Silviculture Best Management Practices Implementation Monitoring

A Framework for State Forestry Agencies

SOUTHERN GROUP OF STATE FORESTERS

Southern Group of State Foresters
Water Resources Committee

June 2007

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Foreword

The Federal Water Pollution Control Act Amendments recognized nonpoint source pollution, and called on states to develop and implement water quality management plans. Since then, state forestry and state water quality agencies have been working closely with the Environmental Protection Agency (EPA) to minimize silviculture-related sources of nonpoint source pollution.

To address silviculture related water pollution in the southern states, a traditional regulatory approach was initially proposed. However, after further analysis and consultation with the forestry community, EPA and the states generally agreed that a non-regulatory approach was more effective. This approach was based primarily on education and field demonstration, with the following basic components:

1. Identification of Best Management Practices (BMPs) to protect water quality during forestry operations; and

2. Widespread education/training of forestry practitioners and forest landowners to facilitate the implementation of BMPs; and

3. Routine monitoring of forestry operations to determine the level of BMP implementation.

To date, all southern states have developed silviculture BMPs, which have been approved by EPA. Most of these states have recently revised or updated their BMPs to keep current with changing information and technology. Likewise, all southern states have developed and conducted education and training sessions for forestry practitioners, landowners, managers and loggers, which include the distribution of materials and emphasize BMP implementation.

However, not all of these states have developed routine BMP monitoring procedures to measure actual implementation levels. In addition, no model procedure for conducting such monitoring exists. Thus, states with monitoring programs have measured and reported BMP implementation using significantly different methods. Consequently, monitoring results have been met with varying degrees of acceptance by the public and by regulatory agencies. Inconsistency among states with respect to statistical design, reproducibility, and general objectivity have been cited as areas of concern.

In order to improve and maximize the integrity of BMP implementation monitoring in the South, the Southern Group of State Foresters appointed a Task Force to develop recommendations for a more consistent approach to BMP monitoring in the region. Specifically, the Task Force was charged with developing a framework to provide south-wide guidance for monitoring BMP implementation that would be statistically sound, objective, and technically defensible. This framework would achieve analytical consistency and results would be generally comparable among states.

The Task Force, composed of hydrologists and water quality specialists from state forestry agencies, U.S. Forest Service, and forestry industry, in consultation with EPA Region IV, met during 1996 – 1998 and completed the initial document. On March 25-26, 2002, a subcommittee of that Task Force reconvened and completed this revision.

Task Force Members

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Table of Contents

Introduction

This document is presented as an Implementation Monitoring Framework within which state forestry agencies can build or revise their current monitoring programs. Widespread utilization of this document within the region is expected to improve consistency among states in the specific aspects of BMP monitoring listed below. In addition, the recommendations for each specific aspect are envisioned to be core elements of a credible evaluation and reporting process.

Monitoring Frequency

Issue: How frequently should BMP implementation monitoring be conducted and reported?

Alternatives Considered: Annual, biennial, every three years and continual monitoring.

Recommendation: Statewide implementation monitoring should be conducted and reported at a minimum of every three years.

Rationale: Due to the large number of forestry operations conducted annually, the number of sites necessary to achieve statistical reliability, and the logistics of locating, visiting and evaluating them, annual monitoring and reporting is often not practical. Further, there are no significant advantages of annual monitoring and reporting that justify the additional burdens.

Monitoring and reporting on at least a three year basis is more logistically achievable, and is consistent with typical 319 funding cycles for states receiving federal grants. In addition, monitoring at this frequency is considered often enough to allow visual observations of on-site problems and take timely corrective action.

Site Selection

Issue: What characteristics should a forestry site/operation exhibit in order to qualify as a BMP implementation monitoring site?

Alternatives Considered:
1. Minimum/no minimum area (acres)
2. Presence/absence of surface water on site
3. Time since treatment (years)
4. Site selection methodology (to eliminate bias)
5. Sample size (statistically valid confidence interval)

Recommendations:
1. No minimum area, but a site must be part of a normal, ongoing silvicultural operation, i.e., not in the process of conversion to another land use.

Rationale: Since forestry operations occur on tracts of all sizes and BMPs apply regardless of acres involved, all forestry operations should be eligible for monitoring. However, operations that include timber harvesting as part of a change in use, should be disqualified regardless of the size of the operation. Such activities would not accurately reflect normal silvicultural operations.

2. The presence of surface water features is not necessary for a site to be eligible for BMP implementation monitoring.

Rationale: BMP implementation in most states is not contingent upon the presence of surface water on-site. However, those states that have proximity restrictions associated with BMP implementation should select monitoring sites using the appropriate criteria.

3. The most recent silviculture activity(s) on a site to which BMPs apply must not have been completed more than 2 years prior to implementation monitoring.

Rationale: Forestry operations more than 2 years prior are increasingly difficult to evaluate because of rapid regrowth of vegetation and more difficult access. Likewise, evidence of erosion and sedimentation become less visible over time, as does the opportunity to correct such problems without "re-disturbing" sensitive areas.

4. Sites for implementation monitoring may be located using aerial reconnaissance, severance tax records, notification logs, or other available sources of information. However, it is essential to achieve random, stratified random or randomized cluster statistical design to obtain an unbiased sample.

Rationale: Several data sources can provide the information necessary to select a random sample of forestry operations sites. However, it is important that the sample population accurately reflect actual conditions in a given state. For example, portions of a state in which forestry operations are concentrated should be sampled accordingly, as should those with fewer operations.

5. The sample size should be sufficient to achieve an estimate of implementation that is ± 5% within the 95% confidence interval.

Rationale: To maximize the validity and credibility of the monitoring results, the number of sites evaluated for BMP implementation should be calculated to provide minimum error (± 5%) and high confidence (95%). Designing a statistically valid sampling procedure for implementation monitoring and analyzing the results should be consistent with "*Sampling and Estimating Compliance with BMPs*" (1) and/or the *Statistical Guide for BMP Implementation Monitoring* found in the Appendix.

Practices to be Evaluated

Issue: Which categories of practices should be evaluated for BMP implementation monitoring?

Alternatives Considered: Harvesting; Site Preparation (mechanical, chemical, burning); Forest Roads; Stream Crossings, Streamside Management Zones, Firebreaks, Forest Chemical Application (fertilization, herbicides).

Recommendation: All of the above alternatives should be evaluated.

Rationale: These BMP categories contain all practices that are generally associated with operational silviculture in the South.

Basis for Practice Evaluation and Reporting

Issue: On what basis should BMPs be evaluated and reported?

Alternatives Considered: Individual practices, Categories of practices, Overall site.

Recommendation: Evaluation and reporting should include all three levels of BMPs listed above.

Rationale: Evaluation of BMPs at the practice level provides the basic measure of on-site BMP implementation. This level of information also allows for comparison of a specific practice among all monitoring sites and against any other site variables. Such comparisons are useful for identifying those variables most often associated with non-implementation.

In addition, by evaluating categories of practices, monitoring can provide broader conclusions about BMP implementation for stream crossings, roads, etc. Also, this information can identify training needs for forestry agency personnel, and education needs for forestry practitioners.

It is likewise useful to water quality agencies, other interested parties and particularly forest landowners to know the overall or cumulative level of BMP implementation for individual forestry operations. This is a primary and traditional measure of program success, and indicates the efficacy of the non-regulatory approach to controlling silvicultural related nonpoint source pollution.

Scoring Methodology

Issue: How should BMP implementation monitoring be scored?

Alternatives Considered: Pass/Fail; Graduated Scale; Percent Correct Implementation; Yes/No

Recommendation: An individual practice should be scored as "Yes" when applied <u>as specified</u> in the state's BMP Manual. If a particular practice is not applicable, this should be noted as well. Any significant deviation from practice specifications should result in a

“No” answer for BMP implementation. Categories and overall scores should be expressed as a simple percentage of all applicable practices. For example, if 100 practices were applicable but only 90 were actually implemented correctly, then the score would be 90% for that category or site, as the case may be.

Rationale: Evaluating whether or not BMPs have been properly implemented, and their applicability to specific site conditions yields the most objective and reproducible method of implementation monitoring. While some judgment will always be necessary in questionable situations, objectivity can be maximized by training. In addition, subjectivity and confusion are minimized by avoiding practice evaluations based on graduated scales for partial implementation, or arbitrary "Pass/Fail" declarations. Simple “Yes/No” scoring of BMPs also facilitates the calculation, summarization and reporting of category and overall implementation levels on a percentage basis.

Risk Assessment

Issue: How should the risk to water quality resulting from failure to implement BMPs be evaluated and documented?

Alternatives Considered: No evaluation of risk; Risk evaluated and significant risk noted.

Recommendation: Risk to water quality should be evaluated and significant risk documented. Significant risk may be attributed to non-implementation for a specific BMP, category of BMPs or the overall operation. The field evaluation of significant risk should be based on **existing** on-the-ground conditions resulting from failure to correctly implement BMPs, that if left unmitigated will likely result in an adverse change in the chemical, physical or biological condition of a waterbody. Such change may or may not violate water quality standards.

Key site conditions often associated with significant risk include, but are not limited to: steep topography and highly erodible soils. Forestry operations conducted under one or more of these conditions without proper implementation of certain BMPs may have a high potential to result in significant risk to water quality. Some examples of forestry activities where significant risks have been identified are equipment operation in close proximity to surface waters, stream crossings, logging slash disposal and intensive mechanical site preparation. A list of on-site indicators of significant risks to water quality is located in the Appendix.

Significant risk should be considered as a situation or set of conditions that can be remedied or otherwise mitigated (2). In addition, failure to implement BMPs that results in risks to site productivity, road usability or other site values should not be considered a significant risk in the context of implementation monitoring. Significant risk should be directly and exclusively related to water quality impairment.

Rationale: Documenting the occurrence of significant risk serves a number of useful and practical purposes. First, risk assessment lends much credibility and integrity to the BMP monitoring process by recognizing that high risk conditions can occur, and that prevention and/or restoration is a high priority for state forestry agencies. Second, routine documentation of significant risk will determine whether such instances are the exception rather than the rule, and that lack of BMPs during a silviculture operation may not necessarily equate to or result in a water quality problem - this is particularly important as it relates to BMP effectiveness monitoring (3). Finally, providing forest landowners with an objective risk assessment is a valuable public service that not only protects the environment, but can also protect the landowner and/or operator from what might otherwise result in enforcement proceedings or other personal liability.

Follow-up Actions

Issue: What specific actions should states take following BMP implementation monitoring?

Alternatives Considered: No follow-up; Courtesy copies of monitoring results; Personal visit; Referral (where necessary) to regulatory agency.

Recommendation: Landowners who have participated in the implementation monitoring should be provided a copy and explanation of the monitoring results. In addition, participating landowners should receive recommendations for any remedial actions deemed necessary by the field observer. In cases where a significant risk has been identified, state forestry personnel should attempt to schedule a follow-up site visit with the landowner, to insure that recommendations were understood and implemented satisfactorily.

Rationale: Follow-up activities with landowners and/or loggers serves as a useful educational opportunity, as well as a demonstration of cooperation and courtesy. The BMP monitoring data provides an excellent focal point for reviewing the performance of an operator and the responsibilities of the landowner, in terms of water quality and site protection. Remedial or other actions can also be recommended at this time, as can commendation for a job well done.

Where a significant risk has been identified in the monitoring process, an on-site follow-up can be vital to insuring that the landowner/operator is aware of the seriousness of the situation and advised of remedial actions.   Potential consequences of inaction can be explained and discussed at that time also, and should include environmental impacts as well as possible enforcement actions or other liabilities. This effort can provide the basis for fulfilling the responsibilities of the state forestry agency, and provide the landowner with the information from which to make an informed decision.

References

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(2) Vowell, Jeffery L. and Roy Lima, 2002. Results of the 2001 Silviculture BMP Compliance Survey. Florida Department of Agriculture and Consumer Services, Division of Forestry; Tallahassee, Florida.

(3) Dissmeyer, George E. 1994. Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards. USDA Forest Service, Miscellaneous Publication 1520.

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Glossary

Implementation Monitoring – The process used to determine the proper application of BMPs according to the specifications in individual state BMP Manuals.

Risk Assessment – The process and criteria used to identify a significant risk to the chemical physical or biological integrity of water quality.

Significant Risk – An existing on-the-ground condition resulting from failure to correctly implement BMPs, that if left unmitigated will likely result in an adverse change in the chemical, physical or biological condition of a waterbody. Such change may or may not violate water quality standards.

APPENDIX

Statistical Guide for BMP Implementation Monitoring

Significant Water Quality Risk Indicators

Statistical Guide for
BMP Implementation Monitoring

by

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Table of Contents

Statistical Guide for BMP Implementation Monitoring

Introduction

Implementation monitoring is the process used to determine the proper application of Best Management Practices (BMPs) according to the specifications in individual state BMP Manuals. In 1999, the Southern Group of State Foresters (SGSF) endorsed a monitoring framework designed to provide regional guidelines for monitoring BMP implementation so that consistency and reliability of southern state efforts would be maximized. The framework calls for evaluations to be conducted on randomly selected forestry operations and to result in data that is statistically valid.

Field evaluations consist of answering "yes", "no", or "not applicable" to questions regarding proper implementation of specific BMPs. These are typically broken down into several activity categories (roads, trails, stream crossings, etc.). Each question represents a specific BMP ("yes" means the BMP was implemented correctly and "no" means it was not). If a BMP listed on the evaluation form was not applicable to that site, "not applicable" is recorded. Additionally, the presence of a significant risk to water quality is noted for each question if, due to a lack of or malfunction of a BMP, water quality has been impacted or is clearly threatened. To determine the implementation rate, the total number of "yes" answers is summed and then divided by the total number of applicable answers (yes / yes + no) to determine the total BMP Implementation rate, expressed as a percent, for the site.

After combining all results, BMP implementation may be reported for the state, regions of the state, landowner types, forestry activities, river basins or watersheds, and BMP groups or other categories of interest for reporting purposes. Strengths (BMPs along streams) and weaknesses (BMPs on roads) are generally identified from the results.

In 2004, a task force of the SGSF Water Resources committee was formed to develop this statistical guidebook to assist the southern state forestry agencies with BMP implementation monitoring design and reporting. Included with this guidebook is an Excel spreadsheet created to help states determine how many sites are needed to conduct a statistically reliable survey, calculate the margin of error for each BMP evaluated and reported, and analyze statistical trends in BMP implementation.

Major elements in the design of a statistically valid BMP implementation survey include:

- sampling intensity (total number of sites needed for the survey)
- methodology of choosing sites
- how to ensure randomness of the samples
- stratification of field sites (# of samples per county, landowner type, etc.) so that sound conclusions can be drawn from each.

Key calculations for the analysis of a BMP implementation survey will include:

- determining statistical significance of BMP trends
- confidence intervals and margin of error

Survey Design

Determining the sample size, or number of sites to evaluate

$$n = \frac{4p\,(100 - p)}{m^2}$$

Where n = the number of sites to evaluate
p = the estimated overall percent implementation in the state
m = the margin of error (5%)

Notes:

- *p* must be estimated because it is unknown (% implementation from the most recent round of monitoring may be used)
- The closer the estimated value of *p* is to 100, the lower the value of *n* will be.
- *n* is highest when *p* is estimated to be 50%.
- m is the margin of error associated with the estimate of p. There is .95 (95%) probability that the sample taken will produce an estimate which differs from p by a value of m

Example:

$$n = \frac{4p\,(100 - p)}{m^2}$$

Where p (overall BMP implementation) is estimated at 80%

$$n = \frac{4\,(80) * (100 - 80)}{5^2}$$

$$n = \frac{6400}{25}$$

$$\mathbf{n = 256}$$

Using the spreadsheet:

The spreadsheet is set up so that all that must be entered is the estimated value of p (Est. % BMP Impl). It will then automatically calculate the number of sites to evaluate based on an embedded formula and a margin of error equal to 5% (as recommended by the SGSF framework).

*** These equations calculate the minimum number of sites necessary to evaluate. Increasing the sample size will yield an even more accurate estimate of BMP implementation. A minimum of 100 sites is recommended.**

Data Storage

BMP implementation monitoring data can be stored in a number of different formats. The easiest is an Access database consisting of the individual state's BMP monitoring form (checklist), data tables, queries, and reports. Site evaluations can then be entered directly into the database in a user friendly format. Queries and filters can be created to display the "target" data (i.e. implementation scores for tracts in which a professional forester was involved) for export to the *Statistical Guidebook Spreadsheet.* Reports can provide a quick glance at the results of the survey (i.e. % implementation by county). GIS programs can import data for geographical representation and further analysis. A sample database is available for states to customize to fit their needs.

Site Selection

BMP field sites may be selected in a number of ways: aerial reconnaissance, severance tax records, timber deeds, drive-bys etc. To avoid bias, it is important that personnel involved in the site selection process do not contact consulting foresters, industry foresters, or large landowners to provide a list of recent harvesting operations. This could bias samples to the "good" sites. Of equal importance is to avoid selecting sites thought to be either "good" or "bad". The SGSF framework calls for sites to be no older than 2 years after the most recent treatment activity.

Ensuring Randomness

Ensuring randomness is critical in any type of sampling. One way to help achieve randomness is to identify twice as many sites as are needed for the survey, and use a random number generator to identify specific sites to monitor.

Stratification of Field Sites by Ownership, Watershed, or Other Factors

Stratifying the monitoring sites based on important characteristics such as ownership type, watershed, or physiographic region, can add substantial value to the survey's results. It is important that the sample taken be reflective of the actual conditions. There are two ways to accomplish this:

- Take a truly random sample from the population (this will solve the stratification but is extremely difficult).
- Intentionally select sample sites based on their stratum

Forest Inventory and Analysis (FIA) data may be used to estimate the number of sites undergoing forestry operations by landowner type. This percentage can then be used to estimate the number of monitoring sites each landowner group should comprise.

Data Analysis

Margin of Error

The margin of error expresses the maximum likely difference observed between the sample mean and the true population mean with 95% probability. It is an important statistical calculation and can be performed for an individual BMP evaluation question (i.e. SMZ width). The following formula is used to perform this calculation:

$$m = 2\sqrt{\frac{P(100-P)}{n}}$$

Where m = margin of error for a single BMP
P = the percent implementation for a single BMP
n = the number of sites on which the BMP were evaluated

Notes:

- If the actual value of P is larger than the estimated value of P, then the actual margin of error will be smaller than m.
- This equation is not valid for a subset of all possible sites (i.e. calculating margin of error from the % BMP implementation for NIPF landowners.)
- For a BMP that is not applicable to all sites, the actual margin of error will be larger than m.
- Estimating the average % BMP implementation across all possible sites for a group of BMPs and then using this number of sites will produce a margin of error that is smaller than m.
- If the value of P is 100%, the margin of error is not zero. No calculation can be made.

Example:

$$m = 2\sqrt{\frac{P(100-P)}{n}}$$

Where P (% BMP impl. for adequate SMZ width) was evaluated to be 89% on 125 sites

$$m = 2\sqrt{\frac{89\ (100-89)}{125}}$$

$$m = 2\sqrt{\frac{979}{125}}$$

$$m = 2\sqrt{7.832}$$

$$\boldsymbol{m = 5.597}$$

Using the spreadsheet:

The spreadsheet is designed to calculate the margin of error for a single BMP. All that must be entered is the % implementation for a single BMP (% for single BMP) and the number of sites on which that BMP was evaluated (# of sites).

95% Confidence Interval

The 95% confidence interval is a tool that statisticians use to demonstrate their confidence in the measured mean of a sample. It provides a range for which they are 95% confident (i.e. 19 times out of 20) that the actual mean will be found within that range. To calculate the 95% confidence interval, you must also calculate the mean, variance, standard deviation, standard error, and margin of error.

Example:

Let's calculate the 95% confidence interval for the following sample:

95%, 80%, 88%, 100%, 77%

First calculate the mean.

$$\frac{95+80+88+100+77}{5} = \frac{440}{5} = \mathbf{88\%}$$

Then calculate the variance.

Step 1: USS = $95^2 + 80^2 + 88^2 + 100^2 + 77^2 =$ ***39,098***
Step 2: SUM = 95 + 80 + 88 + 100 + 77 = ***440***
Step 3: CF = $440^2/5 = 193{,}600/5 =$ ***38,720***
Step 4: CSS = 39,098 – 38,720 = ***378***
Step 5: DF = 5 – 1 = ***4***
Step 6: Variance = 378 / 4 = ***94.5***

Next calculate the standard deviation.

Std dev. = $\sqrt{variance} = \sqrt{94.5} = \mathbf{9.721}$

After that, calculate the standard error.

Std. error = (Std dev. / $\sqrt{\text{number of sites}}$) = $9.721 / \sqrt{5} = \mathbf{4.347}$

Next, calculate the margin of error.

Margin of Error = 2(Std. error) = 2 (4.347) = **8.695**

Finally, use the margin of error to calculate the 95% confidence interval.

95% Confidence interval = Mean ± Margin of Error = **(79.305, 96.695)**

Using the Spreadsheet

The spreadsheet is set up so that all that must be entered is the individual tract scores (Indiv. % Impl) and the total number of sites (# of sites). The spreadsheet automatically calculates the mean, variance, standard deviation, standard error, margin of error, and the 95% confidence interval (low and high ends).

BMP Trend Analysis

Analyzing trends or patterns in BMP implementation can be useful to target areas or ownership types for concentrated educational efforts (i.e. additional logger training workshops). Commonly reported trends include higher BMP implementation rates when professional foresters are used, the landowner is familiar with BMPs, and the logger has attended BMP training.

In order to determine trends in BMP implementation, several statistical analyses should be performed. First, a parametric two sample t-test is conducted because of the large sample size. This percentage data must undergo an arcsine square root transformation prior to analysis. Percentage data must be transformed because they are not normally distributed, which invalidates the normality assumption of the parametric test. A non-parametric test (Wilcoxon) may also be performed to add greater statistical validity.

To determine statistical significance, the resulting P value was compared to the level of significance. The P value is the probability of observing a value of the test statistic as contradictory (or more) to the null hypothesis as the computed value of the test statistic. In these tests, a 0.05 (5%) level of significance was used. For the two implementation ratings to be significantly different, the P value must be lower than the level of significance.

Using the spreadsheet:

The spreadsheet is set up so that all you have to do is enter the individual scores for the tracts that answered "yes" to the particular trend question and likewise for those that answered "no" in the respective column. It will then perform the arcsine square root transformation and conduct a parametric two sample t-test on the new data, based on a level of significance of .05. This value will be used to determine whether the difference in implementation scores for that particular trend is statistically significant. This classification is noted by the answer "TRUE" found under the Stat. Diff column.

The arcsine square root transformation was conducted so that Microsoft Excel could perform the analysis. More robust tests (non-parametric tests like the Wilcoxon) may be conducted to add greater statistical validity. These tests are not included in basic Microsoft Excel programs but can be found in programs like *JMP, SAS, or Statistica.*

Area Weighting BMP Implementation Data

Results are typically reported giving equal weight to all sites (i.e. a 20 acre tract counts the same as a 450 acre tract when compiling all data). Statistically, tracts could also be weighted based on their acreage, i.e. larger tracts would have a greater influence on the total % BMP implementation than the smaller tracts. This analysis can be performed to provide information on how the practices are impacting the total landscape. Both methods are useful in reporting BMP implementation rates, though the SGSF framework does not call for area-weighting. The following formula may be used to perform this calculation.

AW % = Σ (((indiv A/Total A) *100)) * % Impl)))

Where AW % = area weighted BMP implementation %
A = area (acres)
% Impl = individual tract % BMP implementation

Example:

For this example, let's use 5 individual tract scores and their respective size:

95% - 100 acres, 80% - 35 acres, 88% - 70 acres, 100% - 275 acres, 77% – 20 acres

Equal weighted % BMP Implementation = Sum of scores divided by number of sites

$$\frac{95+80+88+100+77}{5} = \frac{440}{5} = \mathbf{88\%}$$

Area weighted % BMP implementation = Sum of scores proportional to tract size

% BMP Impl	*Tract Size*	*% of Total*	*AW %*
95	*100*	*20*	*19*
80	*35*	*7*	*5.6*
88	*70*	*14*	*12.3*
100	*275*	*55*	*55*
77	*20*	*4*	*3.1*
Total	***500***	***100***	***95***

= ***95%***

% of Total = Tract Size / Total Size
*AW % = % of Total * % BMP Implementation for each individual tract*
Area Weighted % BMP Implementation = Sum of individual AW %

Using the spreadsheet:

The spreadsheet is set up so that all that must be entered are the individual percent BMP implementation rates and their respective tract sizes in acres. It will then automatically weight the BMP implementation scores based on the tract size.

Reporting

Using the statistical procedures contained in this guide, BMP Implementation data can be reported in the following ways:

- Overall % BMP implementation for the state
- % BMP implementation by landowner group
- % BMP implementation by BMP category
- Area weighted % BMP implementation

Significant Water Quality Risk Indicators

Significant Water Quality Risk – An existing on-the-ground condition resulting from failure to correctly implement BMPs, that if left unmitigated will likely result in an adverse change in the chemical, physical or biological condition of a waterbody. Such change may or may not violate water quality standards.

On-Site Indicators of Significant Risk to Water Quality

The conditions listed below are often associated with significant water quality risks. They should be viewed as "red flag" warnings that the chemical, physical and/or biological quality of adjacent waterbodies will likely be threatened if not mitigated.

- Temporary stream crossings remain in channel following operation
- Stream crossings and approaches not stabilized
- Logging debris in waterbody affecting or obstructing flow
- Evidence of excessive sediment entering waterbody from adjacent treated area
- Canopy completely or almost completely removed from SMZ on perennial waterbody
- Evidence of heavy equipment operation in stream channel
- Waterbody banks compromised by equipment or skidding activities
- Water diversion devices absent or severely compromised on roads or skid trails where runoff is likely to enter waterbody
- Ruts or other excessive physical damage to soils and cover within the SMZ
- Fill material in stream crossing without adequate means for conveyance of flow
- Un-stabilized fireline tied directly into waterbody
- Oil, chemicals, batteries or other hazardous materials leaking or remaining on site following operation
- Road or skid trail too steep or so poorly located that stabilization is improbable
- Excessive defoliation of riparian vegetation caused by herbicide application