its findings to the Attorney General of the State of Montana. The Attorney General may then place a lien against the real and personal property of the operator, timber owner or landowner in an amount to be recommended by the board.

(3) The operator, timber owner or landowner shall be given the opportunity to appear before the board for the purpose of presenting facts pertaining to the alleged violation and the proposed expenditure. All hearings and appeal procedures shall be in accordance with sections 82-4209 through 82-4217.

Section 108

(1) Any person or operator who violates any of the provisions of this act or rules or orders adopted shall pay a civil penalty of not less than one hundred dollars (\$100.00) nor more than one thousand (\$1,000.00) for each day during which a violation continues. The operator may be enjoined from continuing such violations as hereinafter provided by the sections of this act. These penalties shall be recoverable in any action brought in the name of the State of Montana by the Attorney General in the court of the first judicial district of this State, or in the district court having jurisdiction of the defendant.

(2) The Attorney General shall, upon the request of the director, sue for the recovery of the penalties provided for in this section, and bring an action for a restraining order, temporary or permanent, against an operator or other person violating or threatening to violate an order adopted under this act.

SILVICULTURE 208 QUESTIONNAIRE

This study will identify and evaluate impacts to stream water quality resulting from past, present, and future silvicultural activities. The study area will include all private, state, and federal lands (except U.S. Forest Service Lands) in the statewide 208 area.

GENERAL QUESTIONS:

- (1) Where are the areas of checkerboard ownership, inholdings, and adjacent ownership? (Identify areas and ownership).
- (2) What drainages contain non-USFS ownerships where harvesting (or other silvicultural activities occur?
- (3) How are these operations co-ordinated with activities on USFS lands? (road building, harvesting, road closures, other management)
- (4) What are the potentials for future harvest and other silvicultural activities? (specific drainages, time factor, type of activity)
- (5) What drainages provide water for human consumption? (municipal reservoirs, etc.)

- (6) What procedure is followed when a problem area is identified?
(administrative, technical)

LOCATION:

County _____

T _____ R _____ Sec. _____

Drainage _____

Access _____

TYPE OF PROBLEM: (change in stream geometry, temperature, sedimentation, nutrients, other biological implications, increased water yield)

CAUSE OF PROBLEM: (road construction, drainage structures, maintenance, slope factors, soil factors, area harvested, harvesting methods, regeneration factors, herbicides, pesticides)

EXTENT OF PROBLEM: (downstream impacts, duration, type of waters affected)

RESPONSIBILITY: (owner, contractor, addresses)

ABATEMENT PROCEDURE RECOMMENDED; (if any)

a. Technical (adequate drainage, etc.)

b. Legal/Political (role of USFS, State WQB, others)

INFORMATION ON PROBLEM (references, hard data, etc.)