Indiana DNR Division of Forestry

State Forest Properties

1996 through 2016

Forestry Best Management Practices Monitoring Results

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1996 through 2016
State Forest BMP Report

I. Executive Summary

Forestry Best Management Practices (BMPs) monitoring, as an internal audit by Division of Forestry personnel of all timber harvests on State Forest properties, began on Nov. 1, 2000. Timber harvests being sold starting July 1, 1999 were monitored when Forestry BMPs were included on the timber sale contract and enforced, although commonly practiced since the 1980s. The Statewide Forestry BMP program conducted four rounds of monitoring before this time in which state properties were monitored by monitoring teams that included DoF personnel as well as private and industry individuals interested in forestry in the state. This report includes 566 timber harvests monitored for Forestry BMPs between Nov. 1, 1996 and Dec. 31, 2016, and ranging in size from 1 to 821 acres.

The overall rates for forestry BMPs on state forests since 1996 are 86.32 percent application and 92.39 percent effectiveness in protecting the soil and water quality of the 566 sites monitored. In other words, 86.32 percent of the practices were applied as directed in the BMP guidelines, and another 13.02 percent were classified as minor departures as defined in the monitoring sheet (Appendix B). Major departures (166) represent only 0.66 percent of all practices monitored. Of the total 566 sites monitored on State properties, only one application question (0.00 percent) has scored a “Total Negligence.” Of the 7.61 percent of BMPs that were ineffective at protecting the resources of the site, 2.96 percent were indirect and temporary, 0.9 percent were indirect and prolonged, 2.52 percent were direct and temporary and 1.23 percent were direct and prolonged in their impacts.

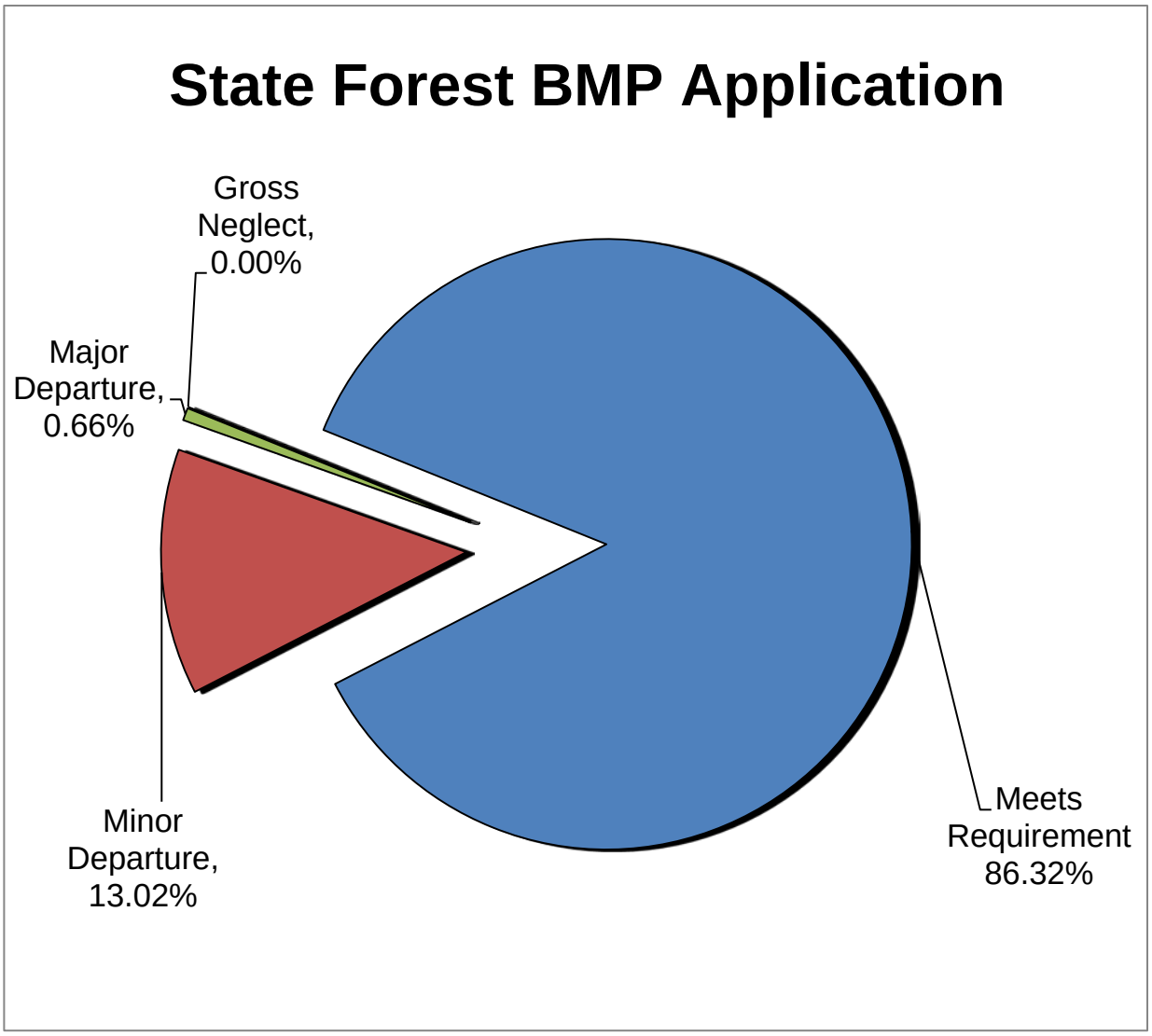

Figure 1: Overall state forest BMP application percentages.

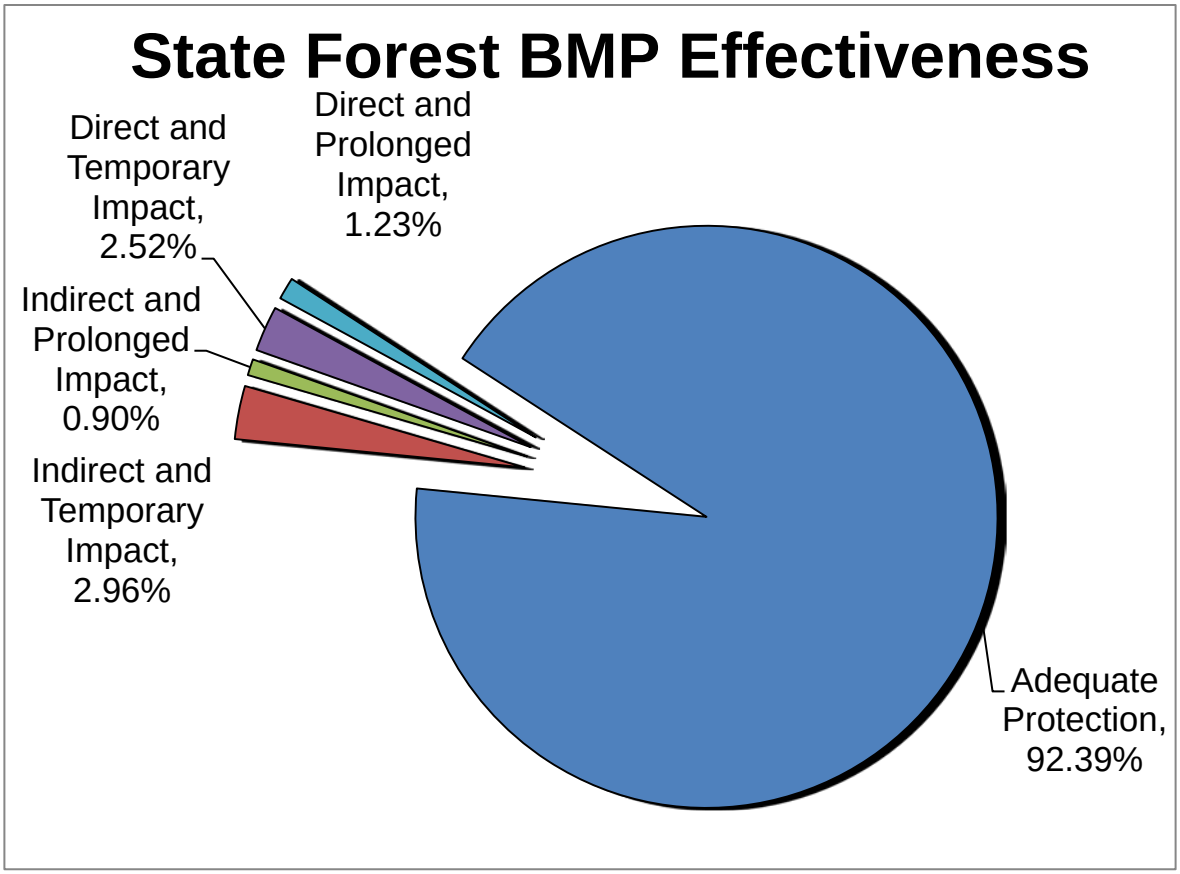

Figure 2: Overall state forest BMP effectiveness percentages.

II. Introduction

Indiana has 6.2 million acres of forestland — 26.8 percent of the state's land base — providing many benefits to Indiana residents and wildlife. The State Forest system owns only 2.5 percent (156,600 acres) of Indiana's forestland. However, state forestland is important to all Hoosiers who frequently use state forest properties for various forms of recreation, including hiking, biking, hunting, fishing and wildlife watching. Since state forestland is also important to the public as a model for forest management, it is imperative that timber harvesting at state forests is done in a way that minimizes environmental impacts as much as possible. Although forests are known to be the best way to reduce nonpoint source pollution (NPS) to waterways, they also can be a source of these pollutants. When forest soils are exposed, there is opportunity for NPS pollution to occur. Forestry BMPs are employed to protect forest soils and water quality during and after a harvest.

Forestry BMPs are a foundation for water quality protection and provide guidelines for protecting water quality during forest operations. The purpose of BMPs is to minimize the impact of forest activities that may affect soil and water quality. This report is a summary of the application and effectiveness of BMPs for timber harvests conducted on state forest properties from the time they officially were placed in the contracts of all state forest timber sales in July 1999 through the present. Data covers all BMP monitoring on State Forest Properties, analyzing time trends and making comparisons.

From July 1999 to winter 2003, BMP monitoring on state forests was conducted with the Watershed Conservation (WC) Forester and/or the License Timber Buyer (LTB) Forester from the Special Programs Section of the Division of Forestry, the Administering Forester of the timber harvest being monitored, Administering Forester from another property, and the Property Specialist who administered the timber harvest program. The Property Specialist stopped coordinating and participating in the monitoring of sites late in 2003. In October 2004, the Division of Forestry started to change the monitoring system to a sampling method. The transition was halted during a change in Division leadership and subsequently returned to a 100 percent monitoring. At present, 100 percent of timber harvests are monitored after completion, but the present monitoring team consists of a person from the State Forest BMP monitoring staff, the Administering Forester of the timber harvest being monitored, and any qualified help they can get from the property staff or BMP monitoring staff.

BMP Monitoring is a site evaluation based on the Indiana Logging and Forestry Best Management Practices: BMP Field Guide (BMP Field Guide) and Indiana's Forestry BMP Monitoring Worksheet. Fifty-eight BMP specifications are evaluated under five forestry operation categories: 1) forest access roads, 2) log landings, 3) skid trails, 4) stream crossings, and 5) riparian management zones. Each BMP specification is rated for application of the BMP and the effectiveness in protecting water quality. Seven general questions are posed on the evaluation dealing with the root of the noted failures and successes, and records other land uses on the site that could affect water quality.

III. Methods

A. BMP Monitoring Objectives

The objectives of BMP monitoring are: 1) to assess the effectiveness of BMP guidelines in minimizing soil erosion and stream sedimentation; 2) to provide information on the extent of BMP implementation, past and current; 3) to identify areas to focus future program training and educational efforts to improve BMP implementation and effectiveness; 4) to identify BMP specifications that may need technical modification; and 5) to identify improvements needed in future monitoring efforts; 6) to maintain certification of Indiana State Forests through the Forest Stewardship Council® (FSC®-CO12858) and the Sustainable Forestry Initiative® (SFI®) program (www.sfiprogram.org).

B. Monitoring Team Selection

For State Forest Properties, we first tried to have the WC and LTB foresters come to every BMP monitoring. However, there were many sites at which one or the other was absent for personal or professional reasons, but the monitoring continued, which kept a good balance for consistency in the monitoring and results without the monitoring falling behind. There is now a BMP Monitoring staff that includes the LTB Forester and one or two intermittent positions whose focus is BMP monitoring.

The other participants are the Administering Forester and possibly another forester from that property, which balances the team for input in the site evaluation of monitoring process and provides good training and discussion.

From July 1999 until 2003, the coordination of monitoring dates and people was carried out by the Property Specialist who also attended the monitoring of every timber harvest. This practice was discontinued when administrative duties increased for that position and coordination of monitoring was passed to the LTB forester.

C. Site Selection

Every timber harvest conducted on state forest property is monitored if the timber was sold after July 1999, unless the harvest occurred in order to change the land use. For example, Ferdinand State Forest had a site where timber was harvested before the area was cleared for a pipeline right-of-way. This kind of land-use change makes it impossible to monitor for forestry BMPs.

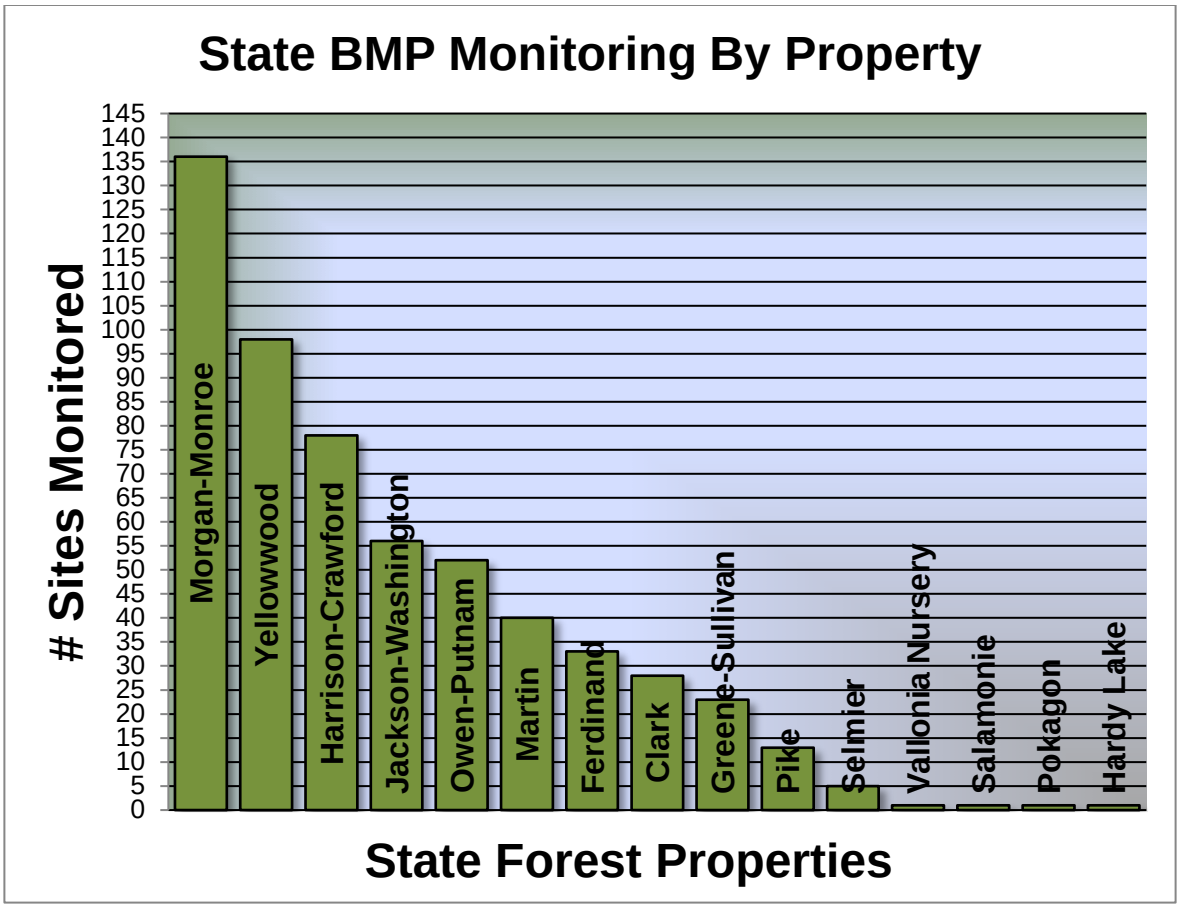

Figure 3: The number of harvests monitored at each property, for a total of 566 sites.

D. Monitoring Process

BMP monitoring is based on the evaluation of each specific practice for application and effectiveness. Application is the installation of a practice and the condition of the practice at the time of monitoring. Effectiveness is the level of success a practice has in the prevention of pollutants entering a water body and the level of impact the pollutant is having on the water body at the time of monitoring. It is possible to apply all of the BMPs properly and get a good score in application, but still have soil entering a stream, which would call for a lower score in effectiveness. The opposite may be possible as well.

Monitoring on state forest properties follows the same format as all other forestry BMP monitoring in Indiana except that the team of monitors is made up of professionals with similar backgrounds. On any monitoring day, the team meets at the forest office and goes to the field to conduct the BMP monitoring on a harvest that is completed and closed. The team walks each part of the harvest area, covering all access roads, inspecting log landings, skid trails, riparian management zones, and stream crossings as suggested in the Indiana BMP Monitoring Protocol, and commenting on successes and departures from the BMP guidelines.

Once on the site, the state forest monitoring team walks the area and its adjacent and interior intermittent or larger streams carrying maps of the site, the BMP monitoring form and the BMP Field Guide. This allows each team member to evaluate the BMPs on the site. Once team members have walked most of the area, they come together to discuss each question on the BMP monitoring form until they reach consensus on both scores for each question.

IV. Results

A. Overall application and effectiveness

The BMP monitoring form includes 58 specifications that are evaluated on each site. To date, 566 state forest sites have been monitored. Therefore, when scores of 0 (questions not applicable) are removed from the dataset there are 25,210 questions answered in regard to BMP application and effectiveness of BMPs on State Forests. Overall BMP application on State Forest land is 86.32 percent with a 92.39 percent effectiveness rate. In other words, BMPs that were needed were implemented correctly 86.32 percent of the time and were effective at protecting water quality from NPS 92.39 percent of the time.

When looking at application, 23,290 (86.32 percent) of the 25,210 questions were answered with a "1," which means the practice met the BMP guideline when it was needed. If an answer had a "0" in application, it meant the practice was not needed on the site and was not included in counting the percentage of application. A score of "2" or higher indicated departures from the BMP guidelines to some degree and occurred on 3,282 (13.02 percent) of all application scores that were tallied.

When looking at effectiveness, 23,290 (92.39 percent) of the 25,209 questions were answered with a "1," which meant there was adequate protection of the water resource by the BMP guidelines. If an answer had a "0" in application, it meant the practice was not needed to protect water quality on the site and was not included in counting the percentage of effectiveness. A score of "2" or higher indicated a visible impact to water quality to some degree and occurred on 1,919 (7.61 percent) of all effectiveness scores that were tallied.

More detailed definitions can be found on the Forestry BMP Monitoring Worksheet (Appendix B).

B. BMPs by Category; Application & Effectiveness

1. Access Roads

Access road BMPs were applied correctly 95.1 percent of the time. All access road BMP specifications employed had a 98.3 percent effectiveness rate.

Table 1: Application and effectiveness of BMP specifications for access roads.

Access Roads	% Application	% Effective
A1. Uses existing routes where appropriate	99.8	99.8
A2. Adequate buffer strip next to watercourses and sensitive areas	94.2	98.4
A3. Avoids unstable gullies, seeps, very poorly drained areas	95.7	99.2
A4. Road grades are within standards	98.1	100
A5. Amount of roads minimized	99.8	100
A6. Stream crossings minimized	100	100
A7. Road excavation minimized	98.2	99.8
A8. Excavated and fill materials placed properly	99.0	99.2
A9. Roads constructed to drain well	87.1	97.3
A10. Appropriate road stabilization, drainage and diversions installed	85.1	93.9
A11. Water diversions functioning properly	91.3	96.0
A12. Runoff diverted onto stable forest floor areas	88.9	92.3
A13. Public road drainage system maintained	99.0	99.4
A14. Public road's drainage maintained	99.4	99.8
A15. Traffic barriers installed	91.7	98.8
Overall Access Road	95.1	98.3

Access road drainage needs some further attention with the installation of drainage diversions and road stabilization. Although this area had an 85.1 percent application rate, there was a 93.9 percent effectiveness rate, indicating virtually no visible impact to water quality due to these departures. 87.1 percent of the time access roads were constructed to drain well (A9), this does leave some room for improvement. Effectiveness of this specification (A9) is 97.3 percent therefore departures in application are causing minimal impact to the resources. Many of the access roads are permanent fire trails or other roads that are used and maintained to varying degrees. Thus some are more structurally stable while others have had the diversions worn down by use over long periods.

2. Log Landings

Log landing BMPs were applied correctly 90.6 percent of the time. All log landing BMP specifications employed were 97.7 percent effective at protecting the water resources of the site.

Table 2: Application and effectiveness of the BMP specifications for log landings.

Log Landings	% Application	% Effective
Y1. Suitable number and size of landings	94.6	99.6
Y2. Landings located outside RMZ	95.5	99.1
Y3. Landings located on stable areas	93.2	99.3
Y4. Excavation of site minimized	93.2	98.4
Y5. Landings avoid concentrating or collecting runoff	75.6	96.1
Y6. Landing's runoff enters stable area	82.7	94.1
Y7. Proper water diversions in working order	88.8	95.2
Y8. Landing smoothed and soil stabilized	88.9	96.6

Y9. Landings free of fuel and lubricant spills and litter	93.9	98.7
Y10. Landing location suitable for equipment fueling and maintenance	99.3	99.8
Overall Log Landings	90.6	97.7

Correct drainage of landings was not universally applied well in log yards, with an application rate of only 75.6 percent (Y5). However, the effectiveness rate was 96.1 percent (Y5). Diversion of runoff to stable areas (Y6) had an 82.7 percent application rate, but a 94.1 percent effectiveness rate. Therefore application shortfalls of landing drainage tended to have a minor impact upon the resources of the sites. This is because landings tend to be placed on hill tops and areas away from water resources onsite.

3. Skid Trails

Skid trail BMPs were correctly applied 76.6 percent of the time. All of the skid trail BMP specifications employed were 88.6 percent effective at protecting the water resources of the sites.

Table 3: Application and effectiveness of BMP specifications for skid trails.

Skid Trails	% Application	% Effective
S1. Uses existing routes were appropriate	97.4	98.5
S2. Adequate buffer strip next to water courses and sensitive areas	68.8	85.0
S3. Avoids steep and long straight grades (>20% for >200')	73.5	97.0
S4. Avoids unstable gullies, seeps, poorly drained areas	80.5	90.9
S5. Amount of skid trails minimized	81.1	93.8
S6. Trail excavation minimized	85.4	94.5
S7. Appropriate drainage and diversions installed	50.1	79.6
S8. Water diversions in working order	79.0	87.8
S9. Runoff diverted onto stable forest floor areas	69.2	76.3
S10. Streams not used as skid trails (except for crossings)	81.2	83.4
Overall Skid Trail	76.6	88.6

Skid trails often are in rough areas with limited options for diversion installation, and often there is debate as to whether or not diversions are necessary, thus the 50.1 percent application rate. Despite low application in this specification, the effectiveness rate is 79.6 percent. Runoff diverted onto the stable forest floor areas has a 69.2 percent application rate and a 76.3 percent effectiveness rate, with 94 out of 132 departures having indirect and temporary impacts, 22 having indirect and prolonged impacts, 14 having direct and temporary impacts, and 2 having a direct and prolonged impact. Of the 559 sites having diversions on skid trails, 445 had no negative effect on water quality. Of the 114 sites with diversions that had effectiveness departures, 78 were indirect and temporary, 23 were indirect and prolonged, 10 were direct and temporary, and 3 were determined to have direct and prolonged impact. Skid trail application could be improved by avoiding areas that have a higher probability of negative impact if they are utilized during a harvest. These areas include watercourses and sensitive areas, long and steep straight grades, gullies,

seeps and poorly drained areas. BMP application for avoidance of these areas ranges from 68.8 to 80.5 percent (S2 – S4). However, the effectiveness from these 3 specifications was good, ranging from 85 to 97 percent. This indicates that when these areas were entered, that it was done in a manner that would protect the resources of most sites.

4. Stream Crossings

Stream crossing BMPs were applied correctly 77.5 percent of the time. All stream crossing BMP specifications employed were 79.4 percent effective at protecting the water resources of the sites.

Table 4: Application and effectiveness of BMP specifications for stream crossings.

Stream Crossing	% Application	% Effective
X1. Number of crossings minimized	88.8	91.3
X2. Crossings minimize disturbance to the natural bed and banks	70.2	72.6
X3. Streambank approaches properly designed and stabilized	63.5	65.9
X4. Water runoff diverted from road prior to crossing	61.7	64.1
X5. Crossing as close to 90 degrees as practicable	86.5	91.3
X6. Crossing does not unduly restrict water flow	82.2	83.2
X7. Soil has not been used as fill in the stream (except culverts)	77.7	78.6
X8. Ford constructed of non-erosive materials	86.7	87.3
X9. Fords have stable banks and streambeds	64.6	64.1
X10. Culverts are properly sized and installed	66.7	70.4
X11. Culverts clear of significant flow obstructions	69.2	73.1
X12. Temporary structures properly anchored	96.6	96.6
X13. Temporary structures and resulting obstructions removed	84.4	84.4
Stream Crossing	77.5	79.4

Stream crossings always deal directly with water bodies, so whether there are departures or not, there may be some impact to the water quality. If there is an impact, it will almost always be direct. The likely impacts of stream crossings are why managers will often avoid using them if possible. The avoidance of stream crossings by sale administrators and loggers is reflected in the statistic for stream crossings – 360 sites (63.6 percent) had no crossings, and only 206 sites (36.4 percent) out of 566 sites monitored had at least one stream crossing. Ninety-eight sites had only one crossing, 37 had two crossings, 24 had three crossings, 10 had four crossings, seven sites had five crossings, five had six crossings, three had seven crossings, one site had eight crossings, two had nine crossings, one had 10 crossings, one had 12 crossings, two sites had 13 crossings, one site had 15 crossings and one site had 60 crossings for a total of 519 crossings on state properties over a 20-year period. The site with 60 crossings was a large (821 acre) site at Clark State Forest that was a tornado salvage sale.

Unmapped intermittent stream crossings numbered at 204 (39.3 percent of crossings). Unmapped intermittent streams are those streams that meet the definition of intermittent stream in the glossary of the Indiana Logging and Forestry Best Management Practices;

BMP Field Guide, but the USGS quadrangle maps did not map them as intermittent streams. There were 303 crossings on intermittent streams identified on the USGS maps. There were 12 crossings on perennial streams.

5. Riparian Management Zones

Riparian management zone (RMZ) BMPs were applied correctly 82.4 percent of the time. All of the RMZ BMP specifications employed were 86.7 percent effective at protecting the water resources of the sites.

Table 5: Application and effectiveness of BMP specifications for Riparian Management Zones.

Riparian Management Zones	% Application	% Effective
Z2. Perennial & large intermittent streams clear of obstructing debris	70.0	71.5
Z3. Tree tops and cutoffs placed back from water course to prevent movement into streams during floods	90.9	93.9
Z4. RMZ free of excavated material & debris (other than above)	94.6	96.9
Z5. Less than 10% bare mineral soil exposed within RMZ (not including crossings)	96.3	97.5
Z6. Adequate tree stocking in primary RMZ next to perennial streams	99.0	99.0
Z7. RMZ free of roads and landings (except crossing)	65.8	87.3
Z8. Water diverted from roads before entering RMZ	84.2	88.4
Z9. Water diverted onto stable areas of the forest floor	86.5	89.6
Z10. Road and trail surfaces stabilized as needed within RMZ	89.2	89.9
Z11. Ephemeral channels free of excavated material	63.1	64.4
Riparian Management Zones	82.4	86.7

Perennial & large intermittent streams clear of obstructing logging debris on state forest properties has had varied definitions since the beginning of Indiana State Forest BMP monitoring because of the “4-Foot Rule” adopted as an automatic “large intermittent” stream starting July 1, 1999 when BMPs officially were put in timber sale contracts. On other forest ownership types, the definition of a “large intermittent” was determined by the interpretation of the monitoring crew at the site. As of July 1, 2010, consistency across all landowner classifications was attained by defining “large intermittent” streams as those that were mapped as intermittent streams on the USGS 7.5 Minute Quadrangle maps. So, between July 1, 1999 and July 1, 2010, there may have been logging debris (Z2) departures counted on state forest properties that may not have been counted as departures on other landowner types in similar streams.

Out of 566 sites, 503 had a water body of some type that had a RMZ. In specification Z2, “streams clear of obstructing debris,” the application rate was 70 percent and the effectiveness rate was 71.5 percent. Of the 136 sites that had a departure in effectiveness for Z2, six were indirect and temporary, nine were indirect and prolonged, 25 direct and temporary, and 96 direct and prolonged. The nature of the debris would be prolonged unless it could be removed or mitigated in some way. In a few rare cases there is debris in

the stream that is to remain in the stream for additional aquatic habitat. There are a few areas of debris found in streams that were determined that they would breakdown and move down stream within a year which explains the small temporary effectiveness ratings. Mitigation by removing debris is the standard recommendation. Roads and landings in the RMZ scored lower in application with a 65.8 percent but had 87.3 percent effectiveness. This suggests that although there were some roads or landings in the RMZ water quality of the sites was protected. In Z11 ("ephemeral channels free of excavated material"), there were 199 departures in application, 189 of which were minor and 10 were major. There were 191 departures in effectiveness for the Z11 specification; 122 with an indirect and temporary impact on soil and water quality, 61 indirect and prolonged, and eight direct and temporary impacts.

C. Yearly BMP Monitoring Trends

All monitoring rounds on state forest properties from 1996 to present were broken down by year to determine the overall application and effectiveness rates. Arranging the data in this manner can be helpful in determining the presence of any possible trends. In Figure 4, it is apparent application and effectiveness rates are lower for all years following 1999. These lower numbers can be attributed to 1) the change in the "4-Foot Rule" at the beginning of the 2000 monitoring year, and 2) that internal BMP monitoring of state forest harvests was started that year.

All monitoring prior to 2000 was completed by monitoring teams formed of people within and outside the Division of Forestry who volunteered for BMP monitoring on different types of land ownerships. These rounds of monitoring are better explained in the reports Indiana Forestry Best Management Practices Report of Findings: 1996, 1997, 1999, 2000, 1996-2003, 1996-2004, 1996-2005 1999-2006, 1996-2007, 1996-2008, 1996-2009, 1996 - 2010, and 1996 -2011, 1996-2012, 1996-2013, 1996-2014, 1996-2015.

Table 6: Overall application and effectiveness of all BMP monitoring rounds.

Year	% Application rate	% Effectiveness rate	# sites (n)
1996	93.0	96.2	12.0
1997	93.5	95.8	7.0
1999	96.2	99.2	3.0
2000	87.1	94.6	15.0
2001	87.9	89.2	19.0
2002	89.6	94.6	25.0
2003	83.6	91.7	15.0
2004	83.5	92.2	21.0
2005	89.8	95.6	22.0
2006	92.6	96.0	25.0
2007	89.3	95.7	26.0
2008	84.0	92.9	47.0
2009	82.9	90.6	48.0
2010	84.2	91.4	24.0
2011	84.8	91.3	52.0
2012	87.2	91.7	52.0
2013	83.5	89.5	49.0
2014	95.0	89.6	39.0
2015	86.4	91.5	34.0
2016	88.4	92.7	31.0
Overall	86.2	92.3	566.0

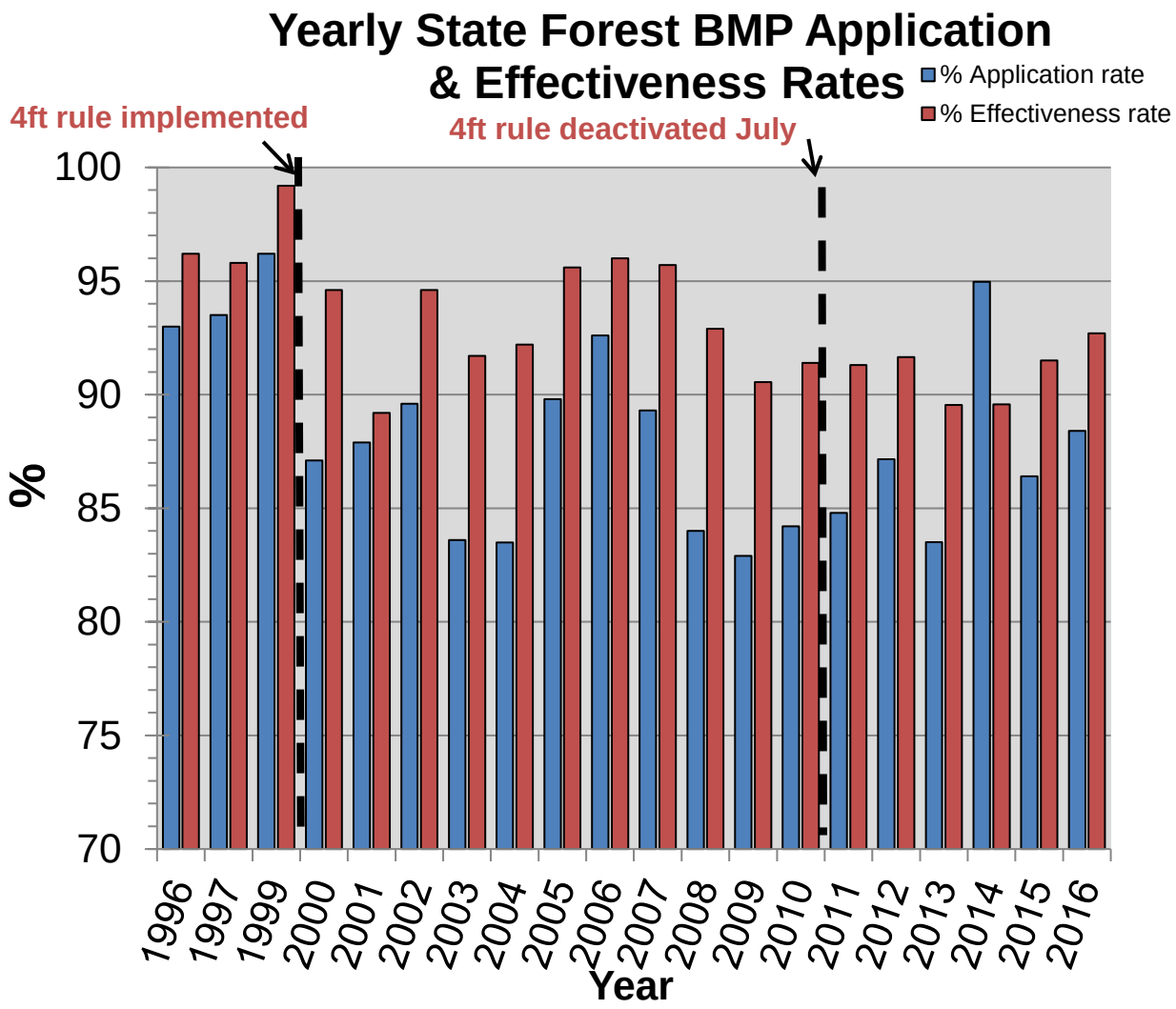

Figure 4: Overall application and effectiveness rates for each year of BMP monitoring.

D. Overall Site Ratings

On the final page of the monitoring form, there is an opportunity for each site monitor to rank his or her overall subjective impression of the site's BMP application and effectiveness (Appendix B). Sites can be rated from 1 to 4.

The application rating scale is: 1=above average, 2=average, 3=poor, 4=total negligence. The effectiveness rating scale is: 1= no visible impact, 2=slight, 3=moderate, 4=severe. Table 7 shows the average ratings for all the sites monitored on the state forests. The overall site rating is an average of the application and effectiveness ratings. On average the monitors found BMPs on Indiana State Forests to be applied between average and above average. They also found effectiveness of sites, on average, to have between no visible impact and slight impact.

Table 7. The average site ratings for application, effectiveness and the overall site rating.

Overall Application	Overall Effectiveness	Overall Site Rating
1.59	1.79	1.69

V. Discussion

The overall BMP application rate was 86.3 percent at the time of this report. BMPs on state forest properties were also found to be 92.4 percent effective at protecting water quality. Time trends show that as BMP monitoring became internal to the Division of Forestry, the application rate declined, not because application of BMPs on state properties dropped but because the standard of BMPs on state forest properties was being raised. The effectiveness scores have remained consistent over the years; evidence that BMPs always were practiced.

Also, the implementation of the "4-Foot Rule" tightened the restriction of tops in the stream on state properties, which is always a 4 or 5 in effectiveness, but is often mitigated by being cleaned out soon after the monitoring, unless there is another reason the Administrating Forester has for keeping the top in the stream, such as stream restoration or wildlife habitat.

In looking at the application rate, the 1s (meets requirement) were at 86.3 percent; the 2s (minor departure) accounted for 13 percent; the 3s (major departures) accounted for 0.6 percent. The 1 application score out of 25,210 with a score of 4 (total negligence).

In effectiveness, 1s (adequate protection) accounted for 93.4 percent of a total of 25,209 scores; 3 percent were 2s (indirect and temporary impacts), 0.9 percent were 3s (indirect and prolonged), 2.5 percent were 4s (direct and temporary), and 1.2 percent were 5s (direct and prolonged).

The high application and effectiveness scores show there are many sound practices taking place on state forest timber harvest sites to maintain the integrity of the soil and water resources. When there are problems in either application or effectiveness, they are mostly minor and short term.

Forest harvest activities on access roads and log landings had little to no effect on water quality. Roads and landings are established with the knowledge these are areas where the concentration and amount of repeated traffic will be highest. During site planning and layout, managers will put roads and landings on the most stable areas outside RMZs (94.2 percent and 95.5 percent application, respectively). Sometimes site landform and characteristics force the roads to cross streams or be in a RMZ or force landings to be within a RMZ, in which case, managers are more thoughtful and careful about how the harvest and closeout are carried out (98.4 percent and 99.1 percent effectiveness,

respectively). The results of the monitoring show the above inferences to be true by having all effectiveness scores in both categories above 98 percent.

For skid trails, 76.6 percent of the application scores were 1, but effectiveness scores of 1 account for 88.6 percent, showing a difficulty in implementing some practices within the guidelines, but affecting water quality to some degree only 11.4 percent of the time. Skid trails can have a spectrum of disturbance levels depending on how often equipment drives over a particular point on the ground. For instance, the main trail just off the landing would have a higher disturbance level because all harvested logs have to be moved to the landing, while an area traveled over only twice — once to access trees and the other pulling the logs out — has a much lower level of disturbance. Also, skid trails go to areas that other equipment cannot access, so it may cross drainages, travel down or across hill slopes, or go into areas that are wet most of the time. Therefore, most of the application and effectiveness issues of a site are from skid trails. Also, most closeout practices are put in place with limited space as landforms, and adjacent vegetation will often limit the equipment's ability to place structures where they would be most effective. This causes minor departures in application (22.7 percent of skid trail application scores are minor departures) with little to no effect on water quality.

Stream crossings are difficult to use without having some impact to water quality. The stream crossings cross some sort of water body, so any impact would be direct in effectiveness causing a 4 or 5 as an effectiveness score if anything goes wrong. Consequently, the Division of Forestry tries to avoid crossing streams if possible and still be able to access the site. Of 566 sites, only 36.4 percent (206 sites) had stream crossings. At those 206 sites, there were 519 crossings; 303 on mapped intermittent streams, 204 on unmapped intermittent streams, and 12 on perennial streams. In stream crossing applications, 77.5 percent of the practices were implemented within guidelines and had a 79.4 percent effectiveness score. As mentioned, stream crossings have a direct effect according to the definitions in effectiveness scoring. There are only 9 scores (0.4 percent) of 2 and 6 scores of 3 in effectiveness (0.3 percent), but 13.6 percent of the effectiveness scores had a 4 (direct and temporary impacts) and 6.3 percent had a score of 5 (direct and prolonged impacts). There was an average of 2.5 crossings for the 206 sites that had a crossing. The two largest areas of impact for stream crossings are bank stabilization and water diversions prior to crossing. Bank stabilization has a slightly lower impact on water quality at 65.9 percent effectiveness and 64.1 percent effectiveness for water diversions.

RMZs are much like stream crossings in that they are in close proximity to water bodies. If there is a problem, it often leads to direct impacts to water quality, so managers often try to avoid placing high impact infrastructure such as access roads or landings in RMZs unless they already exist. There were 503 sites with at least one RMZ; 331 (65.8 percent) had no roads or landings. There were 172 sites with skid trails and/or landings in the RMZ; 108 had no impact to water quality, 20 had an indirect and temporary effect, 3 had an indirect and prolonged effect, 35 had a direct but temporary effect, and 6 had a direct and prolonged effect.

VI. Recommendations

- Concentrate on areas where problems are more common, such as skid trails, RMZs, and stream crossings in order to improve what we are already doing well.

- Continue to emphasize importance of diverting water before it concentrates on roads, landings, skid trails and enters streams and RMZs.

- Continue providing BMP educational information and programs for loggers and resource professionals that work on state properties. If there is an area of concern on state properties, focus training on that area.

VII. Conclusions

The Indiana Forestry BMP Guidelines are scrutinized and enforced on state forest properties more than any other general landowner category in the state of Indiana. When the internal inspections began, the application scores actually dropped due to the standards on the state forest properties being raised by factors such as the "4-Foot Rule." However, effectiveness in protecting water quality, which is the main goal of Indiana's Forestry BMPs, has always been high and continues at the time of this report.

Our state forest system has diverse uses. It is the responsibility of the Division of Forestry to ensure forest resources are protected. Forestry BMPs are the means used to safeguard harvest sites by eliminating or reducing soil erosion on disturbed ground. Minimal soil erosion allows for quick recovery of the site because the topsoil is still in place to allow for natural succession to take place. Limited sedimentation to the surface waters of the forest protects or restores water quality.

Appendix A

BMP Definition Clarification: 4-Foot Rule

Background

The BMP Field Guide states, "Remove felled tops and logging debris from the channels of perennial and large intermittent streams." On the BMP Monitor Sheet (expanded) the definition of the streams was further defined as "…wider than 6'…" The purpose was to identify a specified width **for monitoring purposes** rather than leaving a vague descriptive term (e.g. large intermittent). It should be realized that BMPs are guidelines. In some instances even a 6-foot width may not be "large" while in other situations more narrow streams may be large from a hydrological standpoint. Foresters therefore are expected to interpret the local hydrology and make on-site determinations when applying BMPs. This is clearly true for this BMP standard.

At the start of BMP monitoring on State Forests, it was decided to try to adhere to a tighter standard for streams on State Forests; hence the 4-foot standard for large intermittent streams. This would serve both as a demonstration of commitment to water quality and as a demonstration and test of a tighter standard.

Variable stream width cropped up as a problem early in this process, requiring clarification of stream width. Streams would widen out over four feet then narrow to less than four feet. This created a burden of trying to find the last point upstream that a stream was four feet wide. To solve this, it was decided that to meet the 4-Foot Rule, a stream had to be consistently 4-feet wide or wider. This solved some concerns, but there are other concerns, such as what debris needs to be removed and where a stream is consistently four-feet wide or wider.

Below is the latest attempt to clarify the 4-Four-Rule. This covers the definition of the stream and what debris is to be removed.

Removing Logging Debris from Streams – 4-Foot Rule

To meet the BMP Field Guide guidelines for riparian zones that states "Remove felled tops and logging debris from the channels of perennial and large intermittent streams," the BMP Monitor Sheet has Item Z2 "Perennial & large intermittent streams clear of obstructing debris." On state forests, all streams that are to meet this standard will have a clearly defined bed with a width that equals or exceeds four feet.

The bed is that portion of the stream that is the lowest level where water commonly flows at typical (not storm) levels. This generally will be at the base of the banks and will usually consist of aggregate or exposed alluvium. The bed generally will be free of any significant vegetation because of the regular scouring and water flows. An area with a strong, well-rooted vegetative component with a relatively stable soil surface will not be considered

streambed. In streams where the channel is strewn with large rocks, the bed will be the area of smaller gravel at the base of the large rocks.

The stream will be considered four feet or wider until the bed, moving upstream, reaches the first point where the stream bed width drops below four feet for a lineal distance of 10 feet or more. Any portion of the drainage system up stream of this point will not be subject to the debris removal guidelines for large intermittent streams, and debris left in these portions of the drainage will not be considered a departure during monitoring.

Downstream of the identified 4-foot-wide point, all logging debris, except as noted below, that will come in contact with the water when the stream is “bank full” and impede or divert stream flow must be removed from the stream channel. Unattached, individual pieces of debris less than two inches in diameter or less than four feet in length ordinarily will not impede flow and does not need to be removed. Debris that bridges the stream channel from top of bank to top of bank, does not impede flow, and is unlikely to fall into the stream channel within one year is not required to be removed. Debris less than two inches in diameter obstructing less than 20 percent of the stream channel does not need to be removed.

Debris removal is to be accomplished in a manner that minimizes disturbance to the stream banks. The recommended method of removal is to pull the material free of the channel using a cable skidder or other equipment that is kept back from the stream edges. Another option is to cut debris into smaller pieces that can be removed from the channel or would no longer impede flow. Equipment should not be used in the stream channel to push the material out of the channel. Careful marking of the trees to be harvested, use of directional felling, and clearly explaining the BMP requirements during the pre-harvest conference will minimize the amount of debris that must be removed from stream channels.

The point where the stream channel reaches the four-foot width threshold should be clearly delineated in harvest areas. While upstream of this point will not be considered subject to debris removal from streams, care should be taken to avoid excessive, intentional deposition of debris in all naturally occurring drainage features regardless of size. Excessive piling (beyond felling) of debris in any drainage that severely impedes flow may be considered a departure.

Appendix B

FORESTRY BMP MONITORING WORKSHEET

(2000)

DATE INSPECTED:_____TEAM:_____
OWNER:_____ PHONE:_____.
_____
_____

COUNTY:_____Site #:_____ ACRES HARVESTED:_____
CIVIL TWP:_____ USGS QUAD:_____
SEC:_____TWP:_____ RANGE:_____
MAJOR WATERSHED:_____
DATE OF ACTIVITY:_____
HARVEST EQUIPMENT USED: Dozer:__ Skidder:__ Horses:__ Other:__
TYPE OF HARVEST: Diameter limit:__ Single Tree:__ Group Selection:__ Clear Cut:__ Other:__

SITE CONDITIONS

TERRAIN: BOTTOMLAND_____% RIDGES_____% SIDE SLOPES_____%
SLOPE STEEPNESS: (2-6%)_____ (6-12%)_____ (12-20%)_____ (20+%)_____
LAKES PRESENT: name:_____shore length:_____
PERENNIAL STREAMS PRESENT: name:_____width:_____length:_____
SINKHOLES PRESENT: Yes_____ No_____ FLOWING SPRINGS PRESENT: Yes_____ No_____
OPEN WATER WETLANDS PRESENT: Yes_____ No_____ .

FOR OFFICE USE – DO NOT COMPLETE

OPERATOR/FORESTER: (leave blank)_____

TYPE OF OWNERSHIP: nipf:__ clf:__ industry:__ state:__ fed:__ county:__ other:__

APPLICATION	EFFECTIVENESS
0--The Practice Not Needed or Applied on Site	**1--Adequate Protection of Water Resources.**
1--Operation Meets Requirement of Bmp	**2--Indirect and Temporary Impacts on Water Resources.**
2--Minor Departure from Bmp	**3--Indirect and Prolonged Impacts on Water Resources.**
3--Major Departure from Bmp	**4--Direct and Temporary Impacts on Water Resources.**
4--Gross Neglect of Bmp	**5--Direct and Prolonged Impacts on Water Resources.**

APPLICATION DEFINITIONS (BY EXAMPLE)

MINOR DEPARTURE: Practice not clearly needed; attempted practice but poorly applied; small potential for soil to reach streams.
MAJOR DEPARTURE: Practice clearly needed; common departures from practice; large potential for soil to reach streams.
GROSS NEGLECT: No attempt at application; total disregard for water quality; large and direct impacts.

EFFECTIVENESS DEFINITIONS (BY EXAMPLE)

ADEQUATE: Small amount of material eroded; material does not reach drainages, streams, lakes or sinkhole openings.
INDIRECT IMPACT: Erosion and delivery of material to drainages (including ephemerals) but not to intermittent or perennial streams, lakes or sinkhole openings.
DIRECT IMPACT: Erosion and subsequent delivery of sediment to intermittent or perennial streams, lakes or sinkhole openings.
TEMPORARY IMPACT: Impacts lasting one year or less; no more than one runoff season; small amount of material involved.
PROLONGED IMPACT: Impacts lasting more than one year; large amount of material involved.

***It is possible to have a departure from BMPs and still have adequate protection.**

ACCESS ROADS							APPLICATION (0-4)		
								EFFECTIVENESS (1-5)	
									COMMENTS
There is no access road present _____ (If true, do not answer questions below)									
A1. Uses existing routes where appropriate									
A2. Adequate buffer strip next to watercourses and sensitive areas									
A3. Avoids unstable gullies, seeps, very poorly drained areas									
A4. Road grades are within standards									
A5. Amount of roads minimized									
A6. Stream crossings minimized									
A7. Road excavation minimized									
A8. Excavated and fill materials placed appropriately									
A9. Roads constructed to drain well									
A10. Appropriate road stabilization, drainage & diversions installed									
X=applied	water bars_____ dips/rolls_____ outslopes_____ berms cut_____ culverts____ geotextile____ rock____ seed____ mulch_____								
A11. Water diversions are in working order (_____% working) Failure due to: installation, damage, location, timing, weather, other									
A12. Runoff diverted onto stable forest floor areas									
A13. Mud kept off public roadways									
A14. Public road drainage system maintained									
A15. Appropriate traffic barriers installed									

APPLICATION

0--The Practice Not Applicable
1--Operation Meets Requirement of Bmp
2--Minor Departure from Bmp
3--Major Departure from Bmp
4--Gross Neglect of Bmp

EFFECTIVENESS

1--Adequate Protection of Water Resources.
2--Indirect and Temporary Impacts on Water Resources
3--Indirect and Prolonged Impacts on Water Resources.
4--Direct and Temporary Impacts on Water Resources.
5--Direct and Prolonged Impacts on Water Resources.

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LOG LANDINGS								
							APPLICATION (0-4)	
								EFFECTIVENESS (1-5)
								COMMENTS
Y1. Suitable number and size of landings								
Y2. Landings located outside RMZ								
Y3. Landings located on stable areas								
Y4. Excavation of site minimized								
Y5. Landings avoid concentrating or collecting runoff								
Y6. Landing's runoff enters stable area								
Y7. Proper water diversions in working order								
Y8. Landing smoothed and soil stabilized								
Y9. Landings free of fuel and lubricant spills and litter								
Y10. Landing location suitable for equipment fueling and maintenance								
Number of log landings _____ Size: (acres) _____.								

APPLICATION

0--The Practice Not Applicable
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EFFECTIVENESS

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SKID TRAILS				
			APPLICATION (0-4)	
				EFFECTIVENESS (1-5)
				COMMENTS
S1. Uses existing routes where appropriate				
S2. Adequate buffer strip next to watercourses & sensitive areas				
S3. Avoids steep and long straight grades (>20% for >200')				
S4. Avoids unstable gullies, seeps, poorly drained areas				
S5. Amount of skid trails minimized				
S6. Trail excavation minimized				
S7. Appropriate drainage and diversions installed				
X= applied	water bars____ outslopes____ dips/rolls____ berms cut____ culverts____ seed____ mulch____ rock____ other____			
S8. Water diversions in working order (_____% working) Failure due to:installation, damage, location, timing, weather, other				
S9. Runoff diverted onto stable forest floor areas				
S10. Streams not used as skid trails (except crossings)				
Types of streams involved and length of disturbance: perennial_____ , mapped intermittent_____. Unmapped intermittent_____ , ephemeral_____.				

APPLICATION

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EFFECTIVENESS

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STREAM CROSSINGS			
	APPLICATION (0-4)		
		EFFECTIVENESS (1-5)	
			COMMENTS
X1. Number of crossings minimized			
X2. Crossings minimize disturbance to the natural bed & banks			
X3. Streambank approaches properly designed and stabilized			
X4. Water runoff diverted from road prior to crossing			
X5. Crossing as close to 90 degree angle as practicable			
X6. Crossing does not unduly restrict water flow			
X7. Soil has not been used as fill in the stream (except culverts)			
X8. Ford constructed of non erosive materials that will not degrade water quality			
X9. Fords have stable banks and streambed			
X10. Culverts are properly sized and installed			
X11. Culverts clear of significant flow obstructions			
X12. Temporary structures properly anchored			
X13. Temporary structures and resulting obstructions removed			

Number of perennial crossings_____ widths_____.

Number of intermittent crossings_____ widths_____ Number of unmapped intermittents widths_____.

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RIPARIAN MANAGEMENT ZONES			
	APPLICATION (0-4)		
		EFFECTIVENESS (1-5)	
			COMMENTS
Z1. RMZ present on this site include: _____ lakes, _____ rivers, _____ perennial streams, _____ intermittent streams, _____ sinkhole openings (specify), _____ open water wetlands, _____ unmapped intermittent streams			
Z2. Perennial & large intermittent streams clear of obstructing logging debris			
Z3. Logging debris placed back from watercourse to prevent movement into streams during floods			
Z4. RMZ free of piled slash, debris and fill			
Z5. Less than 10% bare mineral soil scattered within RMZ - not including crossing			
Z6. Adequate tree stocking in primary RMZ next to perennial streams			
Z7. RMZ free of roads and landings (except crossings) Were roads pre-existing? _____			
Z8. Water diverted from roads before entering RMZ			
Z9. Water diverted onto stable areas of the forest floor			
Z10. Road and trail surfaces stabilized as needed within RMZ			
Z11. Ephemeral channels free of excavated material			

APPLICATION

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EFFECTIVENESS

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SUPPLEMENTAL QUESTIONS AND SUMMARY

1) WHAT WENT RIGHT ON THIS SITE? (SUMMARIZE HIGHLIGHTS)

2) WHAT WENT WRONG ON THIS SITE? (SUMMARIZE PROBLEMS)

3) HAVE OTHER ACTIVITIES OCCURRED ON THIS SITE THAT POTENTIALLY IMPACT WATER QUALITY? (E.G. ATV use, vehicle traffic, grazing, etc.)
If so, please explain.

4) WERE TRAFFIC BARRIERS IN PLACE TO PREVENT TRESPASS DAMAGE? _____.
WHAT KIND OF TRESPASS DAMAGE WAS OBSERVED?

5) ARE THERE MITIGATING ACTIVITIES THAT SHOULD TAKE PLACE ON THIS SITE OR IS CORRECTIVE ACTION ALREADY BEING TAKEN.

6) -HAS THE SALE ADMINISTRATOR RECEIVED BMP TRAINING? Yes_____ No_____Unknown_____.
- HAS THE OPERATOR (LOGGER) RECEIVED ANY BMP TRAINING? Yes_____ No_____Unknown_____.
- WAS THE SALE ADMINISTERED BY A FORESTER? Yes_____ No_____Unknown_____.
- IS THE LANDOWNER AWARE OF BMPs? Yes_____ No_____Unknown_____.

7) GIVE THIS SITE AN OVERALL RATING OF 1-8 COMBINING APPLICATION OF BMPs WITH IMPACT TO WATER QUALITY.

RATE THIS SITE FROM 1-4 FOR THE OVERALL APPLICATION OF BMPs _____
1=above average 2=average 3=poor 4=total negligence

RATE THIS SITE FROM 1-4 FOR ITS OVERALL IMPACT TO WATER QUALITY _____
1= no visible impact 2=slight 3=moderate 4=severe

SITE RATING _____/2=_____

Note: These numbers do no necessarily need to directly reflect the worksheet ratings for application or effectiveness

Field Guide Cross Reference

On this page is each question in the monitoring sheet and the corresponding pages on the subject in the BMP Field Guide.

ACCESS Roads == Section II, pages 8-16

- **A1 == pages 4, 8, 10**
- **A2 == pages 8, 9, 12, Section V page 32, 33, Table 4 page 34, 35**
- **A3 == page 8**
- **A4 == page 8**
- **A5 == page 10**
- **A6 == page 8 and Section IV page 24 – 30**
- **A7 == pages 8, 10**
- **A8 == pages 10, 12, 24, 29**
- **A9 == pages 8, 10, Table 1 page 11, 12**
- **A10 = pages 8, 10 Table 1 page 11, 12, 14, 15, Table 2 page 21, 22**
- **X=Applied == (waterbars, pages 21-22), (dips/rolls, pages 21-22), (outslopes, Glossary), (berms cut, Glossary),(culverts, pages 27-28), (geotextile, Glossary), (rock, page 10), (seed, Appendix A), (mulch, Appendix A).**
- **A11 = pages 14, 15, Table 1 page 11, 18, Table 2 page 21**
- **A12 = page 10**
- **A13 = pages 13, 14**
- **A14 = page 14**

LOG LANDINGS == Section IV, pages 36-40

- **Y1 == pages 36, 39**
- **Y2 == Table 4 page 34, 36**
- **Y3 == page 36**
- **Y4 == page 38**
- **Y5 == pages 36, 38-40**
- **Y6 == pages 38-40**
- **Y7 == pages 38-40**
- **Y8 == pages 38-40**
- **Y9 == pages 39, 40**
- **Y10 = page 39**

SKID TRAILS == Section III, pages 18-22

- **S1 == pages 4, 18**
- **S2 == pages 18, 20, Section V pages 32-35**
- **S3 == page 18**
- **S4 == page 18**
- **S5 == page 18**
- **S6 == page 18**
- **S7 == Table 1 page 11, pages 18-20, Table 2 page 21, 22, 27, 28**
- **X=Applied == (waterbars, pages 21-22), (dips/rolls, pages 21-22), (outslopes, Glossary), (berms cut, Glossary),(culverts, pages 27-28), (geotextile, Glossary), (rock, page 10), (seed, Appendix A), (mulch, Appendix A).**
- **S8 == Table 1 page 11, pages 14, 15, 20 Table 2 page 21**
- **S9 == page 20**
- **S10 = pages 18-20, Section IV pages 24-30**
- **Types of Streams == page 24, Glossary, and Section V pages 32-35**

STREAM CROSSINGS == Section IV, pages 24-30

- **X1 == page 24**
- **X2 == page 24**
- **X3 == pages 24, 25**
- **X4 == pages 24, 25**
- **X5 == page 24**
- **X6 == pages 24-26, 28**
- **X7 == pages 24, 29**
- **X8 == pages 24, 29**
- **X9 == pages 24, 25, 29**
- **X10 = pages 25, 27, Table 3 page 28**
- **X11 = pages 24, 27, 28**
- **X12 = pages 25, 26**
- **X13 = pages 25-29**

RIPARIAN MANAGEMENT ZONES == Section V, pages 32-35

- **Z1 == pages 32, 34, Glossary**
- **Z2 == page 33**
- **Z3 == pages 32-34**
- **Z4 == pages 32-34**
- **Z5 == pages 32-34**
- **Z6 == pages 32-34**
- **Z7 == pages 32, 34**
- **Z8 == pages 33, 34**
- **Z9 == pages 32-34**
- **Z10 = pages 33, 34**
- **Z11 = page 35**