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# Best Management Practices for Water Quality

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## Evaluating BMP Compliance on Forest Lands in Minnesota: A Three-Year Study



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# **MINNESOTA**

**BEST MANAGEMENT PRACTICES FOR WATER QUALITY.**

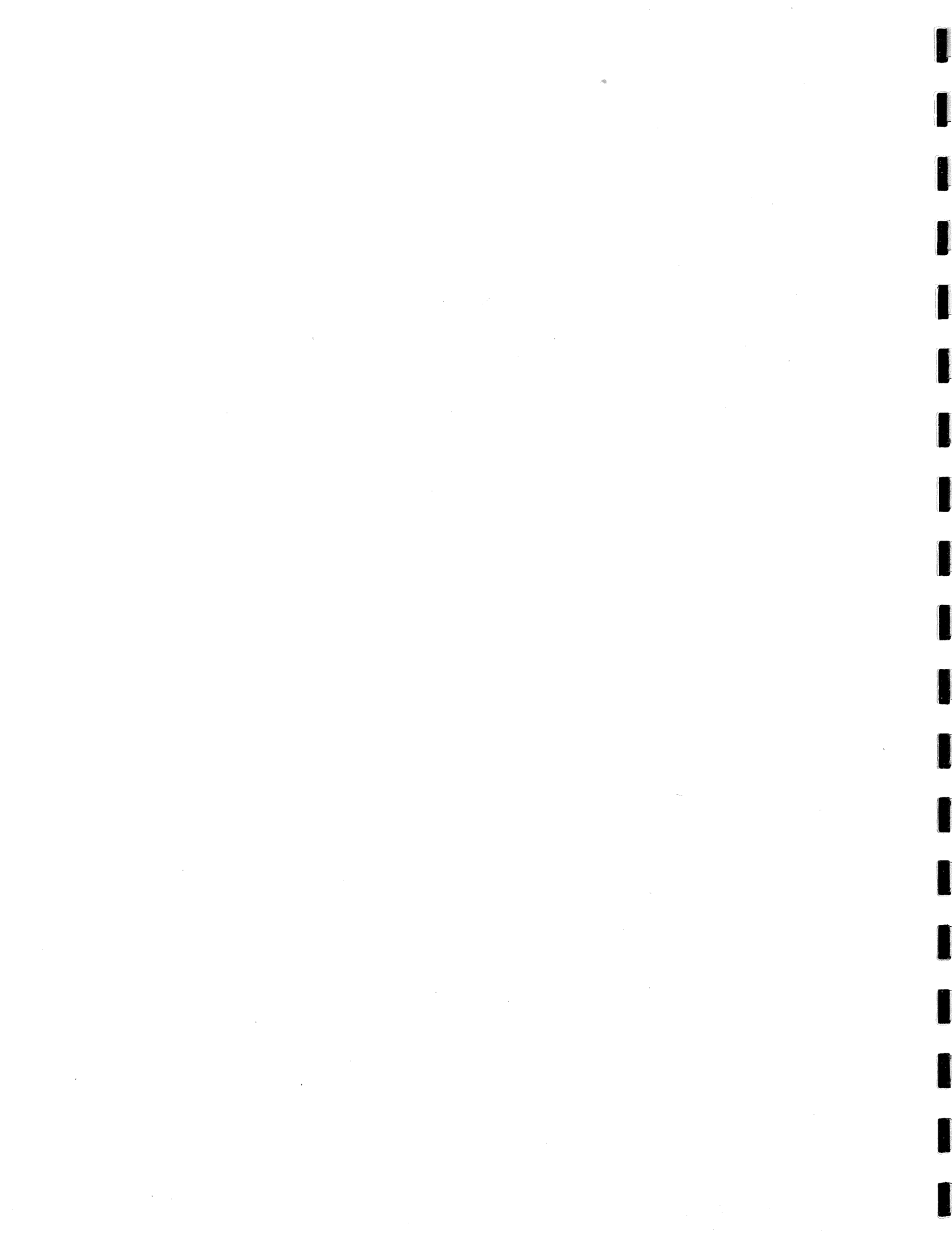
**EVALUATING BMP COMPLIANCE ON FOREST LANDS  
IN MINNESOTA:**

**A THREE YEAR STUDY**

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1994



## EXECUTIVE SUMMARY

Best management practices (BMPs) serve as the cornerstone for the forestry water quality protection program in Minnesota. The use of BMPs has been actively promoted in Minnesota since 1988 in response to mandates contained in the 1987 Amendments to the Clean Water Act (PL 100-4). As part of the implementation strategy, the Minnesota Department of Natural Resources, Division of Forestry (DOF) established an annual field auditing program in 1991 designed to evaluate BMP compliance on state, federal and county lands; private industrial lands; American Indian lands; and nonindustrial private forest lands. The field audit process was funded through section 319 of the Clean Water Act and with general funds from the DOF.

The field audits were conducted by interdisciplinary teams assigned to operate in each of the DOF regions. The audit teams were composed of representatives from federal, state and county agencies; forest industry; logging interests; forest landowner groups, the University of Minnesota; the public; and environmental and conservation organizations. Efforts were made to ensure that each team incorporated expertise in road engineering, soil science, hydrology, fisheries and forest management.

Field audit evaluations were based on the BMPs contained in the guidebook Water Quality in Forest Management: Best Management Practices in Minnesota. Ninety-six practices were incorporated in the audit forms for 1991. The forms were modified after the first year of audits. Audit forms contained 97 practices in 1992 and 1993. Each audit site was rated for the applicability of the specific BMPs (yes or no), whether the applicable BMPs were installed or used correctly (5-point scale), and the observed effectiveness of the BMP application (6-point scale).

The forest management activities most commonly rated were road construction and maintenance and timber harvesting. Mechanical site preparation, prescribed burning and pesticide use were also evaluated. For the three years of field audits, the teams rated a total of 5,707 practices on 261 sites.

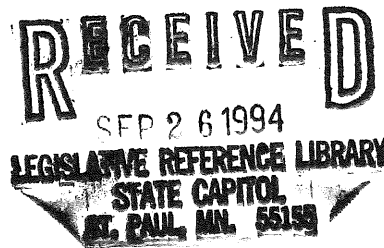
The major findings for the field audits from 1991 to 1993 are summarized below:

- Compliance with BMP recommendations averaged 84% across all forest landowners. The rate of compliance was highest on county and private industrial lands (90%) and lowest on nonindustrial private forest (77%) and American Indian (75%) lands. State and US Forest Service lands had compliance levels of 85% and 87%, respectively.
- The majority of departures from BMP recommendations (77%) were minor. Minor departures were small in magnitude and localized with a small potential to impact water quality.

- Where BMPs were properly applied, adequate protection to the water resource was found 99% of the time. Even with minor departures from recommended practices, adequate protection was provided 60% of the time. The magnitude of the impact to water quality increased to the extent to which the BMP recommendations were ignored or not followed.
- Departures from BMP recommendations were more frequent in southeastern Minnesota compared to the northern half of the state. The lower compliance level for southeastern Minnesota reflected the steeper and more difficult operating terrain common to that region of the state.
- Major departures and gross neglects were found for less than 4% of total practices rated, with the highest proportion found on American Indian and nonindustrial private forest lands. These departures were more frequently found in southeastern Minnesota compared to the northern forested areas of the state.
- Compliance with filter strip BMP recommendations across all forest landownerships averaged 91%, indicating that operators, resource managers and land owners are generally cautious when operating near water.
- Departures from BMP recommendations were common for water diversion devices and drainage structures on roads and skid trails. These practices are important because they influence the volume, velocity and direction of surface flow. Other groups of practices where departures were frequent were those related to rehabilitation and maintenance, water crossings, and the depositing of slash and logging debris into open water and wetlands. These practices accounted for 15% of total practices rated, but represented 45% of all departures identified. However, 75% of the departures for these practices were minor.
- Minnesota compliance rates are consistent with results reported nationally.

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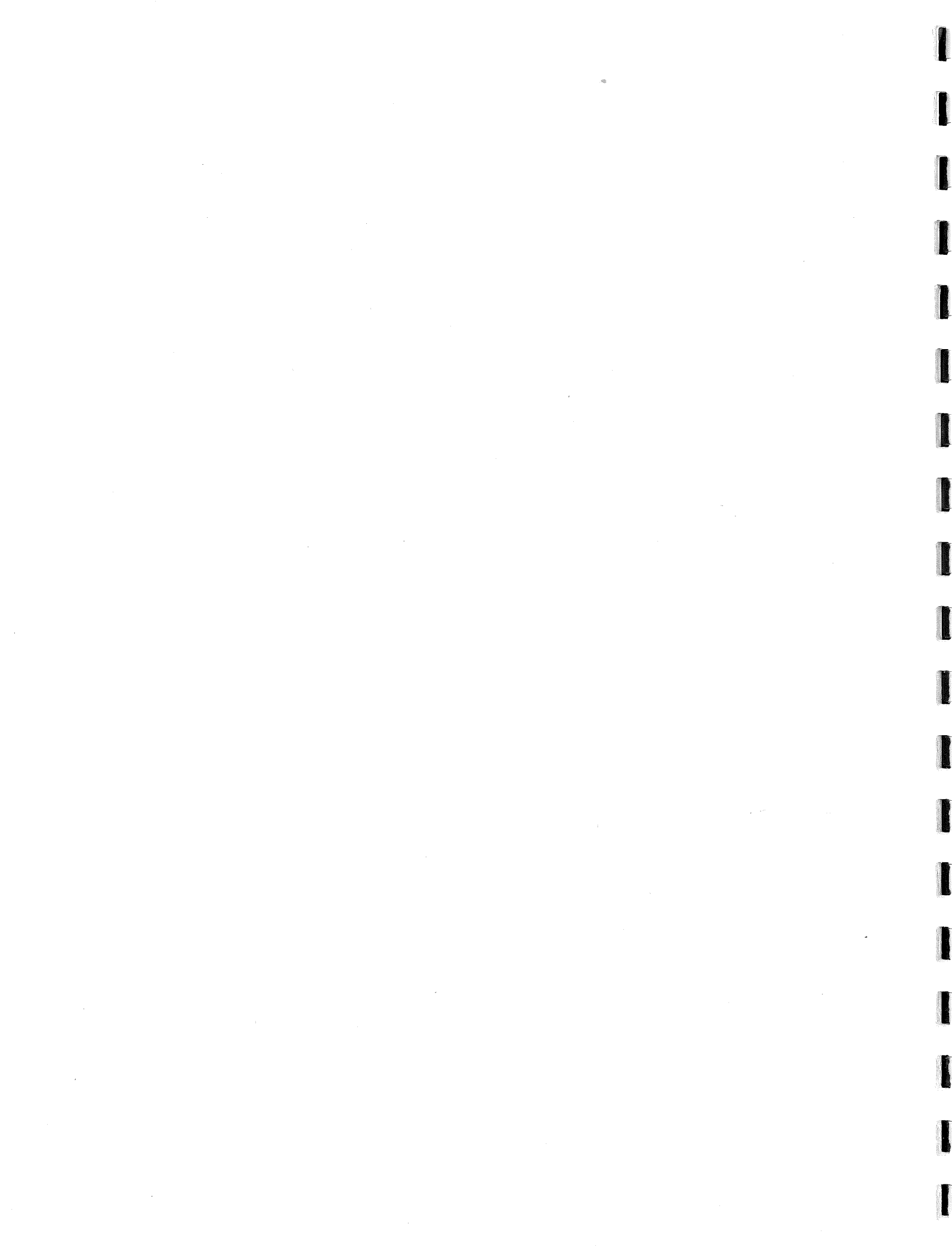
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## I. INTRODUCTION

Minnesota is blessed with vast acreages of forested land and plentiful, high quality water. Much of the abundance of high quality water originates from forests. These natural resources provide diverse ecosystems, unlimited recreational opportunities, and thousands of jobs. The bounty of lakes, streams and wetlands in Minnesota dictates that many forest management activities will occur adjacent to water. Minimizing the impacts of these activities on our water resources poses a special challenge to landowners, resource managers and operators.

Natural resource managers and the public continue to be concerned about the ecological and visual impact of forest management practices on the nation's water resources. The principal forestry water quality concern attributable to forest management operations is nonpoint source (NPS) pollution. The leading NPS pollutant is sediment contributed principally from the construction and use of logging roads and skid trails (Megahan 1972). Fire line construction, mechanical site preparation, and the application of pesticides and other chemicals are activities that also contribute sediment and other NPS pollutants.

Nonpoint source pollution from forest management activities differs from that generated by other land uses. With the exception of constructing and maintaining permanent roads and trails, forest management is characterized by short periods of intense activity followed by extended periods of minimal or no activity. Because of the dispersed nature of these activities and long rotations, NPS pollution problems are generally localized and short term (Curtis *et al.* 1990). However, sedimentation and other NPS problems associated with individual poorly designed or executed practices can cause significant and prolonged problems.

Water quality and forestry were linked with passage of the 1972 Federal Water Pollution Control Act (PL 92-500), commonly referred to as the Clean Water Act (CWA). For the first time, silvicultural or forest management activities were identified in federal water legislation. The 1972 Act and subsequent amendments served as the basis for current efforts to maintain and protect water quality. Specifically, Sections 208 and 404 of the 1972 Amendments to the CWA and Section 319 of the 1987 Amendments (PL 100-4) provided the framework for the development of state water quality protection programs for silvicultural activities.

Enacting Section 319 of the CWA established a comprehensive national program to control NPS pollution and, for the first time, made federal funding available to the states to control nonpoint sources. To be eligible for the funding, states were required to develop 1) an assessment report detailing the extent of NPS pollution problems and 2) a management program specifying NPS pollution controls to address those problems. This requirement included the development of Best Management Practices (BMPs) and programs to achieve implementation of BMPs.

Best Management Practices serve as the cornerstone for the water quality protection programs developed by most states (Boyette 1993). These programs have been shaped by the particular physiographic, economic, technical and political characteristics of each state. Nationally, silvicultural NPS management programs can be broadly characterized as voluntary to regulatory. Regardless of the degree of regulation, these programs rely on a variety of monitoring and implementation strategies (Brown *et al.* 1993).

Minnesota has adopted a voluntary BMP program. The Minnesota Department of Natural Resources, Division of Forestry (DOF) in concert with the forestry community have committed themselves to a sustained effort to ensure effective implementation. Starting in 1987, Minnesota's first step in the program was a broadly based cooperative effort to develop a set of forestry BMPs which were published in 1989. Following BMP adoption, attention focused on the major components of a BMP implementation program: education, technical assistance, monitoring and research.

Implementation or compliance monitoring is the glue that binds the BMP process together. The forestry profession in many states uses annual or biennial field audits or surveys to determine the degree of compliance with silvicultural BMPs and to help identify specific implementation and practice deficiencies (Boyette 1993, Conner *et al.* 1989, Rossman and Phillips 1992, Schultz 1990). Several key characteristics are common to an effective compliance monitoring program. Compliance monitoring (i.e. field audits) must be simple and provide for timely review of multiple sites. The audit process must be comprehensive and the results easily summarized and made available to interested individuals and organizations. The field audits should provide a qualitative measure of the effectiveness or inadequacy of specific practices. Finally, the audit process must be accomplished at reasonable cost.

Minnesota recognized the need to develop a field audit process that met the above criteria. It was also important that the process be viewed as credible by the public, the regulatory agencies, and the forestry community if it was to be an effective tool of management. The DOF developed and implemented a BMP compliance monitoring program in cooperation with the forestry community, the water quality agencies, and several public interest groups. This report summarizes the results of the 1991, 1992, and 1993 field audits. These form the baseline data against which future audits will be evaluated.

The field audit process was funded with 319 grants (\$58,000) from EPA through the Minnesota Pollution Control Agency (PCA) with assistance from the DOF (\$8,000), and from in-kind contributions by numerous public agency and industry professionals. The objectives of the field audits were to:

- 1) evaluate the level of BMP application for all forestry ownerships, i.e. state, federal, county, industrial private, nonindustrial private and American Indian

lands;

- 2) provide a qualitative assessment of BMP effectiveness;
- 3) identify necessary modifications of the BMPs; and
- 4) obtain adequate BMP application monitoring data to target future education efforts and technical assistance.

## **II. METHODS**

### **A. Development of Field Audit Process**

The forestry field audit process and procedures were developed by a DOF work group in consultation with the Pollution Control and other agencies, and representatives from the forestry community and public interest groups. The DOF work group was comprised of representatives from soils, utilization and marketing, and roads programs. The audit process was based on the design used by the Montana Department of State Lands (Schultz 1990). The principal functions of the work group were to:

- develop the field audit rating guide and forms.
- formulate criteria for site selection.
- recruit audit team members and alternates.
- organize a calibration (training) workshop for audit team members and alternates to ensure consistent application of rating standards.
- convene a "debriefing" meeting with representatives from organizations involved on the audit teams. The purpose of the meeting was to review results, evaluate the audit process from the previous field season, and recommend changes to field audit procedures.
- prepare reports on results from the field audits.
- modify the audit process as needed.

### **B. Audit Team Selection**

To implement a credible field audit program, it was essential that the audit teams be comprised of individuals with a broad range of interests and expertise in forestry issues. Representatives from federal, state and county agencies; forest industry; logging interests; forest landowner groups; the University of Minnesota; the public; and

environmental and conservation organizations were canvassed to participate on the audit teams either as members or alternates. From the respondents, efforts were made to ensure a diversity of interests on each audit team and to ensure that teams incorporated expertise in road engineering, soil science, hydrology, fisheries and forest management. Team leaders were staff from the DOF. Final selection of team members was the responsibility of the DOF work group.

The pilot audit process was field tested in 1991 (Rossman and Phillips 1992). Two teams consisting of six to eight members, were assigned to the southeastern and northeastern areas of the state. The audit process was expanded to four teams for the 1992 and 1993 field audits to provide coverage for the entire forested area of Minnesota. Individual teams were assigned to the southeastern, northeastern, north central, and northwestern areas of the state. See Appendix A for a complete list of agencies, organizations and companies represented.

The EPA 319 grants and state funds supporting the field audit process included funds to pay travel, food, and lodging expenses for all audit team members, and provided a \$50 per day stipend for those who volunteered to participate on their own time.

### **C. Site Selection**

Forest landownership in Minnesota is divided among six categories: state, county, federal, American Indian, private industrial (PI) and nonindustrial private forest (NIPF) landowners. Site selection among landowners was accomplished by soliciting state, county, and federal agencies, tribal land managers (BIA) and private industry to submit all timber harvest and site preparation projects that met the criteria in Section D below. Audit sites were randomly selected from those submitted. A minimum of 25 sites were selected for each audit area per year. In addition, several of the sites from the previous year were randomly selected for reaudits in 1992 and 1993. Reaudits provided the opportunity to observe whether the severity of impacts had increased or decreased and to evaluate the consistency of ratings.

There is not a method of identifying all potential audit sites on NIPF lands. The reporting of timber harvests to a state agency is not required in Minnesota. Private forest management specialists within the DOF and private industry and private forestry consultants were contacted to identify sales that they were involved with or had knowledge of, in their respective work areas. This method incorporated a potential bias in the selection process for NIPF landowners. Activities on NIPF lands where professional assistance was not utilized were underrepresented in the selection process. Identifying means to improve the selection of NIPF landowners is a priority for the audit process.

### **D. Site Selection Criteria**



Lakes, perennial streams, intermittent drainages and other water bodies are integral components of forests in Minnesota. Not all forest lands, however, are adjacent to water, and specific criteria were developed so that only sites in close proximity to open water or intermittent drainages would be audited. The following criteria were used to select audit sites:

- Areas harvested by clearcutting, site prepared using mechanical or mechanical and chemical means, or road projects designed for forest management. Selective harvest was included in southeastern Minnesota.
- Activities completed or closed since the previous April (for 1992 and 1993).
- Activities conducted within 200 feet of a lake, perennial or intermittent stream, or open water wetland (including beaver ponds).
- Forest management sites of at least 10 acres in northeastern Minnesota and 5 acres in southeastern Minnesota.
- Forest management sites located within one mile walk of a road (added for 1992 and 1993 audits).

Ownerships were audited in approximate proportion to the volume of timber harvested based on 1990 data (Minnesota DNR 1992).

#### **E. Audit Forms**

Audit forms were developed by the DOF. The forms listed the specific BMPs identified in the guidebook Water Quality in Forest Management: Best Management Practices in Minnesota. Ninety-six practices were incorporated in the 1991 forms. Based on the 1991 pilot study (Rossman and Phillips 1992) additions and modifications were made to the form resulting in 97 practices for the 1992 and 1993 worksheets.

Field audit sites were rated for:

- 1) applicability of each BMP to the site (yes or no),
- 2) whether the applicable BMPs were applied correctly (5-point scale), and
- 3) the observed effectiveness of BMP applications (6-point scale).

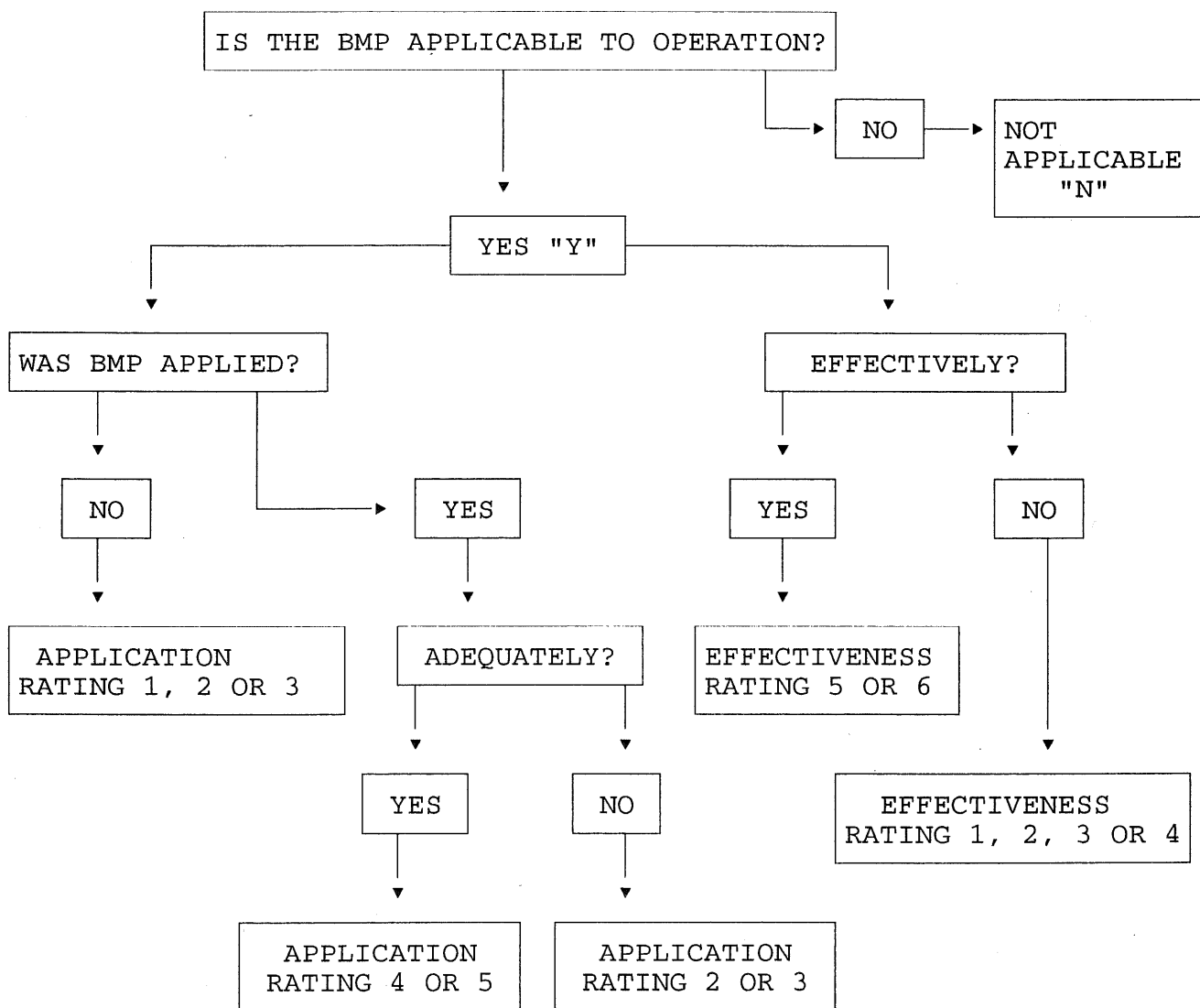
A lack of adequate application or misapplication was considered a departure from the BMP. Ratings for each BMP were determined by the consensus of the field audit team. A copy of the audit form is found in Appendix B. Modifications to the audit process and

audit forms over the three year period are given in Appendix C.

The decision matrix for evaluating on-site BMP compliance is given in Figure 1. If the specific BMP was applicable to the site, then the rating guide to determine the level of application of BMPs was:

- 5: operation exceeds requirement of BMP
- 4: operation meets requirement of BMP
- 3: minor departure from BMP
- 2: major departure from BMP
- 1: gross neglect of BMP

Figure 1. Decision matrix for on-site evaluation of BMP compliance.



Ratings 5 and 4 are self explanatory. Minor departures (rating 3) applied to those which were small in magnitude and localized. This rating was appropriate where the practice was not clearly needed, or was attempted but poorly applied, or had a small potential to impact water quality. Major departures applied where the practice was clearly needed, but where there was no attempt at application or where the BMP was consistently ignored. This rating applied where there was a large potential to impact water quality. Gross neglect (rating 1) applied where the potential risk to water resources was significant and direct with no apparent evidence that any attempt had been made by the operator to apply the BMP. This indicated the operators disregard for protecting water quality.

The effectiveness ratings provided a single, point-in-time, qualitative evaluation of how well the applied BMP was preventing the movement of sediment to water bodies or intermittent drainages. Less emphasis was placed on evaluating other nonpoint source components (e.g. nutrients, pesticides, increases in water temperature). The effectiveness ratings guide was:

- 6: improved protection of soil and water resources over pre-project condition
- 5: adequate protection of soil and water resources
- 4: indirect and temporary impacts on soil and water resources
- 3: direct and temporary impacts on soil and water resources
- 2: indirect and prolonged impacts on soil and water resources
- 1: direct and prolonged impacts on soil and water resources

The terms indirect and direct were used for the 1992 and 1993 field audits. They substituted for the terms minor and major, respectively, which were used in 1991 (Rossman and Phillips 1992). This change was needed to eliminate confusion with the application of the terms minor and major as used to rate the level of BMP application.

The terms for effectiveness are defined as follows:

Adequate: small amount of material eroded; material does not reach drainages, streams, lakes or open water wetlands.

Indirect: erosion and delivery of material to intermittent drainages or non open water wetlands, but not directly to streams, lakes or open water wetlands.

Direct: erosion and delivery of sediment directly to streams, lakes or open water wetlands. It should not be inferred that direct necessarily indicates a serious impact to water quality. The delivery of sediment could vary from small amounts to large quantities.

Temporary: impacts lasting one year or less; no more than one runoff

season.

Prolonged: impacts lasting more than one year.

The comments column was used to describe specifics related to departures and potential effects, and to further describe site characteristics. Attempts were made in the comments section to quantify impacts wherever possible. These comments served as background information to aid evaluation of the data.

#### **F. Supplemental Questions to the Field Audit Worksheet**

For the 1993 field audits, a supplemental questions page was added as an addendum to the field audit ratings form (see Appendix D). This additional field sheet was used to provide an overall evaluation of the forest management operation. When evaluating the sites, most of the time was spent reviewing the problems with the operation. The supplemental questions page provided an opportunity to assess the overall quality of the forest management operations, both good and bad, and to qualitatively assess the overall impact of the operations to water quality.

#### **G. Field Procedure for On-Site BMP Evaluation**

Prior to initiating the field audits, a two-day calibration workshop was held each year to familiarize the team members and alternates with the objectives and procedures of the field audits and to instill continuity among teams in rating audit sites. The calibration workshop consisted of a half day classroom session followed by a day and a half of field review and discussions. All team members were required to attend the calibration workshop in order to participate in the audits.

The on-site procedure followed by the field audit teams is given below.

1. Site characteristics and management activities were reviewed by the audit team leader. Team members were provided with maps, air photos, where available, and audit forms. Where possible, the landowner, site manager or logger provided additional background information on the forest management activities.
2. After the preliminary site overview, the team traversed the site as a group or as individuals checking for BMP application and effectiveness. Team members focused on potential impact areas such as roads, skid trails, and along streams, wetlands or lakes. Each team member was encouraged to make notes on their individual evaluation forms.
3. Once all team members had completed the examination of the site (generally one to three hours) the team reconvened at a central location to

discuss the site evaluation. The team leader lead the discussion in rating the site and filled out the evaluation worksheet. When auditing state administered land, the opportunity was given for someone from an organization other than the DOF to lead the discussion to dispel any potential bias in rating the site. Each rating was determined by group consensus and a single rating form was produced for each site.

## **H. Post Audit Review**

After completion of the field audits, each team leader was responsible for submitting the completed field audit sheets to the data manager. In most cases the team leader provided a copy of the field audit worksheet to the land owner or site administrator with a short description of the results of the audit team findings. Data from each field audit worksheet was entered into a relational database (R-base) for analysis. The data were analyzed and put into a preliminary report consisting primarily of tables reflecting BMP application and effectiveness. This preliminary report for each year was then distributed for discussion at the spring "debriefing" meeting typically held in March following the audits. This meeting served the purpose of not only reviewing the preliminary results but also of setting strategies for the following year's audits. Many of the changes to the field audit process were proposed during the "debriefing" meeting.

## **I. Limitations to Field Audits**

The limitations inherent in this type of process were articulated by Schultz (1990). The audits provided a point-in-time sampling which documented problems in the first or second year after a forest management operation when impacts were most likely to occur. However, the audits may not have identified problems that occurred during the operations themselves. The audits provided a visual evaluation of BMP use and a qualitative evaluation of BMP effectiveness based on a one-time observation of erosion and sediment movement.

On large sites, there was not always adequate time to review the entire site. In those cases, team members concentrated their review on the critical areas where potential problems were likely to occur.

Where subjective evaluation is the principal method of analysis, it is probable that some differences between teams will occur in rating specific practices. However, the two day calibration workshop and continuous dialogue among team members and between team leaders should have minimized such differences and provided continuity between teams in how to rate specific practices.

The creation of the site pool for selection of audit sites had two limitations. The first was the lack of records to identify sites on NIPF lands with no professional assistance. Over 40% of the forest land in Minnesota is owned by NIPF landowners.

Most timber harvest and other forest management activities on these lands take place with no public record of occurrence (Gathman *et al.* 1992). The selection process relied on the knowledge of field foresters and other cooperators. This provided a limited and incomplete listing of potential sites to select from.

The second limitation was the reliance on each agency to provide "in good faith" a complete list of all sites that met the selection criteria. Although the cooperation has been good, this is an area subject to criticism because the DOF could not verify that all projects meeting the site selection criteria were submitted. It is in the interest of the professional forest community to maintain the credibility of the field audit process by submitting all projects that meet the site selection criteria. The uncertainties in submitting sites support the need to improve the site selection process.

### III. RESULTS AND DISCUSSION

#### A. Distribution of Field Audit Sites

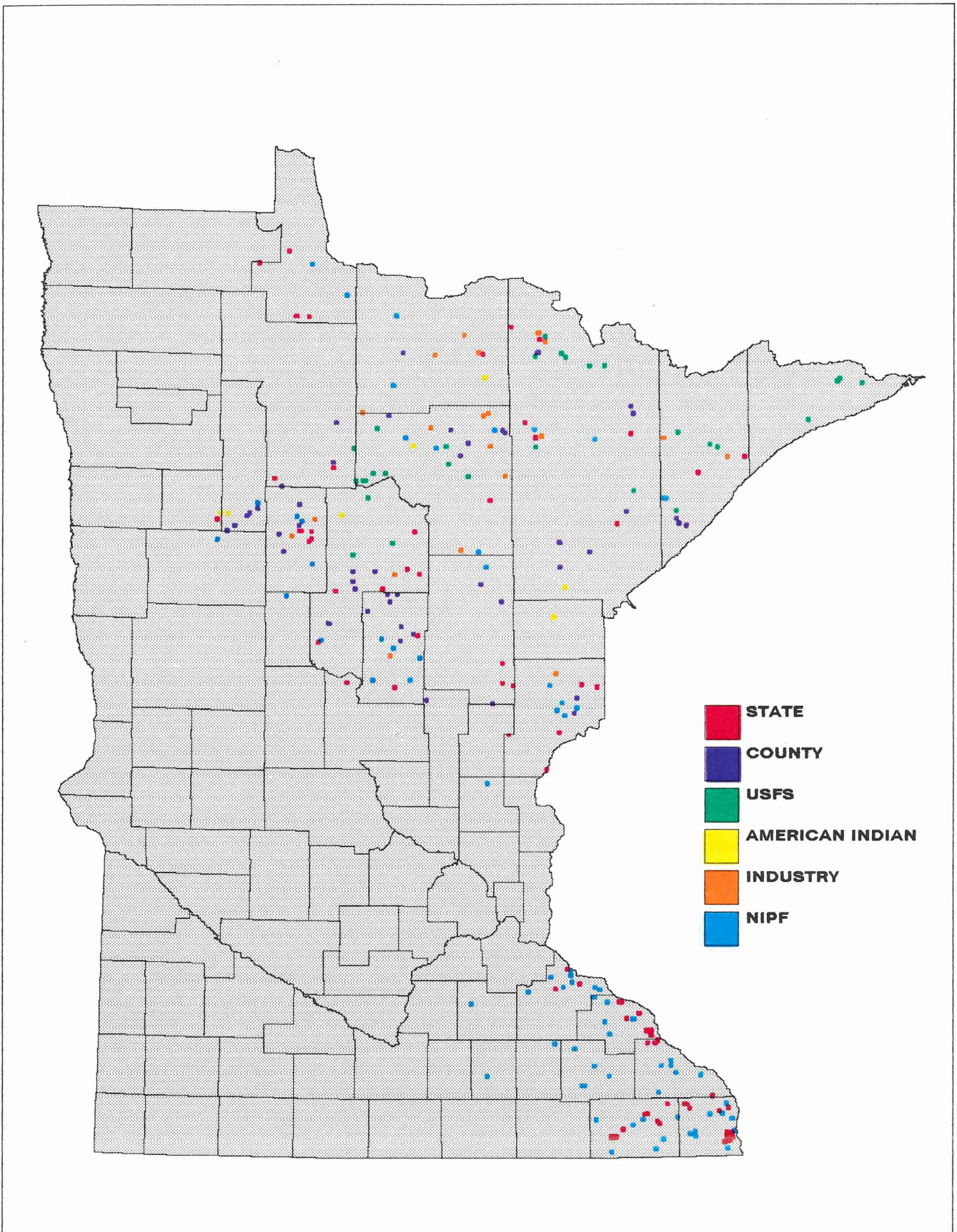
From 1991 to 1993, 261 individual forest management sites were audited for compliance with BMPs (Table 1). These sites were distributed over the forested area of Minnesota (Figure 2 and Appendix E) with the highest proportion of sites located in the northeastern and southeastern forested regions (Table 2). The number of sites audited by landowner type was generally proportional to the volume of timber harvested for each landowner type (Figure 3) based on 1990 data (Minnesota DNR 1992). The majority of field audits were conducted on state (29%) and NIPF (29%) ownerships.

The number of sites audited by region, however, was not proportional to each regions contribution to the total statewide harvest. Although southeastern Minnesota accounted for only 3% of the statewide harvest volume (Minnesota DNR 1992), the proportion of sites audited for this region was 31% (Table 2). A deliberate decision was

**Table 1. Annual field audits completed for each landowner type.**

Landowner Type	Year			Total
	1991	1992	1993	
State	17	36	23	76
County	4	24	23	51
US Forest Service	5	12	11	28
American Indian	-	3	5	8
Private Industrial	5	9	8	22
NIPF	17	26	33	76
Total Sites	48	110	103	261

Figure 2. Statewide distribution of forestry field audit sites from 1991 - 1993



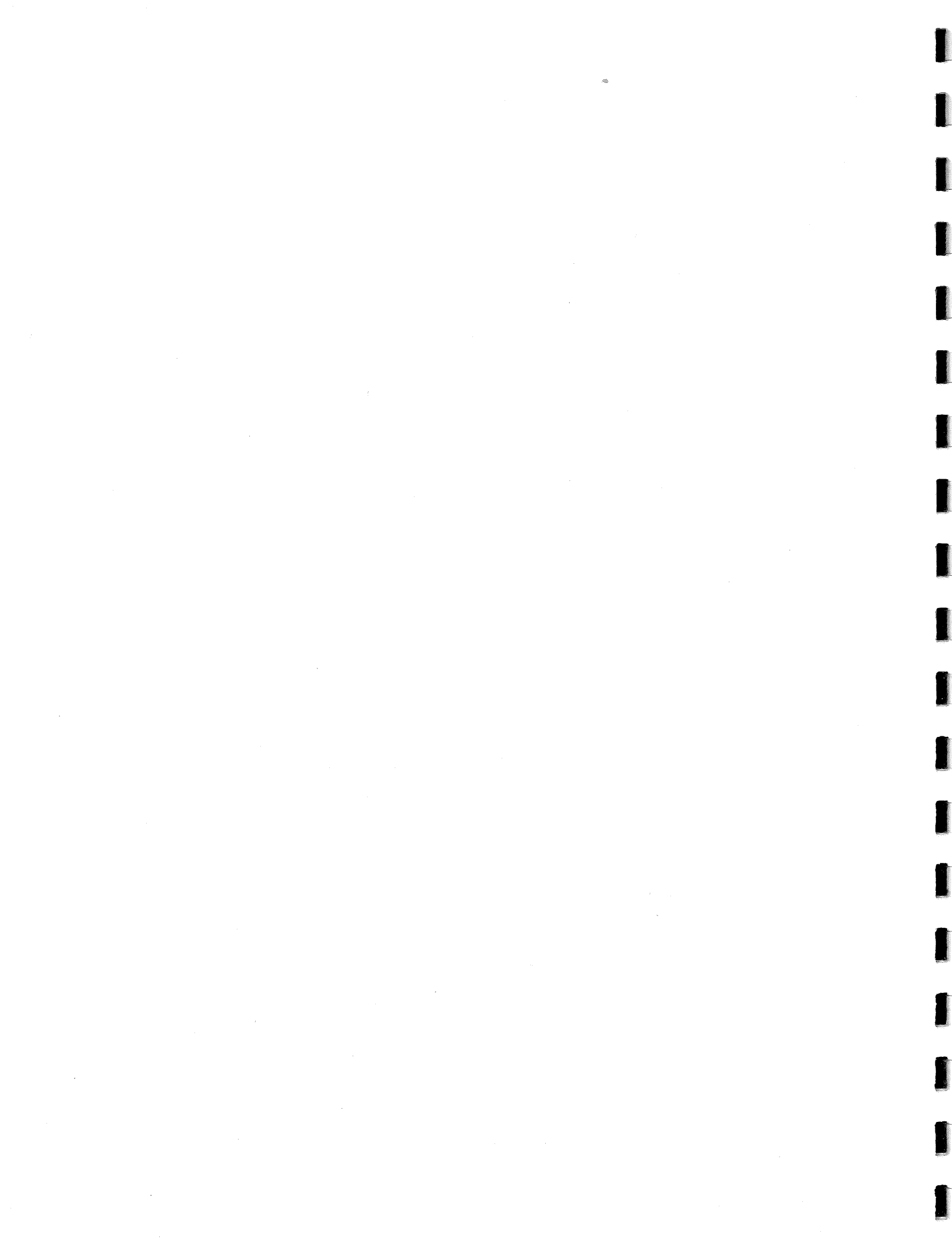
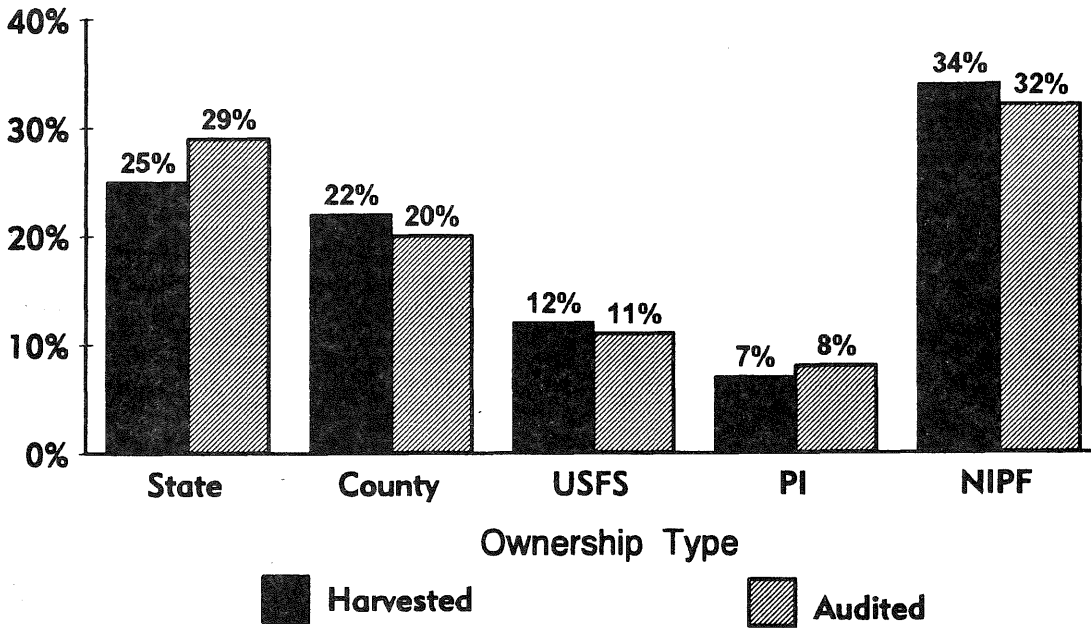




Figure 3. Comparison of the percentage of sites audited to the percentage of total state harvest volume by landowner type.



NIPF lands include American Indian Lands

Table 2. Field audits completed by region for each landowner type.

Landowner Type	Number of Sites Audited				
	Northwest	Northeast	Central	Southeast	Total
State	10	14	16	36	76
County	13	20	18	-	51
US Forest Service	10	18	-	-	28
American Indian	4	4	-	-	8
Private Industrial	6	13	3	-	22
NIPF	9	8	14	45	76
Total Sites	52	77	51	81	261

made to target this region for increased audits because the steep topography and erodible soils created a higher risk of water quality impacts compared to other regions.

Southeastern Minnesota had a proportionally higher number of field audits as this region was also selected as one of two sampling regions for the first year of audits.

Rating a site often involved evaluating more than one specific category of forest management activity (Table 3). In particular, timber harvesting, forest road activities and fuel, lubricant and equipment management (general category) were commonly rated for the same site.

**Table 3. Number of field sites audited for each forest management activity by landowner type.**

Landowner Type	Forest Management Activities					
	General	Forest Roads	Timber Harvest	Site Preparation	Pesticide Use	Prescribed Burning
State	70	40	57	21	17	4
County	48	37	51	2	1	1
US Forest Service	28	25	28	1	-	1
American Indian	8	7	7	1	-	2
Private Industrial	22	18	21	5	1	7
NIPF	66	36	66	4	10	2
All Sites	242	163	230	34	29	17

## B. Statewide Application of BMPs

A total of 5707 individual practices were rated on 261 sites during the first three years of field audits (Table 4). Individual sites were rated for each BMP practice observed or determined to be appropriate for the site from a list of practices identified on the rating form (Appendix B). On average, 22 practices were applicable per site, ranging from 19 to 28 practices per site for state lands and US Forest Service (USFS) lands, respectively (Table 5). The low average for state lands was a consequence of the majority of sites rated for pesticide application occurring on state administered lands (Table 3). Pesticide application sites typically had fewer BMPs rated per site. The number of BMP practices rated on USFS lands was higher than for other landowner types because roads were more frequently associated with activities rated on USFS lands (25 of 28 sites). Forest roads had the highest number of BMP practices identified of any category of activity.

Best management practice requirements across all ownerships were met or exceeded 84% of the time. Minnesota's audit results are consistent with those from other states (Conner *et al.* 1989, Schultz 1990). Compliance ranged from a high of 90% for county and private industrial (PI) lands to a low of 75% for American Indian lands (Table 4). Compliance levels on American Indian lands were similar to those found for NIPF lands. Sample size was limited (8 sites) on American Indian lands. The results for the NIPF and American Indian lands indicates the need to target education efforts and technical assistance to these landowner types.

**Table 4. Level of compliance with BMP recommendations for each landowner type statewide.**

Landowner Type	Number of Practices Rated	Level of BMP Application by Rating Category (Percent)			
		Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
State	1,451	85	13	2	<1
County	1,230	90	9	1	-
US Forest Service	795	87	11	2	-
American Indian	189	75	18	7	-
Private Industrial	523	90	9	<1	-
NIPF	1,519	77	15	7	1
All Sites	5,707	84	12	3	<1

**Table 5. Percentage of sites with departures in each ratings category for each landowner type.**

Landowner Type	Number of Sites	Practices Rated/Site (Mean)	Percent of Sites With Departures			
			No Departures	Minor Departures	Major Departures	Gross Neglect
State	76	19	26	74	18	3
County	51	24	27	69	16	-
US Forest Service	28	28	11	86	29	-
American Indian	8	24	-	100	50	-
Private Industrial	22	24	23	77	5	-
NIPF	76	20	13	75	41	9
Totals	261	22	20	76	25	3

The level of compliance by landowner type decreased in the order:

*county = PI > USFS > state > NIPF > American Indian*

These results indicate that compliance with forestry BMPs is relatively high, especially for state, county, USFS and PI lands. Possible reasons for state and USFS lands having lower compliance levels compared to county and private industry lands include: 1) less opportunity under existing state and federal contracting procedures to be selective in choosing loggers, 2) larger bureaucracies having less direct oversight of field foresters to ensure uniformity of contracts, 3) more diverse workloads on state and federal lands which may reduce time available to oversee contracts, and 4) contract loggers on private industrial lands may have a financial advantage or incentive to apply BMPs.

Where BMP requirements were not met, the vast majority of departures were minor (Table 4). Major departures and gross neglects were found for less than 4% of practices rated, with the highest proportion occurring on NIPF and American Indian lands. Gross neglects were confined to 2 sites on state lands and on 7 sites for NIPF lands. Of the 26 practices rated as gross neglects, 17 occurred on the 2 NIPF sites in southeastern Minnesota. The few sites where gross neglects were identified suggests that this level of disregard is confined to isolated cases.

Of the 261 sites audited, 52 or 20% were found to have no departures from BMP requirements (Table 5). The majority of sites (198 or 76%) reviewed had at least one minor departure, and more than one quarter (73 or 28%) of the sites had at least one major departure or gross neglect.

The BMP field audit results by geographic region are presented in Table 6. The average level of BMP compliance across all landowner types was similar for the three northern regions. The compliance level for southeastern Minnesota was lower which reflected the steeper and more difficult operating terrain common to that region of the state. Major departures and gross neglects were more frequent in southeastern Minnesota than the other forested regions of the state. It was previously mentioned that a higher proportion of sites were audited in southeastern Minnesota relative to that region's contribution to total statewide harvest activity. This intensity of sampling in southeastern Minnesota likely skewed the statewide compliance levels downward.

The majority of practices rated (92%) were associated with timber harvesting and forest road development (Table 7). Activities associated with mechanical site preparation and general management (e.g. fuel, lubricant and equipment management) accounted for most of the remaining activities rated. Few practices were rated for activities associated with pesticide use and prescribed burning.

Auditing pesticide applications was mostly confined to sites in southeastern Minnesota. Prescribed burns audited in southeastern Minnesota were broadcast burns

**Table 6. Regional compliance with BMP recommendations for each landowner type.**

Audit Region		Number of Practices Rated	Level of BMP Application by Rating Category (Percent)			
			Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
NW	State	316	84	13	3	-
	County	327	91	7	2	-
	US Forest Service	248	92	7	1	-
	American Indian	88	74	16	10	-
	Private Industrial	141	91	8	1	-
	NIPF	171	91	5	4	-
	Totals	1,291	88	9	3	-
NE	State	293	90	9	1	-
	County	529	91	8	1	-
	US Forest Service	547	85	13	2	-
	American Indian	101	75	20	5	-
	Private Industrial	326	89	11	-	-
	NIPF	235	81	13	6	-
	Totals	2,031	87	11	2	-
NC	State	301	87	12	1	-
	County	374	87	12	1	-
	Private Industrial	56	98	2	-	-
	NIPF	229	81	16	3	<1
	Totals	960	86	12	1	<1
SE	State	541	82	15	3	<1
	NIPF	884	72	17	9	2
	Totals	1,425	76	16	6	2
Statewide Totals		5,707	84	12	3	<1

and associated activities such as fire line construction. Prescribed burns audited in the northern regions were primarily confined to slash piling and burning where the principal BMP concern was placement of the slash piles. Compliance levels for these activities must be viewed with caution due to small sample size.

### C. Application of Specific BMPs

Proper application of BMPs by a landowner, resource manager or operator requires the selection and installation of appropriate BMPs that collectively prevent or minimize impacts to water quality from NPS pollution. The previous sections summarized the overall compliance levels with BMP requirements. While each of these BMPs provides a degree of protection, arguably not all BMPs provide the same degree of direct protection to water quality. "Obtaining proper permits" for water crossings or prescribed burning has less direct impact to water quality than "installing water diversion devices on road surfaces" or "draining surface water into filter strips or vegetative draws".

Those BMPs which provide the most direct protection to water quality need to be identified and monitored most closely. The BMPs which fit this category in the judgement of the authors are: 1) the use of filter strips, and 2) those critical to reducing the direct addition or delivery of sediments and other NPS pollutants to water bodies. The BMPs which fall in the second category, identified as critical BMPs, were selected by the authors. Others reviewing the results could debate the relative importance of these compared to other specific BMPs.

**Table 7. Level of compliance with BMP recommendations for each of the forest management activities audited.**

Forest Management Activities	Number of Practices Rated	Level of BMP Application by Rating Category (Percent)			
		Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
General*	243	78	20	2	<1
Forest Roads	1,959	84	13	3	<1
Timber Harvest	3,302	85	11	3	1
Site Prep	134	92	7	1	-
Pesticides Used	28	75	18	7	-
Prescribed Burning	41	78	20	2	-

\* Refers to general management categories on audit worksheet. See Appendix B.

**Table 8. Application of specific filter strip BMPs statewide.**

Filter Strip Practices		Number of Practices Rated	Level of BMP Application by Rating Category (Percent)			
Line No.	Specific BMPs		Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
ROADS*						
2E1**	Filter strip width	113	89	10	1	-
2E2	Filter strip disturbance	106	96	3	1	-
2E3	Filter strip slash disposal	99	94	5	1	-
TIMBER HARVEST						
11C	Minimize mineral soil exposure in filter strip	218	97	3	<1	-
13B	Locate skid trails outside of filter strips	220	85	11	4	-
14B	Locate landings outside of filter strip	207	90	7	3	-
SITE PREPARATION						
15B	Provide adequate filter strips for site preparation	31	87	13	-	-
PRESCRIBED BURNING						
18C	Establish filter strips for fire lines	3	100	-	-	-
18D	Avoid placement of debris piles for burning in filter strips or sensitive areas	14	50	43	7	-
All Practices		1,011	91	7	2	-

\*Refers to general categories on the audit worksheet. See Appendix B.

\*\*Refers to line numbers on the audit worksheet. See Appendix B.

**1. Filter Strip BMPs**

Nine specific BMPs were related to filter strips (Table 8). These BMPs accounted for approximately 18% of all BMP practices rated. Overall compliance was high for each of the landowner types (Table 9) and for individual filter strip BMPs (Table 8). The importance of minimizing disturbance near open water is apparently well understood and respected. Where departures were found, the majority were minor in nature and tended to occur adjacent to small open water wetlands.

**Table 9. Application of filter strip BMPs by landowner type statewide.**

Landowner Type	Number of Practices Rated	Level of BMP Applications by Rating Category (Percent)			
		Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
State	267	87	12	1	-
County	222	97	3	-	-
US Forest Service	137	98	1	1	-
American Indian	32	91	3	6	-
Private Industrial	108	95	5	-	-
NIPF	245	84	11	5	-
All Sites	1,011	91	7	2	-

The placement of debris piles for burning was the only filter strip related BMP with a high percentage of departures (Table 8) and accounted for most of the departures found for prescribed burning (Table 7). However, this practice was rated only a few times. Corrective action to improve compliance for this BMP should be relatively easy to accomplish through education of loggers and resource managers and through specifications in contract language.

Few regional patterns were evident in the application of filter strip BMPs (Table 10). Of the three northern regions, the north central region had the lowest level of compliance with filter strip BMP requirements. Compliance on state lands was particularly low for this region, primarily due to skid trail intrusion into filter strips. For the southeastern region, compliance with filter strip BMPs was substantially below levels found for the three northern regions. The steep terrain increased the occurrence of intermittent drainages and required wider filter strips and, thus, increased the likelihood of an infraction occurring. However, the majority of departures (35 of 47) for the southeastern region were minor.

## **2. Critical BMPs**

The critical BMPs were those that modified activities adjacent to water bodies (e.g. avoid activity below ordinary high water mark) and those that influenced the volume, velocity and direction of surface water flow (e.g. install water diversion devices on roads and skid trails). Compliance levels for the critical BMPs are presented in Table 11. The overall compliance level for critical BMPs was 77%, substantially lower than that for filter strip BMPs (Table 9).



**Table 10. Regional application of filter strip BMPs by landowner type.**

Audit Region		Number of Practices Rated	Level of BMP Application by Rating Category (Percent)			
			Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
NW	State	67	93	7	-	-
	County	75	99	1	-	-
	US Forest Service	46	98	-	2	-
	American Indian	17	100	-	-	-
	Private Industrial	35	97	3	-	-
	NIPF	36	94	6	-	-
	Totals	276	96	3	<1	-
NE	State	58	95	3	2	-
	County	89	97	3	-	-
	US Forest Service	91	98	2	-	-
	American Indian	15	80	7	13	-
	Private Industrial	63	95	5	-	-
	NIPF	40	88	7	5	-
	Totals	356	95	4	1	-
NC	State	56	82	18	-	-
	County	58	97	3	-	-
	Private Industrial	10	90	10	-	-
	NIPF	39	87	10	3	-
	Totals	163	89	10	1	-
SE	State	86	79	17	4	-
	NIPF	130	78	15	7	-
	Totals	216	79	16	5	-
Statewide Totals		1,011	91	7	2	-

**Table 11. Application of specific critical BMPs statewide.**

Critical Practices		Number of Times Practice Rated	Level of BMP Application by Rating Category (Percent)			
Line No.	Specific BMPs		Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
1a	Adequate storage and disposal for fuel, debris, lubricants.....	243	78	20	2	<1
2b	Minimize number of water crossings	85	96	4	-	-
2d	Avoid activity below OHW	89	97	3	-	-
4c	Temporary/winter crossings removed prior to breakup	14	64	29	7	-
5a	Culverts properly sized and installed	30	67	23	10	-
5c1 5c2 5c3 5c4	Install water diversion devices on road surfaces: broad base dips; open culverts; water bars	64	27	56	17	-
5d	Drain surface water into filter strip or vegetative draw	85	81	11	8	-
5e1 5e2 5e3	Design ditches to avoid carrying water long distances: lead-offs; cross culverts; cross drains	33	61	27	12	-
9a 10a	Properly close occasional use and abandoned roads when not in use	94	74	22	3	1
9c 10c	Proper water diversion devices on occasional use and abandoned roads	30	60	33	7	-
13c	Design skid trails to avoid concentrating runoff	196	88	8	2	2
13d1-4	Install water diversion devices on skid trails	73	22	52	18	8
13e 14g	Drain surface water from skid trails and landings into vegetative draw	183	92	4	2	1
13i	Minimize number of skid trail water crossings	69	87	13	-	-
13l	Temporary/winter skid trail crossings removed prior to spring breakup	13	54	31	8	8
All Practices		1,301	77	17	5	1

The critical BMP most commonly rated was the management of fuel, lubricant and debris. The procedures for the storage and disposal of these products were mostly adequate. Instances were noted where maintenance debris (e.g. oil filters, lubricant containers) were left on site. Most of the departures were related to small spills or leaks. Under the rules for conducting the audits, finding any evidence of even a small spill was considered to be a minor departure. One gross neglect rating did occur where engine oil was drained onto a landing located in a wetland.

The forestry community was essentially in compliance with BMPs that modified practices adjacent to water (lines 2b, 2d and 13i, Table 11). This provided additional support to the view expressed in the filter strip discussion that the forestry community is generally cautious when operating adjacent to surface waters.

A notable problem area for the application of critical BMPs was the installation of water diversion devices on roads and skid trails. These included broad based dips, open top culverts and water bars. The installation of water diversion devices on roads and skid trails met the BMP requirements only 27% and 22% of the time, respectively. Water diversion devices on occasional use and abandoned roads were properly installed more often. A significant proportion (41%) of the major departures and gross neglects for the critical BMPs were related to deficiencies in the use of water diversion devices.

The removal of temporary crossings prior to spring breakup for roads and skid trails was another problem area. While rated relatively few times, the results indicate that removal of temporary crossings is an opportunity to improve compliance.

The application of critical BMPs by landowner type is shown in Table 12. The highest level of compliance was found for PI lands. Lowest levels of compliance were found for NIPF and American Indian lands. While minor departures were common for all landowner types, major departures were most frequently found on NIPF and American Indian lands. No major departures for critical BMPs were found for county or PI lands. The application of critical BMPs was similar between the northern regions (Table 13), but lower for southeastern Minnesota where a higher percentage of the sites audited occurred on NIPF lands.

#### **D. Frequent Departures from BMPs**

An effective BMP implementation program requires an evaluation of the extent to which the appropriate BMPs are utilized. It is also necessary to identify the consistent deficiencies in the application of BMPs so that limited resources, technical assistance and education efforts can be targeted to specific problem areas. Specific BMPs for which departures were rated at least 33% of the time are shown in Table 14. These BMPs represented only 15% of the practices rated, but accounted for 45% of all departures. Although the number of departures for these specific BMPs are a concern, the majority of departures were minor which suggests that the problems are correctable.

**Table 12. Application of critical BMPs by landowner type statewide.**

Landowner Type	Number of Practices Rated	Level of BMP Application by Rating Category (Percent)			
		Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
State	327	79	17	3	<1
County	266	81	19	-	-
US Forest Service	178	80	16	3	-
American Indian	47	68	23	9	-
Private Industrial	113	88	12	-	-
NIPF	370	69	17	10	4
Statewide	1,301	77	17	5	1

The BMPs rated with departures greater than 33% are grouped into five categories of practices for discussion purposes.

### **1. Water Crossings and Drainage Structures**

Water crossings and drainage structures are identified by lines 3D, 5A, 5B, 5E1 and 13M (Table 14). These BMPs were rated 97 times, and departures were found 42% of the time. Although the majority of departures were minor, a significant number (17 of 42) were major departures or gross neglects. These practices were generally installed in direct contact with water. When working in direct contact with water there is a high probability that improper installation will result in impacts to water quality. Because of the high potential for impact there is a need for increased emphasis on education to improve performance in the application of these practices.

### **2. Water Diversion Devices**

Departures from BMP requirements were commonly found for water diversion devices (lines 5c2, 5c3, 5c4, 9C, 10C, 13D1, 13D3, and 13D4). The majority of departures were minor (73%). Most of the major departures and gross neglects (19 of 32) were related to skid trails. Special emphasis on skid trails is clearly justified based on the numbers of major departures and gross neglects. Emphasis on the proper installation of water diversion devices is an education priority.

### **3. Depositing Slash**

Avoidance of depositing slash and logging debris in streams, lakes or wetlands (lines 11D and 11E, Table 14) represents 6% of the total practices rated, but accounted for 13% of the total departures. The majority of these departures (86 of 118) were minor.

**Table 13. Regional application of critical BMPs by landowner type.**

Audit Region		Number of Practices Rated	Level of BMP Application by Rating Category (Percent)			
			Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
NW	State	73	71	25	4	-
	County	61	85	15	-	-
	US Forest Service	57	96	4	-	-
	American Indian	19	63	26	11	-
	Private Industrial	35	91	9	-	-
	NIPF	31	84	6	10	-
	Totals	276	83	14	3	-
NE	State	50	84	16	-	-
	County	122	83	17	-	-
	US Forest Service	121	73	22	5	-
	American Indian	28	71	21	7	-
	Private Industrial	65	83	17	-	-
	NIPF	54	72	20	7	-
	Totals	440	78	19	3	-
NC	State	64	83	17	-	-
	County	83	76	24	-	-
	Private Industrial	13	100	-	-	-
	NIPF	51	73	20	6	2
	Totals	211	79	19	1	<1
SE	State	140	80	14	5	1
	NIPF	234	65	18	12	6
	Totals	374	71	16	9	4
Statewide Totals		1,301	77	17	5	1

**Table 14. Application of BMPs where departures were found to equal or exceed 33 percent.**

Line No.	Specific BMPs	Number of Times Rated	Departures (Percent)	# of Departures		
				Minor	Major	Gross
3D	Low water crossings constructed of non-erosive and stable material	13	38	3	2	-
4C	Temp/winter roads removed prior to spring breakup	14	36	4	1	-
5A	Culverts properly sized and installed	30	33	7	3	-
5B	Culverts properly armored	11	55	3	3	-
5c2	Water diversion on roads: open culverts	7	86	4	2	-
5c3	Water diversion on roads: water bars	35	91	25	7	-
5c4	Water diversion on roads: outsloping	8	50	2	2	-
5E1	Lead-offs	18	67	8	4	-
6B	Shape inslopes and backslopes to 1 1/2:1 or flatter	45	38	17	-	-
6E	Shape and stabilize borrow pits	16	44	7	-	-
7C	Stabilize erodable soils by seeding	35	34	11	1	-
9C	Proper water diversion devices on occasional use roads	18	45	6	2	-
10C	Proper water diversion devices in working order on abandoned roads	12	33	4	-	-
11D	Streams, lakes, wetlands free of debris	199	37	53	19	1
11E	Avoid felling timber into nonforested wetlands	135	33	33	12	-
11G	Erosion barriers properly maintained	12	50	5	1	-
13D1	Water diversion on skid trails: Broad base dips and grade rolls	8	62	2	2	1
13D3	Water bars	56	80	32	9	4
13D4	Outsloping	8	87	4	2	1
13G	Shape inslopes and backslopes of skid trails	22	73	16	-	-
13H	Remove berms from skid trails	28	54	10	5	-
13L	Temp/winter crossing removed prior to breakup	13	46	4	1	1
13M	Temporary crossings properly located and installed	25	36	4	4	1
13N	Rehabilitate skid trails	86	48	31	8	2
18A	Locate fire lines on contour	3	67	2	-	-
18D	Avoid placement of debris piles for burning in filter strips or sensitive areas	14	50	6	1	-

However, few issues have generated as much comment and discussion as the placement of logging debris and slash in streams, lakes and wetlands. Departures for these BMPs were common although the majority were minor (73%). The high level of departures for these BMPs reflected disagreement or a lack of acceptance by landowners, loggers and resource managers that there was a problem in not removing these materials once they were deposited in sensitive areas. Many of these individuals expressed the view that a case had not been made that this was a significant problem. Improvements in compliance are achievable through education, specifications in contract language, and by more clearly defining what material should be removed. Increased implementation for these BMPs also provides a cost-effective opportunity to obtain progressive improvement in overall BMP compliance.

#### **4. *Rehabilitation and Maintenance***

Departures were common for BMPs related to rehabilitation and maintenance of forest roads and skid trails (lines 4C, 6B, 6E, 7C, 11G, 13G, 13H, 13L, and 13N, Table 14). For these specific BMPs, departures were found 46% of the time. However, a majority of these departures (107 of 122) were minor.

The BMPs for shaping inslopes and backslopes (lines 6B and 13g) were modified for the third year of field audits. In 1991 and 1992, all backslopes greater than 1.5 or flatter were rated as departures. For 1993, the general consensus was that on steeper slopes, it was impractical to shape to the BMP requirement without causing unacceptable exposure of bare soil. This change in evaluating the BMP was supported by the data which showed that the majority of departures (88%) had no observable impact to water quality.

#### **5. *Prescribed Burning***

Prescribed burning was rated a limited number of times. Departures were common for two of the prescribed burning BMPs (lines 18A and 18D) although all but one of the departures were minor. Improvement in compliance for these practices is easily achievable.

#### **E. *Compliance on NIPF Lands***

Results for the NIPF landowners were analyzed based on whether or not individual landowners received professional management assistance (Table 15). For monitoring purposes, professional assistance was defined broadly to include: verbal assistance, brief written plan, stewardship plan, cost-share assistance, and full oversight of forest practices by a professional forester.

On NIPF lands, BMP compliance poses a special challenge for the BMP program. It is not known how many of Minnesota's 130,000 NIPF landowners receive professional

**Table 15. Level of compliance with BMP recommendations for NIPF landowners who received professional forestry assistance compared to those who received no assistance.**

Level of Forester Assistance	Number of Sites	Number of Practices Rated	Level of BMP Application by Rating Category (Percent)			
			Meets or Exceeds	Minor Departure	Major Departure	Gross Neglect
No Assistance	24	485	73	16	11	<1
Forester Assisted*	52	1,034	79	14	5	2
All NIPF Sites	76	1,519	77	15	7	1

\*Forester-assisted sites included those sites that received any assistance from a professional forester (e.g., state, industry, consultant). This assistance ranged from verbal assistance and a brief plan to having the forester administer the entire project.

management assistance in a given year. The DNR estimates that only 15% to 20% of all NIPF landowners receive professional assistance in managing forestry operations on their lands (Tom Kroll, pers. comm.; Gathman *et al.* 1992). It is relatively easy to identify NIPF landowners who receive professional assistance. It is much more problematic identifying those receiving no assistance. Obtaining a more representative sample of NIPF landowners is the critical need to improve the design of the field audit process. Under consideration is the use of aerial photography, satellite imagery and intensive ground surveys in selected geographic locations.

Approximately two thirds of the NIPF sites audited received some type of professional management assistance (Table 15). The higher proportion of sites audited where professional assistance was used greatly exceeded the proportion that is estimated to receive assistance in a given year. Future audits should reflect the correct proportion of assisted to unassisted sites.

There was little apparent difference in BMP compliance levels between NIPF landowners who received professional management assistance and those who did not. When developing the field audit system, it was assumed that NIPF landowners who received professional management assistance would have a higher compliance level with BMPs. The theory was that these NIPF landowners would be better informed of practices needed to protect water quality and would have more of a conservation ethic. There are several probable reasons for the apparent lack of a major difference in compliance rates between assisted and unassisted NIPF operations. The definitions of what constituted professional forestry assistance may have been too broad. It could not be determined if: 1) the forest professional communicated the need to include BMPs in the management



prescription, 2) the landowner chose to use the advice provided by the forester, or 3) the operator modified BMP recommendations provided by the forester. On NIPF lands, a professional forester often provides advice and makes recommendations but may not control the actual operations on the ground. Future audits should clarify whether professional forestry assistance included BMP recommendations as well as the extent to which these recommendations were followed.

#### **F. Effectiveness of BMPs**

The effectiveness rating provided a point-in-time qualitative measure of the degree of protection to water resources. What was being evaluated was the erosion and sediment movement to intermittent drainages and perennial water courses and deposition of slash and logging debris into water and wetlands (see Methods, Section E). This was generally a post-operation evaluation where impacts were observed one year after activities were complete. An obvious weakness in the methodology is that impacts that occurred during operations were not evaluated unless evidence of the impacts was still visible one year later. Given the limited funding and personnel available, evaluating operations after completion was the preferred sampling time.

Table 16 provides a summary of the effectiveness for all practices rated by landowner type. Statewide, 92% of the practices rated statewide provided adequate protection. This level of protection exceeded the percentage of practices which met or exceeded the BMP requirement (Table 4). This effect is shown in Figure 4. Where application met or exceeded the BMP requirement, adequate protection was provided in 99% of the cases. Even where minor departures were found, adequate protection was provided 60% of the time. What this indicated was that adequate protection was provided even where departures occurred. However, where major departures were noted, a substantial increase in major long term impacts were found. Where the BMPs were followed, they appeared to work, and the magnitude of the impact to water quality increased with the extent to which the BMP requirements were ignored or not followed.

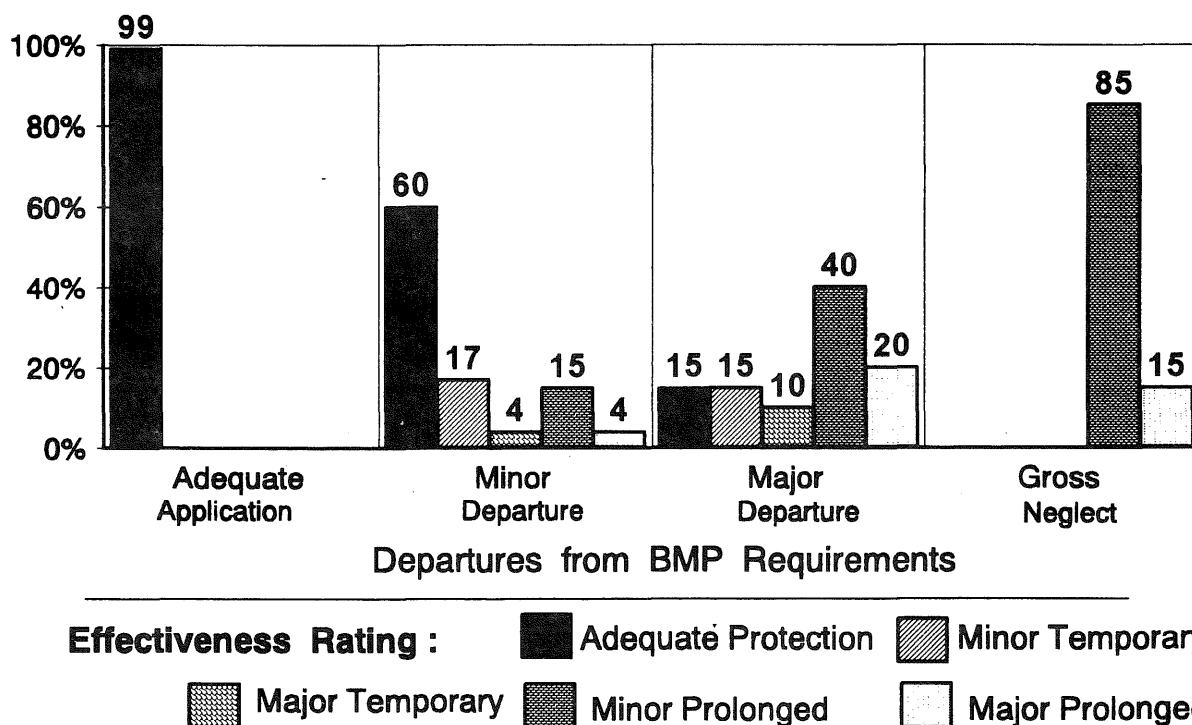
#### **G. Audit Site Revisits**

In 1992 and 1993, reaudits were conducted on 12 sites that had been audited the previous year. Reaudits provided an opportunity to evaluate consistencies of ratings and to observe whether the severity of impacts increased or decreased. However, there was not always consistency between teams in the on-site procedures for reauditing the sites. Narrative descriptions were used for the 1992 reaudits to evaluate the condition of the site relative to the previous years departures. Audit team members were aware of the previous years ratings. For 1993, narrative descriptions were not used. The usual procedures for auditing sites were utilized. Some teams chose to provide team members with the results of the previous years audits. Other teams did not use the information from the previous years audits.

**Table 16. Effectiveness of BMPs in preventing observed sediment movement for each landowner type statewide.**

Landowner Type	Number of Practices Rated	Effectiveness Rating (Percent)				
		Adequate Protection	Indirect Temporary	Direct Temporary	Indirect Prolonged	Direct Prolonged
State	1,451	93	3	1	2	1
County	1,230	96	1	<1	2	<1
US Forest Service	795	96	<1	1	2	2
American Indian	189	86	6	-	8	-
Private Industrial	523	96	2	1	1	1
NIPF	1,519	85	5	1	7	2
All Sites	5,707	92	3	1	3	1

**Figure 4. Effectiveness of BMPs in preventing sediment movement compared to the level of application for all sites statewide.**



The differences in methodologies used to reaudit sites make direct comparisons between sites somewhat questionable. There is a need to standardize review procedures for future reaudits. However, some of the generalizations are worth noting. Of the 12 sites reaudited, good agreement with the previous years ratings was found for 10 of the sites. These sites generally had improved ratings, especially in the effectiveness categories. This is to be expected as impacts would be healed over to a greater degree by the second visit to the site.

Fewer BMPs were found to be applicable in the reaudits compared to the initial audits. This decrease was attributed to the additional vegetative growth that made it more difficult to thoroughly traverse the sites. The problems associated with revisiting the sites demonstrates the need to evaluate BMP compliance within a year of the completion of timber harvest activity.

## H. Supplemental Questions

There was general consensus among audit team members to develop an overall subjective rating for sites that did not emphasize individual numbers or practices (Table 17). A supplemental questions page (see Appendix D) was drafted and utilized for the 1993 field audits. This page included several questions requesting a narrative summary of the quality of site activities and then an overall numerical rating for application of BMPs and impact to water quality, similar to the ratings for individual practices. The supplemental page served as an effective summary for the landowners and resource managers after the audits were complete.

**Table 17. Average site ratings for overall BMP application and observed impact to water quality.**

Landowner Type	Number of Sites Rated	Average* Application Rating	Average* Impact Rating	Average Combined Rating
State	23	4.3	4.5	8.8
County	23	4.0	4.2	8.2
US Forest Service	11	3.8	4.3	8.1
American Indian	5	3.4	3.2	6.6
Private Industrial	8	4.2	4.2	8.4
NIPF	33	3.4	3.8	7.2
All Sites	103	3.8	4.1	7.9

\*Both application and impact ratings were on a scale of 1 to 5. Overall site rating was the sum of the two.

An analysis of the overall ratings provided similar conclusions as were found for the audit worksheets: a general high level of BMP compliance and a low level of impact to water quality on state, USFS, PI and county lands. Overall ratings were substantially lower for American Indian and NIPF lands.

#### **IV. CONCLUSIONS**

The audit process is a positive and productive approach to dealing with a complex natural resource issue. After three years the use of field audits has become recognized as a credible process for monitoring the application of BMPs. Other agencies (e.g. PCA, Department of Agriculture, DNR-Division of Waters) have looked to the forestry audit process as a model for other programs. The forestry community recognizes that a voluntary program of proactive management combined with increased technical assistance, education initiatives and incentive approaches, are needed to maintain a credible and effective program that can balance calls for regulatory programs.

The field audit results indicate that compliance with BMPs is relatively high, particularly on state, county, USFS and PI lands. The field audits provide a means of identifying the successes (e.g. filter strip use) as well as problem areas (e.g. proper installation of water diversion devices). The ability to identify specific problem areas is critical to more effectively target education efforts and technical assistance. By focusing on these problem areas, the forestry community will be able to effectively utilize limited resources to correct deficiencies in the NPS control program.

Two significant additional benefits of the audits were: 1) the educational opportunity provided to landowners, operators, professional resource managers, and team members, and 2) the positive interaction between resource managers, the public and the environmental community. The audit teams spent several weeks together in the field and used goodwill, positive dialogue and communication to evaluate a natural resource issue. It would be desirable to carry that type of positive momentum into the future in dealing with other natural resource issues. This could be particularly appropriate in addressing the issues raised in the Generic Environmental Impact Statement on expanded timber harvesting in Minnesota.

#### **V. RECOMMENDATIONS**

- Establish long term goals for BMP compliance.
- Revise water quality BMPs to incorporate needed modifications based on updated auditing information.
- Focus on BMPs where immediate improvements are feasible with minimal effort and cost (e.g. deposition of slash and logging debris in wetlands, location of slash

piles for burning and installation of water diversion devices on skid trails).

- Develop BMPs for wetlands in forested regions of Minnesota and incorporate wetland BMPs into a revised BMP guidebook.
- Modify forestry field audits to evaluate compliance with wetland BMPs.
- Revise audit form to reflect changes to BMPs.
- Improve methodology for site selection.
- Clarify whether NIPF audit sites that received professional forestry assistance included BMP recommendations and the extent to which the BMP recommendations were followed.
- Increase logger involvement in field audit process.
- Continue use of four audit teams in field audits.
- Continue interdisciplinary makeup of field audit teams.
- Identify and prioritize specific erosion problem areas to better focus assistance and corrective action efforts.
- Obtain guidance from the Pollution Control Agency on reporting, disposing and cleanup of fuel and lubricants.
- Quantify effectiveness of filter strips and other BMPs in reducing sediment delivery to perennial streams and other water bodies.
- Continue education of loggers, landowners and resource managers based on problem areas identified in the audit process.
- Emphasize proper siting and installation of water crossings, drainage structures and water diversion devices in education efforts and contract management.
- Work with tribal councils and BIA to expand BMP education efforts to American Indian lands.
- Develop early education curriculum in cooperation with the Minnesota Association of Science Teachers and Project Learning Tree.
- Quantify net costs of BMP implementation (research need).

- Improve and increase incentives for BMP adoption and use.
- Establish BMP demonstration areas in combination with equipment demonstration areas.
- Improve cost share programs (eg. MFIP and SIP) to ensure BMPs are a requirement.
- Standardize procedures for reauditing sites.
- Investigate use of data recorders and/or lap top computers to improve timeliness of data analysis.
- Improve public awareness of audit results.

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## VII. APPENDICES

### Appendix A. Organizations, agencies, and companies participating in field audit teams.

#### State agencies:

- DNR - Division of Forestry
- DNR - Division of Fisheries and Wildlife
- DNR - Division of Waters
- Board of Water and Soil Resources
- Department of agriculture
- University of Minnesota
- Pollution Control Agency, Water Quality Division

#### Federal Agencies:

- US Forest Service - Chippewa National Forest
- US Forest Service - Superior National Forest
- US Forest Service - North Central Forest Experiment Station

#### Counties:

- Minnesota Association of County Land Commissioners
- St. Louis County Land Department
- Hubbard County Land Department
- Beltrami County Land Department

#### Forest Industry:

- Blandin Paper Company
- Potlatch Corporation
- Boise Cascade Corporation
- Champion International
- Trust Joist MacMillian

#### Environmental and Conservation Organizations:

- Audubon Society
- Sierra Club
- Izaak Walton League of America
- Ruffed Grouse Society
- Minnesota Forestry Association
- Minnesota Conservation Federation

#### other:

- Minnesota Science Teachers Association
- Associated Contract Loggers
- Private Forestry Consultants



**Appendix B. Forestry Best Management Practices field audit worksheet with application ratings for all practices rated.**

**FORESTRY BEST MANAGEMENT PRACTICES AUDIT WORKSHEET**

SITE NUMBER: \_\_\_\_\_ DATE: \_\_\_\_\_  
 OWNERSHIP: \_\_\_\_\_ OPERATOR: \_\_\_\_\_  
 LEGAL DESCRIPTION: \_\_\_\_\_ SALE OR PROJECT NUMBER: \_\_\_\_\_  
 PROJECT ACRES REVIEWED: \_\_\_\_\_ TEAM INITIALS: \_\_\_\_\_  
 EXTENT OF FORESTER ASSIST: \_\_\_\_\_

SITE CONDITIONS	PRACTICES
LANDFORM: _____ GENERAL SOILS: _____ DRAINAGE: _____ SLOPE RANGE: _____ WETLANDS (TYPE & SIZE): _____ _____ LAKES PRESENT: _____ _____ DEPTH/WIDTH OF STREAMS (type): _____ _____ INTERMITTENT STREAMS: _____ _____	STAGE ("x" if completed) PREHARVEST ( ) ROAD CONSTRUCTION ( ) HARVEST ( ) SLASH DISPOSAL ( ) SITE PREP ( ) DATE OF ACTIVITY: _____ ROADS: NEW CONSTRUCTION (length): _____ RECONSTRUCTION (length): _____ LENGTH OF ROAD RATED: _____ HARVEST ACRES: _____ HARVEST METHOD: _____ SITE PREP ACRES: _____ SITE PREP METHOD: _____ SLASH DISPOSAL: _____ PESTICIDES USED: _____ OTHER: _____

**RATING GUIDE**

<p style="text-align: center;"><b>APPLICATION</b></p> 5—OPERATION EXCEEDS REQUIREMENT OF BMP 4—OPERATION MEETS REQUIREMENT OF BMP 3—MINOR DEPARTURE FROM BMP 2—MAJOR DEPARTURE FROM BMP 1—GROSS NEGLECT OF BMP
<p style="text-align: center;"><b>EFFECTIVENESS</b></p> 6—IMPROVED PROTECTION OF WATER RESOURCES OVER PRE-PROJECT CONDITION. 5—ADEQUATE PROTECTION OF WATER RESOURCES. 4—INDIRECT AND TEMPORARY IMPACTS ON WATER RESOURCES. 3—DIRECT AND TEMPORARY IMPACTS ON WATER RESOURCES. 2—INDIRECT AND PROLONGED IMPACTS ON WATER RESOURCES. 1—DIRECT AND PROLONGED IMPACTS ON WATER RESOURCES.
<p style="text-align: center;"><b>DEFINITIONS (BY EXAMPLE)</b></p> ADEQUATE: Small amount of material eroded; material does not reach drainages, streams, lakes, or wetlands. MINOR: Practice not clearly needed, attempted practice but poorly applied, small impact potential. MAJOR: Practice clearly needed, no attempt at application, large impact potential. GROSS: Common departures from practice, disregard for water quality, large and direct impacts. INDIRECT: Erosion and delivery of sediment to streams, lakes, or open water wetlands. TEMPORARY: Impacts lasting one year or less; no more than one runoff season. PROLONGED: Impacts lasting more than one year. *It is possible to have a departure from BMPs and still have adequate protection.

BEST MANAGEMENT PRACTICE	NUMBER OF TIMES RATED	LEVEL OF APPLICATION BY RATING CATEGORY			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
<b>GENERAL PRACTICES</b>					
<b>1 Fuel, Lubricant and Equipment Management (p11 &amp; 12)</b>					
1a Adequate storage and disposal for fuel, debris, lubricants, fluids and rinsate from equipment cleanup	243	78%	20%	2%	<1%
<b>FOREST ROADS</b>					
<b>2 Alignment (p17-20)</b>					
2a Minimize the total road mileage required to meet the landowner's objectives	166	97%	3%	-	-
2b Minimize the number of water crossings	85	96%	4%	-	-
2c Minimize cut and fill	106	94%	5%	1%	-
2d Avoid activity below the ordinary high water mark	89	97%	3%	-	-
2e Provide adequate filter strips (p14) between roads and lakes, streams, and intermittent waterways					
- width	113	88%	10%	2%	-
- disturbance	106	96%	3%	1%	-
- slash disposal	99	94%	5%	1%	-
<b>3 Water Crossings (p20-23)</b>					
3a Cross streams at right angles	45	98%	-	2%	-
3b1 Minimize amount of natural stream channel disturbance	48	90%	6%	4%	-
3b2 Streambank approaches properly designed	30	94%	3%	3%	-
3c Crossings do not impede fish migration	20	80%	20%	-	-
3d Low water crossings constructed of non-erosive and stable material	13	62%	15%	23%	-
3e Proper permits obtained	3	100%	-	-	-
<b>4 Winter Roads or Temporary Crossings (p23 &amp; 24)</b>					
4a Temporary crossings properly located and installed	24	87%	13%	-	-
4b Avoid use of mineral soil as fill on winter crossings	19	79%	16%	5%	-
4c Temporary/winter crossings removed prior to breakup	14	64%	29%	7%	-

BEST MANAGEMENT PRACTICES	NUMBER OF TIMES RATED	LEVEL OF APPLICATION BY RATING CATEGORY			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
<b>5 Drainage (p24-29)</b>					
5a Culverts properly sized and installed	30	67%	23%	10%	-
5b Culverts properly armored if needed	11	46%	27%	27%	-
5c Install water diversion devices on road surfaces:					
- Broad base dips/grade rolls	15	60%	40%	-	-
- Open culverts	7	14%	57%	29%	-
- water bars	35	9%	71%	20%	-
- outsloping	8	50%	25%	25%	-
5d Drain surface water into filter strip or vegetative draw	86	82%	10%	8%	-
5e Design ditches to avoid carrying water long distances. Use proper size and number of:					
- lead-offs	18	33%	44%	22%	-
- cross culverts under road	7	86%	14%	-	-
- cross drains under road	8	100%	-	-	-
5f install silt fences were needed	1	-	100%	-	-
5g Remove all berms	41	71%	22%	7%	-
<b>6 Construction, Clearing &amp; Excavation (p28-31)</b>					
6a Proper placement of clearing debris	111	88%	9%	2%	1%
6b Shape inslopes and backslopes to 1 1/2:1 or flatter to stabilize soils	45	62%	38%	-	-
6c Properly compact fill material	36	94%	6%	-	-
6d Install proper subgrade support	18	94%	6%	-	-
6e Shape and stabilize borrow pits	16	56%	44%	-	-
6f Stabilize erodible soils by seeding	53	76%	19%	6%	-
6g Properly surface road to minimize water quality impacts	77	91%	9%	-	-
<b>Maintenance</b>					
<b>7 All Roads (p36)</b>					
7a properly surface road to minimize water quality impacts	7	100%	-	-	-
7b Erosion control features functional	25	68%	32%	-	-
7c Stabilize erodible soils by seeding	35	66%	31%	3%	-
7d Restrict use of roads during wet periods and spring breakup if use could impact water quality	52	79%	13%	4%	4%

BEST MANAGEMENT PRACTICES	NUMBER OF TIMES RATED	LEVEL OF APPLICATION BY RATING CATEGORY			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
<b>8 Active roads (p37)</b>					
8a maintain proper surface to maintain drainage and prevent erosion	26	69%	31%	-	-
8b Proper use of dust control agents	1	100%	-	-	-
<b>9 Occasional use roads</b>					
9a Properly close when not in use	48	69%	23%	6%	2%
9b Stabilize road surface	45	89%	9%	2%	-
9c Proper water diversion devices in working order	18	56%	33%	11%	-
<b>10 Temporary/Abandoned roads</b>					
10a Properly close abandoned roads	46	78%	22%	-	-
10b Stabilize road surface	43	88%	12%	-	-
10c Proper water diversion devices in working order	12	67%	33%	-	-
<b>TIMBER HARVEST</b>					
<b>11 GENERAL</b>					
11a Employ a suitable harvest system for the site	227	100%	-	-	-
11b Time harvest compatible with soil and topography	227	92%	6%	2%	-
11c Minimize mineral soil exposure in filter strip (less than 5%)	218	97%	3%	<1%	-
11d Streams, lakes, wetlands free of logging debris	199	63%	27%	10%	<1%
11e Avoid felling timber into nonforested wetlands	135	67%	24%	8%	-
11f Restore water courses to approximate natural condition	18	72%	22%	6%	-
11g Erosion barriers properly maintained	12	50%	42%	8%	-
<b>12 Shade Strips (p47)</b>					
12a Maintain vegetation adjacent to designated trout streams or lakes	16	94%	6%	-	-

BEST MANAGEMENT PRACTICES	NUMBER OF TIMES RATED	LEVEL OF APPLICATION BY RATING CATEGORY			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
<b>13 Skid Trails</b>					
13a Minimize the total skid trail mileage required to meet the landowner's objectives	195	93%	6%	1%	-
13b Locate skid trails outside of filter strips	220	85%	11%	4%	-
13c Design skid trails to avoid concentrating runoff	196	88%	8%	2%	2%
13d Install water diversion devices on skid trails:					
- Broad base dips/grade rolls	8	38%	25%	25%	13%
- Open culverts	1	100%	-	-	-
- water bars	56	20%	57%	16%	7%
- outsloping	8	13%	50%	25%	13%
13e Drain surface water into filter strip or vegetative draw	89	87%	7%	6%	1%
13f Proper placement of clearing debris	77	92%	5%	3%	-
13g Shape inslopes and backslopes to 1 1/2:1 or flatter to stabilize soils	22	27%	73%	-	-
13h Remove all berms	28	46%	36%	18%	-
13i Minimize the number of water crossings	69	87%	13%	-	-
13j Minimize amount of natural stream channel disturbance	52	79%	13%	6%	2%
13k Low water crossings constructed of non-erosive and stable material	11	91%	9%	-	-
13L Temporary/winter crossings removed prior to breakup	13	54%	31%	8%	8%
13m Temporary crossings properly located and installed	25	64%	16%	16%	4%
13n Rehabilitate skid trails when needed	86	52%	36%	9%	2%
<b>14 Landings</b>					
14a Design suitable size and number of landings	215	97%	3%	<1%	-
14b Locate landings outside of filter strips	207	91%	7%	2%	-
14c Location suitable for maintenance and fueling	193	90%	8%	2%	-
14d Proper placement of clearing debris	146	90%	7%	3%	-
14e Provide for maximum cross-drainage and minimum down slope flow	113	98%	2%	-	-
14f Proper water diversion devices in working order	8	75%	12%	-	12%
14g Drain surface water into filter strip or vegetative draw	95	97%	2%	-	1%
14h Erosion control features functional	7	86%	14%	-	-
14i Stabilize erodible soils by seeding	55	88%	11%	-	2%
14j Rehabilitate landings when needed	55	87%	9%	-	2%

BEST MANAGEMENT PRACTICES	NUMBER OF TIMES RATED	LEVEL OF APPLICATION BY RATING CATEGORY			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
<b>MECHANICAL SITE PREP</b>					
<b>15 General Recommendations (p50)</b>					
15a Site prep technique appropriate to the site	35	94%	6%	-	-
15b Provide adequate filter strips	31	87%	13%	-	-
15c Avoid operating during periods of saturated soil	29	97%	3%	-	-
15d Maintain adequate vegetation adjacent to designated trout streams	4	100%	-	-	-
15e Site prep technique properly employed (p50-52)					
- Shearing and raking	8	100%	-	-	-
- Disking	1	100%	-	-	-
- Patch or row scarification	12	84%	8%	8%	-
- Other	14	93%	7%	-	-
<b>PESTICIDE USE</b>					
16 Prevent entry of pesticide residues into surface and ground waters (p57-75)	28	75%	18%	2%	-
<b>PRESCRIBED BURNING</b>					
<b>17 Planning (p78)</b>					
17a Obtain proper permits	9	3%	-	-	-
<b>18 Prescriptions (p79-81)</b>					
18a Locate fire lines on the contour	3	1%	1%	-	-
18b Use natural or in-place fire barriers	9	3%	-	-	-
18c Establish filter strips for fire lines	3	2%	-	-	-
18d Avoid placement of debris piles for burning in filter strips or sensitive areas	14	3%	3%	-	-
18e Limit water quality impacts from fire line construction by using mowing, herbicides, retardant etc.	3	2%	-	-	-
<b>19 Maintenance (p81)</b>					
19a Maintain erosion control measures on firelines	0	-	-	-	-

## Appendix C. Modifications to the audit process and audit forms

Throughout the 3 year field audit process, the work group made minor modifications to the process and to the audit forms. Modifications were made in response to information gained from the previous year and recommendations from the spring debriefing meeting. These changes reflected the team findings and improved the fairness of rating sites. The following is a summary of the changes made over the 3 year period:

- Expanded from 2 teams in 1991 to 4 teams in 1992 and 1993.
- Conducted audits on American Indian lands in 1992 and 1993.
- Expanded site selection criteria to restrict audits to sites within a 1 mile walk from a road.
- Added a Supplemental Questions page to the audit worksheet in 1993 to obtain a more subjective view of the sites.
- Modified criteria for rating roads in 1992 and 1993. The change required rating only that portion of a road that had potential to impact water quality (close to water or sloping to water).
- Modified rating for road closure. For 1992 and 1993 the road closure issues were only rated for roads that provided some reasonable access or presented a risk for further impact to water quality if not closed. This avoided the issue of BMPs calling for closure of all forest access roads.
- Encouraged the site operators to accompany audits where feasible for the 1993 audits.

### *Changes to the field audit form:*

- Added degree of forester assistance to the cover page of the worksheet to indicate how much professional assistance was provided on NIPF sites.
- Added lines to cover page to identify the presence of intermittent streams.
- Modified site conditions section of form to include specific wetland type and sizes and to identify lakes present.
- Added "length of road rated" to the cover sheet.
- Changed terminology for effectiveness from minor or major to indirect or direct.
- Added outsloping as a water diversion method in lines 5c and 13d.

- Reworded line 5g to read "Remove berms where needed."
- Reworded line 6b to read "Shape inslopes and backslopes to 1 1/2:1 or flatter to stabilize soils *where appropriate*".
- Incorporated line 7a into 8a, line 7b into 8b, line 7c into 6f, line 9b and 10b and line 7d into 8c.
- Added "if use could impact water quality" to lines 9a and 10a
- Reworded line 13h to read "Remove berms where needed".
- Reworded line 13n to read "rehabilitate skid trails when needed".
- Reworded line 14j to read "rehabilitate landings when needed."



## APPENDIX D. SUPPLEMENTAL QUESTIONS FOR OVERALL SITE RATINGS.

1. WHAT THINGS WENT RIGHT ON THIS SITE? (SUMMARIZE HIGHLIGHTS):
  
2. WHAT THINGS WENT WRONG ON THIS SITE? (SUMMARIZE PROBLEMS):
  
3. HAVE OTHER ACTIVITIES OCCURRED ON THIS SITE THAT POTENTIALLY IMPACT WATER QUALITY (i.e., ATV use, hunting traffic, grazing, etc.)? IF SO, PLEASE EXPLAIN:
  
4. ARE THERE MITIGATING ACTIVITIES THAT SHOULD TAKE PLACE ON THIS SITE OR IS THERE CORRECTIVE ACTION ALREADY BEING TAKEN?:
  
5. HAS THE SALE OR PROJECT ADMINISTRATOR RECEIVED BMP TRAINING? ..... \_\_\_\_\_  
HAS THE OPERATOR RECEIVED BMP TRAINING? ..... \_\_\_\_\_  
IS THE LANDOWNER AWARE OF BMPs OR RECEIVED BMP TRAINING? ..... \_\_\_\_\_
6. GIVE THIS SITE AN OVERALL RATING OF 1-10 COMBINING APPLICATION OF BMPS WITH IMPACT TO WATER QUALITY:  
  
RATE\* THIS SITE FROM 1-5 FOR THE OVERALL APPLICATION OF BMPS ..... \_\_\_\_\_  
1=total negligence, 2=poor, 3=average, 4=good, 5=excellent  
  
RATE\* THIS SITE FROM 1-5 FOR ITS OVERALL IMPACT TO WATER QUALITY ..... \_\_\_\_\_  
1=severe, 2=moderate, 3=slight, 4=negligible 5=no visible impact  
  
COMBINED RATING ..... \_\_\_\_\_

\*These numbers do not necessarily need to directly reflect the worksheet ratings for application and effectiveness.

**Appendix E.**  
**Location of audit sites by legal description and county.**

<u>Site number</u>	<u>Ownership type</u>	<u>Legal Description</u> sec.twp.range	<u>County</u>
1	State	16-146N-35W	Beltrami
2	State	31-143N-33W	Hubbard
3	Industry	28-058N-22W	Itasca
4	NIPF	20-061N-22W	Itasca
5	NIPF	23-061N-20W	St.Louis
6	State	04-060N-20W	St.Louis
7	Industry	28-060N-23W	Itasca
8	Industry	21-062N-23W	Itasca
9	County	27-061N-22W	Itasca
10	Industry	30-062N-23W	Itasca
11	County	21-061N-22W	Itasca
12	USFS	34-059N-26W	Itasca
13	USFS	25-058N-25W	Itasca
14	State	33-044N-16W	Pine
15	NIPF	28-044N-19W	Pine
16	County	18-042N-17W	Pine
17	County	19-043N-17W	Pine
18	USFS	30-057N-13W	St.Louis
19	State	22-059N-06W	Lake
20	Industry	21-059N-07W	Lake
21	USFS	19-064N-02E	Cook
22	USFS	25-064N-01E	Cook
23	State	06-102N-11W	Fillmore
24	NIPF	15-103N-10W	Fillmore
25	State	22-102N-12W	Fillmore
26	State	21-103N-09W	Fillmore
27	State	18-104N-08W	Fillmore
28	NIPF	22-105N-09W	Winona
29	State	08-108N-09W	Winona
30	State	04-108N-09W	Winona
31	State	11-108N-10W	Winona
32	State	14-109N-10W	Wabasha
33	NIPF	17-112N-13W	Goodhue
34	NIPF	18-112N-15W	Goodhue
35	State	21-112N-16W	Goodhue
36	NIPF	29-113N-16W	Goodhue
37	NIPF	18-111N-12W	Wabasha
38	NIPF	07-102N-06W	Houston
39	NIPF	06-103N-05W	Houston
40	State	29-104N-04W	Houston
41	State	15-102N-04W	Houston
42	NIPF	25-110N-13W	Wabasha
43	NIPF	06-111N-13W	Wabasha
44	NIPF	22-112N-13W	Goodhue

45	NIPF	19-102N-06W	Houston
46	NIPF	10-113N-15W	Goodhue
47	State	09-113N-15W	Goodhue
48	NIPF	22-113N-15W	Goodhue
201	State	16-147N-31W	Beltrami
202	State	32-143N-33W	Hubbard
203	State	23-142N-33W	Hubbard
204	State	13-142N-33W	Hubbard
205	County	07-141N-34W	Hubbard
206	County	06-144N-33W	Hubbard
207	USFS	23-141N-30W	Cass
208	NIPF	06-140N-32W	Hubbard
209	County	26-144N-37W	Clearwater
210	County	23-143N-38W	Clearwater
211	County	32-143N-38W	Clearwater
212	USFS	24-146N-30W	Beltrami
213	USFS	21-146N-29W	Itasca
214	Industry	15-142N-34W	Hubbard
215	State	36-143N-33W	Hubbard
216	USFS	26-145N-29W	Cass
217	Industry	07-143N-32W	Hubbard
218	NIPF	03-152N-27W	Koochiching
219	State	24-157N-34W	Lake of the Woods
220	State	23-157N-33W	Lake of the Woods
221	State	09-161N-34W	Lake of the Woods
222	County	22-150N-31W	Beltrami
223	County	09-147N-31W	Beltrami
224	USFS	14-148N-30W	Beltrami
225	Industry	01-149N-25W	Koochiching
226	Industry	05-150N-29W	Koochiching
227	NIPF	21-149N-26W	Itasca
228	Am. Indian	01-148N-26W	Itasca
229	USFS	05-149N-28W	Itasca
230	County	03-054N-10W	Lake
231	County	24-055N-11W	Lake
232	USFS	35-060N-08W	Lake
233	USFS	29-060N-08W	Lake
234	NIPF	08-056N-11W	Lake
235	NIPF	09-056N-11W	Lake
236	State	21-058N-09W	Lake
237	County	03-055N-14W	St.Louis
238	State	36-055N-15W	St.Louis
241	Am. Indian	02-048N-19W	Carlton
240	County	30-052N-18W	St.Louis
239	County	06-053N-18W	St.Louis
242	County	30-053N-16W	St.Louis
243	State	36-061N-14W	St.Louis
244	NIPF	11-060N-16W	St.Louis
245	Am. Indian	04-064N-23W	Koochiching
246	State	20-067N-19W	St.Louis
247	USFS	26-066N-20W	St.Louis

248	USFS	21-067N-19W	St.Louis
249	USFS	22-066N-18W	St.Louis
250	State	30-068N-21W	St.Louis
251	Industry	12-067N-20W	St.Louis
252	Industry	13-067N-25W	Koochiching
253	Industry	25-066N-27W	Koochiching
254	Industry	03-060N-20W	St.Louis
255	Industry	28-053N-25W	Itasca
256	State	09-056N-23W	Itasca
257	County	13-006N-25W	Itasca
258	USFS	28-060N-26W	Itasca
259	State	36-139N-28W	Cass
260	County	11-137N-29W	Crow Wing
261	County	20-138N-27W	Crow Wing
262	County	02-138N-27W	Crow Wing
263	County	23-140N-30W	Cass
264	State	36-044N-30W	Crow Wing
265	State	16-140N-26W	Cass
266	NIPF	35-046N-28W	Crow Wing
267	NIPF	12-046N-30W	Cass
268	State	16-047N-28W	Crow Wing
269	State	02-132N-30W	Morrison
270	NIPF	18-044N-28W	Crow Wing
271	State	28-140N-25W	Cass
272	County	29-047N-29W	Crow Wing
273	County	02-138N-27W	Crow Wing
274	County	11-139N-30W	Cass
275	County	25-139N-30W	Cass
276	County	12-136N-27W	Crow Wing
277	County	11-137N-29W	Crow Wing
284	State	36-041N-19W	Pine
285	State	24-038N-20W	Chisago
286	State	07-045N-22W	Aitkin
287	State	19-044N-22W	Aitkin
288	NIPF	05-111N-13W	Wabasha
289	NIPF	20-109N-12W	Wabasha
290	NIPF	16-107N-08W	Winona
291	NIPF	28-107N-08W	Winona
292	NIPF	26-107N-09W	Winona
293	NIPF	11-106N-08W	Winona
294	NIPF	11-102N-04W	Houston
295	NIPF	15-103N-04W	Houston
296	NIPF	01-103N-05W	Houston
297	NIPF	21-101N-12W	Fillmore
298	NIPF	25-103N-11W	Fillmore
299	NIPF	16-106N-06W	Winona
300	NIPF	23-110N-11W	Wabasha
301	NIPF	23-110N-11W	Wabasha
302	NIPF	17-106N-12W	Olmsted
303	NIPF	29-107N-13W	Olmsted
304	NIPF	18-106N-20W	Steele

305	State	07-110N-10W	Wabasha
306	State	25-109N-10W	Wabasha
307	State	27-104N-07W	Houston
308	State	31-102N-04W	Houston
309	State	31-102N-04W	Houston
310	State	31-102N-04W	Houston
311	State	16-104N-07W	Houston
312	State	16-104N-07W	Houston
313	State	34-104N-05W	Houston
314	State	06-102N-11W	Fillmore
315	State	02-103N-10W	Fillmore
316	State	03-103N-10W	Fillmore
401	NIPF	31-144N-33W	Hubbard
402	NIPF	09-143N-33W	Hubbard
403	County	17-143N-33W	Hubbard
404	County	02-142N-35W	Hubbard
405	USFS	06-146N-28W	Itasca
406	USFS	01-146N-28W	Itasca
407	USFS	22-146N-29W	Itasca
408	Am. Indian	30-144N-30W	Cass
409	USFS	28-142N-27W	Cass
410	County	17-144N-36W	Clearwater
411	County	34-144N-37W	Clearwater
412	County	32-143N-38W	Clearwater
413	NIPF	04-158N-30W	Lake of the Woods
414	NIPF	06-160N-32W	Lake of the Woods
415	State	04-160N-36W	Lake of the Woods
416	Industry	13-064N-27W	Koochiching
417	Industry	23-063N-26W	Koochiching
418	NIPF	23-142N-39W	Becker
419	State	10-143N-39W	Mahnomen
420	County	36-146N-35W	Beltrami
421	NIPF	04-144N-36W	Clearwater
422	Am. Indian	28-144N-38W	Clearwater
423	Am. Indian	25-144N-39W	Clearwater
424	County	24-061N-26W	Itasca
425	USFS	33-060N-20W	St.Louis
426	Am. Indian	13-050N-18W	St.Louis
427	State	01-061N-21W	St.Louis
428	NIPF	25-060N-27W	Itasca
429	NIPF	14-157N-27W	Koochiching
430	State	36-143N-26W	Cass
431	County	06-150N-27W	Itasca
432	County	09-059N-25W	Itasca
433	USFS	17-065N-16W	St.Louis
434	USFS	17-065N-15W	St.Louis
435	USFS	26-066N-18W	St.Louis
436	Am. Indian	04-064N-23W	Koochiching
437	County	31-155N-26W	Koochiching
438	County	13-066N-20W	St.Louis
439	Industry	28-067N-19W	St.Louis

440	Industry	19-066N-23W	St.Louis
441	State	20-066N-23W	Koochiching
442	County	01-062N-14W	St.Louis
443	County	19-062N-13W	St.Louis
445	Industry	07-060N-11W	St.Louis
446	USFS	31-061N-10W	St.Louis
447	USFS	34-064N-03E	St.Louis
448	USFS	12-061N-R2W	St.Louis
449	County	31-055N-10W	Lake
450	County	13-055N-11W	Lake
453	State	36-139N-28W	Cass
454	ST	32-135N-16W	Cass
456	ST	28-044N-17W	Pine
457	State	34-139N-31W	Cass
458	State	36-044N-22W	Aitkin
459	State	05-040N-22W	Pine
460	Industry	34-140N-27W	Cass
461	Industry	34-046N-30W	Crow Wing
462	Industry	02-044N-19W	Pine
463	NIPF	11-135N-32W	Cass
464	NIPF	15-044N-31W	Crow Wing
465	NIPF	02-135N-28W	Crow Wing
466	NIPF	09-138N-34W	Wadena
467	NIPF	29-052N-23W	Aitkin
468	NIPF	26-053N-24W	Itasca
469	NIPF	32-043N-18W	Pine
470	NIPF	08-042N-17W	Pine
471	NIPF	28-042N-18W	Pine
472	NIPF	13-042N-19W	Pine
473	NIPF	13-037N-24W	Isanti
474	County	06-136N-31W	Cass
475	County	06-138N-27W	Crow Wing
477	County	26-136N-26W	Crow Wing
478	County	35-051N-24W	Aitkin
479	County	06-049N-22W	Aitkin
480	County	33-043N-23W	Aitkin
481	County	30-043N-27W	Aitkin
482	County	20-140N-28W	Cass
483	State	22-102N-12W	Fillmore
484	State	12-102N-12W	Fillmore
485	State	27-103N-09W	Fillmore
487	State	14-111N-12W	Wabasha
488	State	14-111N-12W	Wabasha
489	State	07-112N-14W	Goodhue
490	State	31-102N-04W	Houston
491	State	31-105N-05W	Winona
492	State	18-102N-04W	Houston
494	State	14-109N-10W	Wabasha
495	State	14-109N-10W	Wabasha
496	State	22-110N-11W	Wabasha
497	NIPF	24-111N-22W	Rice

498	NIPF	10-108N-16W	Dodge
499	NIPF	24-108N-15W	Olmsted
500	NIPF	04-105N-14W	Olmsted
501	NIPF	04-105N-14W	Olmsted
502	NIPF	16-103N-13W	Fillmore
503	NIPF	16-101N-09W	Fillmore
504	NIPF	12-103N-08W	Fillmore
505	NIPF	25-102N-09W	Fillmore
506	NIPF	17-101N-04W	Houston
507	NIPF	17-104N-04W	Houston
508	NIPF	14-102N-07W	Houston
509	NIPF	26-112N-18W	Goodhue
510	NIPF	01-112N-15W	Goodhue

