Final Report

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**ASSESSMENT AND SELECTION OF STORMWATER BEST MANAGEMENT
PRACTICES FOR HIGHWAY CONSTRUCTION, RETROFITTING,
AND MAINTENANCE**

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The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Indiana Department of Transportation or the Federal Highway Administration at the time of publication. The report does not constitute a standard, specification, or regulation.

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INTRODUCTION

Federal and State stormwater regulations require the Indiana Department of Transportation (INDOT) to reduce contaminant loading of stormwater draining from their property or right-of-way in geographic areas designated as Municipal Separate Storm Sewer Systems (MS4s). INDOT must apply for a National Pollutant Discharge Elimination System (NPDES) permit and implement a Storm Water Quality Management Plan (SWQMP) designed to improve the water quality of stormwater runoff. These regulations and the need for INDOT to comply will require revisions to INDOT's standard documents.

A significant aspect of INDOT's compliance will be the removal of pollutants in stormwater runoff from State-maintained roadways. In the past, few types of structural Best Management Practices (BMPs) have been required or designed, constructed, and installed by INDOT for this purpose. Regulatory compliance has dictated this examination of the most appropriate BMPs, based on BMP placement, pollutant removal performance, cost of construction and maintenance.

The contents of this report and section reflect the views of the investigators. The content does not necessarily reflect the official views or policies of INDOT or the Federal Highway Administration (FHWA). The report does not constitute a design procedure, standard, specification, or regulation. This report is independent from INDOT's SWQMP in that INDOT may at their discretion choose to accept, reject, or implement the recommendations contained

herein and are under no obligation to accept, implement, or pursue any of the recommendations.

PROBLEM STATEMENT

The Federal and State stormwater regulations will require an improvement in the quality of stormwater runoff from INDOT roadways to waters of the State. Contaminants in roadway drainage can be significantly reduced by implementing appropriate Construction and Post-Construction phase stormwater BMPs and the maintenance of such measures. BMP cost, selection criteria, installation requirements, and maintenance considerations are all factors that need to be addressed.

Analysis and review of pertinent INDOT literature, documents and drawings are necessary in order to recommend changes that will facilitate INDOT compliance with current stormwater regulations and NPDES requirements.

OBJECTIVE AND PURPOSE

The objectives of this study are:

1. Research existing data for structural and non-structural BMPs pertaining to the Phase II NPDES Stormwater Construction and Post-Construction Minimum Control Measures. Identify BMPs suitable for use in construction, reconstruction, rehabilitation and retrofitting activities, that along INDOT roadways. Consideration will be given to the Indiana

- geological and meteorological conditions and the INDOT resources available for maintenance of such BMPs.
2. Review documents on the INDOT Publications List and make recommendations regarding potential revisions and/or additions to the documents to adequately address the NPDES Stormwater Program requirements as they pertain to INDOT activities.

WORK PLAN

This project will be completed as two tasks: (1) BMP research, and (2) review of current INDOT documentation.

TASK 1: BMP research will include review of data for structural and non-structural BMPs pertaining to the Phase II NPDES Stormwater MS4 Construction and Post-Construction Minimum Control Measures. This task of the research will be conducted by reviewing relevant resources from the FHWA and State Departments of Transportation (DOTs), State and regional BMP manuals, general stormwater articles and websites, independent studies and other related industry centers that are pertinent to Indiana's geological, environmental, and meteorological conditions. BMPs that could be applied to INDOT activities will be identified. Selection criteria for these BMPs, including published data on the effectiveness, cost, installation, and maintenance requirements will be organized into an evaluation matrix. Matrix information, along with a description of the specific BMP advantages and disadvantages, will be summarized in individual fact sheets.

TASK 2: Review of current INDOT documentation. The purpose of this review will be to make recommendations regarding potential revisions and/or additions to the INDOT standard documents that would be needed to adequately address Phase II NPDES Stormwater Program requirements. Recommendations will primarily be organized by the document reviewed, or according to the specific Construction or Post-Construction phase BMPs identified under Task 1. Additional non-existing documents, programs, or certification courses will be recommended for development by INDOT to facilitate compliance with current stormwater regulations and NPDES requirements.

ANALYSIS OF DATA

After reviewing numerous articles, books, presentations, and design manuals, only those that focused primarily on BMP design, construction, selection, relative effectiveness, or relative cost were evaluated further and entered into a database. The database divided the studies and reports into three categories:

1. **General Stormwater BMP Studies and Reports** – These studies were typically sponsored by universities or other research groups and were not necessarily specific to highway construction, retrofitting, or maintenance projects.
2. **Department of Transportation Manuals** –These manuals were developed by other DOTs and their consulting engineers and were typically developed to assist DOTs and their contractors with

complying with local, State, or Federal stormwater management regulations. These documents often included design and construction specifications and BMP selection criteria and guidance.

3. **State/Regional Stormwater Manuals** – These manuals were typically developed by State or regional organizations as guidance manuals to help municipalities, the development community, and other various entities comply with stormwater regulations. BMP applications identified in these manuals were not necessarily specific to DOT applications. These documents often included design and construction specifications and BMP selection criteria.

Each database citation includes background data such as title, sub-title, authors, publication date, source, document type, publication number, link, format, types of BMPs, depth of information, nature of information, level of detail, apparent applicability to cold climate, BMP selection criteria, cost and maintenance considerations, description, and notes. Details can be found in **Appendix 1**.

Based on the BMP material studied, engineering expertise and a Study Advisory Committee, a list of Construction and Post-Construction BMPs typical of INDOT construction, retrofitting, and maintenance projects was compiled into two matrices which can be found in **Appendix 2**. The *Construction BMP Selection Matrix* allows a user to quickly compare and select the most appropriate BMP based on installation, maintenance, water quantity rate control benefit, and water quality benefit.

In consideration of the types of projects that INDOT typically undertakes, BMPs were classified into linear and non-linear applications. Linear projects are those whose right-of-way is generally at or below standard clear zone requirements. Non-linear projects are those that require additional right-of-way to incorporate additional features (e.g. interchanges, rest stops, maintenance facilities). Linear and non-linear stormwater BMPs used during the Construction phase are further categorized by whether the water quality practice relies on the mechanism of erosion control or sediment control. The *Post-Construction BMP Selection Matrix* is a 3-step filtering process used to determine the most appropriate BMP, or group of BMPs to address Stormwater runoff. *Step 1* addresses physical feasibility factors and allows the designer to determine whether development site conditions such as area requirements, soils, terrain, depth to water table, drainage area, head, or whether the site is ultra-urban. Those BMPs that are not eliminated in *Step 1* are considered in *Step 2*, stormwater treatment suitability. Each remaining BMP is rated based on its effectiveness to provide water quantity and water quality benefits. BMPs that remain after *Step 2* are considered in *Step 3*. This final step considers community and environmental factors including construction costs, maintenance, community acceptance and benefit for wildlife habitat.

A BMP fact sheet was developed for each Construction and Post-Construction BMP identified. The fact sheets are intended to provide more detailed information about each BMP. Each Construction Phase BMP fact sheet includes quick reference bullet points that identify when to use, advantages,

limitations, installation cost, maintenance effort, runoff rate and volume control. Similarly, the Post-Construction BMP fact sheets include quick reference bullet points that identify when to use, advantages, limitations, percent pollutant removal, runoff volume and rate control, annual maintenance cost, relative construction cost and effective life. Construction BMP fact sheets can be found in **Appendix 3** and Post-Construction BMP fact sheets can be found in **Appendix 4**.

The review of INDOT documentation portion of the project included review of forty-five INDOT documents related to the design, construction, and maintenance of INDOT roadways. A listing of all the documents reviewed can be found in **Appendix 5**. Recommended changes and additions that INDOT may decide to accept, reject or implement are included for the following documents in the appendices as noted:

- **Appendix 6** - Construction Activity Environmental Manual (CAEM)
- **Appendix 7** - General Instruction to Field Employees (GIFE),
- **Appendix 8** - Procedural Manual for Environmental Studies (PMES),

Recommendations to be accepted rejected or implemented for the following documents are in **Appendix 9**

- INDOT Design Manuals (all)
- INDOT Standard Specifications
- INDOT Recurring Special Provisions
- INDOT Standard Drawings

Due to the integrated nature of the above four categories of document, and for the ease of adoption or rejection, suggested revisions to these documents are organized by specific BMP measure, rather than by document. Such suggested

revisions are provided in **Appendix 9**. In this way, the respective Construction Phase and Post-Construction Phase BMP measures may be adopted or rejected by INDOT without affecting the remainder of the suggested revisions. In some instances this has resulted in duplication of recommended changes to specific sections. However, this approach provides INDOT with the maximum flexibility with regards to acceptance or exclusion of individual measures without major modification to the remainder of the suggestions.

CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of analysis and review of comprehensive INDOT literature, documents and drawings, and the subsequent suggested revisions necessary to facilitate INDOT compliance with NPDES requirements. Recommendations for changes to the CAEM, GIFE and PMES documents are provided in **Appendices 6, 7 and 8**, respectively. Because of the integrated nature of the INDOT Design Manuals, Standard Specifications, Recurring Special Provisions and Standard Drawings, suggested revisions were provided on a BMP measure-by-measure basis. These suggestions are provided in **Appendix 9**. Several new documents specific to the goals and directive of this study are suggested for further research. These new perceived document needs are outlined in **Appendix 10**.

IMPLEMENTATION SUGGESTIONS

The appropriate committees within INDOT should review the suggested revisions to water quality practices available to designers and consultants, presented in the matrices of **Appendix 2**. Concise fact sheets of such measures are provided for Construction and Post-Construction phases of facility operations in **Appendices 3 and 4**, respectively. Suggested revisions to the CAEM, GIFE and PMES documents are provided in **Appendices 6, 7 and 8**. The most prominent change to the engineering community would be the implementation of suggested changes to INDOT Design Manuals, Standard Specifications, Recurring Special Provisions and Standard Drawings, presented in **Appendix 9**. Upon acceptance or rejection by INDOT of suggested revisions outlined herein, it is further suggested that INDOT coordinate with IDEM for concurrence on full compliance with outstanding NPDES requirements. **Appendix 10** outlines some areas of further research that would be useful to INDOT as they seek implementation of their SWQMP and should help streamline incorporation of improved water quality practices into the INDOT planning, design and construction processes.

APPENDIX 1

DATABASE OF RESEARCH DOCUMENTS

GENERAL STORMWATER BMP STUDIES AND REPORTS

Center for Research in Water Resources

Title:	A Review and Evaluation of Literature Pertaining to the Quantity and Control of Pollution from Highway Runoff and Construction
Sub Title:	
Authors:	Michael E. Barrett, M.S., Robert D. Zuber, M.S., E.R. Collins, III, M.S., Joseph F. Malina, Jr. P.E., Randall J. Charbeneau, P.E., and George H. Ward, Ph.D.
Publication Date:	April 1993
Source:	Center for Research in Water Resources. The University of Texas.
Document Type:	University Study (Technical Report)
Publication #:	N/A
Link:	N/A
Format:	Hard Copy
Types of BMPs:	Prevention: Stormwater: Ponds, Wetlands, Infiltration, Filters Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Conceptual
Level of Detail:	High
Applicability to Cold Climate:	Limited
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Relative/General discussions on cost/maintenance.
Description:	This document summarizes a review of previous research into the quality of stormwater runoff, the environmental impacts of highway construction and operation, and feasible mitigation strategies to control negative impacts of runoff.
Notes:	

National Cooperative Highway Research Program

Title:	Best Management Practices for Environmental Issues Related to Highway and Street Maintenance
Sub Title:	A Synthesis of Highway Practice
Authors:	William A. Hyman and Donald Vary
Publication Date:	1999
Source:	NCHRP
Document Type:	General Environmental
Publication #:	N/A
Link:	http://ntl.bts.gov/lib/21000/21800/21818/PB99143489.pdf
Format:	Hard Copy (PDF)
Types of BMPs:	Prevention: Stormwater: Sediment:
Depth of Information:	General
Nature of Information:	Conceptual
Level of Detail:	Moderate
Applicability to Cold Climate:	Yes
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	General discussions.
Description:	The report describes a variety of BMPs related to road and street maintenance. Includes a summary of literature research on BMPs and a survey of federal, state, and local transportation agencies.
Notes:	

Metropolitan Seattle Water Pollution Control Department

Title:	Biofiltration Swale Performance, Recommendations, and Design Considerations
Sub Title:	
Authors:	Zahid Khan, Cindy Thrush, Phil Cohen, Louise Kulzer, Robert Franklin, Del Field, John Koon, Richard Horner
Publication Date:	October 5, 1992
Source:	N/A
Document Type:	Biofiltration Swales Performance and Design
Publication #:	N/A
Link:	N/A
Format:	Hard Copy
Types of BMPs:	Prevention: Stormwater: Biofiltration Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Comprehensive
Level of Detail:	High
Applicability to Cold Climate:	Somewhat
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Limited discussions on costs. General discussions on maintenance.
Description:	The study evaluates the pollutant removal efficiency of grassy swales of differing lengths.
Notes:	

Center for Research in Water Quality

Title:	Evaluation of The Performance Of Permanent Runoff Controls: Summary and Conclusions
Sub Title:	N/A
Authors:	Barrett, M.E., Keblin, M.V., Walsh, P.M., Malina, J.F., Jr., and Charbeneau, R.J.
Publication Date:	November 1997
Source:	Center for Research in Water Resources
Document Type:	Permanent Runoff Controls
Publication #:	N/A
Link:	http://www.crrw.utexas.edu/reports/1997/rpt97-3.shtml
Format:	Digital – pdf
Types of BMPs:	Prevention: Stormwater: Vegetative Controls and Filtration Systems Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Conceptual
Level of Detail:	High
Applicability to Cold Climate:	Limited
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Very Limited
Description:	This study was designed to assist the Texas Department of Transportation to identify the types of runoff control systems that are most applicable to their area.
Notes:	

Federal Highway Administration

Title:	Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring
Sub Title:	N/A
Authors:	Federal Highway Administration
Publication Date:	May 2000
Source:	North Carolina DOT
Document Type:	Federal Highway Administration
Publication #:	N/A
Link:	http://www.fhwa.dot.gov/environment/ultraurb/index.htm
Format:	Hardcopy (PDF)
Types of BMPs:	Prevention: Stormwater: Ultra Urban Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Comprehensive
Level of Detail:	High
Applicability to Cold Climate:	Somewhat
BMP Selection Criteria:	Yes
Cost and Maintenance Considerations	Relative capital and O&M Costs
Description:	The purpose of this document is to provide a planning level review of applicability and use of new and more traditional BMPs in ultra urban areas.
Notes:	Not considered a design manual.

University of Washington Department of Civil Engineering Services

Title:	Technology Review: Ultra Urban Stormwater Treatment Technologies
Sub Title:	
Authors:	Brueske, Christopher C.
Publication Date:	September 2000
Source:	University of Washington
Document Type:	Ultra Urban
Publication #:	N/A
Link:	N/A
Format:	Hard Copy
Types of BMPs:	Prevention: Stormwater: In line BMPs (Gravity, Swirl concentration, Screening) Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/ Design
Level of Detail:	High
Applicability to Cold Climate:	Somewhat
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Very Limited
Description:	This study was designed to provide a review of Ultra-Urban Stormwater Treatment Technologies. Summarizes hydraulic principles of each BMP and summarizes a review of literature on performance data.
Notes:	

Virginia Transportation Research Council

Title:	Testing of Ultra-Urban Stormwater Best Management Practices
Sub Title:	
Authors:	Yu, Shaw L., Stopinski D. Monika
Publication Date:	January 2001
Source:	Virginia Transportation Research Council
Document Type:	Ultra Urban
Publication #:	N/A
Link:	http://www.virginiadot.org/vtrc/main/online_reports/pdf/01-r7.pdf
Format:	Hard Copy (PDF)
Types of BMPs:	Prevention: Stormwater: Ultra Urban Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/ Experimental
Level of Detail:	High
Applicability to Cold Climate:	Somewhat
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Compares capital and O&M costs of four ultra-urban BMPs.
Description:	This study was designed to evaluate the use of Ultra Urban BMPs in Virginia as innovative stormwater control technologies for application to highway nonpoint source pollution.
Notes:	

Center for Research in Water Resources

Title:	Water Quality and Quantity Impacts of Highway Construction and Operation: Summary and Conclusions
Sub Title:	N/A
Authors:	Barrett, Michael E., Malina, Joseph E., Charbeneau, Randall J., Ward, George H.
Publication Date:	November 2001
Source:	Center for Research in Water Resources
Document Type:	Highway Runoff Quality and Quantity
Publication #:	N/A
Link:	N/A
Format:	Hard Copy
Types of BMPs:	Prevention: Stormwater: Grass Swales and Sand Filters Sediment: Rock Berms, Silt Fences
Depth of Information:	Moderate
Nature of Information:	Experimental
Level of Detail:	Moderate
Applicability to Cold Climate:	Limited
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Very Limited
Description:	This study was designed to evaluate the effects of highway runoff on the quality of receiving waters.
Notes:	

DEPARTMENT OF TRANSPORTATION MANUALS

North Carolina Department of Transportation

Title:	Best Management Practices for Construction and Maintenance Activities
Sub Title:	N/A
Authors:	North Carolina DOT
Publication Date:	August 2003
Source:	North Carolina DOT
Document Type:	Construction and Maintenance BMPs
Publication #:	N/A
Link:	http://www.doh.dot.state.nc.us/operations/BMP_Manual/download/BMP_Manual.pdf
Format:	Hardcopy (PDF)
Types of BMPs:	Prevention: Stormwater: Sediment: Check Dams, Impervious Dikes, Temporary Seeding.
Depth of Information:	Comprehensive
Nature of Information:	Conceptual
Level of Detail:	High
Applicability to Cold Climate:	Limited
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Limited discussions on cost. General discussions on maintenance.
Description:	The Manual is designed for employees and contractors to construct, and maintain the NCDOT roadway systems while minimizing adverse impacts on the water resources of the State. The manual discusses BMPs that should be used for both general and specific DOT projects, and then discusses specifics including design and installation guidance for construction site BMPs.
Notes:	

Maine Department of Transportation

Title:	Best Management Practices for Erosion & Sediment Control
Sub Title:	N/A
Authors:	Maine Department of Transportation
Publication Date:	September 2002
Source:	Maine Department of Transportation
Document Type:	PDF (Hard Copy)
Publication #:	N/A
Link:	http://www.maine.gov/mdot/contractor-consultant-information/bmprevision90602.pdf
Format:	Hard Copy (PDF)
Types of BMPs:	Prevention: Stormwater: Sediment: Check Dams/ Mulching/ Seeding/ etc.
Depth of Information:	Moderate
Nature of Information:	Conceptual/Design
Level of Detail:	Moderate
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	Limited Guidance
Cost and Maintenance Considerations:	Limited to no discussion of cost. General discussion on maintenance for each BMP.
Description:	Provides a variety of information on temporary erosion and sediment control BMPs. Discussions on each BMP include "What is it, When and where to use it, What to consider, Maintenance/performance." Is not a specification document. However, design considerations are listed when appropriate. Not a comprehensive Stormwater Manual.
Notes:	

Virginia Transportation Research Council

Title:	Development of A Stormwater Best Management Practice Placement Strategy for the VDOT
Sub Title:	N/A
Authors:	Yu, Shaw L., Stopinski D. Monika
Publication Date:	October 2003
Source:	Virginia Transportation Research Council
Document Type:	Post-Construction BMP Placement
Publication #:	N/A
Link:	http://www.virginiadot.org/vtrc/main/online_reports/pdf/04-cr9.pdf
Format:	Electronic (PDF)
Types of BMPs:	Prevention: Stormwater: Ponds and Post-Construction Sediment:
Depth of Information:	Moderate
Nature of Information:	Experimental
Level of Detail:	Moderate
Applicability to Cold Climate:	Limited
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Calculates cost effectiveness of various BMPs.
Description:	The goal of this study was to develop an approach to determine the optimal placement of the BMPs so that the combined affects of the BMPs will provide the most cost effective way of treating stormwater from highways and other sources.
Notes:	Not very useful for BMP selection or design guidance.

Washington¹ State Department of Transportation

Title:	Highway Runoff Manual
Sub Title:	
Authors:	Washington State Dept of Transportation
Publication Date:	March 2004
Source:	Environmental and Engineering Service Center
Document Type:	General Stormwater and BMP Manual
Publication #:	M 31 - 16
Link:	http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/HighwayRunoff.pdf
Format:	Digital – pdf
Types of BMPs:	Prevention: None Stormwater: Detention / Retention / Sediment: Construction / Soil Erosion
Depth of Information:	Comprehensive
Nature of Information:	Conceptual / Design
Level of Detail:	High
Applicability to Cold Climate:	Somewhat Applicable
BMP Selection Criteria:	Yes
Cost and Maintenance Considerations:	Estimates cost relative to drainage area. General Discussions on typical maintenance requirements.
Description:	The <i>Highway Runoff Manual</i> was developed to direct the planning and design of stormwater management facilities for existing and new Washington State highways, rest areas, park-and-ride lots, ferry terminals, and highway maintenance facilities throughout the state.
Notes:	

¹ Summary comes directly from the *Minnesota Urban Small Sites BMP Manual*.

West Virginia Department of Transportation

Title:	Erosion and Sediment Control Manual
Sub Title:	N/A
Authors:	West Virginia Department of Transportation. Division of Highways.
Publication Date:	March 2003
Source:	West Virginia Department of Transportation. Division of Highways.
Document Type:	ESC Manual
Publication #:	N/A
Link:	http://www.wvdot.com/engineering/files/EROSION/Erosion2003.pdf
Format:	Web Based
Types of BMPs:	Prevention: None Stormwater: None Sediment: Sediment Traps, Temporary Berms, Diversions, Sediment Basins
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/Design
Level of Detail:	Moderate
Applicability to Cold Climate:	Applicable
BMP Selection Criteria	No
Cost and Maintenance Considerations:	Very Limited
Description:	To serve as a guide to WVDOT personnel, contractors, and consultants involved in the design, construction and maintenance of highways, so that they can better perform individual erosion and sediment control tasks.
Notes:	

Montana Department of Transportation

Title:	Erosion and Sediment Control Best Management Practices
Sub Title:	Field and Reference Manuals
Authors:	CDM
Publication Date:	March 2003
Source:	Montana DOT
Document Type:	Construction Site BMPs
Publication #:	N/A
Link:	www.mdt.state.mt.us/research/projects/env/erosion.shtml
Format:	Electronic PDF
Types of BMPs:	Prevention: Stormwater Sediment: Soil Stabilization, Temporary Sediment Controls, Tracking Controls
Depth of Information:	Comprehensive
Nature of Information:	Comprehensive (Construction BMPs)
Level of Detail:	High
Applicability to Cold Climate:	Yes
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Limited discussions on cost. General discussions on maintenance.
Description:	The purpose of the Manual is to describe the procedures and methods to reduce erosion and sedimentation associated with highway related pre-construction, construction, Post-Construction activities. Main focus seems to be on construction activities.
Notes:	

California Department of Transportation (Caltrans)

Title:	Stormwater Quality Handbooks
Sub Title:	Construction Site Best Management Handbooks
Authors:	Caltrans. State of California Department of Transportation.
Publication Date:	March 2003
Source:	Caltrans. State of California Department of Transportation.
Document Type:	ESC Manual
Publication #:	N/A
Link:	http://www.dot.ca.gov/hq/construc/stormwater/CSBMPM_303_Final.pdf
Format:	Hard Copy (PDF)
Types of BMPs:	Prevention: Waste Management, Material Storage Stormwater: None Sediment: Sediment Basins, Traps, and Barriers, Check Dams, Inlet Protection.
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/Design
Level of Detail:	Comprehensive
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	Yes, but limited
Cost and Maintenance Considerations:	Detailed cost estimates for Construction BMPs. Post-Construction BMP estimates based on cubic meters of water treated. Limited discussions on BMP Maintenance.
Description:	To provide Contractors and Caltrans with detailed information on design and implementation of construction site BMPs.
Notes:	

California Department of Transportation (Caltrans)

Title:	Stormwater Quality Handbooks
Sub Title:	Project Planning and Design Guide
Authors:	Caltrans. State of California Department of Transportation.
Publication Date:	September 2002
Source:	Caltrans. State of California Department of Transportation.
Document Type:	Planning and Design
Publication #:	N/A
Link:	http://www.dot.ca.gov/hq/construc/stormwater/CSBMPM_303_Final.pdf
Format:	Hard Copy (PDF)
Types of BMPs:	Prevention: Waste Management, Material Storage, Vehicle Fueling Stormwater: None Sediment: Sediment Basins, Traps, and Barriers, Check Dams, Inlet Protection.
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/Design
Level of Detail:	Comprehensive
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	Yes
Cost and Maintenance Considerations:	Detailed cost estimates for installation, but limited for maintenance.
Description:	To provide design guidance of incorporating stormwater controls into projects during the planning and design phase. Detailed information on selection and BMP design.
Notes:	

STATE & REGIONAL STORMWATER MANUALS

Georgia State Manual

Title:	Georgia Stormwater Management
Sub Title:	Technical Handbook
Authors:	AMEC, Center for Watershed Protection, Debo and Associates, Jordan, Jones, and Goulding, Atlanta Regional Commission
Publication Date:	August 2001
Source:	N/A
Document Type:	Post-Construction BMPs
Publication #:	N/A
Link:	http://www.georgiastormwater.com
Format:	Electronic (PDF)
Types of BMPs:	Prevention: Stormwater: Ponds, Wetlands, Bio-retention, sand filters, infiltration, etc Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Comprehensive/ Design
Level of Detail:	High
Applicability to Cold Climate:	Limited
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Limited discussion on costs. General discussion on maintenance.
Description:	This study was designed to assist local governments and developers control the quality and quantity of downstream waters. BMP discussions are broken down into general applicability and limited applicability discussions.
Notes:	

Maryland² State Manual

Title:	Maryland Stormwater Design Manual
Sub Title:	N/A
Authors:	Maryland Department of the Environment
Publication Date:	1998
Source:	Maryland Department of the Environment
Document Type:	Digital - pdf
Publication #:	N/A
Link:	http://www.mde.state.md.us/environment/wma/stormwatermanual/
Format:	Digital - pdf
Types of BMPs:	Prevention: Housekeeping / Low Impact Development / Operations and Maintenance Stormwater: Detention / Retention / Infiltration / Filtration / Constructed Wetlands / Hydraulic Devices Sediment: Construction / Soil Erosion / Sediment Control
Depth of Information:	Comprehensive
Nature of Information:	Conceptual / Design
Level of Detail:	High
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	Yes
Cost and Maintenance Considerations:	Cost (Relative to Drainage Area) Ease of Maintenance
Description:	The manual provides guidance to protect the waters of the State from adverse impacts of urban runoff, provides guidance on the most effective structural and non-structural BMPs for development sites, and to improve the quality of BMPs that are constructed in the State, specifically with regard to performance, longevity, safety, ease of maintenance, community acceptance and environmental benefit.
Notes:	Specific design criteria and computations included. Figure quality varies by BMP. Comprehensive performance criteria included.

² Summary comes directly from the *Minnesota Urban Small Sites BMP Manual*. Comments on Selection and cost and Maintenance were developed independently.

Idaho State Manual

Title:	Catalog of Stormwater Best Management Practices
Sub Title:	For Idaho Cities and Towns
Authors:	Idaho Department of Environmental Quality
Publication Date:	August 2001
Source:	Idaho Department of Environmental Quality
Document Type:	Web-Based (Electronic)
Publication #:	N/A
Link:	www.deq.state.id.us/water/permits_forms/permitting/catalog_bmps.cfm
Format:	Web Based
Types of BMPs:	<p>Prevention: Spill Prevention/ Housekeeping/Vehicle and Equipment Washing</p> <p>Stormwater: Detention / Retention/ Infiltration/</p> <p>Sediment: Construction/ Soil Erosion/Sediment Control/Slope Protection</p>
Depth of Information:	Comprehensive
Nature of Information:	Conceptual
Level of Detail:	Moderate
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	Yes
Cost and Maintenance Considerations:	Limited to no discussion of cost. General discussion on maintenance.
Description:	The Catalog of Stormwater BMPs for Idaho Cities and Counties provides technical guidance for the selection and site design of stormwater best management practices (BMPs). Measures such as those described in the manual and other recognized equivalents should be used to manage both the quantity and quality of stormwater runoff from land development.
Notes:	

University of Virginia

Title:	Field Monitoring and Evaluation of Stormwater Ultra-Urban BMPs
Sub Title:	N/A
Authors:	Shaw L. Yu, Monika D. Stopinski and Jenny X. Zhen
Publication Date:	Late 1990's
Source:	University of Virginia
Document Type:	Ultra-Urban BMPs
Publication #:	N/A
Link:	http://www.people.virginia.edu/~engstorm/pdf/ultraBMP.pdf
Format:	Hard Copy (PDF)
Types of BMPs:	Prevention: Stormwater: Ultra-Urban Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Experimental/Comparison
Level of Detail:	High
Applicability to Cold Climate:	Somewhat
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Compares installation and maintenance costs of four BMPs.
Description:	This document summarizes a study of several Ultra-Urban BMPs over a two year period. Evaluates a stormceptor, a bioretention area, and the Vortechs Stormwater treatment system. The study was sponsored by the Virginia Department of Transportation.
Notes:	

Reno – Truckee Meadow

Title:	Truckee Meadows Construction Site Best Management Practices
Sub Title:	N/A
Authors:	Kennedy/Jenks Consultants
Publication Date:	February 2003
Source:	North Carolina DOT
Document Type:	Construction Site BMPs
Publication #:	N/A
Link:	www.cityofreno.com/gov/pub_works/stormwater/pdfs/TruckeeMeadowsBMP_rev01.pdf
Format:	Web Based
Types of BMPs:	Prevention: Site and Materials Management Stormwater: Sediment: Construction Site BMPs
Depth of Information:	Comprehensive
Nature of Information:	Comprehensive
Level of Detail:	High
Applicability to Cold Climate:	Limited
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Limited discussions on cost. General discussion on BMP maintenance.
Description:	The primary purpose of the BMP handbook is to assist local users with the requirements of NDEP's permit and the local policies developed in response to the permit requirements. The intended users of the handbook include the owners/operators of construction sites, developers, design engineers, contractors and staff from the Cities of Reno and Sparks and Washoe County.
Notes:	

Tennessee State Manual

Title:	Guide to the Selection & Design of Stormwater Best Management Practices.
Sub Title:	A Guide for Phase II entities for Protecting Post-Construction Stormwater Quality and Managing Stormwater Flow.
Authors:	Tennessee Water Resources Research Center. The University of Tennessee
Publication Date:	March 2003
Source:	Tennessee Department of Environment and Conservation
Document Type:	Post-Construction
Publication #:	N/A
Link:	http://eerc.ra.utk.edu/divisions/wrrc/BMP/bmp.htm
Format:	Hard Copy
Types of BMPs:	Prevention: None Stormwater: Structural and Nonstructural Post-Construction BMPs Sediment:
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/Design
Level of Detail:	Comprehensive
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	No Matrix but provides guidance.
Cost and Maintenance Considerations	BMPs rated for cost, but non specific. General discussions and ratings on maintenance.
Description:	Provides a variety of information on structural and nonstructural Post-Construction best management practices including, Description, Selection Guidance, Designing and Layout, Construction, Costs, Limitations for each BMP. Detailed Exhibits/Figures.
Notes:	

Minnesota³ State Manual

Title:	Protecting Water Quality in Urban Areas
Sub Title:	Best Management Practices for Dealing with Storm Water Runoff from Urban, Suburban and Developing Areas of Minnesota
Authors:	Minnesota Pollution Control Agency
Publication Date:	March 2000
Source:	Minnesota Pollution Control Agency
Document Type:	PDF (Hard Copy)
Publication #:	N/A
Link:	http://www.pca.state.mn.us/water/pubs/sw-bmpmanual.html
Format:	Web Based
Types of BMPs:	Prevention: Housekeeping/ Low Impact Development /Operations Stormwater: Detention / Retention/ Infiltration/Filtration/ Constructed Wetlands/ Hydraulic Devices Sediment: Construction/ Soil Erosion/Sediment Control
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/Design
Level of Detail:	High
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	Yes
Cost and Maintenance Considerations:	Limited information on cost. General discussion on maintenance.
Description:	A Comprehensive BMP reference. Content is largely borrowed from familiar sources. Provides a good deal of information on pollution prevention, erosion control, and sediment control. Some generalized info regarding the use of proprietary BMPs. No Design Computations.
Notes:	

³Summary comes directly from the *Minnesota Urban Small Sites BMP Manual*. Comments on Selection and cost and Maintenance were developed independently.

Northern Virginia Regional Manual

Title:	Northern Virginia BMP Handbook.
Sub Title:	A Guide to Planning and Designing Best Management Practices in N Northern Virginia
Authors:	Northern Virginia Planning District Commission. Engineers and Surveyors Commission.
Publication Date:	November 1992
Source:	Maine Department of Transportation
Document Type:	PDF (Hard Copy)
Publication #:	N/A
Link:	http://www.novaregion.org/pdf/NVBMP-Handbook.pdf
Format:	Web Based
Types of BMPs:	Prevention: None Stormwater: Wet and Dry Ponds, Infiltration Basins Sediment:
Depth of Information:	Moderate
Nature of Information:	Conceptual
Level of Detail:	Moderate
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	Limited Guidance
Cost and Maintenance Considerations:	Information on O&M costs by BMP type relative to capital construction costs. Refers to another study for capital cost of BMPs.
Description:	The Handbook is intended for use by designers and reviewers of urban BMPs in meeting the water quality requirements of Northern Virginia. The Handbook includes discussion of the theory and practice of implementing BMP controls, and presents the requirements set by local jurisdictions for calculating phosphorus removal as well as for determining site coverage, storage volume, and orifice size requirements for BMPs necessitated by the development of land.
Notes:	

Los Angeles Regional Manual

Title:	Reference Guide for Stormwater Best Management Practices
Sub Title:	N/A
Authors:	City of Los Angeles. Stormwater Management Division Bureau of Sanitation, Department of Public Works.
Publication Date:	July 2000
Source:	Stormwater Management Division Bureau of Sanitation, Department of Public Works.
Document Type:	PDF (Hard Copy)
Publication #:	N/A
Link:	www.lacity.org/SAN/wpd/download/pdfs/publications/bmp_refguide.pdf
Format:	Hard Copy (PDF)
Types of BMPs:	Prevention: Construction Scheduling, Material Use, Site Maintenance Stormwater: Vegetative Systems, Infiltration Sediment: Traps, Basins, Seeding, Barriers
Depth of Information:	Moderate
Nature of Information:	Conceptual/Selection
Level of Detail:	Moderate
Applicability to Cold Climate:	Somewhat Applicable
Cost and Maintenance Considerations:	General cost and maintenance evaluations
Description:	To provide general guidance and information on stormwater and urban runoff best management practices. Identify information on BMPs, assess BMPs, and select BMPs.
Notes:	

North Carolina⁴ State Manual

Title:	Stormwater Best Management Practices
Sub Title:	N/A
Authors:	North Carolina Department of Environment and Natural Resources – Water Quality
Publication Date:	April, 1999
Source:	North Carolina Department of Environment and Natural Resources – Water Quality
Document Type:	General Stormwater and BMP Manual
Publication #:	EPA 841-K-94-003
Link:	http://h2o.enr.state.nc.us/su/documents/BMP_Manual.pdf
Format:	Web – Based
Types of BMPs:	Prevention: None Stormwater: Detention / Retention / Infiltration / Filtration / Constructed Wetlands Sediment Control: None
Depth of Information:	Comprehensive
Nature of Information:	Conceptual / Design
Level of Detail:	High
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	General discussion for most BMPs.
Description:	A concise stormwater BMP reference. This document is very comprehensive with a chapter devoted to each of the most commonly used stormwater treatment BMPs in North Carolina. An excellent reference.
Notes:	Very concise, nice document. Contains examples of designs and computations for the application of each BMP. Provides advantages and disadvantages for each BMP. Excellent Figures.

⁴ Summary comes directly from the *Minnesota Urban Small Sites BMP Manual*. Comments on Selection and cost and Maintenance were developed independently.

New York State Manual

Title:	Stormwater Management Design Manual
Sub Title:	N/A
Authors:	Center for Watershed Protection.
Publication Date:	October 2001
Source:	New York Department of Environmental Conservation
Document Type:	PDF (Hard Copy)
Publication #:	N/A
Link:	http://www.dec.state.ny.us/website/dow/toolbox/swmanual/
Format:	Web Based
Types of BMPs:	Pollution Prevention: Stormwater: Ponds/Wetlands/Infiltration/Filtering/Open Channel Sediment Control:
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/Design
Level of Detail:	Comprehensive
Applicability to Cold Climate:	Yes
BMP Selection Criteria:	Yes
Cost and Maintenance Considerations:	Ease of Maintenance Cost (Relative to Drainage Area)
Description:	To provide designers a general overview on how to size, design, select and locate BMPs. The manual contains detailed appendices on construction specifications and design examples. The Document also has detailed guidance on selection and implementation of Post-Construction practices.
Notes:	

Tennessee State Manual

Title:	Tennessee Erosion and Sediment Control Handbook
Sub Title:	A guide for protection of State Waters Through the Use of Best Management Practices.
Authors:	John C. Price, Robert Karesh
Publication Date:	March 2002
Source:	Tennessee Department of Environment and Conservation
Document Type:	PDF (Hard Copy)
Publication #:	N/A
Link:	http://www.state.tn.us/environment/wpc/sed_e ro_controlhandbook/
Format:	Web Based
Types of BMPs:	Prevention: None Stormwater: None Sediment: Sediment Basins, Traps, Barriers, Check Dams, Inlet Protection.
Depth of Information:	Comprehensive
Nature of Information:	Conceptual/Design
Level of Detail:	Comprehensive
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	No
Cost and Maintenance Considerations:	Limited discussions on cost. General maintenance discussions.
Description:	Provides a variety of information on BMPs including, Definition, Purpose, Conditions, Planning Considerations, Construction Specifications and Maintenance.
Notes:	

Virginia State Manual

Title:	Virginia Stormwater Management Handbook
Sub Title:	A Guide to Planning and Designing Best Management Practices in Northern Virginia
Authors:	Virginia Department of Conservation and Recreation
Publication Date:	1999
Source:	Virginia Department of Conservation and Recreation
Document Type:	PDF (Hard Copy)
Publication #:	N/A
Link:	http://www.dcr.state.va.us/sw/stormwat.htm#handbook
Format:	Web Based
Types of BMPs:	Prevention: None Stormwater: Wet and Dry Ponds, Porous Pavement, Grassed Swales. Sediment:
Depth of Information:	Moderate
Nature of Information:	Conceptual
Level of Detail:	Moderate
Applicability to Cold Climate:	Applicable
BMP Selection Criteria:	Yes
Cost and Maintenance Considerations:	Limited discussions on cost. General discussion on maintenance.
Description:	To provide guidance for compliance with Virginia Stormwater Management Regulations. Gives overview of local stormwater regulations and detailed description of numerous Post-Construction BMPs.
Notes:	

APPENDIX 2

CONSTRUCTION AND POST-CONSTRUCTION MATRICES

A. CONSTRUCTION PHASE EROSION CONTROL BMP PRACTICES APPROPRIATE FOR LINEAR and NON-LINEAR PROJECTS

Suggested BMPs	Fact Sheet	Installation Cost	Maintenance	Water Quantity Benefit		Water Quality Benefit					
				Rate Control	Volume Reduction	Pollution Prevention Benefit		Pollutant Removal			
						Erosion Control	Sediment Control	TSS	P&N	Metals	Fecal Coliform
Grading	CEC-1	\$3.50-12.00/cys ⁽³⁾	Medium	Varies	Varies	Primary	N/A	Some	Some	Some	No
Soil Roughening	CEC-2	\$0.10 – \$0.50/sy	Low	Some	No	Primary	N/A	No	No	No	No
Sequencing	CEC-3	Varies ⁽⁴⁾	N/A	No	No	Primary	Primary	Some	Some	Some	No
Straw Bale Ditch Check	CEC-4	\$4.00-\$8.00/lf	High	Some	No	Primary	N/A	Yes	Some	Some	No
Fiber Wattle Roll Ditch Check	CEC-5	\$6.00-\$8.00/lf	Medium	Some	No	Primary	N/A	Yes	Some	Some	No
Straw Mulch	CEC-6	\$0.20 - \$0.40/sy	Low	Some	No	Primary	N/A	Some	Some	No	No
Bonded Fiber Matrix (BFM Mulch)	CEC-7	\$1.50 - \$2.50/sy	Low	Some	No	Primary	N/A	Some	Some	No	No
Erosion Control Blanket	CEC-8	\$1.00 - \$2.50/sy	Low	Some	No	Primary	N/A	Some	Some	No	No
Native Seeding (Temporary)	CEC-9	\$0.50-\$1.00/sy	Medium	Some	Some	Primary	N/A	Some	Some	No	No
Surface Water Diversion	CEC-10 CEC-11 CEC-12	Varies	Medium	No	No	Primary	N/A	No	No	No	No
Turbidity Curtain	CEC-13	\$15-25/sy	Medium	No	No	N/A	Primary	No	No	No	No
Riprap	CEC-14	Varies	Medium	No	No	Primary	Varies	No	No	No	No

TSS = Total Suspended Solids; P&N = Phosphorus & Nitrogen; Primary = Primary Design Benefit

B. CONSTRUCTION PHASE SEDIMENT CONTROL BMP PRACTICES APPROPRIATE FOR LINEAR PROJECTS

Suggested BMPs	Fact Sheet	Installation Cost	Maintenance	Water Quantity Benefit		Water Quality Benefit					
				Rate Control	Volume Reduction	Pollution Prevention Benefit		Pollutant Removal			
						Erosion Control	Sediment Control	TSS	P&N	Metals	Fecal Coliform
Vehicle Tracking Pads	CSC-1	\$2000-4000/each ⁽²⁾	High	No	No	Secondary	Primary	Some	Some	Some	No
Silt Fences	CSC-2	\$1.00-3.00/ft	High	Some	No	N/A	Primary	No	No	No	No
Inlet Protection	CSC-3	\$50-150/inlet	High	No	No	N/A	Primary	Yes	Some	Some	No
Sediment Trap	CSC-4	\$1,000 - \$1,500/per acre of drainage	High	Some	Some	N/A	Primary	Yes	Some	Some	No
Rock Check Dam	CSC-5	\$20-40/ton	High	Some	Some	N/A	Primary	Yes	Some	Some	No

TSS = Total Suspended Solids; P&N = Phosphorus & Nitrogen; Primary = Primary Design Benefit

C. CONSTRUCTION PHASE SEDIMENT CONTROL BMP PRACTICES RESERVED FOR NON-LINEAR PROJECTS

Suggested BMPs	Fact Sheet	Installation Cost	Maintenance	Water Quantity Benefit		Water Quality Benefit					
				Rate Control	Volume Reduction	Pollution Prevention Benefit		Pollutant Removal			
						Erosion Control	Sediment Control	TSS	P&N	Metals	Fecal Coliform
Sediment Basin	CSC-6	\$20-30/ton material removed	High	Some	Some	Primary	Primary	Yes	Some	Some	No

TSS = Total Suspended Solids; P&N = Phosphorus & Nitrogen; Primary = Primary Design Benefit

Notes:

- (1) Adapted from the Minnesota Metropolitan Council's "Urban Small Sites Best Management Practice Manual"
<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>
- (2) Assumes 50-ft long entrance with 30-ft radii at main roadway, 3" No. 53 stone over 12" No 2 stone.
- (3) Assumes earthwork is Common Excavation. Price would increase for factors such as wetness, or environmental contamination.
- (4) Cost is usually not paid for directly, but hidden amongst the cost of various pay items. More detailed sequencing requirements will usually result in higher cost.

Overview of Common Post-Construction BMP Practices ⁽¹⁾

BMP Group	Fact Sheet(s)	Treatment Mechanism	Common Characteristics	Linear BMPs	Non-Linear BMPs	Effective Years of Life ⁽³⁾
Detention Systems ⁽²⁾	PSC-1 PSC-2 PSC-3 PSC-4	Particulate settling	Adequate hydrology and soils required	Dry Swale	Wet Pond Extended Detention Pond Dry Pond	Ponds: 20-50 Swale: 5-20
Constructed Wetlands ⁽²⁾	PSC-5 PSC-6	Particulate settling Biological filtering	Adequate hydrology and soils required	Stormwater Wetland Wet Swale	Stormwater Wetland	Wetland: 20-50 Swale 5-20
Infiltration Systems	PSC-7 PSC-8	Adsorption Biodegradation Precipitation	Adequate soil media critical	Infiltration Trench	Infiltration Basin	5-15
Filtration Systems	PSC-9 PSC-10 PSC-11 PSC-12	Straining Adsorption Chemical transformation Microbial decomposition	Effective suspended solids removal	Bioretention Filter Strip Turf Reinforcement Mat (TRM) ⁽⁴⁾ Native Seeding (permanent) ⁽⁴⁾	Bioretention Filter Strip Turf Reinforcement Mat (TRM) ⁽⁴⁾ Native Seeding (permanent) ⁽⁴⁾	5-20
Water Quality Structures	PSC-13	Settling Buoyancy of oils & floatables	Pretreatment	Hydrodynamic Separators	Hydrodynamic Separators	50-100

(1) Adapted from "Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring", Federal Highway Administration <http://www.fhwa.dot.gov/environment/ultraurb/uubmp3p1.htm>

(2) Assumes pretreatment with a sediment forebay (ponds and wetlands)

(3) Assumes effective regular maintenance is performed

(4) Not a stand alone post-construction BMP. Can increase the effectiveness of other BMPs when incorporated into their design and construction.

THREE-STEP PROCESS FOR BMP SELECTION

The following outlines a process for selecting the best stormwater treatment BMP or group of BMPs to meet water quality and water quantity requirements as well as factors to consider for BMP placement. This outline guides the designer through a three step process adapted from Minnesota Metropolitan Council's "Urban Small Sites Best Management Practice Manual" and Maryland Department of the Environment's "Maryland Stormwater Design Manual". The steps progressively screen for:

- Physical Feasibility Factors
- Stormwater Treatment Suitability
- Community and Environmental Factors

The above noted reference documents are available online (as of November 2005) at the following web address links:

<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm> and http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

Step 1: Physical Feasibility Factors

The first step addresses and allows the designer to determine whether development site conditions such as soils, terrain, depth to water table, drainage area, slope or head conditions, and area requirements will limit the use of a particular BMP.

Area Requirements – Linear or non-linear area requirements.

Soils – Evaluation of soils is based on USDA or NRCS hydrological soils group at the site.

Water Table – Indicates the minimum depth to the seasonally high water table from the bottom or floor of a BMP.

Drainage Area – Refers to the drainage area that is considered typical for the BMP.

Head – Estimate of the elevation difference needed at a site (from inflow to outflow).

Ultra-Urban Sites –BMPs that work well in urban environments, where space is limited and original soils have been disturbed.

Step 2: Stormwater Treatment Suitability:

Using those BMPs that are not eliminated in step one, identify BMPs effective at providing water quantity and water quality benefits. These include rate control, volume reduction, and percent removal of total suspended solids, phosphorus, nitrogen, metals, and fecal Coliform.

Water Quantity – Effectiveness of the BMP to control the rate and volume of stormwater runoff.

Water Quality – Indicates a BMPs ability to remove Total Suspended Solids (TSS), Phosphorus (P), Nitrogen (N), Metals, and fecal Coliform from stormwater runoff.

Accept Hotspot Runoff – Ability of the BMP to treat stormwater runoff from land uses that may produce highly polluted runoff (gas stations, maintenance facilities, salvage yards, and industrial sites).

Step 3: Community and Environmental Factors

The remaining BMPs are then filtered through the third step. This step considers: frequency and cost of maintenance, construction cost, community acceptance, and benefit to wildlife.

Construction Cost – Represents base capital costs for BMP installation to treat stormwater runoff from a 5 acre site.

Low = \$0 - \$10,000 for application of BMP on 5 acre site.

Medium = \$10,001 - \$20,000 for application of BMP on 5 acre site.

High = \$20,000+ for application of BMP on 5 acre site.

Maintenance – Assesses the relative maintenance needed for a BMP based on frequency and cost of maintenance.

Community Acceptance – The community's acceptance of a BMP based on nuisance problems, visual orientation, and community preference surveys.

Wildlife Habitat – Ability to provide wildlife or wetland habitat based on size, water feature, wetland feature, and vegetative cover.

STEP 1 – PHYSICAL FEASIBILITY FACTORS

Are there any physical constraints at the project site that may restrict or preclude the use of a particular BMP?

BMP Group	Specific BMP	Area Requirements	Soil Groups	Terrain	Water Table ⁽¹⁾ (ft)	Drainage Area ⁽²⁾ (acre)	Head ⁽²⁾ (ft)	Ultra Urban
Detention Systems	Wet Pond	Non-linear	C,D	Low lying areas (liner for karst areas)	3	>2	3-6	No
	Extended Detention Pond	Non-linear						
	Dry Pond	Non-linear	Any ⁽³⁾	Low lying areas	3	>2	3-8	
	Dry Swale	Linear	Any	Moderate slope	3	2-4	2-6	
Constructed Wetlands	Stormwater Wetland	Linear	Any ⁽⁴⁾	Low lying areas	0	>1	1-8	No
	Wet Swale	Linear	Any	Moderate slope	0	<4	2-3	
Infiltration Systems	Infiltration Trench	Linear	A,B	No karst areas	3	2-4	3-8	Sometimes
	Infiltration Basin	Non-linear	A,B	No karst areas	3	2-20	3-4	No
Filtration Systems	Bioretention	Linear	Any	Low lying areas	3	2-4	2-3	Yes
	Filter Strip	Linear	Any	Moderate slopes	3	<5	Negligible	No
	Turf Reinforcement Mat (TRM) ⁽⁵⁾	Linear	Any	Any	N/A	N/A	N/A	Yes
	Native Seeding (permanent) ⁽⁵⁾	Linear	Any	Moderate Slope	N/A	All	N/A	Yes
Water Quality Structures	Hydrodynamic Separators	Linear	Any	Any	>3	Varies ⁽⁶⁾	Varies by vendor	Yes

- (1) Recommended minimum elevation above water table. Special consideration should be given if anticipated pollutant includes bacteria or other harmful constituents to drinking water or groundwater
- (2) Adapted from "Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring", Federal Highway Administration <http://www.fhwa.dot.gov/environment/ultraurb/uubmp3p1.htm>
- (3) When dry ponds are installed in C or D type soils, the bottom of the basin should be sloped to allow for complete dewatering and avoid ponded areas. Perforated tile underdrains may also be installed for dewatering.
- (4) Below water table.
- (5) Not a stand alone post-construction BMP. Can increase the effectiveness of other BMPs when incorporated into their design and construction.
- (6) Due to the increasing number of manufacturers of proprietary water quality structures, the upper limit of drainage area may vary from 2 to 300 acres.

STEP 2 – STORMWATER TREATMENT SUITABILITY

Do the BMP(s) from Step 1 provide needed water quantity and water quality benefit?

Suggested BMPs		Water Quantity Benefit		Water Quality Benefit ⁽¹⁾ % Removed					Accept Hotspot Runoff
BMP Group	Specific BMP	Rate Control	Volume Reduction	TSS	P	N	Metals	Fecal Coliform	
Detention Systems	Wet Pond	High	Low	46-98	20-94	28-50	24-89	N/A	Varies
	Extended Detention Pond								
	Dry Pond	High	Varies ⁽²⁾	67-93	75-94	N/A	N/A	N/A	Varies
	Dry Swale	Medium	Low	30-90	20-85	0-50	0-90	N/A	Yes
Constructed Wetlands	Stormwater Wetland	High	Low	65	25	20	35-65	N/A	No
	Wet Swale	Low	Low	65	25	20	35-65	N/A	No
Infiltration Practices	Infiltration Trench	Medium	High	75-99	50-75	45-70	75-99	75-98	No
	Infiltration Basin	Medium	High	75-99	50-75	45-70	50-90	75-98	No
Filtration Systems	Bioretention	Medium	Medium	75	50	50	75-80	N/A	Yes
	Filter Strip	Medium	Medium	27-70	20-40	20-40	2-80	N/A	Yes
	Turf Reinforcement Mat (TRM) ⁽⁵⁾	Low	Low	81 ⁴	9 ⁴	38 ⁴	42-71 ⁴	N/A	No
	Native Seeding (permanent) ⁽⁵⁾	Low	Low	81 ⁴	9 ⁴	38 ⁴	42-71 ⁴	N/A	No
Proprietary Systems ⁽³⁾	Hydrodynamic Separators	None	None	80-90	N/A	N/A	N/A	N/A	Yes

(1) Adapted from “Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring”, Federal Highway Administration <http://www.fhwa.dot.gov/environment/ultraurb/uubmp3p1.htm>

(2) Dry pond volume reduction highly dependent on soil permeability.

(3) Not a stand alone post-construction BMP. Can increase the effectiveness of other BMPs when incorporated into their design and construction.

(4) Median percent removal for vegetated swales from United States Environmental Protection Agency Office of Water. EPA 832-F-99-006 Storm Water Technology Fact Sheet Vegetated Swales September 1999.

(5) Due to variability of units, refer to independent data supplied by manufacturer.

STEP 3 – COMMUNITY & ENVIRONMENTAL FACTORS

Are there important community or environmental factors that might influence the selection process of the remaining BMPs?

BMP Group	Specific BMP	Construction Cost (5-acre site) ¹	Maintenance		Community Acceptance	Wildlife Habitat
			Frequency	Annual Cost (based on Construction Cost) ¹		
Detention Systems	Wet Pond	Low	Annual	3-5%	Moderate	Medium
	Extended Detention Pond	Low	Annual	3-5%	Moderate	Medium
	Dry Pond	Low	Mowing Schedule	5-7%	Moderate	Low
	Dry Swale	Low	Annual	3-5%	Moderate	Low
Constructed Wetlands	Stormwater Wetland	Medium	Annual	5-7%	Moderate to High	High
	Wet Swale	Medium	Mowing Schedule	5-20%	Moderate	Medium
Infiltration Systems	Infiltration Trench	High	Biannual	5%-7%	Moderate to High	None
	Infiltration Basin	Medium	Biannual	5-20%	Moderate	Low
Filtration Systems	Bioretention	High	Mowing Schedule	5-7%	Moderate	Medium
	Filter Strip	Low	Mowing Schedule	5-7%	High	Medium
	Turf Reinforcement Mat (TRM)	Medium	Meeting Schedule	1-5%	High	Medium
	Native Seeding (permanent)	Low	Annual	1-5%	High	Medium
Water Quality Structures	Hydrodynamic Separators	High	Biannual	1-5%	High	None

1. United States Environmental Protection Agency, Office of Water. EPA-821-R-99-012: Preliminary Data Summary of Urban Storm Water Best Management Practices-Chapter 6: Costs and Benefits of Stormwater BMPs, August 1999.
2. United State Environmental Protection Agency, Office of Water. EPA-821-99-002: Stormwater Technology Fact Sheet Turf Reinforced Mats, September 1999

APPENDIX 3

CONSTRUCTION PHASE BMP FACT SHEETS

Stormwater Quality Best Management Practices Construction Sites

Grading

When to use:

- Land grading, as an erosion control measure, is applicable to sites with uneven or steep topography or easily erodible soils
- Grading plans that minimize erosion potential can be applied to all projects

Advantages:

- Careful planning in this area can significantly reduce construction and long term erosion

Limitations:

- Extensive grading increases costs

Description:

Grading can be planned and used during and after construction to control surface runoff and minimize soil erosion and sedimentation. Grading activities should maintain existing drainage patterns where possible, and minimize slope lengths and steepness. (EPA, 2000)

Grading practices, such as selecting a milder side slope gradient (e.g. 6:1 vs. 3:1), can help reduce runoff velocity and help prevent rill erosion. Final grades selected should be based on considerations of the soil characteristics at the specific site (e.g. sands vs. clays). Upon completion of grading activities or when a slope will remain disturbed for extended timeframes, slopes should be track-walked from bottom to top with tracked machinery. This practice reduces rill erosion and runoff velocities.

BMP Type:	Construction Practice
Installation Cost:	\$3.50-\$12.00/cys
Maintenance Effort:	Medium
Runoff Rate Control:	Varies
Runoff Volume Control:	Varies

EPA, 2000

Grading

Drawings:

Figure1: Terracing
(North Augusta, 2004)

Figure 2: Contour Furrows
(North Augusta, 2004)

Figure 3: Stepped Slope
(North Augusta, 2004)

Reference:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

North Augusta , 2004. *The City of North Augusta Erosion and Sediment Control Manual*. City of North Augusta, Stormwater Management Department.
http://www.northaugusta.net/Dept_Serv/Engin_PublicWorks/stormwater/developers.htm

Stormwater Quality Best Management Practices Construction Sites

Soil Roughening

When to use:

- Appropriate on all soil types
- Where wind erosion may be a problem
- To aid in vegetation (seed) establishment.
- To reduce rill and gully erosion on slopes.

Advantages:

- Reduces both water and wind erosion.
- Improves vegetation establishment.
- Inexpensive for short-term erosion control when used with other measures.

Limitations:

- Not appropriate for rocky slopes.
- Can lead to soil compaction
- Significant rainfall limits effectiveness
- Should be combined with seeding, mulching, or erosion control blanket.
- Limited to exposed slopes mild enough to be traversed by appropriate equipment (approximately 2:1 slope)

Description:

Soil roughening is a temporary erosion control practice useful with grading operations associated with sloped areas. Soil roughening involves increasing the relief of a bare soil surface with horizontal grooves, stair-stepping (running parallel to the contour of the land), or tracking using a cleated roller, crawler tractor, or similar construction equipment. Slopes that are not fine graded and that are left in a roughened condition can reduce erosion. Soil roughening reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares the soil for seeding and planting by giving seed an opportunity to take hold and grow. It also reduces erosion and sedimentation resulting from wind (EPA, 2000).

BMP Type:	Construction Practice
Installation Cost:	\$0.10 – 0.50/sy
Maintenance Effort:	Low to Medium
Runoff Rate Control:	Some
Runoff Volume Control:	No

TDEC, 2002

Soil Roughening

Drawings:

TRACKING

Figure 1: Machine Tracking
(North Augusta, 2004)

References:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

North Augusta , 2004. *The City of North Augusta Erosion and Sediment Control Manual*. City of North Augusta, Stormwater Management Department.
http://www.northaugusta.net/Dept_Serv/Engin_PublicWorks/stormwater/developers.htm

Stormwater Quality Best Management Practices Construction Sites

Construction Sequencing

When to use:

- All projects that involve land disturbance activity

Advantages:

- Reduce the cost of erosion and sediment control portion of a project
- Can improve efficiency and effectiveness of erosion and sediment control measures
- Reduces the gross amount of disturbed or active construction at a given time

BMP Type:	Construction Practice
Installation Cost:	Varies
Maintenance Effort:	Medium
Runoff Rate Control:	No
Runoff Volume Control:	No

Limitations:

- Often requires field adjustments for unforeseen circumstances to initial plan
- Weather conditions can interfere with initial sequencing plan

Description:

A construction sequence schedule is a specified work schedule that coordinates the timing of land-disturbing activities and the installation of erosion-protection and sedimentation-control measures. Sequencing includes phasing of construction through sequential development of smaller portions of a large project site. Each portion is stabilized before beginning land disturbance on subsequent portions, to minimize exposure of disturbed land to erosion.

Construction Sequencing

STORMWATER QUALITY BEST MANAGEMENT PRACTICES CONSTRUCTION SITES

Straw Bale Ditch Check

When to use:

- Concentrated flow areas such as vegetated ditches and swales
- Should NOT be used in streams
- Where temporary seeding has recently been implemented

Advantages:

- Low installation cost
- Not a traffic hazard

Limitations:

- High failure rate
- Improper installation can facilitate erosion around ends of check dams
- Difficult to maintain and remove completely

Description:

Straw bale ditch checks are small dams constructed across a swale or ditch. Straw bale ditch checks are used to slow the velocity of concentrated flow thereby reducing erosion. As a lesser function, straw bale ditch checks can also be used to catch sediment from the swale itself or from the contributing drainage area as storm water runoff flows through the structure. However, the use of straw bale ditch checks should not be a substitute for the use of other sediment-trapping and erosion control measures. Straw bale ditch checks are most effective when used in combination with other storm water and erosion and sediment control measures (Metropolitan Council, 2001).

BMP Type:	Sediment Control Linear
Installation Cost:	\$4.00-\$8.00/lft
Maintenance Effort:	High
Runoff Rate Control:	Some
Runoff Volume Control:	No

Idaho Bureau of Land Management, undated

Straw Bale Ditch Check

Drawings:

Figure 1: Isometric View
(INDOT, 2005, Standard Drawings)

Figure 2: Plan View
(INDOT, 2005, Standard Drawings)

Figure 3: Front View
(INDOT, 2005, Standard Drawings)

Straw Bale Ditch Check

References:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.

http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

INDOT, 2005. *Indiana Department of Transportation Design Manual, Part 4, Chapter 37 – Temporary Erosion and Sediment Control*. Indiana Department of Transportation, Division of Design.

<http://www.in.gov/dot/div/contracts/standards/dm/Part4Vol.2/Ch37/ch37.htm>

INDOT, 2005. *Indiana Department of Transportation Standard Drawings – Sections 100 through 300*. Effective Sept. 2005. Indiana Department of Transportation, Division of Design.

<http://www.in.gov/dot/div/contracts/standards/drawings/sep05/e/sep1to3.htm>

Stormwater Quality Best Management Practices Construction Sites

Fiber Wattle Roll Ditch Check

When to use:

- Concentrated flow areas such as vegetated ditches and swales
- Should NOT be used in streams
- Where temporary seeding of channels has been recently implemented

Advantages:

- Can be left in place after site is stabilized
- Not a traffic hazard

Limitations:

- Can wash away if not well anchored
- Improper installation can facilitate erosion around ends of check dams

Description:

A fiber wattle roll consists of straw, flax or other similar materials that are rolled and bound into a tight roll that is generally placed on the face of slopes at regular intervals to intercept runoff, reduce flow velocity, release the runoff as sheet flow and provide the removal of sediment. When used as a ditch check, it slows the velocity of concentrated flow in a channel thereby reducing the erosion in the swale or channel (Caltrans, 2005).

BMP Type:	Sediment Control Linear
Installation Cost:	\$6.00-\$8.00/lft
Maintenance Effort:	Medium
Runoff Rate Control:	Some
Runoff Volume Control:	No

Carver County, undated

Fiber Wattle Roll Ditch Check

Drawings:

Figure 1: Fiber Wattle Roll Ditch Check with Tie-Downs
(Caltrans, 2003)

Figure 2: Fiber Wattle Roll Anchored by Staking - Cross Section
(Caltrans, 2002)

Figure 3: Tie-Downs – Cross Section
(Caltrans, 2003)

Figure 4: Tie-Downs – Plan View
(Caltrans, 2003)

Fiber Wattle Roll Ditch Check

References:

Caltrans, 2005. *Caltrans Storm Water Quality Handbooks Project Planning and Design Guide*. State of California Department of Transportation.

<http://www.dot.ca.gov/hq/oppd/stormwtr/PPDG-with-revisions-7-26-05.pdf>

Caltrans, 2003. *Caltrans Storm Water Quality Handbooks Construction Site Best Management Practices Manual*. State of California Department of Transportation.

<http://www.dot.ca.gov/hq/construc/stormwater/details.htm>

Carver County, Undated, *Construction Site Erosion and Sediment Control for Small Sites – Fiber Rolls*. Department of Planning & Zoning, Carver County, Minnesota.

http://www.co.carver.mn.us/water/user_documents/FiberRolls.pdf

Stormwater Quality Best Management Practices Construction Sites

Straw Mulch

When to use:

- On bare areas that will be undisturbed for 14 or more days
- To protect seeding and sensitive plantings
- Where temporary seeding can not be used (due to growing season or scheduling)

Advantages:

- Provides an immediate, effective, and inexpensive erosion control
- Improves the success of temporary and permanent seeding

Limitations:

- Straw can be washed away with heavy rainfall
- May delay seed germination due to increased soil temperature

Description:

Straw mulching is a temporary erosion control practice. Mulching is highly recommended as a stabilization method and is most effective when used in conjunction with vegetation establishment. Mulching can also reduce storm water runoff velocity. When used in combination with seeding or planting, mulching can aid plant growth by holding seeds, fertilizers, and topsoil in place, preventing birds from eating seeds, retaining moisture, and insulating plant roots against extreme temperatures. (EPA, 2000) The effectiveness of straw mulch may be increased when mulch is applied with a tackifier.

BMP Type:	Sediment Control Linear
Installation Cost:	\$0.20-\$0.40/sy
Maintenance Effort:	Low
Runoff Rate Control:	Some
Runoff Volume Control:	No

CBBEL file, 2005

References:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

Straw Mulch

Stormwater Quality Best Management Practices Construction Sites

Bonded Fiber Matrix Mulch

When to use:

- Steep slopes
- Areas that are not accessible for conventional mulching or erosion control blanket installation

Advantages:

- Can be used on steep slopes where other covers would not adhere to slope
- Reduced labor requirements
- Provides immediate, temporary surface stabilization

Limitations:

- Specialized installation methods

Description:

A bonded fiber matrix (BFM) refers to a continuous layer of elongated wood fiber strands that are held together by a water-resistant bonding agent to form a water-absorbing crust. When properly dried, this acts as an erosion-control blanket. This mulch is applied with a mechanically agitated pumping machine (hydroseeder). Properly applied, bonded fiber matrices can provide excellent erosion protection and revegetative support (Metropolitan Council, 2001).

BMP Type:	Erosion Control Linear
Installation Cost:	\$1.50-\$2.50/sy
Maintenance Effort:	Low
Runoff Rate Control:	Some
Runoff Volume Control:	No

Emerald Seed and Supply

References:

Emerald Seed and Supply, 2005. Bonded Fiber Matrix Mulch product webpage.
http://www.emeraldseedandsupply.com/erosioncontrol/ec_bfm.html

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.
<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

Bonded Fiber Matrix Mulch

Stormwater Quality Best Management Practices Construction Sites

Erosion Control Blanket

When to use:

- On steep slopes
- In areas with concentrated flow such as ditches and swales
- Where the soil is erodible but will support vegetation

Advantages:

- Can use in areas where other mulches would wash away
- Works well as a stand alone measure

Limitations:

- Labor intensive installation
- Improper installation can lead to gully erosion beneath the blanket
- Must be stored properly prior to installation to avoid degradation.

Description:

Erosion control blankets are made of biodegradable materials such as jute matting, excelsior wood fiber, coconut fiber, straw or interwoven paper strips, and a netting made of a biodegradable polypropylene or extruded plastic. These materials are formed into sheets that are used as temporary or permanent mulching to stabilize disturbed slopes. Erosion control blankets provide the same benefits as other types of mulching, but are much more stable and longer lasting than normal mulches and can be used in areas of moderate concentrated flow such as ditches and swales (MDOT, 2002).

BMP Type:	Erosion Control Linear
Installation Cost:	\$1.00-\$2.50/sy
Maintenance Effort:	Low
Runoff Rate Control:	Some
Runoff Volume Control:	No

NCDOT, 2003

Erosion Control Blanket

References:

MDOT, 2002. *Maine Department of Transportation Best Management Practices (BMPs) for Erosion and Sedimentation Control*. Maine Department of Transportation, Environmental Office, Surface Water Resources Unit.

<http://mainegov-images.informe.org/mdot/contractor-consultant-information/bmprevision90602.pdf>

NCDOT, 2003. *Best Management Practices for Construction and Maintenance Activities*. North Carolina Department of Transportation, Division of Highways, Highway Operations.

http://www.ncdot.org/doh/operations/BMP_Manual/download/BMP_Manual.pdf

Stormwater Quality Best Management Practices Construction Sites

Native Seeding – Temporary

When to use:

- On bare areas or stockpiles that will be undisturbed for 14 or more days

Advantages:

- Highly effective means of erosion reduction
- Ease of installation in many cases
- Inexpensive

Limitations:

- Establishment can be hampered by weather conditions
- Can not establish vegetation during winter months

Description:

The first step in erosion control on construction sites is to limit the extent of cleared vegetation. The next step is to revegetate disturbed areas as quickly as possible. Exposed soils that cannot be permanently stabilized should be temporary seeded if work is not scheduled for at least 14 calendar days. Annual grasses which are quick to germinate such as oats or wheat, should be seeded and mulched to provide prompt, temporary soil cover. Seeding minimizes the area of a construction-site prone to erosion and should be used where the construction operations allow for vegetation to be established. (Metropolitan Council, 2001)

BMP Type:	Erosion Control Linear
Installation Cost:	\$0.50-\$1.00/sy
Maintenance Effort:	Medium
Runoff Rate Control:	Some
Runoff Volume Control:	Some

Oregon State University, 1995

References:

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.
<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

Oregon State University, 1995. *National Forage & Grasslands Curriculum – Grasses Lecture Topic*. Oregon State University, Corvallis, Oregon.
<http://forages.oregonstate.edu/nfgc/topics.cfm?ID=90>

Native Seeding – Temporary

Stormwater Quality Best Management Practices Construction Sites

Temporary Slope Drain

When to use:

- Where cut or fill height exceeds 10 feet prior to the installation of permanent stormwater drainage structures.
- Can be used during embankment construction by continually adding sections to the top of the pipe as the height of the embankment increases

Advantages:

- Reduces soil exposure to erosive forces.
- Relatively inexpensive to install

Limitations:

- Inadequate pipe inlet capacity leads to failure from overtopping
- Physical obstructions substantially reduce the effectiveness of the drain
- Can be damaged by vehicular traffic
- Construction equipment and vehicular traffic must be rerouted around slope drains

Description:

Temporary slope drains are surface water diversions that involve the intentional redirection of runoff or streams in order to direct stabilized off-site runoff around onsite control measures or to direct turbid water to a treatment measure. A temporary slope drain is a flexible conduit extending the length of a disturbed slope and serving as a temporary outlet for a diversion. Temporary slope drains convey runoff without causing erosion on or at the bottom of the slope. This practice is a temporary measure used during grading operations until permanent drainage structures are installed and until slopes are permanently stabilized. They are typically used for less than 2 years. (EPA, 2000)

BMP Type:	Erosion Control
	Linear
Installation Cost:	Varies
Maintenance Effort:	Medium
Runoff Rate Control:	No
Runoff Volume Control:	No

Cacapone, 2001

Temporary Slope Drain

Drawings:

Figure 1: Temporary Slope Drain – Isometric View
(INDOT, 2005, Standard Drawings)

Figure 2: Temporary Slope Drain – Plan View
(INDOT, 2005, Standard Drawings)

Figure 3: Temporary Slope Drain – Profile View

Temporary Slope Drain

(INDOT, 2005, Standard Drawings)

Figure 4: Temporary Slope Drain System – Plan View
(INDOT, 2005, Design Manual)

Figure 5: Temporary Slope Drain System – Profile View
(INDOT, 2005, Design Manual)

Reference:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmpps/pdf/small_files/main.pdf

INDOT, 2005. *Indiana Department of Transportation Design Manual, Part 4, Chapter 37 – Temporary Erosion and Sediment Control*. Indiana Department of Transportation, Division of Design.
<http://www.in.gov/dot/div/contracts/standards/dm/Part%204%20Vol.%202/Ch%2037/ch37.htm>

Capacone, 2001, *Capacone, Volume 11, Number 1*, Capacone Institute, December 2001.
<http://cacaponinstitute.org/PDF/Newsletterdec2001.PDF>

Stormwater Quality Best Management Practices Construction Sites

Interceptor Berm

When to use:

- Along construction perimeters to keep construction runoff separate from off-site runoff.
- Within construction sites to control runoff patterns to minimize erosion or to route to treatment

Advantages:

- Keeps clean and dirty water separate to reduce volume of water that must be treated.
- Inexpensive to construct

Limitations:

- Do not have any pollutant removal capability
- Concentrated runoff in the channel or ditch has increased erosion potential

Description:

Interceptor berms are surface water diversion measures that involve the intentional redirection of runoff or streams in order to minimize contact between surface water and bare soil or to direct turbid water to a treatment measure. Diversion berms can be installed alone or in combination with a channel bypass. When located on the upslope side of a site, diversion berms help to prevent off-site runoff from entering a disturbed construction site. Interceptor berms can be located on the downslope side of a construction site to divert sediment-laden runoff to onsite sediment trapping devices, preventing movement of soil laden water to adjacent undisturbed areas. (EPA, 2000)

BMP Type:	Erosion Control Linear
Installation Cost:	\$160 - \$500 / 100ft
Maintenance Effort:	Medium
Runoff Rate Control:	No
Runoff Volume Control:	No

EPA, 2000

Interceptor Berm

Drawings:

Figure 1: Interceptor Berm and Ditch in a Cut Section
(Intercepts runoff from undisturbed off site areas and diverts around work site)
(INDOT, 2005, Standard Drawing)

Figure 2: Interceptor Berm and Ditch in a Fill Section
(Intercepts sediment laden runoff and diverts to sediment trapping device and protects slope)
(INDOT, 2005, Standard Drawing)

Figure 3: Interceptor Berm and Ditch Cross Section A-A
(INDOT, 2005, Standard Drawing)

Interceptor Berm

Figure 4: Example of Interceptor Berm to Divert Runoff from Off-site
(Metropolitan Council, 2001)

Reference:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

INDOT, 2005. *Indiana Department of Transportation Standard Drawings – Sections 100 through 300*. Effective Sept. 2005. Indiana Department of Transportation, Division of Design.
<http://www.in.gov/dot/div/contracts/standards/drawings/sep05/e/sep1to3.htm>

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.
<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

Stormwater Quality Best Management Practices Construction Sites

Channel Bypass

When to use:

- For small structure and culvert replacement
- Bridge repair sites
- In perennial or intermittent streams
- During the dry season

Advantages:

- Keeps clean and dirty water separate to reduce volume of water that must be treated.
- Allows for work in the channel with minimum wildlife disturbance

Limitations:

- Larger streams or rivers require more involved, engineered solutions
- Fabric lined channels may cause thermal pollution in the summer months
- May require a substantial work area

Description:

A channel bypass is a surface water diversion that involves the intentional redirection of runoff or streams in order to minimize contact between surface water and bare soil or to direct turbid water to a treatment measure. A channel bypass is a method of diverting flow of a stream to a temporary alternate route during construction. A channel bypass is typically constructed adjacent to the work area and is lined with geotextile to reduce erosion of the diversion channel. (NCDOT, 2003)

BMP Type:	Erosion Control
	Linear
Installation Cost:	Varies
Maintenance Effort:	Medium
Runoff Rate Control:	No
Runoff Volume Control:	No

NCDOT, 2003

References:

NCDOT, 2003. *Best Management Practices for Construction and Maintenance Activities*. North Carolina Department of Transportation, Division of Highways, Highway Operations.
http://www.ncdot.org/doh/operations/BMP_Manual/download/BMP_Manual.pdf

Channel Bypass

Stormwater Quality Best Management Practices Construction Sites

Turbidity Curtain

When to use:

- When performing work on a stream bank or shoreline in a small localized area.
- When the repair or construction activities will not require an extended period of time to complete.
- Should NOT be used across flowing streams
- In streams with flows of less than 5 ft/sec

Advantages:

- Often most practical option to protect work in waterway

Limitations:

- Improper anchoring leads to ineffective control
- Can require frequent repositioning
- Can not be used along fast flowing waterways, (>5 ft/s) where bank stabilization methods are often required

Description:

Turbidity curtain barriers are useful when working on the bank of an existing waterbody or in the rarer instance where the proposed work encroaches into the waterbody. The purpose of a turbidity curtain is to prevent the flow and/or washing of disturbed debris into a water source: stream, river, pool, lake or reservoir. In essence, a turbidity curtain is a floating silt fence. A turbidity curtain should not be used as a dam. It will not "hold back" the water flow of a river or stream, but it will inhibit sediment laden water from entering the main waterway.

BMP Type:	Sediment Control Linear
Installation Cost:	\$15 – 30 / sq. yd.
Maintenance Effort:	Medium
Runoff Rate Control:	No
Runoff Volume Control:	No

NCDOT, 2003

Turbidity Curtain

Drawings:

Figure 1: Curtain Installation, Plan View
(NYDOT, 2002)

Figure 2: Cross Sectional View A-A
(NYDOT, 2002)

References:

NYDOT, 2002. *Soil Erosion and Sediment Control Standard Sheet M209-8 – Turbidity Curtain*. State of New York Department of Transportation.

<http://www.dot.state.ny.us/caddinfo/design/stdsheets/standardpdf/m209-8.pdf>

NCDOT, 2003. *Best Management Practices for Construction and Maintenance Activities*. North Carolina Department of Transportation, Division of Highways, Highway Operations.

http://www.ncdot.org/doh/operations/BMP_Manual/download/BMP_Manual.pdf

Stormwater Quality Best Management Practices Construction Sites

Riprap

When to use:

- Around the inlets and outlet of pipes, culverts, and paved ditches.

Advantages:

- Can prevent virtually all erosion from the protected area.
- Reduces downstream erosive forces

Limitations:

- Should not be used on slopes steeper than 2:1.
- Potential hazard in the clear zone

BMP Type:Construction
Practice

Installation Cost:

Maintenance Effort:

Runoff Rate Control:

Runoff Volume Control:

Description:

Riprap can be used to provide permanent and temporary erosion protection on small construction sites in several ways. Three such methods are inlet and outlet protection, temporary diversion structures, and permanent diversion structures. Pipe inlet and outlet protection is a protective armor for the immediate area around the inlet and outlet of a pipe or culvert to protect it and the receiving channel from scour and deterioration. This practice applies to culverts and principal spillways. Riprap should not be used in areas where native vegetation would be effective. However, riprap should be considered in areas of potential high velocity and areas below the ordinary high water level where vegetation will not easily establish.

NCDOT, 2003

References:

NCDOT, 2003. *Best Management Practices for Construction and Maintenance Activities*. North Carolina Department of Transportation, Division of Highways, Highway Operations. http://www.ncdot.org/doh/operations/BMP_Manual/download/BMP_Manual.pdf

Riprap

Stormwater Quality Best Management Practices Construction Sites

Vehicle Tracking Pad

When to use:

- At all points of egress to public roads
- Where construction vehicles leave active construction areas onto surfaces where runoff is not checked by sediment controls

Advantages:

- Cost-effective
- Highly effective for sediment control

Limitations:

- Can require intensive maintenance
- Stone can become quickly saturated under muddy conditions

Description:

The vehicle tracking pad is intended to be the final perimeter control at the construction site. The base should consist of stable compacted aggregate to minimize settling. Above the base, aggregate should be placed that is large enough to cause exiting vehicles to move in such a way to dislodge sediment. This is usually accomplished when the aggregate size of the upper stone layer ranges in size from 3 to 6 inches in diameter. A corrugated metal plate, known as a shaker plate, can also be incorporated to facilitate sediment removal.

BMP Type:	Construction Practice
Installation Cost:	\$2,000-\$4,000
Maintenance Effort:	High
Runoff Rate Control:	No
Runoff Volume Control:	No

Vehicle tracking pad with optional shake plate, EPA, 2000

Vehicle Tracking Pad

Drawings:

Figure 1: Vehicle Tracking Pad – Isometric View
(CBBEL file)

Figure 2: Example of Wash Rack
(Metropolitan Council, 2001)

Reference:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.
<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

North Augusta, 2004. *The City of North Augusta Erosion and Sediment Control Manual*. City of North Augusta, Stormwater Management Department.
http://www.northaugusta.net/Dept_Serv/Engin_PublicWorks/stormwater/developers.htm

Stormwater Quality Best Management Practices Construction Sites

Silt Fence

When to use:

- Around the base of stockpiled erodible material
- Along banks of waterways
- As perimeter protection
- On sites with relatively small drainage areas
- Where runoff will be occurring as low-level shallow flow

Advantages:

- Cost-effective on smaller sites
- Construction community is already very familiar with use of silt fence

Limitations:

- High maintenance
- Frequent failure due to improper installation and inadequate maintenance
- Not effective in rocky areas where fence can not be entrenched
- Can not handle concentrated flow
- High winds can present a problem
- Not for use on fill slopes

Description:

A silt fence is a fabric or wire mesh barrier used to retain sediment from small, sloping disturbed areas by reducing the velocity of sheet flow. Silt fence captures sediment by ponding water to allow deposition on the uphill side. Silt fences consist of a length of geotextile or wire mesh stretched between anchoring posts spaced at regular intervals along the site perimeter. The geotextile should be entrenched in the ground between the support posts. A silt fence is not recommended to divert water; nor is it to be used across a stream, channel, or anywhere that concentrated flow is anticipated (EPA, 2000). Silt fence should be used parallel to contour

elevation lines only. Placing silt fence perpendicular to contour lines can actually increase erosion by concentrating flow along the disturbed embedment trench.

BMP Type:	Sediment Control Linear
Installation Cost:	\$1.00-\$3.00/lft
Maintenance Effort:	High
Runoff Rate Control:	Some
Runoff Volume Control:	No

TDEC, 2002

Silt Fence

Drawings:

Figure 1: Silt Fence Entrenchment and Dimensions
(INDOT, 2005, Standard Drawings)

Figure 2: Embedment Detail
(INDOT, 2005, Standard Drawings)

Figure 3: Tieback Detail
(INDOT, 2005, Standard Drawings)

Figure 4: Silt Fence Placement Relative to R/W Line
(Modified from INDOT, 2006)

Silt Fence

Figure 5: Silt Fence Placement with Channel in R/W
(INDOT, 2005, Standard Drawings)

Reference:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

INDOT, 2005. *Indiana Department of Transportation Standard Drawings – Sections 100 through 300*. Effective Sept. 2005. Indiana Department of Transportation, Division of Design.
<http://www.in.gov/dot/div/contracts/standards/drawings/sep05/e/sep1to3.htm>

INDOT, 2006. *Indiana Department of Transportation Standard Specifications – Section 200*. Effective Sept. 2005. Indiana Department of Transportation, Division of Design.
<http://www.in.gov/dot/div/contracts/standards/book/sep06/2-2006.pdf>

Stormwater Quality Best Management Practices Construction Sites

Inlet Protection

When to use:

- On existing drop inlets, bridge deck drains, and curb inlets for rehab or reconstruction projects
- Following installation of new inlets
- For drainage areas no greater than 1 acre per inlet
- For relatively low-sediment, low-volume flows

Advantages:

- Allows for continuous use of storm drain system

Limitations:

- Should be used in conjunction with other measures
- Require frequent maintenance
- Only practical for low-sediment, low-volume flows
- Can cause erosion to unprotected areas if clogged
- Designer should evaluate bypass flow path under the condition of fully blocked/clogged inlet

Description:

Storm drain inlet protection measures are controls that help prevent soil and debris from site erosion from entering storm drain drop or curb inlets. Typically, these measures are temporary controls that are implemented prior to large-scale disturbance of the surrounding site. These controls are advantageous because their implementation allows storm drains to be used during construction activities (EPA, 2000). Inlet protection is often the last opportunity to minimize sediment impact to a receiving water body (WSDOT, 2004). Inlet protection can cause inadvertent flooding of adjacent areas if not properly installed.

BMP Type:	Sediment Control Linear
Installation Cost:	\$50 to \$150/inlet
Maintenance Effort:	High
Runoff Rate Control:	No
Runoff Volume Control:	No

MoDNR, 1999

Inlet Protection

Drawings:

Figure 1: Aggregate Ring – Plan View
(INDOT, 2005, Standard Drawings)

Figure 2: Aggregate Ring Cross Section
(INDOT, 2005, Standard Drawings)

Figure 3: Geotextile Box – Plan View
(INDOT, 2005, Standard Drawings)

Inlet Protection

Figure 4: Geotextile Box Cross Sections
(INDOT, 2005, Standard Drawings)

Figure 5: Geotextile Box Trench Detail
(INDOT, 2005, Standard Drawings)

Figure 6: Slotted Barrel – Plan View
(INDOT, 2005, Standard Drawings)

Figure 7: Slotted Barrel – Profile View
(INDOT, 2005, Standard Drawings)

Inlet Protection

Figure 8: Typical Storm Drain Insert Configuration – Cross Section
(WSDOT, 2004)

Figure 9: Typical Storm Drain Insert Configuration – Isometric View
(WSDOT, 2004)

Inlet Protection

Reference:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

INDOT, 2005. *Indiana Department of Transportation Standard Drawings – Sections 100 through 300*. Effective Sept. 2005. Indiana Department of Transportation, Division of Design.
<http://www.in.gov/dot/div/contracts/standards/drawings/sep05/e/sep1to3.htm>

INDOT, 2006. *Indiana Department of Transportation Standard Specifications – Section 200*. Effective Sept. 2005. Indiana Department of Transportation, Division of Design.
<http://www.in.gov/dot/div/contracts/standards/book/sep06/2-2006.pdf>

WSDOT, 2004. *Washington State Department of Transportation Highway Runoff Manual, Publication No. M-31-16*. Washington State Department of Transportation, Environmental and Engineering Service Center.
<http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/HighwayRunoff2004.pdf>

MoDNR, 1999, *Protecting Water Quality, A Field Guide to Erosion, Sediment and Stormwater Best Management Practices For Developing Sites in Kansas and Missouri*, Missouri Department of Natural Resources, Division of Environmental Quality.
<http://www.dnr.state.mo.us/wpscd/wpcp/wpcp-guide.htm>

Stormwater Quality Best Management Practices Construction Sites

Sediment Trap

When to use:

- To slow concentrated runoff velocity and catch sediment
- At the outlets of storm water diversion structures, channels, slope drains, construction site entrance wash racks
- In side ditches in lieu of, or in conjunction with, check dams
- Surrounding drop inlet protection
- Should not be used for drainage areas greater than 5 acres

Advantages:

- Versatility in location, configuration, and application
- Can be combined with many other erosion and sediment control measures

Limitations:

- Effective life span usually limited to less than 24 months
- Short available detention period does not remove fine particles such as silts and clays

Description:

Sediment traps are small impoundments that allow sediment to settle out of runoff water. They are usually installed in a drainageway or other point of discharge from a disturbed area. Temporary diversions can be used to direct runoff to the sediment trap. Sediment traps are used to detain and trap sediments in storm water runoff to protect drainage systems, receiving waters and surrounding areas. Sediment traps are formed by excavating an area or by placing an earthen embankment across a low area or drainage swale. An outlet spillway is often constructed using large aggregate to slow the release of runoff. (EPA, 2000)

BMP Type:	Sediment Control Linear
Installation Cost:	\$1,000 - \$1,500/acre of drainage
Maintenance Effort:	High
Runoff Rate Control:	Some
Runoff Volume Control:	Some

NC DOT, 2003

Sediment Trap

Drawings:

Figure 1: Sediment Trap – Ditch Application
(INDOT, 2005, Standard Drawing)

Figure 1 (cont.): Sediment Trap – Ditch Application
(INDOT, 2005, Standard Drawing)

Figure 2: Sediment Trap – Cross Section
(INDOT, 2005, Standard Drawing)

References:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

INDOT, 2005. *Indiana Department of Transportation Standard Drawings – Sections 100 through 300*. Effective Sept. 2005. Indiana Department of Transportation, Division of Design.
<http://www.in.gov/dot/div/contracts/standards/drawings/sep05/e/sep1to3.htm>

NCDOT, 2003. *Best Management Practices for Construction and Maintenance Activities*. North Carolina Department of Transportation, Division of Highways, Highway Operations.
http://www.ncdot.org/doh/operations/BMP_Manual/download/BMP_Manual.pdf

Stormwater Quality Best Management Practices Construction Sites

Rock Check Dam

When to use:

- Concentrated flow areas such as vegetated ditches and swales
- Should NOT be used in streams
- Where temporary seeding has recently been implemented

Advantages:

- Inexpensive and easy to construct
- More stable than straw bale or fiber wattle check dams
- Rip-rap is reusable after channel is stabilized and rip-rap is removed
- Effective in medium to heavy flow situations

Limitations:

- Improper installation can facilitate erosion around ends of check dams
- Most fine silt and clay particles will pass through the voids
- Require periodic maintenance
- Temporary dams may be difficult to remove

Description:

Check dams are small dams constructed across a swale or ditch. Check dams are used to slow the velocity of concentrated flow thereby reducing erosion. As a lesser function, check dams can also be used to catch sediment from the swale itself or from the contributing drainage area as storm water runoff flows through the structure. The use of check dams should be part of the overall erosion and sediment-control process and not the sole downstream control measure. Check dams are most effective when used in combination with other storm water and erosion and sediment control measures. (Metropolitan Council, 2001)

BMP Type:	Sediment Control Linear
Installation Cost:	\$20 - \$40/ton
Maintenance Effort:	High
Runoff Rate Control:	Some
Runoff Volume Control:	Some

Government of Alberta, 1995

Rock Check Dam

Drawings:

Figure 1: Profile and Spacing
(INDOT, 2005, Standard Drawings)

Figure 2: Cross Section
(INDOT, 2005, Standard Drawings)

Figure 3: Plan View
(INDOT, 2005, Standard Drawings)

References:

INDOT, 2005. *Indiana Department of Transportation Standard Drawings – Sections 100 through 300*. Effective Sept. 2005. Indiana Department of Transportation, Division of Design.

<http://www.in.gov/dot/div/contracts/standards/drawings/sep05/e/sep1to3.htm>

Government of Alberta, 1998 (Revised), *Erosion Control Reference Material*. Alberta Transportation And Civil Engineering Division, Technical Standards Branch, Geotechnical Section.

<http://www.tu.gov.ab.ca/Content/doctype372/production/erogoodbad.pdf>

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.

<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

Stormwater Quality Best Management Practices Construction Sites

Sediment Basin

When to use:

- For drainage areas of 5 to 100 acres.
- In conjunction with stormwater diversion measures and dewatering activities
- For new construction projects when there is adequate right-of-way
- Within interchanges, rest areas, weigh stations
- Where stormwater quality ponds are planned

Advantages:

- Good at removing larger particles
- Can treat larger volumes of water
- Low maintenance
- Can convert to stormwater quality pond after site is stabilized

Limitations:

- Construction cost can be high
- Low ability to remove silt and clay particles
- Require more space than other measures

Description:

A temporary sedimentation basin is a controlled stormwater release structure formed by excavation, or by erecting an embankment of compacted soil or riprap, and installing an outlet structure and outlet pipe. The purpose of the basin is to detain the sediment-laden runoff from disturbed areas long enough for the majority of the sediment to settle out in the basin. This reduces sediment transport off-site. (Metropolitan Council, 2001) Generally, sediment basins are designed to be temporary. However, temporary sediment basins can be converted into permanent storm water runoff management ponds following site stabilization. (INDOT, 2005)

BMP Type:	Sediment Control – Non-Linear
Installation Cost:	\$20-\$30/ton of material removed
Maintenance Effort:	High
Runoff Rate Control:	Some
Runoff Volume Control:	Some

EPA, 2000

Sediment Basin

Drawings:

Figure 1: Sediment Basin, Plan View
(INDOT, 2005)

References:

EPA, 2000. *EPA's Storm Water Phase II Menu of Best Management Practices*. Environmental Protection Agency, National Pollution Discharge Elimination System, Stormwater Team.
http://cfpub2.epa.gov/NPDES/stormwater/menuofbmps/pdf/small_files/main.pdf

INDOT, 2005. *Indiana Department of Transportation Design Manual, Part 4, Chapter 37 – Temporary Erosion and Sediment Control*. Indiana Department of Transportation, Division of Design.
<http://www.in.gov/dot/div/contracts/standards/dm/Part04Vol.2/Ch37/ch37.htm>

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.
<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

APPENDIX 4

POST-CONSTRUCTION BMP FACT SHEETS

Stormwater Quality Best Management Practices

Post-Construction Stormwater Treatment

Dry Pond

When to use:

- In hydrologic soil types A and B or in C and D soil with sloped bottom or underdrains
- In low lying areas
- Water table is at least 3 feet below the pond bottom
- Drainage area of at least 2 acres
- Hydraulic head of 3 to 8 feet
- Not practical for use in ultra urban settings
- Cannot be placed on steep or unstable slopes

Advantages:

- Can achieve 80% TSS removal as a stand alone BMP
- Variable ability to accept pollutants from offsite hotspots
- Low construction cost
- Low to moderate maintenance costs
- Moderate community acceptance
- Provides water quantity benefit in the form of runoff rate control
- Long effective life
- Can act as sediment trap/basin during construction phase
- Excellent retrofit opportunity for existing dry ponds
- Typically requires less excavation than wet ponds

Limitations:

- Requires additional right-of-way beyond standard clear zone limits
- Removal rates vary widely depending on site conditions and storm events
- Low wildlife habitat benefit
- Minimum set-back from high water level required (see local codes)
- Heavy storms may resuspend sediments

BMP Type:	Retention/Detention – Non-Linear
TSS Removal:	67-93%
Nitrogen Removal:	N/A
Phosphorous Removal:	75-94%
Metal Removal:	N/A
E. coli Removal:	N/A
Runoff Volume Control:	Varies
Runoff Rate Control:	High
Annual Maintenance	5-7% ¹
Cost:	
Relative Construction	Low
Cost:	
Effective Life:	20-50 years

¹ Reported as a percentage of Construction Cost

Virginia DCR, 1999

Dry Pond

Description:

Dry ponds, also called "detention ponds," are stormwater basins that are designed to intercept a volume of stormwater runoff and temporarily impound the water for gradual release to the receiving stream or storm sewer system. Traditional dry pond designs do not provide much water quality benefit. However, with a few modifications, dry ponds can be very effective at removing pollutants. Extended detention dry ponds can be designed as two-stage facilities. In these cases, the upper stage stores and reduces flood peaks and the lower stage is designed for water quality control. The lower stage volume may be able to treat a certain depth of water over the impervious area, such as 0.5 inch or a design storm frequency, such as the 1-year 24-hour storm event. Following storm events, dewatering times typically range between 24 and 48 hours. This residence time may allow for greater than 90 percent removal of particulates through settling. A shallow marsh or wetland may be incorporated into the design to facilitate removal of nitrogen and phosphorus. The incorporation of a forebay, energy dissipator, or pretreatment facility before flow enters the pond from a channel or pipe is important to lessen the impact of sediment and grit on the pond and to facilitate pond maintenance. When dry ponds are installed in C or D type soils, the bottom of the basin should be sloped to allow for complete dewatering and avoid ponded areas. Perforated tile underdrains may also be installed for dewatering.

Drawings:

Figure 1: Dry Extended Detention Pond – Plan View
(NRCS, 2003)

Dry Pond

Figure 2: Dry Extended Detention Pond – Section View
(NRCS, 2003)

Reference:

NRCS, 2003. *Urban BMPs – Water Runoff Management*. NRCS Watershed Science Institute with Mississippi State University Center for Sustainable Design.

<http://www.wsi.nrcs.usda.gov/products/UrbanBMPs/water.html>

Virginia DCR, 1999. *Virginia Stormwater Management Handbook*. Commonwealth of Virginia, Department of Conservation and Recreation.

<http://www.dcr.state.va.us/sw/stormwat.htm#handbook>

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Extended Detention Pond With Micropool

When to use:

- In hydrologic soil types C and D or with a clay liner
- In low lying areas
- Water table is at least 3 feet below the pond bottom
- Drainage area of at least 2 acres
- Hydraulic head of 3 to 6 feet
- Not practical for use in ultra urban settings
- Cannot be placed on steep or unstable slopes

Advantages:

- Can achieve 80% TSS removal as a stand alone BMP
- Variable ability to accept pollutants from hotspots
- Low construction cost
- Low to moderate maintenance cost
- Moderate community acceptance
- Medium wildlife habitat benefit
- Provides water quantity benefit in the form of runoff rate control
- Long effective life
- Can act as sediment trap/basin during construction phase
- Excellent retrofit opportunities for existing dry or wet ponds

Limitations:

- Requires additional right-of-way beyond standard clear zone limits
- Removal rates vary widely depending on site conditions and storm events
- Minimum set-back from high water level required (see local codes)
- Heavy storms may resuspend sediments
- Potential for mosquito breeding areas

- Adequate source of water needed to maintain permanent water pool areas year round
- Water can become stagnant
- Evaporation can concentrate levels of salt and algae
- Embankment may be regulated as a dam by IDNR

BMP Type:	Retention/Detention – Non-Linear
TSS Removal:	46-98%
Nitrogen Removal:	28-50%
Phosphorous Removal:	20-94%
Metal Removal:	N/A
E. coli Removal:	N/A
Runoff Volume Control:	Varies
Runoff Rate Control:	High
Annual Maintenance Cost:	5-7% ¹
Relative Construction Cost:	Low
Effective Life:	20-50 years

¹ Reported as a percentage of Construction Cost

Center for Watershed Protection, 2000

Extended Detention Pond With Micropool

Description:

Typical extended detention pond configurations include shallow wetlands or small ponding areas in combination with dry areas, along with the incorporation of a micropool at the outlet (Figure 1). Extended detention ponds with micropools incorporate a permanent pool component that is absent in dry ponds. However, they differ from wet ponds in the amount of the overall basin dedicated to the permanent pool. Runoff is treated by settling and algal uptake in the forebay and micropool. Pollutant removal occurs through settling, biological activity, and adsorption in the areas lateral to the permanent pool. If a shallow wetland is incorporated into the design, microbial breakdown of pollutants can be added to the list of pollutant removal mechanisms.

Drawings:

Figure 1: Typical Extended Wet Detention – Plan View
(with shallow wetland and micropool options)
(Georgia Stormwater Management Manual, 2001)

Extended Detention Pond With Micropool

**Figure 2: Typical Extended Wet Detention – Section View
(with shallow wetland and micropool options)**
(Modified from Georgia Stormwater Management Manual, 2001)

References:

Georgia Stormwater Management Manual, 2001. Volume 2, Section 3.2.1.
<http://www.georgiastormwater.com/>

Center for Watershed Protection, Stormwater Manager's Resources Center, 2000
<http://www.stormwatercenter.net/>

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Wet Pond

When to use:

- In hydrologic soil types C and D or with clay liner
- In low lying areas
- Water table is at least 3 feet below the pond bottom
- Drainage area of at least 2 acres
- Hydraulic head of 3 to 6 feet
- Not practical for use in ultra urban settings
- Cannot be placed on steep or unstable slopes

Advantages:

- Can achieve 80% TSS removal as a stand alone BMP
- Variable ability to accept pollutants from hotspots
- Low construction cost
- Low to moderate maintenance cost
- Moderate community acceptance
- Medium wildlife habitat benefit
- Provides water quantity benefit in the form of runoff rate control
- Long effective life
- Can act as sediment trap/basin during construction phase
- Retrofit opportunities for existing wet ponds
- Large sediment storage volume below water

Limitations:

- Requires additional right-of-way beyond standard clear zone limits
- Removal rates vary widely depending on site conditions and storm events
- Minimum set-back from high water level required (see local codes)
- Heavy storms may resuspend sediments
- Potential for mosquito breeding areas
- Adequate source of water needed to maintain

permanent water pool areas year round

- Water can become stagnant
- Evaporation can concentrate levels of salt and algae
- Embankment may be regulated as a dam by IDNR

BMP Type:	Retention/ Detention – Non-Linear
TSS Removal:	46-98%
Nitrogen Removal:	28-50%
Phosphorous Removal:	20-94%
Metal Removal:	24-89%
E. coli Removal:	N/A
Runoff Volume Control:	Low
Runoff Rate Control:	High
Annual Maintenance Cost:	3-5% ¹
Relative Construction Cost:	Low
Effective Life:	20-50 years

¹ Reported as a percentage of Construction Cost

Virginia DCR, 1999

Wet Pond

Description:

The wet pond is a facility which removes sediment, organic nutrients, and trace metals from stormwater runoff. This is accomplished by slowing down stormwater using an in-line permanent pool or pond effecting settling of pollutants. The wet pond is similar to a dry pond, except that a permanent volume of water is incorporated into the design. Biological processes occurring in the permanent pond pool aid in reducing the amount of soluble nutrients present in the water, such as nitrate and ortho-phosphorus.

The permanent pool is usually maintained at a depth between 6 and 8 ft. High pollutant removal efficiencies for sediment, phosphorus, and nitrogen are achievable when the volume of the permanent pool is at least three times the water quality volume (the volume to be treated). The shape of the pool can help improve the performance of the pond. Maximizing the distance between the inlet and outlet provides more time for mixing of the new runoff with the pond water and settling of pollutants.

Soil conditions are important for the proper functioning of the wet pond. The pond is a permanent pool, and thus must be constructed such that the water must not be allowed to exfiltrate from the permanent portion of the pool. It is difficult to form a pool in soils with high infiltration rates soon after construction. Eventually, however, deposition of silt at the bottom of the pond will help slow infiltration. If extremely permeable soils exist at the site (hydrologic soil group A or B), a geosynthetic or clay liner may be necessary.

Drawings:

Figure 1: Typical Wet Pond with Wetland Perimeter – Plan View
(Georgia Stormwater Management Manual, 2001)

Wet Pond

Figure 1: Typical Wet Pond – Section View
(Modified from Georgia Stormwater Management Manual, 2001)

References:

Georgia Stormwater Management Manual, 2001. Volume 2, Section 3.2.1.

<http://www.georgiastormwater.com/>

Virginia DCR, 1999. *Virginia Stormwater Management Handbook*. Commonwealth of Virginia, Department of Conservation and Recreation.

<http://www.dcr.state.va.us/sw/stormwat.htm#handbook>

PADEP, 2005. *Draft Pennsylvania Stormwater Management Manual, Section 6*. Pennsylvania Department of Environmental Protection.

http://www.dep.state.pa.us/dep/subject/advoun/stormwater/Manual_DraftJan05/Section06-StructuralBMPs-part1.pdf

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Dry Swale

When to use:

- Any soil type
- Water table is at least 3 feet below the swale invert
- Drainage area of 2 to 4 acres
- Hydraulic head of 2 to 6 feet
- Not practical for use in ultra urban settings
- Cannot be placed on steep or unstable slopes

Advantages:

- Can achieve 80% TSS removal as a stand alone BMP
- Can accept pollutants from offsite hotspots
- Low construction cost
- Low maintenance cost
- Moderate community acceptance
- Relatively easy to design, install and maintain

Limitations:

- Removal rates vary widely depending on site conditions and storm events
- Minimum set-back from high water level required (see local codes)
- Heavy storms may resuspend sediments
- Potential for mosquito breeding areas
- Limited runoff quantity and rate control for small storm events
- Effective life may be reduced if not properly maintained
- Low wildlife habitat benefit
- Irrigation may be necessary to maintain vegetative cover

BMP Type:	Retention/ Detention - Linear
TSS Removal:	30-90%
Nitrogen Removal:	0-50%
Phosphorous Removal:	20-85%
Metal Removal:	0-90%
E. coli Removal:	N/A
Runoff Volume Control:	Low
Runoff Rate Control:	Medium
Annual Maintenance Cost:	3-5% ¹
Relative Construction Cost:	Low
Effective Life:	5-20 years

¹ Reported as a Percentage of Construction Cost

Virginia DCR, 1999

Dry Swale

Description:

Dry swales are engineered grassed channels that not only convey stormwater from a roadway but also provide water quality benefits. They can be sized to detain stormwater and address water quantity management needs. Dry swales are designed so that runoff infiltrates through the bottom of the swale into the ground below. The majority of the treatment is provided by the process of soil infiltration, which filters suspended solids and facilitates adsorption of dissolved pollutants. The subsoil must have appropriate permeability and infiltration rates. Treatment efficiency of dry swale designs is dependent on the gradient of the swale, the swale size, and the infiltration rate of the subsoils.

Swales are configured as on-line facilities. They provide effective treatment of small, frequent storms, but must still retain the ability to convey high runoff rates from the roadway when less frequent high-intensity storms occur. During these larger rainfall events, swales provide only marginal treatment of the high flow rates.

Drawings:

Figure 1: Typical Swale Configuration – Section View
(Modified From Center for Watershed Protection)

Dry Swale

Figure 2: Typical Swale Configuration – Plan View
(Modified From Center for Watershed Protection)

References:

Center for Watershed Protection, Stormwater Manager's Resources Center, 2005, *Stormwater Management Fact Sheet, Grassed Channel*.
<http://www.stormwatercenter.net/>

Virginia DCR, 1999. *Virginia Stormwater Management Handbook*. Commonwealth of Virginia, Department of Conservation and Recreation.
<http://www.dcr.state.va.us/sw/stormwat.htm#handbook>

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Stormwater Wetland

When to use:

- Any soil type
- In low lying areas
- Water table at the surface of the proposed wetland bottom elevation.
- Drainage area a minimum of 1 acre.
- Hydraulic head of 1 to 8 feet.
- Not practical for use in ultra urban settings.

Advantages:

- Medium construction cost.
- Low to moderate maintenance cost.
- Moderate to high community acceptance.
- Provides water quantity benefit in the form of runoff rate control.
- High wildlife habitat benefit.
- Has long effective life.
- Can be used as a regional water quality facility.
- May be possible to use existing native seedbank (dormant seeds present in topsoil) in lieu of seeding

Limitations:

- Requires additional right-of-way beyond standard clear zone limits
- Does not achieve 80% TSS removal rates as a stand alone BMP but can be used in conjunction with other BMPs to achieve 80%
- Minimum set-back from high water level required (see local codes)
- Can not accept pollutants from offsite hotspots
- Can accumulate salts and scum which can be flushed out by large storm flows
- Maintenance, including plant harvesting, is required to provide nutrient removal
- Wetland may periodically become a nutrient source

- Hydrology must be adequate to sustain wetland vegetation.
- If native seedbank is inadequate, a qualified professional must select vegetation.

BMP Type:	Constructed Wetland - Linear
TSS Removal:	65%
Nitrogen Removal:	20%
Phosphorous Removal:	25%
Metal Removal:	35-65%
E. coli Removal:	N/A
Runoff Volume Control:	Low
Runoff Rate Control:	High
Annual Maintenance Cost:	5-7% ¹
Relative Construction Cost:	Medium
Effective Life:	20-50 years

¹ Reported as a percentage of Construction Cost

Virginia DCR, 1999

Stormwater Wetlands

Description:

Stormwater wetlands are constructed wetland systems designed to maximize the removal of pollutants from stormwater runoff via several mechanisms: microbial breakdown of pollutants, plant uptake, retention, settling and adsorption. Stormwater wetlands temporarily store runoff in shallow pools that support conditions suitable for the growth of wetland plants. Stormwater wetlands also promote the growth of microbial populations which can extract soluble carbon and nutrients and potentially reduce BOD and fecal coliform levels concentrations.

Stormwater quality wetlands differ from wetlands constructed for compensatory mitigation purposes and wetlands created for restoration. Typically, stormwater wetlands will not have the full range of ecological functions of natural wetlands; stormwater wetlands are designed specifically for flood control and water quality purposes. Similar to wet ponds, stormwater wetlands require relatively large contributing drainage areas and/or dry weather base flow.

Drawings:

Figure 1: Constructed wetland plan view
(Georgia Stormwater Management Manual, 2001)

Stormwater Wetlands

Figure 2: Constructed wetland section view
(Georgia Stormwater Management Manual, 2001)

References:

Georgia Stormwater Management Manual, 2001. Volume 2, Section 3.2.1.
<http://www.georgiastormwater.com/>

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.
<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

Virginia DCR, 1999. *Virginia Stormwater Management Handbook*. Commonwealth of Virginia, Department of Conservation and Recreation.
<http://www.dcr.state.va.us/sw/stormwat.htm#handbook>

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Wet Swale

When to use:

- Any soil type
- Moderately sloping terrain
- Water table elevation is at the swale invert elevation
- Drainage area of 2 to 4 acres
- Hydraulic head of 2 to 3 feet
- Not practical for use in ultra urban settings

Advantages:

- Medium construction cost
- Moderate community acceptance
- Medium wildlife habitat benefit
- Relatively easy to design, install and maintain

Limitations:

- Does not achieve 80% TSS removal rates as a stand alone BMP but can be used in conjunction with other BMPs to achieve 80%
- Minimum set-back from high water level required (see local codes)
- Variable maintenance cost
- Can not handle pollutants from offsite hotspots
- Additional design criteria necessary to achieve runoff quantity control
- Can have a short effective life even with appropriate maintenance.
- Potential for mosquito breeding areas
- Not appropriate for pollutants toxic to vegetation
- Become less feasible as number of culvert crossing increase

BMP Type:	Constructed Wetland - Linear
TSS Removal:	65%
Nitrogen Removal:	20%
Phosphorous Removal:	25%
Metal Removal:	35-65%
E. coli Removal:	N/A
Runoff Volume Control:	Low
Runoff Rate Control:	Low
Annual Maintenance	5-20% ¹
Cost:	
Relative Construction	Medium
Cost:	
Effective Life:	5-20 years

¹ Reported as a percentage of Construction Cost

PA SW Management Manual, 2005

Wet Swale

Description:

Wet swales are engineered grassed channels that not only convey stormwater from a roadway but also provide water quality benefits. Wet swales are distinguished from the simple drainage/grassed channel by design features that maintain a saturated condition in soils at the bottom of the swale. The goal of a wet swale is to create an elongated wetland treatment system that treats stormwater through physical and biological action. Unlike dry swales, infiltration of stormwater is an undesirable condition in a wet swale because it would likely result in conditions detrimental to maintaining saturated soils to support wetland vegetation. Wet swales provide for stormwater treatment in wet soils where treatment may otherwise be nonexistent or negligible. Versatility with this practice allows for off-line placement of wetland cells, as well as the introduction of emergent wetland plant species to encourage creation of habitat. Wet swales can also be sized to detain stormwater and address water quantity management needs.

Drawings:

Figure 1: Plan View of a Wet Swale
(Center for Watershed Protection)

Figure 2: Section view of a wet swale with optional check dam
(Modified from Center for Watershed Protection)

Wet Swale

References:

Center for Watershed Protection, Stormwater Manager's Resources Center, 2005, *Stormwater Management Fact Sheet, Grassed Channel*.

<http://www.stormwatercenter.net/>

PADEP, 2005. *Draft Pennsylvania Stormwater Management Manual, Section 6*. Pennsylvania Department of Environmental Protection.

http://www.dep.state.pa.us/dep/subject/adv coun/stormwater/Manual_DraftJan05/Section06-StructuralBMPs-part1.pdf

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Infiltration Trench

When to use:

- Should not be used in karst areas
- In soil types A and B
- Water table is at least 3 feet below the trench
- Drainage area of 2 to 4 acres
- Hydraulic head of 3 to 8 feet
- Can be used in some ultra urban settings

Advantages:

- Can achieve 80% TSS removal rates as a stand alone BMP
- Highly efficient removal of pollutants of concern
- Low to moderate maintenance cost
- Moderate to high community acceptance
- Provides water quantity benefit in the form of runoff volume control
- Provides groundwater recharge

Limitations:

- High construction cost
- Can not accept pollutants from offsite hotspots
- Can have a short effective life even with appropriate maintenance
- High failure rate due to clogging and high maintenance burden
- Low removal of dissolved pollutants in very coarse soils
- Groundwater monitoring may be needed due to risk of contamination in very coarse soils
- Metal and petroleum hydrocarbons can accumulate in soils to potentially toxic levels
- No wildlife habitat benefit
- Pretreatment of runoff is recommended to minimize sediment loading, avoid clogging. TSS removal

BMP Type:	Infiltration System - Linear
TSS Removal:	75-99%
Nitrogen Removal:	45-70%
Phosphorous Removal:	50-75%
Metal Removal:	75-99%
E. coli Removal:	75-98%
Runoff Volume Control:	High
Runoff Rate Control:	Medium
Annual Maintenance Cost:	5-7% ¹
Relative Construction Cost:	High
Effective Life:	5-15 years

¹ Reported as a percentage of Construction Cost

Portland, OR BMP Manual, 2004

Infiltration Trench

Description:

An infiltration trench is an excavated trench that has been lined and backfilled with stone to form a subsurface basin. Stormwater runoff is diverted into the trench and is stored until it can infiltrate into the soil, usually over a period of several days. Infiltration trenches are very adaptable BMPs, and the availability of many practical configurations make it ideal for small urban drainage areas, such as ultra-urban sites. Infiltration trenches can be either on-line or off-line systems. They are most effective and have a longer life cycle when some type of pretreatment to remove sediment is included in their design. Pretreatment may include techniques such as vegetated filter strips or grassed swales.

Infiltration trenches provide the majority of treatment by processes related to soil infiltration, which include sorption, precipitation, trapping, filtering, and bacterial degradation..

Drawings:

Figure 1: Typical Above Ground Infiltration trench Configuration
(Modified from Georgia Stormwater Management Manual, 2001)

Infiltration Trench

Figure 2: Infiltration Trench, Road Median Application – Plan and Section View
(Metropolitan Council, 2001)

References:

Georgia Stormwater Management Manual, 2001. Volume 2, Section 3.2.1.
<http://www.georgiastormwater.com/>

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.
<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

Portland, Oregon Bureau of Environmental Services, 2004, *Portland Stormwater Management Manual*.
<http://www.portlandonline.com/bes/index.cfm>

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Infiltration Basin

When to use:

- Should not be used in karst areas
- In soil types A and B
- Water table is at least 3 feet below the basin
- Drainage area of 2 to 20 acres
- Hydraulic head of 3 to 4 feet
- Not practical for use in ultra urban settings

Advantages:

- Can achieve 80% TSS removal rates as a stand alone BMP
- Highly efficient removal of pollutants of concern
- Medium construction cost
- Moderate community acceptance
- Provides water quantity benefit in the form of runoff volume control
- Provides groundwater recharge

Limitations:

- Requires additional right-of-way beyond standard clear zone limits
- Moderate to high maintenance cost
- Can not accept pollutants from offsite hotspots
- Can have a short effective life even with appropriate maintenance
- High failure rate due to clogging and high maintenance burden
- Low removal of dissolved pollutants in very coarse soils
- Groundwater monitoring may be needed due to risk of contamination in very coarse soils
- Metal and petroleum hydrocarbons can accumulate in soils to potentially toxic levels
- Requires relatively large amount of right-of-way compared to other measures
- Low wildlife habitat benefit unless vegetation with plantings other than turf grass

BMP Type:	Infiltration System – Non-Linear
TSS Removal:	75-99%
Nitrogen Removal:	45-70%
Phosphorous Removal:	50-75%
Metal Removal:	50-90%
E. coli Removal:	75-98%
Runoff Volume Control:	High
Runoff Rate Control:	Medium
Annual Maintenance Cost:	5-20% ¹
Relative Construction Cost:	Medium
Effective Life:	5-15 years

¹ Reported as a percentage of Construction Cost

PA SW Management Manual, 2005

Infiltration Basin

Description:

An infiltration basin is a surface pond which captures first-flush stormwater and treats it by allowing it to percolate into the ground through permeable soils. Physical, chemical, and biological processes occur within the soil column, which remove both sediments and soluble pollutants. Pollutants are trapped in the upper layers of the soil, and the water is then released to groundwater. Infiltration basins are generally used for drainage areas between 2 and 20 acres. For drainage areas less than 2 acres, an infiltration trench or other BMP may be more appropriate. For drainage areas greater than 20 acres, maintenance of an infiltration basin would be burdensome, and an dry extended detention basin or wet pond may be more appropriate. Infiltration basins are generally dry except immediately following storms, but a low-flow channel may be necessary if a constant base flow is present.

Drawing:

Figure 1 – Plan view of an infiltration basin
(PA SW Management Manual, 2005)

Reference:

PADEP, 2005. *Draft Pennsylvania Stormwater Management Manual, Section 6*. Pennsylvania Department of Environmental Protection.

http://www.dep.state.pa.us/dep/subject/advoun/stormwater/Manual_DraftJan05/Section06-StructuralBMPs-part1.pdf

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Bioretention

When to use:

- Any soil type
- Low lying areas
- Water table is at least 3 feet below the swale invert
- Drainage area of 2 to 4 acres
- Hydraulic head of 2 to 3 feet
- Can be used in ultra urban settings

Advantages:

- Can accept pollutants from offsite hotspots
- Moderate maintenance cost
- Moderate community acceptance
- Medium wildlife habitat benefit
- Good metal removal rates
- Requires relatively little engineering design
- Provides groundwater recharge when runoff is allowed to infiltrate
- Also can serve as landscaping features

Limitations:

- Requires additional right-of-way beyond standard clear zone limits
- Does not achieve 80% TSS removal rate as a stand alone BMP but can be combined with other measures
- High construction cost
- Additional design criteria necessary to achieve runoff quantity control
- Can have a short effective life even with appropriate maintenance
- Low removal of nitrates
- Clogging may be a problem if the BMP receives runoff with high fine particle loads
- Maximum ponds depths may limit the amount of runoff that can be directed to the area
- Construction runoff should be diverted due to the clogging potential

BMP Type:	Filtration System – Linear
TSS Removal:	75%
Nitrogen Removal:	50%
Phosphorous Removal:	50%
Metal Removal:	75-80%
E. coli Removal:	N/A
Runoff Volume Control:	Medium
Runoff Rate Control:	Medium
Annual Maintenance Cost:	5-7% ¹
Relative Construction Cost:	High
Effective Life:	5-20 years

¹ Reported as a percentage of Construction Cost

PA SW Management Manual, 2005

Bioretention

Description:

Bioretention can be described as shallow, landscaped depressions commonly located in parking lot islands, medians, or within small pockets in residential areas. Stormwater flows into the bioretention area, ponds on the surface, and gradually infiltrates into the soil bed. Pollutants are removed by a number of processes including adsorption, filtration, volatilization, ion exchange and decomposition. Filtered runoff can either be allowed to infiltrate into the surrounding soil, or collected by an under-drain system and discharged to the storm sewer system or directly to receiving waters. Infiltration components should not be incorporated into bioretention designs in karst areas. Runoff from larger storms is generally diverted past the area to the storm drain system.

Drawing:

Figure 1: Bioretention Basin
(Virginia DCR, 1999)

References:

PADEP, 2005. *Draft Pennsylvania Stormwater Management Manual, Section 6*. Pennsylvania Department of Environmental Protection.
http://www.dep.state.pa.us/dep/subject/adv coun/stormwater/Manual_DraftJan05/Section06-StructuralBMPs-part1.pdf

Virginia DCR, 1999. *Virginia Stormwater Management Handbook*. Commonwealth of Virginia, Department of Conservation and Recreation.
<http://www.dcr.state.va.us/sw/stormwat.htm#handbook>

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Filter Strip

When to use:

- Any soil type
- Moderately sloping terrain
- Water table is at least 3 feet below the filter strip
- Drainage area of less than 5 acres
- Where sheet flow can be achieved
- Not practical for use in ultra urban settings

Advantages:

- Can accept pollutants from offsite hotspots
- Low construction cost
- Low to moderate maintenance cost
- High community acceptance
- Medium wildlife habitat benefit
- Slightly reduces watershed imperviousness
- Slightly contributes to groundwater recharge

Limitations:

- Can not accept concentrated flow. Concentrated flow must be distributed with a level spreader.
- Does not achieve 80% TSS removal rate as a stand alone BMP
- Additional measures necessary to achieve adequate runoff quantity control
- Removal rates vary widely depending on flow lengths
- Can have a short effective life even with appropriate maintenance
- Requires slopes less than 10%
- Requires low to fair permeability of natural subsoil
- Requires more right-of-way than other BMPs
- Effectiveness significantly reduced if flow becomes concentrated
- Pollutant removal is unreliable in urban settings

BMP Type:	Filtration System - Linear
TSS Removal:	27-70%
Nitrogen Removal:	20-40%
Phosphorous Removal:	20-40%
Metal Removal:	2-80%
E. coli Removal:	N/A
Runoff Volume Control:	Medium
Runoff Rate Control:	Medium
Annual Maintenance Cost:	5-7% ¹
Relative Construction Cost:	Low
Effective Life:	10-20 years

¹ Reported as a percentage of Construction Cost

PA SW Management Manual, 2005

Filter Strip

Description:

Vegetated filter strips, also known as vegetated buffer strips, are vegetated areas with low slopes, designed to accept runoff as overland sheet flow. When used as erosion and sediment control during construction, filter strips are generally not engineered or constructed but rather areas where existing vegetation is preserved. Runoff velocity is reduced by maintaining existing vegetative cover and/or, preserving a natural buffer strip around the lower perimeter of the disturbed land. However, a vegetated filter strip is not an effective control alone and must be combined with other post-construction BMPs.

This factsheet covers the use of engineered vegetated filter strips as a permanent control measure. Vegetated filter strips may range in form from grassland to forest, and are designed to intercept flow, lower flow velocity, and maintain sheet flow conditions. The dense vegetative cover facilitates conventional pollutant removal through detention, sedimentation, filtration by vegetation, and infiltration into soil. Existing vegetative buffers can be preserved during construction and function as post-construction BMPs.

Filter strips are most useful in contributing watershed areas where peak runoff velocities are low. In the ultra-urban environment, filter strips are limited due to the required flow length and are appropriate only where ample room exists for installation. There must be sufficient flow length and gradient to effectively treat the stormwater. The primary highway application for vegetative filter strips is along rural roadways where runoff that would otherwise discharge directly to a receiving water first passes through a filter strip before entering a conveyance system.

Drawings:

Figure 1: Filter Strip – Isometric View
(PA SW Management Manual, 2005)

Filter Strip

Figure 2: Filter Strip modified for quantity control
(Metropolitan Council, 2001)

References:

PADEP, 2005. *Draft Pennsylvania Stormwater Management Manual, Section 6*. Pennsylvania Department of Environmental Protection.

http://www.dep.state.pa.us/dep/subject/advoun/stormwater/Manual_DraftJan05/Section06-StructuralBMPs-part1.pdf

Metropolitan Council, 2001. *Minnesota Urban Small Sites BMP Manual, Stormwater Best Management Practices for Cold Climates*. Metropolitan Council Environmental Services.

<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Turf Reinforcement Mat

When to use:

- Any soil type
- Moderately sloping terrain
- Along channel banks, on slopes, or as a lining on intermittent drainage ways
- Can be used in ultra urban settings

Advantages:

- Can accept pollutants from offsite hotspots
- Low construction cost
- Low maintenance cost
- Moderate community acceptance
- Can increase the effectiveness of other water quality measures

Limitations:

- Increased probability of failure if not installed properly
- Very steep or unstable streambanks require close examination of the underlying soils for stability. May be combined with other bioengineering practices
- Turf reinforcement mats (TRMs) should not be considered to be a stand alone post-construction BMPs. Installation of TRMs can be incorporated into other BMPs, such wet or dry swales.

BMP Type:	Filtration Systems - Linear
TSS Removal:	30-90% ¹
Nitrogen Removal:	0-50% ¹
Phosphorous Removal:	20-85% ¹
Metal Removal:	0-90% ¹
E. coli Removal:	N/A
Runoff Volume Control:	Low
Runoff Rate Control:	Medium
Annual Maintenance:	3-5% ^{1,2}
Cost:	
Relative Construction Cost:	Low
Effective Life:	5-20 years

¹ Data reported as median percent removal of vegetated swales

² Reported as a Percentage of Construction Cost

North American Green, undated

Turf Reinforcement Mat

Description:

Turf reinforcement mats (TRMs) are three dimensional reinforcement matrices that provide sufficient thickness, strength and void space to permit soil filling and/or retention and the development of vegetation within the matrix. TRMs are composed of UV stabilized, non-degradable, synthetic fibers or nettings. Some TRMs also include a biodegradable component to promote vegetation growth. The medium of soil, vegetation, and fiber is designed for permanent and critical hydraulic applications where design discharges exert velocities and shear stresses that exceed the limits of mature, natural vegetation. TRMs should be designed based on allowable shear stress of the channel lining. The primary benefit of TRMs is they allow for infiltration and they can filter runoff from smaller rainfall events once vegetated.

Drawings:

Figure 1: Channel Application
(TDOT, 2005)

References:

North American Green Image Library

http://www.nagreen.com/resources/imagelibrary/SC250/SC250_Slope_Unveg.jpg

TDOT, 2005. *Tennessee Department of Transportation Standard Drawings – Erosion Control and Landscaping*. Tennessee Department of Transportation Design Division.

http://www.tdot.state.tn.us/Chief_Engineer/engr_library/design/Std_Drwg_Eng.HTM

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Native Vegetation – Permanent

When to use:

- For revegetation on completed construction jobs
- For landscaping
- For soil stabilization above the ordinary high water mark on channel banks and on slopes
- In combination with turf reinforcement mats and other bioengineering measures
- In combination with all other water quality measures that call for vegetative components

Advantages:

- Maintenance limited to reseeding sparse or bare areas
- Native vegetation is better adapted to local conditions than non-native
- Aesthetically pleasing
- Can increase the effectiveness of other water quality measures

Limitations:

- Very steep or unstable streambanks require close examination of the underlying soils for stability. May be combined with other bioengineering practices
- Native seeding should not be considered to be a stand alone post-construction BMPs. Native seeding can be incorporated into other BMPs, such wet or dry swales, or anywhere else that revegetation is required

BMP Type:	Retention/ Detention - Linear
TSS Removal:	30-90% ¹
Nitrogen Removal:	0-50% ¹
Phosphorous Removal:	20-85% ¹
Metal Removal:	0-90% ¹
E. coli Removal:	N/A
Runoff Volume Control:	Low
Runoff Rate Control:	Medium
Annual Maintenance:	3-5% ^{1,2}
Cost:	
Relative Construction Cost:	Low
Effective Life:	5-20 years

¹ Data reported as median percent removal of vegetated swales

² Reported as a Percentage of Construction Cost

EPA, 2003

Native Vegetation – Permanent

Description:

Where possible, vegetative measures are preferred to engineered, structural, soil stabilization. On steeper slopes or flow paths, vegetation can be combined with turf reinforcement mats, fiber wattles, or other bioengineering techniques to aid in establishment and stability. The use of vegetative measures requires less maintenance and provides wildlife habitat.

Grasses introduced from Europe and Asia have traditionally been used to establish vegetative cover on construction sites in the Midwest. However, many designers are now specifying native grasses for revegetation, stabilization, and landscaping. Although slower to establish, native species require less maintenance in the long run than nonnative species. They are also better for water quality because they do not require the heavy fertilizer application that introduced species require.

Native grasses will grow on poor soils because they can gain access to nutrients and water that shallower-rooted grasses cannot reach. Therefore, native grasses are desirable for stabilizing soils. Cover crops such as oats or winter wheat should be seeded with native grasses to provide short-term erosion control while they are becoming established. Wildflowers could be added to the seed mixes on many projects. Because they develop very deep root systems, native grasses and wildflowers provide very good long-term erosion control.

References:

EPA Website, 2004. United States Environmental Protection Agency. *Great Lakes Environment, Greenacres, Natural Landscaping Tool Kit, THE NATURAL LANDSCAPING ALTERNATIVE: An Annotated Slide Collection - Slide 7*

<http://www.epa.gov/greenacres/tooltestkit/gallery/TKSlide07.html>

Stormwater Quality Best Management Practices Post-Construction Stormwater Treatment

Hydrodynamic Separators

When to use:

- Any soil type
- Any terrain
- Water table greater than 3 feet below the structure
- Very practical for use in ultra urban settings
- Due to the increasing number of manufacturers of proprietary water quality structures, the upper limit of drainage area may vary from 2 to 300 acres.

Advantages:

- Achieves 80% or greater TSS removal rate as a stand alone measure
- Can accept pollutants from offsite hotspots
- High construction cost
- Low maintenance cost
- High community acceptance
- Very long effective life
- Prefabricated for different standard storm drain designs
- Require minimal space to install

Limitations:

- Does not provide runoff volume or rate control
- Removal rates for pollutants other than TSS vary by manufacturer and often depend on accessories added to the structure
- No wildlife habitat benefit
- Some devices may be vulnerable to accumulated sediments being resuspended during heavy storms
- Can only handle limited amounts of sediment and debris
- Regular maintenance and inspection is required to assess sediment, floatable, and oil accumulation
- Sizing and analysis vary between vendors

BMP Type:	Proprietary System - Linear
TSS Removal:	80-90%
Nitrogen Removal:	N/A
Phosphorous Removal:	N/A
Metal Removal:	N/A
E. coli Removal:	N/A
Runoff Volume Control:	None
Runoff Rate Control:	None
Annual Maintenance Cost:	1-5%
Relative Construction Cost:	High
Effective Life:	>100 years

¹ Reported as a Percentage of Construction Cost

CBBEL file, 2005

Hydrodynamic Separators

Description:

Installation of hydrodynamic separators can be grouped into in-line or off-line installations. Inline installations are typically only found on piped stormwater conveyance systems. Offline systems can be installed on closed stormwater systems or on open channels. Offline systems are often used to treat much larger flow rates than in-line systems. The flow to be treated is usually diverted to the stormwater treatment unit from the main conveyance system flow and then rejoins the main flow path once it is treated.

Hydrodynamic separators can be useful where space is limited or in areas susceptible to spills of petroleum products, such as gas stations. There are many manufacturers of hydrodynamic separators. The sizing and analysis methods used to demonstrate and verify the effectiveness of a unit varies widely among different manufacturers. The designer should establish a percent removal of a target particle size for the calculated water quality treatment rate. Figure 1 illustrates one of many different types of hydrodynamic separators.

Drawings:

Figure 1: General Hydrodynamic Separator Schematic (CBBEL, 2005)

References:

None

APPENDIX 5

INDOT DOCUMENTATION REVIEW LIST

As a part of INDOT's Stormwater Quality Management Plan (SWQMP), a comprehensive review of INDOT documents has been performed. The objective of the review was to identify those document revisions that *are recommended* to be made to help satisfy requirements of the INDOT Storm Water Quality Management Plan (SWQMP).

Forty-five INDOT documents related the design, construction, and maintenance of INDOT roadways have been reviewed as a part of this study. **Table 1** contains a list of *all* of the documents reviewed under the detailed study.

Table 1: INDOT Documents Reviewed

Appraisal Manual	Design Manuals - Project Development	Oversize/Overweight Vehicle Permitting Handbook
Aquifer Protection Guidelines	Design Manuals - Right-of-Way	Partnering Handbook
Buyer's Manual	Design Manuals - Road Design	Pile Approval Form
Certified Aggregate Technician Manual	Design Manuals - Structural Design	Procedural Manual for Preparing Environmental Studies
Certified Hot Mix Asphalt Technician Program Manual	Design Manuals - Traffic Design	Procedure and Special Provisions for Soil Modification
Certified Technician Program Training Manuals - Bridge Construction	Design Manuals - Work Zone Traffic Control	Property Management Procedure Manual
Certified Technician Program Training Manuals - Concrete Paving	Design Memos	INDOT Recurring Special Provisions
Certified Technician Program Training Manuals - Construction Procedures 1	Driveway Permit Manual	Relocation Program Manual
Certified Technician Program Training Manuals - Construction Procedures 2	Environmental Manual on Construction Activity	Requirements for Geotechnical Investigation and Pavement Investigation
Certified Technician Program Training Manuals - Earthworks	Field Operations Manual	Right-of-Way Acquisition Procedure Manual for LPA's
Certified Technician Program Training Manuals - Hot Mix Asphalt	General Instructions for Bridge Structure Investigation	Right-of-Way Engineering Manual
Construction Memorandums	General Instructions to Field Employees	INDOT Standard Drawings
Design Manuals - Hydrology/Hydraulics	Indiana Test Methods or Procedures	Standard Highway Signs
Design Manuals - Location Surveys	Manual on Uniform Traffic Control Devices	INDOT Standard Specifications
Design Manuals - Plan Development	Outdoor Advertising Control Manual	Transportation Enhancement Guide

APPENDIX 6

CONSTRUCTION ACTIVITY ENVIRONMENTAL MANUAL REVIEW

Introduction

From INDOT's website, the Construction Activity Environmental Manual is described as “a reference for Project Engineers/Supervisors, geared to INDOT's construction personnel and contractors. It is intended to improve awareness about what environmental issues may be associated with different construction activities in Indiana. “

The Construction Activity Environmental Manual is divided into several main types of projects or project related concerns that include:

- Grading Operations
- Small Drainage Structures
- Bridges
- Subbase
- Compacted Aggregate Base
- Cement Concrete Pavement
- Concrete Patching
- Utility Relocation
- Finishing Shoulders, Ditches, and Slopes
- Final Trimming and Clearing
- Sodding, Seeding, and Landscaping
- Miscellaneous Concrete Items
- Rest Areas and Weigh Stations
- Acceptance of Completed Work

The document is organized such that within each of these sections pertinent environmental issues are addressed. In many cases this results in redundancy where the same material is repeated numerous times with limited variation in the content. Generally, there appear to be 33 primary information blocks that mainly focus on regulatory permitting and procedural requirements. These information blocks are listed in Table 1 below.

Table 1: Construction Activity Environmental Manual – Information Blocks

Construction Activity – Environmental Manual (General Topics)		
Archaeological /Historic Preservation	COE Section 404/Section 10 Permits (U.S.)	Asbestos
Burning	Coast Guard (U.S.) Bridge Permit and Activity Letter	Concrete/Asphalt Batch Plants
Construction in a Floodway	County/State Department Of Health	Dewatering Well Installation
Ditch Reconstruction	Endangered Species	Fugitive Dust
Hazardous Material	In Stream Blasting Permit	Injection Wells
Karst	Lake Preservation Act (Permit)	Lead Paint
Navigable Waterway Permit	NPDES Permit	Nuclear Regulatory Commission
Open Burning	Rule 5 - Erosion Control	Section 401 Water Quality Certification
Sole Source Aquifer	Solid Waste Disposal	Special Materials - Slag, Foundry Sand
Spill Response	Underground Storage Tanks/Leaking Underground Storage Tanks	Wastewater/Drinking Water Treatment Plants
Water Well Abandonment	Well Abandonment (Oil and Gas)	Wetlands

Recommended Updates and Additional Information

Eight of these information blocks should be updated to include requirements for construction phase erosion and sediment control and post-construction phase stormwater pollution prevention devices. Alternatively, a section could be added that summarizes how the current NPDES Phase II regulations (327 IAC 15-5 and 327 IAC 15-13) relate to INDOT procedures. For organization purposes, the eight potentially affected information blocks are discussed individually below.

Ditch Reconstruction

Regardless of whether an official Ditch Permit is needed from IDNR or if other regulatory permits or approvals are waived or not required, erosion and sediment control measures should be included in all ditch reconstruction projects regardless of size. This is due to water quality concerns.

Fugitive Dust

The fugitive dust is defined by “at least fifty percent (50%) of the dust can be breathed in or is visible crossing the right-of-way.” This number would be very difficult if not impossible to quantify in most situations. Dust emissions can become a particular nuisance in residential areas even when the dust release is not considered fugitive. Dust is a stormwater pollution concern especially when it is blown off-site where it readily washes off during rainfall. Spraying and chemical dust suppressants are identified as measures for dust control.

Soil roughening should also be mentioned as a dust control measure. Soil roughening increases the surface roughness and therefore decreases surface wind velocity and dust generation. Another worthy method of dust control is the maintenance of natural vegetation and wind barriers. If these barriers must be removed for the successful completion of the project, the construction sequencing should be such that the removal is performed as late in the construction process as reasonably possible.

Hazardous Materials and Spill Response

Hazardous materials and spill response are covered under two separate sections in the Construction Activity Environmental Manual. Adequate information is provided in the manual describing the steps that should be taken if hazardous materials are spilled during the construction project. In the event of hazardous material discovery or a spill, the Contractor should prevent hazardous materials from entering waterways as much as possible. This information should also be included in the Stormwater Pollution Prevention Plan (SWPPP) for the project site.

Typically, the SWPPP is developed prior to the project letting by the Designer and will contain this information. However, if this information is not contained in the approved SWPPP, the Contractor is required to modify the SWPPP. On most projects, the Contractor will be amending the SWPPP in some way, shape, or form due to differing stormwater BMP, soil borrow areas or soil disposal areas, or changes in construction sequence. Therefore, the Contractor could simply include the appropriate sections of the Construction Activity Environmental Manual in the amended SWPPP submittal.

In-Stream Blasting Permit

As the name implies, this type of permit is required from IDNR before setting or detonating explosives within Waters of the State. Erosion and sediment control measures, such as a turbidity curtain (silt boom) should be included for in-stream blasting.

Karst

The Construction Activity Environmental Manual identifies karst areas as direct connections to ground water aquifers. Where possible, the natural runoff rates to karst areas should not be modified regardless of whether or not the flow has been treated. Changes to the natural runoff rates may result in undue changes to the karst geology.

Lake Preservation Act (Permit)

This permit is essentially written approval to perform work at or lakeward of the legal shoreline. Similar to ditch reconstruction and in-stream blasting, erosion and sediment control measures, such as a turbidity curtain (silt boom) should be included for underwater blasting or any silt producing activity

Rule 5 - Erosion Control

Rule 5 references should be added to the following sections:

- General Section – Add Rule 5 Permit description
- Grading over Peat Marshes
- Bridges Section – Introduction
- Cofferdams
- Falsework
- Subbase
- Compacted Aggregate Base
- Cement Concrete Pavement
- Utility Relocation
- Landscaping Operations
- Rest Areas and Weigh Stations
- Acceptance of Completed Work

The underlying purpose of adding the Rule 5 permit requirements to these sections is to reinforce the obligation of INDOT through their Contractors to meet the NPDES general permit requirements of 327 IAC 15-5.

Additional information discussed in the following sections should also be included. INDOT is responsible for submitting a Notice of Intent (NOI) to IDEM before land disturbing operations begin. Current regulations also now require that a Stormwater Pollution Prevention Plan (SWPPP) be developed for all new development and redevelopment that disturbs a total project area of 1 acre or greater. There are two primary elements of the SWPPP.

The first element covers construction phase erosion and sediment control measures. This will be the Contractor's main focus related to Rule 5 permitting requirements. The Contractor is responsible for the installation, inspection, modification, and regular maintenance of these measures. Additional measures must be added to prevent erosion and control sediment as site conditions warrant. The measures included in the approved SWPPP or design plans may not be sufficient to satisfy the erosion and sediment control requirements. The SWPPP is intended to be a minimum requirement for approximated site conditions. Two examples of scenarios where additional construction phase SWPPP (erosion and sediment control) measures should be added are:

1. During the design phase it was planned that the area of disturbance would be less than 0.4 ha (1 acre). A construction phase erosion and sediment control plan was developed, but not submitted to or approved by the SWPPP review authority (due to the anticipated acreage). During the construction phase, the Contractor utilizes some surrounding areas for material

stockpile, equipment mobilization, and other construction activities. The additional area results in the total land disturbance being greater than 0.4 ha (1 acre). As a result, an approved SWPPP is legally required for the project.

2. A construction project has an approved SWPPP. Following the first ½ inch rainfall event, the Contractor discovers locations of off-site tributary area that were not anticipated. Although payment for the required measures would likely represent a change order for the contract, the Contractor is still required to amend the SWPPP to include the measures to address this unanticipated runoff.

Under Rule 5 requirements, the Contractor must also have a SWPPP for borrow or disposal areas that disturbed greater than 1 acre of land. Throughout the construction of the project, the Contractor should perform regular inspection of the erosion and sediment control measures. Inspections should be performed weekly or after a rainfall event accumulating more than ½ inch in a 24 hour period. As mentioned in the *INDOT Standard Specification Review Comments*, an inspection log should be maintained by the Contractor.

Post-construction (permanent) stormwater pollution prevention devices are the second primary component of a SWPPP. Such devices should be designed and specified prior to contract letting. The Contractor's responsibility related to post-construction devices is to make sure construction is completed according to the project specifications or special provisions. The Contractor should also be aware that post-construction SWPPP elements should not be installed until upstream areas are stabilized.

Acceptance of Completed Work

Rule 5 requirements should be referenced for acceptance of completed work. In the *INDOT Standard Specification Review Comments*, it is recommended the Contractor shall provide INDOT information certifying that all conditions for the NPDES General Permit Rule 327 IAC 15-5 Notice of Termination (NOT) have been satisfied. The Department should then apply for the NOT once the information has been provided by the Contractor. It is further recommended that final acceptance and payment not be granted to the Contractor until IDEM has accepted the NOT. This is due to the fact that the NOT can be rejected and returned to the Owner (INDOT) due to site deficiencies.

Conclusion

The regulatory stormwater quality regulatory atmosphere has dramatically changed in the past decade. Accordingly, INDOT's obligations and the requirements they place on their Designers and Contractors will also change during the upcoming transition period. The information presented in the above discussion represents a significant change to the responsibility of the Contractor in the INDOT construction process. The Contractor will now be required to update the SWPPP and to provide information to INDOT as the project is finalized to attain the NOT and final payment. It is anticipated that some Contractor's may need assistance in this transition period. Because of this, it may be desirable for INDOT to develop a new independent *Contractor's SWPPP Assistance Manual*. This manual should:

- Identify situations requiring Contractor-initiated SWPPP changes
- Provide guidance on currently proposed changes to Details and Specifications
- Identify maintenance considerations
- Include SWPPP control measure inspection forms
- Contains a checklist for NOT information to be submitted by the Contractor to the Department to gain final acceptance and payment.

APPENDIX 7

GENERAL INSTRUCTION TO FIELD EMPLOYEES REVIEW

Document	INDOT General Instructions to Field Employees
Reference Section	Section 1 - Introduction
Reference Part	Part 1 - Acronyms
Proposed Revision	<ul style="list-style-type: none"> Add the following acronyms to the current list: <i>BFM – Bonded Fiber Matrix</i> <i>BMP – Best Management Practice</i> <i>MS4 – Municipal Separate Storm Sewer Systems</i> <i>NOI – Notice of Intent</i> <i>NOT – Notice of Termination</i> <i>NPDES – National Pollutant Discharge Elimination System</i> <i>SWCD – Soil and Water Conservation District</i> <i>SWPPP – Stormwater Pollution Prevention Plan</i> <i>TRM – Turf Reinforcement Mat</i>
Reason	<ul style="list-style-type: none"> Common abbreviations related to current stormwater pollution prevention and erosion and sediment control requirements.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 1 - Introduction
Reference Part	Part 7 – Utility Relocation Process – Construction Phase
Proposed Revision	<ul style="list-style-type: none"> Add the following information as points 4 and 5. Renumber the subsequent items. 4. <i>If the total land disturbance of the project is anticipated to be greater than 1 acre, verify that an approved SWPPP exists for the utility relocation work. Verify the NOI for Rule 5 permitting requirements has been submitted. Amend the approved SWPPP or develop an additional SWPPP for the work as necessary.</i> 5. <i>Install erosion and sediment control measures prior to initiating land disturbance activities.</i>
Reason	<ul style="list-style-type: none"> Work performed for utility relocations also requires a SWPPP and Rule 5 permitting approval if the total disturbed area of the project will be greater than 1 acre. Erosion control measures should be installed regardless of the project size.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 2 – General Instructions
Reference Part	Part 3 – Initial Duties of the District
Proposed Revision	<ul style="list-style-type: none"> Modify the last sentence of the fifth paragraph to read: <i>On contracts which involve Rule 5 Erosion and Sediment Control Compliance (327-IAC 15-5 or 327 IAC 15-13) the Erosion and Sediment Control / Stormwater Pollution Prevention Review Authority must be invited. Depending on the project location, IDNR Division of Soil Conservation and / or the local municipality may be the Review Authority.</i> Modify the last sentence of the eighth paragraph to read: <i>For projects subject to Rule 5 permitting requirement, the Contractor needs to advise the appropriate Permitting Authority in writing of changes to the approved SWPPP. Changes to be reported include modification to the approved construction sequence, including actual start and completion dates, for each land disturbing activity and variations of the construction phase erosion and sediment control measures from those described in the approved SWPPP. The Contractor will be required to amend the SWPPP or develop a separate SWPPP for borrow and disposal areas not permitted under the approved SWPPP.</i> Modify point 17 under the <i>General Checklist for Pre-Construction Conferences</i> to state: <i>17. Erosion and Sediment Control requirements, including SWPPP amendment procedures, erosion and sediment control measure inspection and maintenance, and documentation of site conditions related to erosion and sediment control devices</i>
Reason	<ul style="list-style-type: none"> It is the Contractor's responsibility to adhere to the approved SWPPP, amend the SWPPP, or develop a separate SWPPPs where land disturbance activities are greater than 1 acre.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 2 – General Instructions
Reference Part	Part 4 – Initial Duties of PE/S
Proposed Revision	<ul style="list-style-type: none"> Add the following items as potential special environmental requirements listed under point (i): <i>Department of Environmental Management permits Rule 5 NOI and SWPPP</i>
Reason	<ul style="list-style-type: none"> Applicable environmental requirements.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 3 – Grading
Reference Part	Part 1 - General
Proposed Revision	<ul style="list-style-type: none"> Modify the first paragraph, starting at the third sentence and going through the end of the paragraph, to state: <i>As the Department's SWPPP was prepared to meet requirements of Rule 5 for compliance with 327 IAC 15-5, the Contractor shall be required to either amend the existing or develop a separate SWPPP to cover any land disturbance operations that are not permitted under the previously approved SWPPP. An addendum shall be submitted to the appropriate Soil and Water Conservation District and/or the Review Authority that received the Department's original SWPPP for review. This submittal shall be made and approved prior to the start of the affected grading operations. This information shall also be provided to the PE/S. The Contractor is also required to obtain any other necessary permits.</i>
Reason	<ul style="list-style-type: none"> Applicable environmental requirements. This wording better defines the SWPPP requirements of the Contractors and the associated process.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 4 – Small Drainage Structures
Reference Part	Part 1 – General
Proposed Revision	<ul style="list-style-type: none"> Add the following paragraph: <i>As the Department's SWPPP was prepared to meet requirements of Rule 5 for compliance with 327 IAC 15-5, the Contractor shall be required to either amend the existing or develop a separate SWPPP to cover any land disturbance operations that are not permitted under the previously approved SWPPP. An addendum shall be submitted to the appropriate Soil and Water Conservation District and/or the Review Authority that received the Department's original SWPPP for review. This submittal shall be made and approved prior to the start of the affected grading operations. This information shall also be provided to the PE/S. The Contractor is also required to obtain any other necessary permits.</i>
Reason	<ul style="list-style-type: none"> This paragraph is copied from the proposed revision for <i>Section 3. Grading point 1. General</i>. This information should also appear in the general information section of <i>Section 4. Small Drainage Structures</i>.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 5 – Bridges
Reference Part	Part 1 – Introduction
Proposed Revision	<ul style="list-style-type: none"> Add the following paragraph: <i>As the Department's SWPPP was prepared to meet requirements of Rule 5 for compliance with 327 IAC 15-5, the Contractor shall be required to either amend the existing or develop a separate SWPPP to cover any land disturbance operations that are not permitted under the previously approved SWPPP. An addendum shall be submitted to the appropriate Soil and Water Conservation District and/or the Review Authority that received the Department's original SWPPP for review. This submittal shall be made and approved prior to the start of the affected grading operations. This information shall also be provided to the PE/S. The Contractor is also required to obtain any other necessary permits.</i>
Reason	<ul style="list-style-type: none"> This paragraph is copied from the proposed revision for <i>Section 3. Grading point 1. General</i>. This information should also appear in the introduction of <i>Section 5. Bridges</i>. SWPPP requirements are applicable to all components of project disturbing greater than 1 acre.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 20 – Sodding, Seeding and Landscaping
Reference Part	General Comment
Proposed Revision	<ul style="list-style-type: none"> General Comment
Reason	<ul style="list-style-type: none"> It is recommended that native Indiana species be used where possible. In the event the Contractor wishes to substitute during seeding, sodding, or landscaping, the INDOT field representative should be aware of acceptable native species for substitution. The potential development of a new document titled INDOT Vegetation Establishment Manual with Indiana Native Species is discussed in the Future Document Needs section of this study.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 27 – Notice of Completed Work
Reference Part	Part 4. Final Acceptance
Proposed Revision	<ul style="list-style-type: none"> Add the following paragraph: <i>For projects that required a Rule 5 permit (327 IAC 15-5), the Contractor shall provide the Department information certifying that all conditions for the NPDES General Permit Rule (327 IAC 15-5) NOT have been satisfied. The Department will apply for the NOT once the information has been provided by the Contractor. The NOT shall be accepted by IDEM prior to final inspection, acceptance, or payment.</i>
Reason	<p>Near the end of a typical INDOT construction project if subject to Rule 5 requirements, the Contractor is to provide information needed to file the NOT. This will primarily include a certification from the Contractor stating that all land disturbing activities have been stabilized, no future land disturbing activities are planned for the project site, and all temporary erosion and sediment control measures have been removed. At this point, INDOT must submit the NOT to the local Soil and Water Conservation District or other the previously designated NOI review entity. The request for termination is then reviewed for concurrence and either returned to the OWNER or sent to IDEM for acceptance. Because the NOT can be returned to the OWNER due to site deficiencies, <u>it is recommended that INDOT consider withholding final payment until the NOT is accepted by IDEM.</u></p>

Document	INDOT General Instructions to Field Employees
Reference Section	Section 40 – Construction Forms and Reports
Reference Part	BMP Inspection Form (New Weekly Form)
Proposed Revision	<ul style="list-style-type: none"> A new standard form should be created for the documentation of BMP inspection. Construction phase temporary erosion and sediment control BMPs should be inspected by the Contractor at a minimum once every 7 days and after rain activities totaling ½ inches of rainfall in a 24 hour period. The Contractor shall keep daily records of a rain gauge installed in an unobstructed area on the project site for measuring daily rainfall accumulation. The daily rainfall totals should be recorded in the project documentation. BMPs that are found to be insufficient or in need of repair should be upgraded or repaired within two days of the inspection.
Reason	<ul style="list-style-type: none"> As mentioned above, the BMP inspection should not only be performed on a weekly basis, but after a ½ daily inch rainfall; therefore, a separate “rainfall event” BMP inspection form may also need to be developed.

Document	INDOT General Instructions to Field Employees
Reference Section	Section 54 – Inspection and Maintenance of Stormwater BMPs (NEW SECTION)
Reference Part	NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Proposed New Section. A new GIFE Section should be developed for the inspection of stormwater BMPs. Both construction phase BMPs for erosion and sediment control and post-construction phase BMPs for long-term stormwater pollution prevention should be inspected on a routine basis once their installation is completed. Although it is the responsibility of the Contractor to inspect, document, and maintain the functionality of these BMPs, the INDOT field personnel should also be qualified to inspect these measures, answer questions the Contractor may have, and ensure proper maintenance is performed.
Reason	<ul style="list-style-type: none"> The BMP Inspection form discussed in Section 40 can also be used by the INDOT Construction Inspector to add to the construction record. An Erosion and Sediment Control Inspector Certification Program would complement this GIFE requirement. The potential development of a new document titled Erosion and Sediment Control Inspection Certification Program is discussed in the Future Document Needs section of this study.

APPENDIX 8

PROCEDURAL MANUAL FOR ENVIRONMENTAL STUDIES AND REVIEW

Introduction

From INDOT's website, the application, purpose, and objective of the Procedural Manual for Preparing Environmental Studies is summarized as:

"This manual applies to all transportation projects developed by the Indiana Department of Transportation (INDOT) and to all local agency highway or local streets and roads projects with funding or approvals by the Federal Highway Administration (FHWA).

The purpose of the "Procedural Manual for Preparing Environmental Studies, August 2003" is to provide assistance with compliance of the National Environmental Policy Act (NEPA) and related federal laws, executive orders, regulations, and policies. The manual is intended for those preparing, reviewing, or sponsoring federally funded highway and related projects.

The objective of the manual is to focus on statutory and regulatory requirements for environmental documents for both local and INDOT projects. The manual sets forth document content and format, as required by law or regulation, and recommended format, if not specified by law or regulation. Reports and documents prepared for projects on the state highway system shall adhere to the content and recommended formats contained herein. In addition, the manual provides a number of tools for the development of the documentation including links to additional information."

The Procedural Manual for Preparing Environmental Studies does not have a numbered table of contents and is divided into categories that discuss pertinent environmental considerations.

There is **one** recommended addition that should be made to this document. Rule 5 permitting considerations should be added to the list of environmental permits. Currently Section 401 Water Quality Act (COE), Section 404 Water Quality Certification (IDEM), and Construction in a Floodway Permit (IDNR) are the only permits currently listed.

APPENDIX 9

SUGGESTED REVISIONS TO INDOT DESIGN MANUALS, STANDARD
SPECIFICATIONS, RECURRING SPECIAL PROVISIONS AND STANDARD
DRAWINGS

December 2005

Comments and Suggested Revisions

**INDOT Design Manuals
INDOT Standard Specifications
INDOT Standard Drawings
INDOT Recurring Special Provisions**

Construction Phase BMP Recommendations

General:

This Section is one part of a comprehensive review of INDOT documentation related to INDOT's Storm Water Quality Master Plan (SWQMP). The comments in this Section are related to Construction Phase Best Management Practices (BMPs).

Documents Covered:

- INDOT Design Manuals
- INDOT Standard Specifications
- INDOT Recurring Special Provisions
- INDOT Standard Drawings

Organization:

Specific recommended revisions and additions to the above listed documents are summarized by BMP as they pertain to individual measures. Some of the recommended BMPs do not require specific revisions to INDOT documents for inclusion within INDOT projects. BMPs that are recommend for use in *constructing, retrofitting, and maintaining INDOT roadways and facilities* are listed in Table 1.

Table 1: Construction Phase BMPs

Construction Phase BMPs	
Bonded Fiber Matrix (BFM Mulch)	
Erosion Control Blanket	
Fiber Wattle Roll Ditch Check	
Grading	
Inlet Protection (Perimeter Barrier)	
Temporary Seeding	
Rock Check Dams	
Sediment Basin	
Sediment Trap	
Sequencing	
Silt Fences	
Soil Roughening	
Straw Bale Ditch Check	
Straw Mulch	
Structural Methods	
Surface Water Diversion	
Turbidity Curtain	
Vehicle Tracking Pads	

Construction Phase BMP Component - Bonded Fiber Matrix (BFM) Mulch

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.02(03) Temporary Seeding and Temporary Mulching
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence as the fourth sentence of the first paragraph: <i>Bonded Fiber Matrix (BFM) is similar to mulching except its use should be considered for areas of steep or sensitive slopes.</i> Modify the beginning of the last paragraph to read “<i>When mulch or BFM.</i>”

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none"> Add the following as new section 205.03(p) Bonded Fiber Matrix (BFM): <i>(p) Bonded Fiber Matrix (BFM). The BFM should be continuous layer of elongated fiber strands held together by a high-grade water-resistant tackifier bonding agent. BFM should be installed so that it adheres directly to the exposed surface and allows no gaps between the product and the soil. It should not form a water-insensitive crust that can inhibit plant growth. The BFM should biodegrade completely into materials known to be beneficial to plant growth. The BFM should not be installed immediately before, during, or after rainfall and shall have a 24-hour precipitation clear period after installation to allow the material to dry.</i> <i>The manufacturer's recommendations shall be followed with regard to shipping, handling, storage, protection, mixing, and installation of the product. Manufacturer's certifications and material samples shall be provided prior to installation.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.06 Method of Measurement
Proposed Revision	<ul style="list-style-type: none"> Modify this section and the method of measurement information:. <i>Bonded fiber matrix (BFM) will be measured by the square meter (square yard) or hectare (acre)</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.07 Basis of Payment
Proposed Revision	<ul style="list-style-type: none"> Modify this section and add the basis of payment information that will be used once construction quantities are accepted. <i>Bonded fiber matrix (BFM) will be paid for by the square meter (square yard) or hectare (acre)</i> Add the following items to the list of pay items: <i>Bonded fiber matrix (BFM).....m²(SYS)</i> <i>Bonded fiber matrix (BFM).....ha (ACRE)</i> Add the following exception under the list of pay items: <i>The cost of mobilization, machinery, batching, application and all necessary incidentals shall be included in the cost of bonded fiber matrix (BFM).</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 621 – SEEDING AND SODDING
Reference Location	621.05 Applying Fertilizer, Seed, and Mulch
Proposed Revision	<ul style="list-style-type: none"> Add the follow mulching method: 6. Method F. <i>The area may be covered in bonded fiber matrix (BFM). This method shall be limited to areas that are excessively steep or are inaccessible for conventional mulching or erosion control blanket installation. See Section 205.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 900 – MATERIALS DETAILS
Reference Location	SECTION 914 – ROADSIDE DEVELOPMENT MATERIALS
Reference Location	914.05 Mulch
Proposed Revision	<ul style="list-style-type: none"> Add the following new section 914.05(a)(6) <i>Bonded Fiber Matrix</i>: <p>6. Bonded Fiber Matrix (BFM) BFM materials shall be made from virgin wood chips blended uniformly with approximately with 10% non-toxic tackifier to form a strong bond with the fiber matrix. The wood chips should be thermally processed to ensure no reduction in seed germination or growth rates. Fertilizer may be added. Any pigmentation used shall be organic and non-toxic. The pH of the applied product shall not cause negative effects on the vegetation or environment.</p> <p>The matrix should be hydraulically applied and limited to areas that are too steep or inaccessible for conventional stabilization methods. Minimum application rates should be 4,480 kg/ha (4,000 lbs/acre) for 1:1 slopes, 3920 kg/ha (3,500 lbs/acre) for slopes between 1:1 and 2:1, and 3,360 kg/ha (3,000 lbs/acre) for 3:1 slopes or flatter. Follow manufacturers batching and installation guidelines.</p> <p>Materials shall remain in factory labeled packages until installation and shall be stored to protect from weather or heat damage.</p> <p>Water content shall be limited to 15% maximum. Limit ash content to 1% maximum. The overall organic content of the system shall be 98% or greater. Do not apply BFM when rainfall is expected within 24 hours of installation.</p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.02 Materials
Proposed Revision	<ul style="list-style-type: none"> Add the following items alphabetically to the list of materials. Add the appropriate section reference number: <p><i>Bonded Fiber Matrix (BFM)</i></p>

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Erosion Control Blanket

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none"> Add the following as new section 205.03(s) Erosion Control Blankets: <p>(s) Erosion Control Blankets. <i>The manufacturer's recommendations shall be followed with regard to shipping, handling, storage, installation, and protection from direct sunlight. The blanket will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, storage, or installation. Each roll shall be labeled or tagged to provide product identification.</i></p> <p><i>The original copies of all necessary current manufacturers' installation manuals shall be provided prior to installation. The blanket shall be anchored and seamed according to manufacturer's recommendations. The blanket must be secured to the ground using staples or other approved method by following the manufacturer's recommended staple pattern based on slope and application.</i></p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.07 Basis of Payment
Proposed Revision	<ul style="list-style-type: none"> Modify this section and add the basis of payment information that will be used once construction quantities are accepted. <p><i>Erosion control blankets will be paid for by the square meter (square yard)</i></p> Add the following items to the list of pay items: <p><i>Erosion control blanket, typem²(SYS)</i></p> Add the following exception under the list of pay items: <p><i>The cost for stapling, anchoring, overlap, and excess material required shall be included in the cost of erosion control blanket.</i></p>

Document	INDOT Standard Specifications
Reference Location	SECTION 900 – MATERIALS DETAILS
Reference Location	SECTION 914 – ROADSIDE DEVELOPMENT MATERIALS
Reference Location	914.09 Miscellaneous Materials
Proposed Revision	<ul style="list-style-type: none"> Add the following text to the end of section 914.09(f) Staples. <p><i>Staples should be installed in accordance with manufacturer's recommended staple patterns. Staple locations should be clearly marked on the mat with paint so the installation can be inspected. The minimum staple requirements shall be met:</i></p> <p> <i>4:1 Slopes – 0.85 staples/m² (0.7 staples/yd²)</i> <i>3:1 Slopes – 1.40 staples/m² (1.15 staples/yd²)</i> <i>2:1 Slopes and Steeper – 2.0 staples/m² (1.7 staples/yd²)</i> <i>Medium/High Flow Channels – 4.1 staples/m² (3.4 staples/yd²)</i> <i>High Flow Channel and Shoreline – 4.5 staples/m² (3.75 staples/yd²)</i> </p>

PART III - INDOT Standard Drawings

Document	INDOT Standard Drawings
Reference Location	Section 200 - Earthwork
Reference Drawing	E 205-TECS-04 (M 205-TECS-04) (Now Unassigned) (NEW DRAWING)
Code Meaning	TECS – Temporary Erosion Control Slope
Drawing Title	Rolled Erosion Control Product Installation (General)
Proposed Revision	<ul style="list-style-type: none"> A new drawing should be created for rolled erosion control blanket installation for slope installations. The drawing should contain information for blanket installation on slopes, along drainage channels, and along shorelines. Seaming, anchoring, and overlapping of the rolls should also be shown. General instructions for all erosion control blanket installations are: <ol style="list-style-type: none"> 1. Prepare the seedbed by raking, seeding and fertilizing. 2. Use trenching and anchoring procedures to secure any exposed material ends. 3. Keep material in direct contact with the ground. 4. Blankets will unroll with appropriate side against soil surface. 5. Use the required number of staples. 6. Secure all material overlaps with the required number and spacing of staples. Seams may also be mechanically sewn according to manufacturer recommendations. 7. In slope and channel applications, overlap material in the direction of water flow. For slope installation applications: <ol style="list-style-type: none"> 1. Prepare soil before installing blankets, including any necessary application of lime, fertilizer, and seed. 2. Anchor the blanket at the top of the slope in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench with a row of staples/stakes approximately 30 cm (12 inches) apart in the bottom of the trench. Leave approximately 30 cm (12 inches) of blanket extended beyond the up-slope portion of the trench. Backfill and compact the trench after stapling and apply seed to compacted soil. Fold remaining 30-cm

	<p>(12-inch) portion of blanket back over and secure blanket with a row of staples/stakes approximately 30 cm (12 inches) apart across the width of the blanket.</p> <ol style="list-style-type: none"> Roll the blankets down or horizontally across the slope. Securely fasten blankets to soil surface with staples/stakes as shown in the staple pattern guide. Staple the edges of parallel blankets with 5 to 12.5 cm (2 to 5 inches) of overlap depending on blanket type. Place consecutive blankets spliced down the slope end over end (shingle style) with an approximate 7.5-cm (3-inch) overlap. Staple through overlapped area, approximately 30 cm (12 inches) apart across entire blanket width. <ul style="list-style-type: none"> For drainage channel installation applications: <ol style="list-style-type: none"> Prepare soil before installing blankets, including any necessary application of lime, fertilizer, and seed. Anchor the blanket at the top of the slope in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench with a row of staples/stakes approximately 30 cm (12 inches) apart in the bottom of the trench. Leave approximately 30 cm (12 inches) of blanket extended beyond the up-slope portion of the trench. Backfill and compact the trench after stapling and apply seed to compacted soil. Fold remaining 30-cm (12-inch) portion of blanket back over and secure blanket with a row of staples/stakes approximately 30 cm (12 inches) apart across the width of the blanket. Unroll center blanket in direction of water flow on bottom of channel. Securely fasten blankets to soil surface with staples/stakes as shown in the staple pattern guide. Place blankets end over end (shingle style) with a 10 to 15 cm (4 to 6 inch) overlap. Secure blankets with a double row of staples staggered 10 cm (4 inches) apart and 10 cm (4 inches) on center. Anchor full-length edge of blankets at top of side slopes with a row of staples/stakes approximately 30 cm (12 inches) apart in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench. Backfill and compact the trench after stapling. Overlap adjacent blankets 5 to 12.5 cm (2 to 5 inches) (depending on blanket type) and staple. In high-flow channel applications, a staple check slot is recommended at 9 to 12 m (30 to 40 foot) intervals using a double row of staples staggered 10 cm (4 inches) apart and 10 cm (4 inches) on center over entire width of channel. Anchor the terminal end of the blankets with a row of staples/stakes approximately 30 cm (12 inches) apart in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench. Backfill and compact the trench after stapling. For shoreline installation applications: <ol style="list-style-type: none"> For easier installation, lower water before installation. Prepare soil before installing blankets, including any necessary application of lime, fertilizer, and seed. Anchor the blanket at the top of the shoreline in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench with a row of staples/stakes approximately 30 cm (12 inches) apart in the bottom of the trench. Leave approximately 30 cm (12 inches) of blanket extended beyond the up-slope portion of the trench. Backfill and compact the trench after stapling and apply seed to compacted soil. Fold remaining 30-cm (12-inch) portion of blanket back over and secure blanket with a row of staples/stakes approximately 30 cm (12 inches) apart across the width of the blanket. Roll blankets either down the shoreline for long banks, or horizontally across the shoreline slope. Securely fasten blanket to soil surface with staples/stakes as shown in the staple pattern guide. Place horizontal and vertical blanket seams shingle style in the direction of predominant erosive action with a 5 to 12.5 cm (2 to 5 inch) overlap. Secure all overlaps with a row of staples spaced approximately 30 cm (12 inches) apart.
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	<p>6. Anchor the edge of the blanket at or below normal water level in a 30-cm (12-inch) deep by 15-cm (6-inch) wide trench with a row of staples/stakes spaced approximately 30 cm (12 inches) apart. Backfill and compact the trench after stapling (stone or soil may be used as backfill).</p> <ul style="list-style-type: none"> The following notes should be added for all installations: <i>"For installation in loose soil, the staple length requirements of 914.09(f) shall be increased to the length required to secure the blanket."</i> The following notes should be added for all installations along drainage channel and shorelines: <i>"For perennial streams with observable baseflow, the erosion control blanket extent below the waterline shall be limited to that length which is required for anchoring the mat."</i>
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Document	INDOT Standard Drawings
Reference Location	Section 200 - Earthwork
Reference Drawing	(NEW DRAWING)
Code Meaning	Needs Code Assigned
Drawing Title	Erosion Control Blanket Staple Patterns
Proposed Revision	<ul style="list-style-type: none"> A new drawing should be created to recommend minimum staple patterns for rolled erosion control blankets. Rolled erosion control blankets come in many roll widths. Common rolls widths include 4-, 6.67-, 8-, 13.5-, and 16-feet. The standard rolls width will vary by manufacturer. The following staple densities are recommended based on application of the erosion control mat: <ul style="list-style-type: none"> 4:1 Slopes – 0.85 staples/m² (0.7 staples/yd²) 3:1 Slopes – 1.40 staples/m² (1.15 staples/yd²) 2:1 Slopes and Steeper – 2.0 staples/m² (1.7 staples/yd²) Medium/High Flow Channels – 4.1 staples/m² (3.4 staples/yd²) High Flow Channel and Shoreline – 4.5 staples/m² (3.75 staples/yd²) Drawings should also be created to show this staple spacing and the approximate location to stitch blanket seams if mechanically sewing is to be used.

Document	INDOT Standard Specifications
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.06 Method of Measurement
Proposed Revision	<ul style="list-style-type: none"> Modify this section and the method of measurement information: <p><i>Erosion control blankets will be measured by the square meter (square yard)</i></p>

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Fiber Wattle Roll Ditch Check

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.03(01) Check Dams
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence to the end of the paragraph: <i>Within the construction clear zone, straw bales, fiber wattle rolls, or other approved means, should be used instead of riprap.</i>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none"> Modify 205.03(c) about check dams to state: (c) Check Dams. Check dams shall at a minimum be constructed of revetment riprap or fiber wattle rolls as shown on the Standard Drawings. Additional check dam construction requirements may be shown on the plans. Add the following as section 205.03(c)(3) as fiber wattle roll ditch checks: 3. Fiber Wattle Roll. Fiber wattle rolls shall be embedded and staked as shown on the plans. At a minimum, the fiber wattle rolls must extend across the full width of the swale or ditch. The bottom elevation of the end wattle rolls shall be a minimum of 6 inches above the top elevation of the lowest wattle roll. The ditch checks shall be spaced at intervals such that the top of the downstream check is at the same elevation as the toe invert of the adjacent upstream check. Place wattle rolls such that gaps between adjacent rolls are eliminated.

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.06 Method of Measurement
Proposed Revision	<ul style="list-style-type: none"> Modify this section and the method of measurement information: <i>Fiber wattle roll check dams will be measured by the meter (linear foot)</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.07 Basis of Payment
Proposed Revision	<ul style="list-style-type: none"> Modify this section and add the basis of payment information that will be used once construction quantities are accepted. <i>Fiber wattle roll check dams will be paid for by the meter (linear foot)</i> Add the following items to the list of pay items: <i>Temporary Check Dam, Fiber Wattle Roll.....m(LFT)</i> Add the following exception under the list of pay items: Modify the note in the third to last paragraph about check dams under the list of pay items to include <i>temporary check dam, fiber wattle roll</i> and include <u>geotextile</u> on the list of materials included in the cost of the pay item.

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.02 Materials
Proposed Revision	<ul style="list-style-type: none"> Add the following items alphabetically to the list of materials. Add the appropriate section reference number: <i>Fiber Wattle Roll</i> <i>Geotextile Under Fiber Wattle Roll</i>

PART III - INDOT Standard Drawings

Document	INDOT Standard Drawings
Reference Location	Section 200 - Earthwork
Reference Drawing	E 205-TECD-03 (M 205-TECD-03) (Now Unassigned) (NEW DRAWING)
Code Meaning	TECD – Temporary Erosion Control Ditch
Drawing Title	Temporary Check Dam, Fiber Wattle Roll
Proposed Revision	<ul style="list-style-type: none"> A new drawing should be created for fiber wattle rolls used as temporary ditch check dams. The drawing will be similar to the details for the straw bale temporary check dam. This drawing should contain the following information either as written text or shown on the drawing: <ul style="list-style-type: none"> Embed the wattle a minimum of 4 inches. The ends of adjacent wattles should be tightly abutted or overlapped 6 inches so that no opening exists for water or sediment to pass through. Wooden stakes should be placed 6 inches from the wattle end and angled towards the adjacent wattle. Space stakes 4 feet on center and drive flush where soil conditions permit. Wattles may not be stacked. The standard wattle size should be 12 inches in diameter. The wattle should be placed such that the top of the downstream wattle is at the elevation of the bottom of the next upstream wattle. Similar to straw bales, two rows of wattles should be used. Joints must be staggered. Wattle should be tied down as needed to offset the effects of buoyancy. Geotextile mat may be installed downstream of the mat for scour protection. Install the geotextile beneath the wattles and extend it to the upstream side. The size of the geotextile mat should vary depending on the width of the swale or ditch. Alternatively, similar to the straw bale detail, a 6-foot 6-inch by 6-foot 6-inch mat could be shown. Secure the mat downstream of the wattles with staples or wooden stakes placed 3 feet on center. Add the following text as a general note: <p><i>Fiber wattle rolls must extend across the full width of the swale or ditch. The bottom elevation of the end wattle shall be a minimum of 6 inches above the top elevation of the wattle. The ditch checks shall be spaced at intervals such that the top of the downstream check is at the same elevation as the toe invert of the adjacent upstream check.</i></p>

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component – Grading

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Inlet Protection (Perimeter Barrier)

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component – Temporary Seeding

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 212 – STOCKPILED SELECTED MATERIALS
Reference Location	212.03 Construction Requirements
Proposed Revision	<ul style="list-style-type: none"> Add the following paragraph within the section: <i>All selected material stockpiles containing earthen or other erodible materials shall be contained and stabilized. At a minimum, the stockpile shall be surrounded with silt fence perimeter protection for sediment containment. If the selected material is topsoil, vegetation scalpings, or other medium suitable for growing vegetation, the stockpile shall receive temporary seeding within 14 days of inactivity. Locate an access point on the upslope side of the stockpile area. Place stockpiles as far as possible from existing waterbodies as site conditions allow. See Section 205.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 203 – EXCAVATION AND EMBANKMENT
Reference Location	203.08 Borrow or Disposal
Proposed Revision	<ul style="list-style-type: none"> Add the following text as the second sentence in the third to the last paragraph regarding the stripping and stockpiling of topsoil in borrow areas: <i>All topsoil stockpiles shall be placed as far away from existing waterbodies as site conditions allow. The stockpile shall be surrounded with temporary silt fence perimeter protection and stabilized with temporary seed and straw mulch.</i>

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Rock Check Dams

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Sediment Basin

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.01(04) Sediment Basin
Proposed Revision	<ul style="list-style-type: none">• Change “<i>about</i>” in the second sentence of the second paragraph to read “<i>at least</i>.”• Amend the fifth sentence of the second paragraph as follows: <i>... minimum water volume equal to the watershed runoff volume resulting from a 2-year, 24-hour storm event. Alternately, in the absence of such a hydrologic calculation, the designer should provide a minimum water volume of 252 m³/ha (3600 ft³/acre) for the watershed tributary to the basin. If the sizing of the sediment basin is reduced due to space limitations, other measures shall be designed to account for the reduced capacity of the measure.</i>

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Sediment Trap

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.01(03) Sediment Trap
Proposed Revision	<ul style="list-style-type: none">• Add the following sentence as the third sentence of the second paragraph: <i>If the sizing of the sediment trap is reduced due to space limitations, other measures shall be designed to account for the reduced capacity of the measure.</i>

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component – Sequencing

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.06 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> • Add the following section: <p><u>37-3.06 Wind Erosion</u></p> <p><i>Measures to prevent erosion and sedimentation resulting from wind should be a consideration during construction sequencing and construction operations. These measures include soil roughening and perimeter barriers. Water trucks may be required to control excessive dust on construction sites. Wind erosion control measures should be specified by the designer.</i></p> <p><i>Perimeter Barrier</i></p> <p><i>Construction projects should be phased to make use of natural wind barriers where they exist. When possible tree and brush lines should be maintained. Where tree and brush lines are designated for removal, construction sequencing of such should aim to reduce exposure of the site to wind erosion.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-4.0 NEW SECTION
Proposed Revision	<p><u>37-4.0 CONSTRUCTION SEQUENCING</u></p> <p><u>37-4.1 Construction Sequencing</u></p> <p><i>The designer of the Stormwater Pollution Prevention Plan should indicate on the plans the anticipated sequence of activities describing implementation of stormwater quality measures relative to land disturbing activities. Changes to the proposed sequencing shown on the plans made the Contractor to match actual means, methods, and equipment would be the responsibility of the Contractor. These changes shall be submitted to and approved by the appropriate permitting authority.</i></p>

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Silt Fences

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

Document	INDOT Standard Specifications
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 212 – STOCKPILED SELECTED MATERIALS
Reference Location	212.03 Construction Requirements
Proposed Revision	<ul style="list-style-type: none"> Add the following paragraph within the section: <p><i>All selected material stockpiles containing earthen or other erodible materials shall be contained and stabilized. At a minimum, the stockpile shall be surrounded with silt fence perimeter protection for sediment containment. If the selected material is topsoil, vegetation scalplings, or other medium suitable for growing vegetation, the stockpile shall receive temporary seeding within 14 days of inactivity. Locate an access point on the upslope side of the stockpile area. Place stockpiles as far as possible from existing waterbodies as site conditions allow. See Section 205.</i></p>

Document	INDOT Standard Specifications
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 201 – CLEARING AND GRUBBING
Reference Location	201.02 General (Construction Requirements)
Proposed Revision	<ul style="list-style-type: none"> Add the following text as the third sentence: <p><i>Erosion and sediment control measures (perimeter protection) shall be installed prior to initiating land disturbance, including clearing and grubbing operations.</i></p>

Document	INDOT Standard Specifications
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 203 – EXCAVATION AND EMBANKMENT
Reference Location	203.08 Borrow or Disposal
Proposed Revision	<ul style="list-style-type: none"> Add the following text as the second sentence in the third to the last paragraph regarding the stripping and stockpiling of topsoil in borrow areas: <p><i>All topsoil stockpiles shall be placed as far away from existing waterbodies as site conditions allow. The stockpile shall be surrounded with temporary silt fence perimeter protection and stabilized with temporary seed and straw mulch.</i></p>

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Soil Roughening

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.06 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Add the following section: <p><u>37-3.06 Wind Erosion</u></p> <p><i>Measures to prevent erosion and sedimentation resulting from wind should be a consideration during construction sequencing and construction operations. These measures include soil roughening and perimeter barriers. Water trucks may be required to control excessive dust on construction sites. Wind erosion control measures should be specified by the designer.</i></p> <p><u>Soil Roughening</u></p> <p><i>Exposed surfaces or the finished surface should be track-walked up and down the slope with a dozer or other tracked equipment, rather than left completely smooth. Track-walking should not be performed parallel to the contour, as this would actually increase erosion.</i></p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 203 – EXCAVATION AND EMBANKMENT
Reference Location	203.09 General Requirements (Construction Requirements)
Proposed Revision	<ul style="list-style-type: none"> In the first sentence of the fourth to the last paragraph regarding soil roughening, the series of ridges and depressions should be created “<i>parallel to the contour</i>” instead of parallel to the roadway.

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Straw Bale Ditch Check

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.03(01) Check Dams
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence to the end of the paragraph: <i>Within the construction clear zone, straw bales, fiber wattle rolls, or other approved means, shall be used instead of riprap.</i>

Document	INDOT Standard Drawings
Reference Location	Section 200 - Earthwork
Reference Drawing	E 205-TECD-02 (M 205-TECD-02)
Code Meaning	TECD – Temporary Erosion Control Ditch
Drawing Title	Temporary Check Dam, Straw Bales
Proposed Revision	<ul style="list-style-type: none"> Revise the notes on this drawing to state (general note and drawing note): <i>Straw bales must extend across the full width of the swale or ditch. The bottom elevation of the end bale shall be a minimum of 6 inches above the top elevation of the lowest bale. The ditch checks shall be spaced at intervals such that the top of the downstream check is at the same elevation as the toe invert of the adjacent upstream check.</i>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none"> Modify 205.03(c) about check dams to state: (c) Check Dams. Check dams shall at a minimum be constructed of revetment riprap or straw bales as shown on the Standard Drawings. Additional check dam construction requirements may be shown on the plans. Modify 205.03(c)(2) about straw bales ditch checks to state the following: 2. Straw Bales. Straw bales shall be embedded and staked as shown on the plans. At a minimum, the bales must extend across the full width of the swale or ditch. The bottom elevation of the end bale shall be a minimum of 6 inches above the top elevation of the lowest bale. The ditch checks shall be spaced at intervals such that the top of the downstream check is at the same elevation as the toe invert of the adjacent upstream check. Adjacent bales shall be chinked to eliminate gaps between the bales. Bales shall be placed such that the bindings are parallel to and not in contact with the ground.

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.07 Basis of Payment
Proposed Revision	<ul style="list-style-type: none">Modify the note in the third to last paragraph about check dams under the list of pay items to include <i>temporary check dam</i>, <i>straw bales</i> and include <u>geotextile</u> on the list of materials included in the cost of the pay item.

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Straw Mulch

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Structural Methods

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Surface Water Diversion

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Turbidity Curtain

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.01 Protection of Adjacent Areas
Proposed Revision	<ul style="list-style-type: none"> Add “<i>turbidity curtain barriers</i>” to the end of the first paragraph.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.01(05)
Proposed Revision	<ul style="list-style-type: none"> Add the following sections: <p>37-3.01(05) Turbidity Curtain Barriers</p> <p><i>The purpose of a turbidity curtain is to prevent the flow and/or washing of disturbed debris into a water source: stream, river, pool, lake or reservoir. In essence, a turbidity curtain is a floating silt fence. Turbidity curtains are manufactured to specification. The variables involved in determining such specifications are: water flow rate, depth of channel to be crossed or controlled, desired filtering properties of the geotextile curtain, tide action (if any), and the length of time the curtain is to be utilized.</i></p> <p><i>A turbidity curtain should not be used as a dam. It will not “hold back” the water flow of a river or stream, but it will control the amount of clouding and silt migration that is caused by construction.</i></p> <p><i>Turbidity curtain barriers are useful when working on the bank of an existing waterbody or in the rarer instance where the proposed work encroaches into the waterbody.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.04(03) NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Add the following section: <p>37-3.04(03) Turbidity Curtain Barriers Alongside Streams</p> <p><i>When a pond, lake, or perennial stream is adjacent to an exposed fill slope and it is necessary to work within the stream itself, the stream should be protected from sediment by the use of a turbidity curtain barriers alongside the stream as described in Section 37-3.01(05).</i></p>

Document	INDOT Standard Drawings
Reference Location	Section 200 - Earthwork
Reference Drawing	E 205-TECP-03 (M 205-TECP-03) (Now Unassigned) (NEW DRAWING)
Code Meaning	TECP – Temporary Erosion Control Perimeter
Drawing Title	Temporary Turbidity Curtain (Silt Boom), Flowing Water
Proposed Revision	<ul style="list-style-type: none"> A new drawing should be created for a temporary turbidity curtain (silt boom). This drawing should contain three types of installation configurations and the following details: <ul style="list-style-type: none"> Type I configuration for protected areas where there is no current and the area enclosed by the turbidity curtain is protected from wind and wave action Type II configuration for areas with mild wind or wave action or where a slow to medium current (less than 3.5 feet per second) is expected Type III configuration for areas that will potentially be subjected to significant wind or wave action or where a considerable current (up to 5 feet per second) is expected A section view of the turbidity curtain installation showing the curtain, end points, external stakes or anchors (as recommended by manufacturer), buoys, and flashing warning lights as necessary (for navigable waters). This detail may also contain the material specifications for the curtain fabric and the floatation devices. Strength requirements of seams, load lines, and external anchors may also be included.

Document	INDOT Standard Specifications
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 108 – PROSECUTION AND PROGRESS
Reference Location	108.04 Prosecution of Work
Proposed Revision	<ul style="list-style-type: none"> Modify point (a) in the eleventh paragraph to read: <p>(a) When work areas are located in or adjacent to bodies of water, a turbidity curtain (silt boom) or other comparable sediment control measure should be used. If site conditions prevent the use of a turbidity curtain (silt boom), such areas shall be separated by a dike or other acceptable barrier to keep sediment contained. Sediment disturbance of these bodies of water shall be minimized during the construction and removal of such barriers.</p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 202 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS
Reference Location	202.03 Removal of Bridges, Culverts, and Other Drainage Structures
Proposed Revision	<ul style="list-style-type: none"> Add the following text as paragraph two: <i>When work areas are located in or adjacent to bodies of water, a turbidity curtain (silt boom) or other comparable sediment control measure should be used. If site conditions prevent the use of a turbidity curtain (silt boom), such areas shall be separated by a dike or other barrier to keep contained. Sediment disturbance of these bodies of water shall be minimized during the construction and removal of such barriers.</i>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none"> Add the following as new section 205.03(o) Turbidity Curtain (Silt Boom): (o) Turbidity Curtain (Silt Boom). <i>The manufacturer's recommendations shall be followed with regard to shipping, handling, storage, installation, and protection from direct sunlight. The geotextile will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacturing, transportation, storage, or installation. Each roll shall be labeled or tagged to provide product identification.</i> <i>Seaming of the floating curtain shall be completed to develop the full strength of the product. External or bottom anchors shall be installed as recommended by the manufacturer. The curtain shall be a bright color and should be installed parallel to the direction of flow.</i> <i>The original copies of all necessary current manufacturers' installation manuals shall be provided prior to installation.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.06 Method of Measurement
Proposed Revision	<ul style="list-style-type: none"> Modify this section and the method of measurement information: <i>Turbidity curtains (silt booms) will be measured by the meter (linear foot)</i>

Document	INDOT Standard Specifications
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.07 Basis of Payment
Proposed Revision	<ul style="list-style-type: none"> Modify this section and add the basis of payment information that will be used once construction quantities are accepted. <i>Turbidity curtains (silt booms) will be paid for by the meter (linear foot)</i> Add the following items to the list of pay items: <i>Temporary Turbidity Curtains (silt booms).....m (LFT)</i> Add the following exception under the list of pay items: <i>The cost of seaming, stakes, posts, anchors and all necessary incidentals for the construction and removal of turbidity curtains (silt booms) shall be included in the cost of the turbidity curtains (silt booms).</i>

Document	INDOT Standard Specifications
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 206 – STRUCTURE EXCAVATION
Reference Location	206.09 Cofferdams and Temporary Construction Dikes
Proposed Revision	<ul style="list-style-type: none"> Add the following text as the second paragraph: <i>When in-channel sediment control measures have not been specified by the plans, they must be included in the amended SWPPP required under Section 108.03. Appropriate in-channel control measures, such as a turbidity curtain (silt boom) Section 205.03(o) shall be used.</i>

Document	INDOT Standard Specifications
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 206 – STRUCTURE EXCAVATION
Reference Location	206.11 Basis of Payment
Proposed Revision	<ul style="list-style-type: none"> Add the following text within the section: <i>If turbidity curtains are required, they shall be paid for at a contract unit price according to Section 205.07. If no contract unit price has been established for this item, the Contractor shall promptly provide a proposed contract unit price to include all costs related to labor, material, overhead and profit prior to implement the turbidity curtain. The Contractor shall not install the turbidity curtain, nor perform any work in the area to be protected by the turbidity curtain, until a contract unit price has been negotiated for this item.</i>

Document	INDOT Standard Specifications																															
Reference Location	SECTION 900 – MATERIALS DETAILS																															
Reference Location	SECTION 918 – SOIL FABRICS																															
Reference Location	918.06 – TURBIDITY CURTAIN (SILT BOOM)																															
Proposed Revision	<ul style="list-style-type: none">• Add the following new section: <p>918.06 Turbidity Curtain. Turbidity curtains (silt boom) should be constructed by the manufacturers for site specific conditions based on the water flow rate, depth of channel to be crossed or controlled, desired filtering properties of the geotextile curtain, tide action (if any),and the length of time the curtain is to be utilized.</p> <p>The turbidity curtain shall be in accordance with the requirements for the components specified as follows:</p> <p>(a) Geotextile. The geotextile shall meet the minimum physical requirements for shown in the table below. Geotextile may be polymer impregnated to negate permittivity and opening size requirements. Hemmed pockets shall be sewn or heat bonded for flotation devices and bottom weights. Panel ends shall have metal grommets placed through a reinforced hem. Connections between panels shall be tightly tied with synthetic or wire rope to prevent flow through the joint.</p> <table><tr><th>TEST</th><th>METHOD</th><th>REQUIREMENTS</th></tr><tr><td>Tensile Strength</td><td>Grab Tensile Strength ASTM D 4632</td><td>1200 N (270 lbs)</td></tr><tr><td>Elongation</td><td>Grab Tensile Strength ASTM D 4632</td><td>25%</td></tr><tr><td>Seam Strength</td><td>Grab Tensile Strength ASTM D 4632</td><td>1070 N (240 lbs)</td></tr><tr><td>Bursting Strength</td><td>Mullen Burst ASTM D 3786</td><td>2.76 MPa (400 psi)</td></tr><tr><td>Puncture Strength</td><td>ASTM D 4833</td><td>445 N (100 lbs)</td></tr><tr><td>Trapezoid Tear</td><td>ASTM D 4533</td><td>445 N (100 lbs)</td></tr><tr><td>Ultraviolet Degradation At 150 h</td><td>ASTM D 4355</td><td>70% strength retained</td></tr><tr><td>Apparent Opening Size (AOS)</td><td>ASTM D 4751</td><td>0.50 mm</td></tr><tr><td>Permeability</td><td>ASTM D 4491 (Permittivity)</td><td>0.6 s⁻¹ (max)</td></tr></table> <p>(b) Flotation. Flotation devices shall be closed-cell polystyrene. The buoyancy (volume) required will depend upon site conditions; however, sufficient freeboard shall be provided to prevent overtopping.</p> <p>(c) Stakes. Stakes, when used to assist in maintaining alignment of the curtain, shall be hardwood or steel with sufficient length and cross-section to support the curtain. External supports may be used; however, embedment depth shall not be less than 1.5 feet.</p> <p>(d) Hardware. All hardware such as stakes, ballast chain, connection bolts, reinforcement plates, and tension cables shall be galvanized, stainless steel, aluminum, or otherwise corrosion resistant. The ballast chain shall have sufficient mass to maintain the geosynthetic in a vertical position, but shall not be less than 0.7 lb/ft.</p>		TEST	METHOD	REQUIREMENTS	Tensile Strength	Grab Tensile Strength ASTM D 4632	1200 N (270 lbs)	Elongation	Grab Tensile Strength ASTM D 4632	25%	Seam Strength	Grab Tensile Strength ASTM D 4632	1070 N (240 lbs)	Bursting Strength	Mullen Burst ASTM D 3786	2.76 MPa (400 psi)	Puncture Strength	ASTM D 4833	445 N (100 lbs)	Trapezoid Tear	ASTM D 4533	445 N (100 lbs)	Ultraviolet Degradation At 150 h	ASTM D 4355	70% strength retained	Apparent Opening Size (AOS)	ASTM D 4751	0.50 mm	Permeability	ASTM D 4491 (Permittivity)	0.6 s ⁻¹ (max)
	TEST	METHOD	REQUIREMENTS																													
	Tensile Strength	Grab Tensile Strength ASTM D 4632	1200 N (270 lbs)																													
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	Apparent Opening Size (AOS)	ASTM D 4751	0.50 mm																													
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Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.02 Materials
Proposed Revision	<ul style="list-style-type: none">• Add the following items alphabetically to the list of materials. Add the appropriate section reference number: <i>Turbidity Curtain (Silt Boom)</i>

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Construction Phase BMP Component - Vehicle Tracking Pads

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.01 Protection of Adjacent Areas
Proposed Revision	<ul style="list-style-type: none"> Add “<i>vehicle tracking pads</i>” to the end of the first paragraph.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-3.01(06) NEW SECTIONS
Proposed Revision	<ul style="list-style-type: none"> Add the following sections: <p>37-3.01(06) Vehicle Tracking Pad</p> <p><i>A vehicle tracking pad may be necessary at construction access locations to reduce the amount of mud transported off-site by vehicles. The pad shall be a minimum of 50 feet long. A geotextile fabric should be used under the riprap, uniform B to minimize the migration of stone into the underlying soil by heavy vehicle loads.</i></p>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none"> Add the following as new section 205.03(q) Vehicle Tracking Pad: <p>(q) Vehicle Tracking Pad. <i>Vehicle tracking pads shall be constructed of riprap, uniform B as shown on the plans.</i></p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.06 Method of Measurement
Proposed Revision	<ul style="list-style-type: none"> Modify this section and the method of measurement information: <p><i>Vehicle tracking pad will be measured per megagram (ton) for each type of aggregate used.</i></p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.07 Basis of Payment
Proposed Revision	<ul style="list-style-type: none"> Modify this section and add the basis of payment information that will be used once construction quantities are accepted. <i>Coarse aggregate for vehicle tracking pad will be paid for per megagram (ton) for each type of aggregate used.</i> Add the following items to the list of pay items: <i>Riprap, Uniform B, for vehicle tracking pad.....Mg(TON)</i> Add the following exception under the list of pay items: <i>The cost of geotextile shall be included in the cost of the vehicle tracking pad.</i>

PART III - INDOT Standard Drawings

Document	INDOT Standard Drawings
Reference Location	Section 200 - Earthwork
Reference Drawing	(NEW DRAWING)
Code Meaning	Needs Code Assigned
Drawing Title	Vehicle Tracking Pad
Proposed Revision	<ul style="list-style-type: none"> A new drawing should be created for a vehicle tracking pad. A vehicle tracking pad is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles. A vehicle tracking pad is sediment control in the form of soil tracking control. This drawing should contain the following details: <ul style="list-style-type: none"> Vehicle tracking pads are constructed of aggregate. It is recommended the construction entrance consist of 6 inches of INDOT riprap, uniform B placed over 6 inches of crushed INDOT No. 53 stone. A note should be added to state: <i>"If INDOT riprap, uniform B is not available locally, INDOT No. 2 stone may be substituted. Additional sediment tracking control measures may be needed due to reduction of aggregate size."</i> The aggregate should be placed over a geotextile fabric. The minimum dimensions of the construction entrance should be 50 feet long by 20 feet wide. Appropriate turning radii should be included at the roadway access points. Additional width may be required to allow for the passing of vehicles. A note should be added to state: <i>"Periodic dressing of the top layer with additional aggregate may be required."</i> A note should be added to state: <i>"Additional sediment tracking control measures should be added as required to prevent the tracking of mud or dirt onto the roadway. Such measures may include tire washes, rumble racks constructed of steel panels with ridges, street sweeping, or vacuuming."</i> A note should be added to state: <i>"Add drainage pipes beneath the temporary construction entrance as needed to maintain ditch or other cross-flow drainage."</i>

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Recommendations

General:

This Section is one part of a comprehensive review of INDOT documentation related to INDOT's Storm Water Quality Master Plan (SWQMP). The comments in this Section are related to Post -Construction Phase Best Management Practices (BMPs).

Documents Covered:

- INDOT Design Manuals
- INDOT Standard Specifications
- INDOT Recurring Special Provisions
- INDOT Standard Drawings

Organization:

Specific recommended revisions and additions to the above listed documents are summarized by BMP as they pertain to individual measures. Some of the recommended BMPs do not require specific revisions to INDOT documents for inclusion within INDOT projects. BMPs that are recommended for use at *INDOT roadways and facilities* for the Post-Construction Phase are listed in Table 1.

Table 1: Post - Construction Phase BMPs

Post - Construction Phase BMPs
Bioretention
Filter Strip
Infiltration Basin
Infiltration Trench
Native Seeding (Permanent)
Riprap
Storage Facility - Dry Pond
Storage Facility - Extended Detention Pond
Storage Facility - Wet Pond
Stormwater Wetland (Native Vegetation)
Turf Reinforcement Mat (TRM)
Water Quality Dry Swale
Water Quality Structures (Hydrodynamic Separators)
Water Quality Wet Swale

Post-Construction Phase BMP Component - Bioretention

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> $I = \text{percent of impervious cover (\%)}$ <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_vA}{12}$ <p>Where : (29-12.3)</p> $P = \text{rainfall in inches (use 1.0 inches for the water quality storm in Indiana)}$ $R_v = \text{volumetric runoff coefficient}$ $A = \text{total drainage area (acres)}$ <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Filter Strip

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Infiltration Basin

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> $I = \text{percent of impervious cover (\%)}$ <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_v A}{12}$ <p>Where : (29-12.3)</p> $P = \text{rainfall in inches (use 1.0 inches for the water quality storm in Indiana)}$ $R_v = \text{volumetric runoff coefficient}$ $A = \text{total drainage area (acres)}$ <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Infiltration Trench

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> $I = \text{percent of impervious cover (\%)}$ <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_v A}{12}$ <p>Where : (29-12.3)</p> $P = \text{rainfall in inches (use 1.0 inches for the water quality storm in Indiana)}$ $R_v = \text{volumetric runoff coefficient}$ $A = \text{total drainage area (acres)}$ <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Treatment Rate Calculation</p> <p>The peak rate of discharge for the water quality design storm is needed for the sizing of off-line diversion structures, such as sand filters, infiltration trenches, and hydrodynamic separators.</p> <p>The following procedure can be used to estimate peak discharges for small storm events. It relies on the Water Quality Volume and the simplified peak flow estimating method above. A brief description of the calculation procedure is presented below.</p> <p>(Step 1): Using Q_{wv}, a corresponding Water Quality Curve Number (CN_{wq}) is computed utilizing the following equation:</p> $CN_{wq} = 1000 / \left[10 + 5P + 10Q_{wv} - 10 \left(Q_{wv}^2 + 1.25Q_{wv}P \right)^{\frac{1}{2}} \right]$ <p>Where : (29.12.5)</p> <p>P = rainfall in inches (use 1.0 inches for the water quality storm in Indiana)</p> <p>Q_{wv} = water quality volume in inches</p> <p>Figure 29-12A, Water Quality Curve Number for percentage of impervious cover, provides a graphical solution of Equation 29-12.5, which can be used to determine CN_{wq}.</p> <p>(Step 2) Once a CN_{wq} is determined, the time of concentration (t_c) is computed (based on the methods described in Section 29-7.0).</p> <p>(Step 3) Using the computed CN_{wq}, t_c, and drainage area (A), the Water Quality Treatment Rate (Q_{wq}) for the water quality storm event is computed using TR-20, HEC-1, HEC-HMS, or other hydrograph oriented procedure. Use SCS Type II rainfall distribution and a rainfall depth of 1.0 inches.</p> <p>When peak runoff calculations are performed using the Rational Method, the water quality treatment rate should be equal to the peak runoff rate from the 5 year recurrence interval storm event.</p> <p>The designer should remember that the water quality volume and the water quality treatment rate are based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Native Seeding (Permanent)

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 621 – SEEDING AND SODDING
Reference Location	621.06 Seed Mixtures
Proposed Revision	<ul style="list-style-type: none"> • In some cases, specific seed mixtures are developed for the seeding of TRM. However, the current INDOT Type D seed mixture may be acceptable for TRM applications, particularly in ditch or channel situations. INDOT should review the seed available seed mixtures for TRM applications. • INDOT may want to consider the addition of a conservation seed mixture (wildflowers or color mix) to its standard seed mixtures. • INDOT should consider warm season versus cool season seed mixtures. They may also want to review all seed mixtures for their location specific applicability for upland versus lowland areas, sandy versus clayey soils, etc. • INDOT should perform a review of all their seed mixtures and vegetation recommendations to ensure that species known to be noxious or invasive in the State of Indiana (such as crown vetch) are not recommended. • INDOT should develop a recommended wetlands seed mixture and add it to the Standard Specifications as a potential seeding type. A performance specification should also be included in this seeding requirement.

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Riprap

PART I - INDOT Design Manuals

No Recommended Revisions

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

Document	<i>INDOT Recurring Special Provisions</i>
Reference Location	SECTION 600 Incidental Construction
Reference Location	621-X-XXX (NEW RECURRING SPECIAL PROVISION)
Proposed Revision	<ul style="list-style-type: none">• Vegetation of Revetment Riprap <p>This special provision should be created by INDOT staff. Native tree vegetation should be recommended in the form of live tree staking. This practice should only be used in drainage channels if the reduced velocity caused by the vegetation has been considered in the design. This special provision may be considered for use in areas where riprap is proposed for toe protection or bank stabilization.</p>

Post-Construction Phase BMP Component - Storage Facility - Dry Pond

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-4.05 Outlet Works
Proposed Revision	<ul style="list-style-type: none">• Add the following paragraph at the end of section 35-4.05: <i>Multiple stage outlet works are recommended for wet and dry ponds that will be used as stormwater BMPs. Multiple stage outlets should generally take the form of one or more low flow orifice outlets with a secondary high-flow pipe. INDOT discourages the use of riser pipes. An emergency spillway is also required. The orifice should be sized for the baseflow. Where baseflow can not be determined, 0.1 cubic feet per second per acre of contributing drainage area may be used as a general guide. However, if the orifice size required is calculated to be less than 4 inches in diameter, a single 4-inch diameter orifice opening shall be installed. In no case shall the orifice diameter be smaller than 100 mm (4 inch) without prior approval due to maintenance concerns.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-4.06 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Add the following as Section 35-4.06: <p><u>35-4.06 Water Quality Design Requirements</u></p> <p><i>The treatment of stormwater to water quality requirements can be completed in storage facilities. Typically, stormwater pollution prevention controls will be designed using water quality volume. Water quality volume requirements must be satisfied below the elevation of the secondary outlet.</i></p> <p><i>The water quality treatment rate may also be needed if off-line diversion structures, such as sand filters, infiltration trenches, or hydrodynamic separators, are used to meet water quality considerations prior to flow entry into the facility. In this case a multiple stage outlet is not required.</i></p> <p>35-4.06(01) Forebay</p> <p><i>Provide a sediment forebay at or upstream of the BMP inlet for wet or dry detention facilities. The forebay should have a small stabilized berm separating it from the rest of the facility and must:</i></p> <ol style="list-style-type: none"> <i>1. be sized to contain a storage volume of $0.1WQ_v$, which counts towards the total water quality volume requirements;</i> <i>2. result in non-erosive exit velocities;</i> <i>3. include appropriate erosion control armoring on the separation berm (overflow);</i> <i>4. have direct maintenance access for appropriate equipment to remove accumulated sediment and floatables;</i> <i>5. have a fixed sediment depth marker; and</i> <i>6. may have a hardened base to make sediment removal easier once 50% of the storage capacity has been lost.</i> <p><i>A low flow outlet pipe should be installed in the forebay to allow for the conveyance of the baseflow. This pipe should be sized in the same manner as the baseflow pipe for the two stage outlet. See Section 35-4.05.</i></p> <p><i>A forebay is required at all locations of concentrated stormwater inflow such as a pipe or channel. Where possible, inflow should be consolidated to avoid multiple forebay locations. Where the construction of a forebay is not possible, the facility sizing should be modified to add 1 foot of depth below the calculated storage volume (or increase the basin volume by 20% above that calculated for water quantity control).</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-6.07 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Add the following as Section 35-6.07: <p><u>35-6.07 Multiple Stage Outlets</u></p> <p><i>When multiple stage outlet works are used, the elevation-discharge relationships from the various outlet works may be added together provided the head calculations were performed on the same datum.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-7.04, 35-7.05 NEW SECTION, Preliminary Basin Dimensions
Proposed Revision	<ul style="list-style-type: none"> Renumber the existing Section 35-7.04 to 35-7.05. Add the following as Section 35-7.04: <p><u>35-7.04 Water Quality Volume Storage</u></p> <p><i>An estimate of the water quality volume requirement for stormwater pollution prevention can be calculated by following the procedure described in Section 29-12.1.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-10.02 Design
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence at the end of point 2: <p><i>Multiple stage outlet works are recommended for ponds that will be used as stormwater BMPs. Multiple stage outlets should generally take the form of low flow orifice outlet(s) with a secondary high-flow pipe. INDOT discourages the uses of riser pipes. This does not eliminate the need for an emergency overflow spillway.</i></p> <ul style="list-style-type: none"> Add the following paragraph as point number 3 for design of dry bottom detention basins. <p><i>3. <u>Quality</u>. Unless the stormwater has been treated prior to entering the storage facility, the basin should be designed to treat the water quality volume calculated using procedures defined in Section 29-12.1. A sediment forebay should be provided per Section 35-4.06(01).</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-10.04 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Add the following section: <p><u>35-10.04 Illustration</u></p> <p><i>See Figure 35-10A for an illustration of a typical dry water quality detention pond.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-13.0 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS
Proposed Revision	<ul style="list-style-type: none">• Add the following items to the list of typical maintenance problems:<ul style="list-style-type: none">9. <i>sediment accumulation within the forebay and the facility</i>10. <i>erosion of the facility components.</i>• Add the following items to the second list of considerations:<ul style="list-style-type: none">7. <i>Sediment accumulation can lead to the loss of both design storage volume and water quality volume. Loss of active storage volume may result in higher release rates. Erosion of facility components, such as the forebay berm, can contribute to sedimentation and undermine the effectiveness of the forebay.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> $I = \text{percent of impervious cover (\%)}$ <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_v A}{12}$ <p>Where : (29-12.3)</p> $P = \text{rainfall in inches (use 1.0 inches for the water quality storm in Indiana)}$ $R_v = \text{volumetric runoff coefficient}$ $A = \text{total drainage area (acres)}$ <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none">• Add the following at the end of section 205.03(m) Detention Ponds: <i>If detention facilities are used as temporary sediment traps during construction, accumulated sediment shall be removed prior to the final acceptance of the project.</i>

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Storage Facility - Extended Detention Pond

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-4.05 Outlet Works
Proposed Revision	<ul style="list-style-type: none">• Add the following paragraph at the end of section 35-4.05: <i>Multiple stage outlet works are recommended for wet and dry ponds that will be used as stormwater BMPs. Multiple stage outlets should generally take the form of one or more low flow orifice outlets with a secondary high-flow pipe. INDOT discourages the use of riser pipes. An emergency spillway is also required. The orifice should be sized for the baseflow. Where baseflow can not be determined, 0.1 cubic feet per second per acre of contributing drainage area may be used as a general guide. However, if the orifice size required is calculated to be less than 4 inches in diameter, a single 4-inch diameter orifice opening shall be installed. In no case shall the orifice diameter be smaller than 100 mm (4 inch) without prior approval due to maintenance concerns.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-4.06 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> • Add the following as Section 35-4.06: <p><u>35-4.06 Water Quality Design Requirements</u></p> <p><i>The treatment of stormwater to water quality requirements can be completed in storage facilities. Typically, stormwater pollution prevention controls will be designed using water quality volume. Water quality volume requirements must be satisfied below the elevation of the secondary outlet.</i></p> <p><i>The water quality treatment rate may also be needed if off-line diversion structures, such as sand filters, infiltration trenches, or hydrodynamic separators, are used to meet water quality considerations prior to flow entry into the facility. In this case a multiple stage outlet is not required.</i></p> <p>35-4.06(01) Forebay</p> <p><i>Provide a sediment forebay at or upstream of the BMP inlet for wet or dry detention facilities. The forebay should have a small stabilized berm separating it from the rest of the facility and must:</i></p> <ol style="list-style-type: none"> 7. <i>be sized to contain a storage volume of $0.1WQ_v$, which counts towards the total water quality volume requirements;</i> 8. <i>result in non-erosive exit velocities;</i> 9. <i>include appropriate erosion control armoring on the separation berm (overflow);</i> 10. <i>have direct maintenance access for appropriate equipment to remove accumulated sediment and floatables;</i> 11. <i>have a fixed sediment depth marker; and</i> 12. <i>may have a hardened base to make sediment removal easier once 50% of the storage capacity has been lost.</i> <p><i>A low flow outlet pipe should be installed in the forebay to allow for the conveyance of the baseflow. This pipe should be sized in the same manner as the baseflow pipe for the two stage outlet. See Section 35-4.05.</i></p> <p><i>A forebay is required at all locations of concentrated stormwater inflow such as a pipe or channel. Where possible, inflow should be consolidated to avoid multiple forebay locations. Where the construction of a forebay is not possible, the facility sizing should be modified to add 1 foot of depth below the calculated storage volume (or increase the basin volume by 20% above that calculated for water quantity control).</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-6.07 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> • Add the following as Section 35-6.07: <p><u>35-6.07 Multiple Stage Outlets</u></p> <p><i>When multiple stage outlet works are used, the elevation-discharge relationships from the various outlet works may be added together provided the head calculations were performed on the same datum.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-7.04, 35-7.05 NEW SECTION, Preliminary Basin Dimensions
Proposed Revision	<ul style="list-style-type: none"> • Renumber the existing Section 35-7.04 to 35-7.05. Add the following as Section 35-7.04: <p><u>35-7.04 Water Quality Volume Storage</u></p> <p><i>An estimate of the water quality volume requirement for stormwater pollution prevention can be calculated by following the procedure described in Section 29-12.1.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-11.02 Design
Proposed Revision	<ul style="list-style-type: none"> • Add the following sentence at the end of point 2: <p><i>Multiple stage outlet works are recommended for ponds that will be used as stormwater BMPs. Multiple stage outlets should generally take the form of a low flow orifice outlet with a secondary high-flow pipe. INDOT discourages the use of risers. This does not eliminate the need for an emergency spillway.</i></p> <ul style="list-style-type: none"> • Add the following paragraph as point number 3 for design of wet bottom detention basins. <p><i>3. Quality. Unless the stormwater has been treated prior to entering the storage facility, the basin should be designed to treat the water quality volume calculated using procedures defined in Section 29-12.1. A sediment forebay should be provided per Section 35-4.06(01).</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-11.03 Other Considerations
Proposed Revision	<ul style="list-style-type: none"> • Add the following sentences to the end of the last paragraph related to maintenance: <p><i>The facility should also be inspected at least annually during dry weather to monitor sediment accumulation within the forebay, inspect the forebay and outlet works for damage, and to identify areas in need of revegetation. Damaged or unvegetated areas should be repaired. Litter and sediment removal should be coordinated with the mowing schedule and be performed as needed.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-11.04 Illustration
Proposed Revision	<ul style="list-style-type: none"> • <i>Figure 35-11A should be updated to show a plan view and cross section of a typical wet water quality detention pond showing water quality volume limits, sediment forebay, and other pertinent components.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-13.0 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS
Proposed Revision	<ul style="list-style-type: none">• Add the following items to the list of typical maintenance problems:<ul style="list-style-type: none">9. <i>sediment accumulation within the forebay and the facility</i>10. <i>erosion of the facility components.</i>• Add the following items to the second list of considerations:<ul style="list-style-type: none">8. <i>Sediment accumulation can lead to the loss of both design storage volume and water quality volume. Loss of active storage volume may result in higher release rates. Erosion of facility components, such as the forebay berm, can contribute to sedimentation and undermine the effectiveness of the forebay.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> $I = \text{percent of impervious cover (\%)}$ <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_v A}{12}$ <p>Where : (29-12.3)</p> $P = \text{rainfall in inches (use 1.0 inches for the water quality storm in Indiana)}$ $R_v = \text{volumetric runoff coefficient}$ $A = \text{total drainage area (acres)}$ <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none">• Add the following at the end of section 205.03(m) Detention Ponds: <i>If detention facilities are used as temporary sediment traps during construction, accumulated sediment shall be removed prior to the final acceptance of the project.</i>

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Storage Facility - Wet Pond

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-4.05 Outlet Works
Proposed Revision	<ul style="list-style-type: none">• Add the following paragraph at the end of section 35-4.05: <i>Multiple stage outlet works are recommended for wet and dry ponds that will be used as stormwater BMPs. Multiple stage outlets should generally take the form of one or more low flow orifice outlets with a secondary high-flow pipe. INDOT discourages the use of riser pipes. An emergency spillway is also required. The orifice should be sized for the baseflow. Where baseflow can not be determined, 0.1 cubic feet per second per acre of contributing drainage area may be used as a general guide. However, if the orifice size required is calculated to be less than 4 inches in diameter, a single 4-inch diameter orifice opening shall be installed. In no case shall the orifice diameter be smaller than 100 mm (4 inch) without prior approval due to maintenance concerns.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-4.06 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> • Add the following as Section 35-4.06: <p><u>35-4.06 Water Quality Design Requirements</u></p> <p><i>The treatment of stormwater to water quality requirements can be completed in storage facilities. Typically, stormwater pollution prevention controls will be designed using water quality volume. Water quality volume requirements must be satisfied below the elevation of the secondary outlet.</i></p> <p><i>The water quality treatment rate may also be needed if off-line diversion structures, such as sand filters, infiltration trenches, or hydrodynamic separators, are used to meet water quality considerations prior to flow entry into the facility. In this case a multiple stage outlet is not required.</i></p> <p>35-4.06(01) Forebay</p> <p><i>Provide a sediment forebay at or upstream of the BMP inlet for wet or dry detention facilities. The forebay should have a small stabilized berm separating it from the rest of the facility and must:</i></p> <ol style="list-style-type: none"> 13. <i>be sized to contain a storage volume of $0.1WQ_v$, which counts towards the total water quality volume requirements;</i> 14. <i>result in non-erosive exit velocities;</i> 15. <i>include appropriate erosion control armoring on the separation berm (overflow);</i> 16. <i>have direct maintenance access for appropriate equipment to remove accumulated sediment and floatables;</i> 17. <i>have a fixed sediment depth marker; and</i> 18. <i>may have a hardened base to make sediment removal easier once 50% of the storage capacity has been lost.</i> <p><i>A low flow outlet pipe should be installed in the forebay to allow for the conveyance of the baseflow. This pipe should be sized in the same manner as the baseflow pipe for the two stage outlet. See Section 35-4.05.</i></p> <p><i>A forebay is required at all locations of concentrated stormwater inflow such as a pipe or channel. Where possible, inflow should be consolidated to avoid multiple forebay locations. Where the construction of a forebay is not possible, the facility sizing should be modified to add 1 foot of depth below the calculated storage volume (or increase the basin volume by 20% above that calculated for water quantity control).</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-6.07 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> • Add the following as Section 35-6.07: <p><u>35-6.07 Multiple Stage Outlets</u></p> <p><i>When multiple stage outlet works are used, the elevation-discharge relationships from the various outlet works may be added together provided the head calculations were performed on the same datum.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-7.04, 35-7.05 NEW SECTION, Preliminary Basin Dimensions
Proposed Revision	<ul style="list-style-type: none"> • Renumber the existing Section 35-7.04 to 35-7.05. Add the following as Section 35-7.04: <p><u>35-7.04 Water Quality Volume Storage</u></p> <p><i>An estimate of the water quality volume requirement for stormwater pollution prevention can be calculated by following the procedure described in Section 29-12.1.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-11.02 Design
Proposed Revision	<ul style="list-style-type: none"> • Add the following sentence at the end of point 2: <p><i>Multiple stage outlet works are recommended for ponds that will be used as stormwater BMPs. Multiple stage outlets should generally take the form of a low flow orifice outlet with a secondary high-flow pipe. INDOT discourages the use of risers. This does not eliminate the need for an emergency spillway.</i></p> <ul style="list-style-type: none"> • Add the following paragraph as point number 3 for design of wet bottom detention basins. <p><i>3. Quality. Unless the stormwater has been treated prior to entering the storage facility, the basin should be designed to treat the water quality volume calculated using procedures defined in Section 29-12.1. A sediment forebay should be provided per Section 35-4.06(01).</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-11.03 Other Considerations
Proposed Revision	<ul style="list-style-type: none"> • Add the following sentences to the end of the last paragraph related to maintenance: <p><i>The facility should also be inspected at least annually during dry weather to monitor sediment accumulation within the forebay, inspect the forebay and outlet works for damage, and to identify areas in need of revegetation. Damaged or unvegetated areas should be repaired. Litter and sediment removal should be coordinated with the mowing schedule and be performed as needed.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-11.04 Illustration
Proposed Revision	<i>Figure 35-11A should be updated to show a plan view and cross section of a typical wet water quality detention pond showing water quality volume limits, sediment forebay, and other pertinent components.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-13.0 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS
Proposed Revision	<ul style="list-style-type: none">• Add the following items to the list of typical maintenance problems:<ul style="list-style-type: none">9. <i>sediment accumulation within the forebay and the facility</i>10. <i>erosion of the facility components.</i>• Add the following items to the second list of considerations:<ul style="list-style-type: none">9. <i>Sediment accumulation can lead to the loss of both design storage volume and water quality volume. Loss of active storage volume may result in higher release rates. Erosion of facility components, such as the forebay berm, can contribute to sedimentation and undermine the effectiveness of the forebay.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> $I = \text{percent of impervious cover (\%)}$ <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_v A}{12}$ <p>Where : (29-12.3)</p> $P = \text{rainfall in inches (use 1.0 inches for the water quality storm in Indiana)}$ $R_v = \text{volumetric runoff coefficient}$ $A = \text{total drainage area (acres)}$ <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none">• Add the following at the end of section 205.03(m) Detention Ponds: <i>If detention facilities are used as temporary sediment traps during construction, accumulated sediment shall be removed prior to the final acceptance of the project.</i>

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Stormwater Wetland (Native Vegetation)

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> $I = \text{percent of impervious cover (\%)}$ <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_v A}{12}$ <p>Where : (29-12.3)</p> $P = \text{rainfall in inches (use 1.0 inches for the water quality storm in Indiana)}$ $R_v = \text{volumetric runoff coefficient}$ $A = \text{total drainage area (acres)}$ <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 603 - FENCES
Reference Location	603.02 Materials
Proposed Revision	<ul style="list-style-type: none"> Add the following items alphabetically to the list of materials. Add the appropriate section reference number: <i>Plastic Vegetation Protection Fence</i> <i>Twine for Vegetation Protection Fence</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 603 - FENCES
Reference Location	603.07 Vegetation Protection Fence (NEW SECTION)
Proposed Revision	<ul style="list-style-type: none"> Change Section 603.07 <i>Method of Measurement</i> to 603.08 <i>Method of Measurement</i>. Add the following text as Section 603.07: <p>603.07 Vegetation Protection Fence. Surround wetland plug plantings or other vegetation that is susceptible to damage from occupation or consumption by wildlife, with vegetation protection fence. Standard farm field fence posts should be used to support the plastic fence fabric. Apply tension to the field fabric so that no sagging occurs in between posts. Place fence posts no more than 8 feet apart. Drive post to a sufficient depth to develop strength. Stretch twine in between fence posts over the enclosed area to form a grid to discourage wildlife from landing in the interior area. Install the twine grid to create a minimum number of 4 foot by 4 foot openings. Additional line posts may be required for the grid establishment.</p> <p>The vegetation protection fence should be removed once the wetland planting performance specifications have been satisfied. All fence posts, twine, and plastic fence fabric material shall be removed.</p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 603 - FENCES
Reference Location	603.09 Basis of Payment (Renumbered)
Proposed Revision	<ul style="list-style-type: none"> Change Section 603.08 <i>Basis of Payment</i> to 603.09 <i>Basis of Payment</i> Add the following items to the list of pay items: <i>Fence, Vegetation Protectionm (LFT)</i> Add the following exception under the list of pay items: <p>The cost of vegetation protection fence installation shall include fence posts, twine, and all incidentals required for the fence installation and maintenance.</p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 622 – PLANTING TREES, SHRUBS, AND VINES
Reference Location	622.02 Materials, General Comments
Proposed Revision	<ul style="list-style-type: none"> Add the following to the list of materials and the appropriate section reference: <i>Vegetation Protection Fence</i> Add a pay item for Wetland Plugs. The suggest method of measurement and basis of payment unit is per EACH plug. It is recommended that payment for fence removal shall be incidental to payment for the wetland plugs.

Document	<i>INDOT Standard Specifications</i>										
Reference Location	SECTION 900 – MATERIALS DETAILS										
Reference Location	SECTION 914 – ROADSIDE DEVELOPMENT MATERIALS										
Reference Location	914.09 Miscellaneous Materials										
Proposed Revision	<p><i>h. Vegetation Protection Fence.</i> <i>The fence netting for vegetation protection pods may be constructed on high visibility orange or natural green durable, UV stabilized high-density polyethylene (HDPE). Vegetation protection fence is not a structural fence system. Physical properties guidelines of the vegetation protection fence are listed below. Actual properties will vary by fabric supplier.</i></p> <table border="1"> <thead> <tr> <th><i>Physical Property</i></th><th><i>Typical Value</i></th></tr> </thead> <tbody> <tr> <td><i>Mesh Size</i></td><td><i>88 mm x 38 mm (3.5 in x 1.5 in)</i></td></tr> <tr> <td><i>Roll Dimensions (length x width)</i></td><td><i>30 m x 1.4 m (100 ft x 4 ft)</i></td></tr> <tr> <td><i>Roll Area</i></td><td><i>37 m² (400 ft²)</i></td></tr> <tr> <td><i>Estimated Roll Weight</i></td><td><i>6.7 kg (14.7 lbs)</i></td></tr> </tbody> </table>	<i>Physical Property</i>	<i>Typical Value</i>	<i>Mesh Size</i>	<i>88 mm x 38 mm (3.5 in x 1.5 in)</i>	<i>Roll Dimensions (length x width)</i>	<i>30 m x 1.4 m (100 ft x 4 ft)</i>	<i>Roll Area</i>	<i>37 m² (400 ft²)</i>	<i>Estimated Roll Weight</i>	<i>6.7 kg (14.7 lbs)</i>
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<i>Estimated Roll Weight</i>	<i>6.7 kg (14.7 lbs)</i>										

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Turf Reinforcement Mat (TRM)

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 30 - Channels
Reference Section	30-3.03(02) Channel Linings
Proposed Revision	<ul style="list-style-type: none"> Add the following definition: <i><u>Turf Reinforcement Mat Lined Channels (TRM)</u> TRM channel linings are three dimensional reinforcement matrices that provide sufficient thickness, strength and void space to permit soil filling and/or retention and the development of vegetation within the matrix. TRMs are composed of UV stabilized, non-degradable, synthetic fibers or nettings. The medium of soil, vegetation, and fiber is designed for permanent and critical hydraulic applications where design discharges exert velocities and shear stresses that exceed the limits of mature, natural vegetation. TRMs should be designed based on allowable shear stress of the channel lining.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 30 - Channels
Reference Section	30-3.03(02) Channel Linings
Proposed Revision	<ul style="list-style-type: none"> The use of TRMs has increased in the past several years as communities have become more aware of water quality concerns. The primary benefit of TRMs is they allow for infiltration and they can filter runoff from smaller rainfall events once vegetated. The other channel linings listed in Section 3.03(02) state an approximate design slope. However, it is recommended that the calculated maximum shear stress be used to design TRMs and other channel linings. Related to TRMs and other channel linings, the shear stress can be calculated using: $\tau = \gamma_{water} y S_o$ <i>Where</i> τ = shear stress γ_{water} = unit weight of water (62.4 lb/ft³) y = maximum design flow depth S_o = channel slope

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 30 - Channels
Reference Section	Figure 30-6C
Proposed Revision	<ul style="list-style-type: none"> Add the permissible shear stress value for TRMs.

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 621 – SEEDING AND SODDING
Reference Location	621.05 Applying Fertilizer, Seed, and Mulch
Proposed Revision	<ul style="list-style-type: none"> Under 5. <i>Method E</i>, add turf reinforcement mat (TRM) to the second sentence of the possible erosion control blankets the contractor is permitted to use. It is recommended that for (d) <i>Excelsior Blankets</i>, (e) <i>Paper Mats</i>, and (f) <i>Straw Mat</i>, the text be changed to state the anchoring, overlapping, and staple patterns used to install and secure the respective erosion control blankets be completed by following the most recent manufacturer installation guidelines based on slope, particular material and application. Add the following text under 621.05 as point (h) turf reinforcement mat (TRM): <p>(h) Turf Reinforcement Mat (TRM). <i>TRM may be used for where specified by the plans or where erosion control blanket is specified for roadside ditches, drainage ditches, swales, stream bank stabilizations, or other high flow areas. The installation of the TRM shall be completed within 24 hours of seeding.</i></p> <p><i>The ground shall be prepared in accordance with 621.04. After the area has been properly shaped, fertilized, and seeded, the TRM shall be unrolled over the designated area so that matting is snugly and uniformly in contact with the soil surface without stretching the material. The rolls shall be butted snugly together and stapled in place. The staples shall be driven through the blanket at a 90 degree angle to the plane of the ground surface. Each staple shall anchor the TRM. Anchoring, overlapping, and stapling of the mat shall be completed following the most current manufacturer installation guidelines. Staple patterns shall be determined based on slopes and application.</i></p> <p><i>For placement on slopes, the TRM shall be placed with the length running from the top of slope to the toe of slope and shall extend a minimum of 0.9 m (3 ft) over the crown of the slope. On slope applications, anchoring and stapling at the uphill and downhill ends end of each roll shall be completed in accordance with manufacturer's recommendations.</i></p> <p><i>For placement in ditch lines, the TRM shall be unrolled parallel to the center line of the ditch. The mat shall be placed so that there are no longitudinal seams within 600 mm (24 in.) of the bottom center line of the ditch. Channel applications shall be completed by following the most current manufacturer installation guidelines. TRM shall not be used below the normal water line of a perennial stream or other water body without prior approval of the Department.</i></p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 900 – MATERIALS DETAILS
Reference Location	SECTION 914 – ROADSIDE DEVELOPMENT MATERIALS
Reference Location	914.10 Turf Reinforcement Mat (TRM)
Proposed Revision	<ul style="list-style-type: none"> Add the following new section <i>914.10 Turf Reinforcement Mat</i>. <p>914.10 Turf Reinforcement Mat (TRM)</p> <p><i>Turf reinforcement mat (TRM) shall consist of a machine produced mat fabricated from straw fiber, coconut fiber, or UV stabilized polypropylene fiber. Paper or paper related products shall not be permitted as a component or TRMs. The exact percentage composition of the TRM will depend on the manufacturer and application of the mat. Manufacturer application and installation guidelines related to permissible shear stress shall be followed when selecting and installing TRMs.</i></p> <p><i>The matrix shall be held intact by three netting layers. The following material specifications are recommended. TRMs with differing material specifications must be specified or reviewed by the Engineer prior to installation. The top and bottom side of the mat shall be covered with a UV stabilized polypropylene net (3.91 kg/100 m² [8.0 lbs/1,000 ft²]). The middle netting layer shall consist of corrugated UV stabilized polypropylene net (11.7 kg/100 m² [24.0 lbs/1,000 ft²]). The approximate grid opening size for the netting layers shall be limited to 12.7 mm by 12.7 mm (0.5 in by 0.5 in). The material matrix shall be evenly distributed to form a uniform thickness across the entire width of the matting. The matrix should be located in between the bottom layer and the middle netting layer.</i></p> <p><i>The matrix and netting layers shall be stitched together on maximum 38.1 mm (1.5 in) centers with UV stabilized thread.</i></p> <p><i>The rolls shall be packaged with suitable protection for outdoor storage at a construction site in a manner which protects them from biodegradation prior to use. The minimum roll width shall be 1.8 m (6 ft).</i></p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.02 Materials
Proposed Revision	<ul style="list-style-type: none"> Add the following items alphabetically to the list of materials. Add the appropriate section reference number: <p><i>Turf Reinforcement Mat (TRM)</i></p>

PART III - INDOT Standard Drawings

Document	INDOT Standard Drawings
Reference Location	Section 200 - Earthwork
Reference Drawing	E 205-TECS-04 (M 205-TECS-04) (Now Unassigned) (NEW DRAWING)
Code Meaning	TECS – Temporary Erosion Control Slope
Drawing Title	Rolled Erosion Control Product Installation (General)
Proposed Revision	<ul style="list-style-type: none"> • A new drawing should be created for rolled erosion control blanket installation for slope installations. The drawing should contain information for blanket installation on slopes, along drainage channels, and along shorelines. Seaming, anchoring, and overlapping of the rolls should also be shown. General instructions for all erosion control blanket installations are: <ol style="list-style-type: none"> 1. Prepare the seedbed by raking, seeding and fertilizing. 2. Use trenching and anchoring procedures to secure any exposed material ends. 3. Keep material in direct contact with the ground. 4. Blankets will unroll with appropriate side against soil surface. 5. Use the required number of staples. 6. Secure all material overlaps with the required number and spacing of staples. Seams may also be mechanically sewn according to manufacturer recommendations. 7. In slope and channel applications, overlap material in the direction of water flow. • For slope installation applications: <ol style="list-style-type: none"> 1. Prepare soil before installing blankets, including any necessary application of lime, fertilizer, and seed. 2. Anchor the blanket at the top of the slope in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench with a row of staples/stakes approximately 30 cm (12 inches) apart in the bottom of the trench. Leave approximately 30 cm (12 inches) of blanket extended beyond the up-slope portion of the trench. Backfill and compact the trench after stapling and apply seed to compacted soil. Fold remaining 30-cm (12-inch) portion of blanket back over and secure blanket with a row of staples/stakes approximately 30 cm (12 inches) apart across the width of the blanket. 3. Roll the blankets down or horizontally across the slope. Securely fasten blankets to soil surface with staples/stakes as shown in the staple pattern guide. 4. Staple the edges of parallel blankets with 5 to 12.5 cm (2 to 5 inches) of overlap depending on blanket type. 5. Place consecutive blankets spliced down the slope end over end (shingle style) with an approximate 7.5-cm (3-inch) overlap. Staple through overlapped area, approximately 30 cm (12 inches) apart across entire blanket width. • For drainage channel installation applications: <ol style="list-style-type: none"> 1. Prepare soil before installing blankets, including any necessary application of lime, fertilizer, and seed. 2. Anchor the blanket at the top of the slope in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench with a row of staples/stakes approximately 30 cm (12 inches) apart in the bottom of the trench. Leave approximately 30 cm (12 inches) of blanket extended beyond the up-slope portion of the trench. Backfill and compact the trench after stapling and apply seed to compacted soil. Fold remaining 30-cm (12-inch) portion of blanket back over and secure blanket with a row of staples/stakes approximately 30 cm (12 inches) apart across the width of the blanket. 3. Unroll center blanket in direction of water flow on bottom of channel. Securely fasten blankets to soil surface with staples/stakes as shown in the staple pattern guide. 4. Place blankets end over end (shingle style) with a 10 to 15 cm (4 to 6 inch)

	<p>overlap. Secure blankets with a double row of staples staggered 10 cm (4 inches) apart and 10 cm (4 inches) on center.</p> <ol style="list-style-type: none"> 5. Anchor full-length edge of blankets at top of side slopes with a row of staples/stakes approximately 30 cm (12 inches) apart in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench. Backfill and compact the trench after stapling. 6. Overlap adjacent blankets 5 to 12.5 cm (2 to 5 inches) (depending on blanket type) and staple. 7. In high-flow channel applications, a staple check slot is recommended at 9 to 12 m (30 to 40 foot) intervals using a double row of staples staggered 10 cm (4 inches) apart and 10 cm (4 inches) on center over entire width of channel. 8. Anchor the terminal end of the blankets with a row of staples/stakes approximately 30 cm (12 inches) apart in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench. Backfill and compact the trench after stapling. <ul style="list-style-type: none"> • For shoreline installation applications: <ol style="list-style-type: none"> 1. For easier installation, lower water before installation. 2. Prepare soil before installing blankets, including any necessary application of lime, fertilizer, and seed. 3. Anchor the blanket at the top of the shoreline in a 15-cm (6-inch) deep by 15-cm (6-inch) wide trench with a row of staples/stakes approximately 30 cm (12 inches) apart in the bottom of the trench. Leave approximately 30 cm (12 inches) of blanket extended beyond the up-slope portion of the trench. Backfill and compact the trench after stapling and apply seed to compacted soil. Fold remaining 30-cm (12-inch) portion of blanket back over and secure blanket with a row of staples/stakes approximately 30 cm (12 inches) apart across the width of the blanket. 4. Roll blankets either down the shoreline for long banks, or horizontally across the shoreline slope. Securely fasten blanket to soil surface with staples/stakes as shown in the staple pattern guide. 5. Place horizontal and vertical blanket seams shingle style in the direction of predominant erosive action with a 5 to 12.5 cm (2 to 5 inch) overlap. Secure all overlaps with a row of staples spaced approximately 30 cm (12 inches) apart. 6. Anchor the edge of the blanket at or below normal water level in a 30-cm (12-inch) deep by 15-cm (6-inch) wide trench with a row of staples/stakes spaced approximately 30 cm (12 inches) apart. Backfill and compact the trench after stapling (stone or soil may be used as backfill). • The following notes should be added for all installations: <i>"For installation in loose soil, the staple length requirements of 914.09(f) shall be increased to the length required to secure the blanket."</i> • The following notes should be added for all installations along drainage channel and shorelines: <i>"For perennial streams with observable baseflow, the erosion control blanket extent below the waterline shall be limited to that length which is required for anchoring the mat."</i>
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Document	INDOT Standard Drawings
Reference Location	Section 200 - Earthwork
Reference Drawing	(NEW DRAWING)
Code Meaning	Needs Code Assigned
Drawing Title	Erosion Control Blanket Staple Patterns
Proposed Revision	<ul style="list-style-type: none"> A new drawing should be created to recommend minimum staple patterns for rolled erosion control blankets. Rolled erosion control blankets come in many roll widths. Common rolls widths include 4-, 6.67-, 8-, 13.5-, and 16-feet. The standard rolls width will vary by manufacturer. The following staple densities are recommended based on application of the erosion control mat: <ul style="list-style-type: none"> 4:1 Slopes – 0.85 staples/m² (0.7 staples/yd²) 3:1 Slopes – 1.40 staples/m² (1.15 staples/yd²) 2:1 Slopes and Steeper – 2.0 staples/m² (1.7 staples/yd²) Medium/High Flow Channels – 4.1 staples/m² (3.4 staples/yd²) High Flow Channel and Shoreline – 4.5 staples/m² (3.75 staples/yd²) Drawings should also be created to show this staple spacing and the approximate location to stitch blanket seams if mechanically sewing is to be used.

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Water Quality Dry Swale

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> $I = \text{percent of impervious cover (\%)}$ <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_v A}{12}$ <p>Where : (29-12.3)</p> $P = \text{rainfall in inches (use 1.0 inches for the water quality storm in Indiana)}$ $R_v = \text{volumetric runoff coefficient}$ $A = \text{total drainage area (acres)}$ <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Water Quality Structures (Hydrodynamic Separators)

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Treatment Rate Calculation</p> <p>The peak rate of discharge for the water quality design storm is needed for the sizing of off-line diversion structures, such as sand filters, infiltration trenches, and hydrodynamic separators.</p> <p>The following procedure can be used to estimate peak discharges for small storm events. It relies on the Water Quality Volume and the simplified peak flow estimating method above. A brief description of the calculation procedure is presented below.</p> <p>(Step 1): Using Q_{wv}, a corresponding Water Quality Curve Number (CN_{wq}) is computed utilizing the following equation:</p> $CN_{wq} = 1000 / \left[10 + 5P + 10Q_{wv} - 10 \left(Q_{wv}^2 + 1.25Q_{wv}P \right)^{\frac{1}{2}} \right]$ <p>Where : (29.12.5)</p> <p>P = rainfall in inches (use 1.0 inches for the water quality storm in Indiana)</p> <p>Q_{wv} = water quality volume in inches</p> <p>Figure 29-12A, Water Quality Curve Number for percentage of impervious cover, provides a graphical solution of Equation 29-12.5, which can be used to determine CN_{wq}.</p> <p>(Step 2) Once a CN_{wq} is determined, the time of concentration (t_c) is computed (based on the methods described in Section 29-7.0).</p> <p>(Step 3) Using the computed CN_{wq}, t_c, and drainage area (A), the Water Quality Treatment Rate (Q_{wq}) for the water quality storm event is computed using TR-20, HEC-1, HEC-HMS, or other hydrograph oriented procedure. Use SCS Type II rainfall distribution and a rainfall depth of 1.0 inches.</p> <p>When peak runoff calculations are performed using the Rational Method, the water quality treatment rate should be equal to the peak runoff rate from the 5 year recurrence interval storm event.</p> <p>The designer should remember that the water quality volume and the water quality treatment rate are based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 700 – STRUCTURES
Reference Location	SECTION 726 – WATER QUALITY STRUCTURES (NEW SECTION)
Reference Location	NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> A new Standard Specification should be developed for water quality structures. These types of structures may include catch basin inserts, hydrodynamic separators, sand filters, or other structural water quality mechanisms. <p>Many of these structures are proprietary. INDOT will have to make a decision which devices will be acceptable or recommended for use on INDOT projects; however, since many of these water quality measures may have to be customized by the Designer to meet site specific requirements, this information could also be covered under INDOT recurring special provisions menu.</p> <p>Regardless of where in the INDOT documents this information is added, some general design parameters and procedures should be established for applicability of various units. The development of such design procedures has been referenced in this study's comment on the INDOT Design Manuals.</p> <p>Parameters to consider include the following:</p> <ul style="list-style-type: none"> Water quality treatment rate Particle removal efficiency (typically 80% TSS) Design particle size Establishment of particular unit's particle removal efficiency, through independent laboratory testing <p>Specific construction considerations that should be evaluated for stormwater BMPs should included:</p> <ul style="list-style-type: none"> Timing of BMP installation. Most upstream areas should be stabilized otherwise the BMP unit may "fill up" with sediment and require maintenance. Substitution. The stormwater BMP market is very competitive. There are many vendors and all products are not equal. The Designer will select a BMP unit based on detailed engineering analysis. If a Contractor wants to substitute a different BMP, INDOT must decide who must be financially responsible for proving to INDOT and the Designer the proposed substitute will not present additional long-term maintenance cost to INDOT and will provide equal or greater water quality benefits than the originally designed unit. Custom materials. Materials used in many BMP units are already covered under the INDOT Standard Specifications (concrete, reinforcing steel, B-Borrow, manholes, castings, etc.). However, the material specifications of some custom proprietary components should be considered by INDOT and the Designer.

PART III - INDOT Standard Drawings

Document	INDOT Standard Drawings
Reference Location	Section 726 – Water Quality Structures (NEW SECTION)
Reference Drawing	(NEW DRAWINGS)
Code Meaning	Needs Code Assigned
Drawing Title	Water Quality Structure
Proposed Revision	<ul style="list-style-type: none"> A standard drawing should be created for hydrodynamic separators BMPs used for stormwater pollution prevention. Installation of water quality structures can be grouped into in-line or off-line installations. Inline installations are typically only found on piped stormwater conveyance systems. Offline systems are often used to treat a much larger flow rate than in-line systems. The flow to be treated is usually piped to the stormwater treatment unit from the main conveyance system flow and rejoins the main flow path once it is treated. Offline systems can be installed on closed stormwater systems or on open channels. A Standard Drawing should be developed that shows a plan view and section view for in-line and off-line water quality structures. Although these systems are proprietary, the detail can be generalized to show required components. Design features that should be shown on the Standard Drawings include: <ul style="list-style-type: none"> Inlet – For an in-line system the inlet will be the approach pipe. For an off-line system, an inlet pipe will diverge from the main flow path towards the unit. Trash Rack – Off-line systems installed on open channel should have a trash rack at the entrance and exit. The trash rack can either be mounted to a headwall, to a concrete end section, or a Type 1 grated box end section may be used. A trash rack should also be located on the outlet pipe for open channel systems, especially in residential areas. Separator Chamber – Separation chambers will vary by manufacturer. Separation chambers should have sediment storage, oil storage, and floatable storage capability. Some separation chambers may contain screens that ensure the removal of 100% of particles larger than the screen size. Cleanout Access – Access to clean out these units is usually through a manhole casting on the top of the unit. Often times, the entire BMP is located within a manhole. Flow Bypass – For in-line units, the bypass within the structure most likely in the form of a high flow by-pass weir. For offline units installed on open channels, either an earthen or concrete bypass weir should be constructed across the channel. The weir should engage for flow rates above the water quality treatment rates. A note should be added for in-line and off-line configurations that “<i>The treatment unit and bypass system should not cause adverse flooding impacts to upstream area or drainage systems.</i>” Outlet - For an in-line system the outlet will be the exit pipe. For an off-line system, an outlet pipe will converge back to the main flow path downstream of the unit. Bedding – Bedding should be specified as a minimum of 12-inches of compacted aggregate (No. 8) stone placed over geotextile.

	<p>Backfill – Material obtained when excavating to place the structure may be used as backfill if it is suitable. If material is not suitable, Structure Backfill (<i>Standard Specifications Section 904</i>) shall be installed. All backfill shall be compacted to a minimum of 95% Standard Proctor.</p>
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PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Post-Construction Phase BMP Component - Water Quality Wet Swale

PART I - INDOT Design Manuals

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<p>29-12.0 WATER QUALITY CALCULATIONS</p> <p>Water Quality Volume Calculation</p> <p>The Water Quality Volume (WQ_v) is the treatment volume required to remove a significant percentage of the stormwater pollution load. This results in the interception and treatment of a portion of the runoff from all storms and all the runoff from storms up to and including the water quality storm event (storms producing less than or equal to 1.0 inches of runoff.)</p> <p>Water quality volume can be represented in units of acre-feet or inches and is represented by:</p> $WQ_v = \text{water quality volume in acre - feet} \quad (29-12.1)$ $Q_{wv} = \text{water quality volume in inches}$ <p>The water quality treatment volume is calculated first by multiplying a 1.0 inch rainfall event by the volumetric runoff coefficient (R_v) and the site area. R_v is defined as:</p> $R_v = 0.05 + 0.009(I)$ <p>Where : (29-12.2)</p> <p>I = percent of impervious cover (%)</p> <p>Water quality volume is then expressed in acre-feet using the following formula:</p> $WQ_v = \frac{PR_v A}{12}$ <p>Where : (29-12.3)</p> <p>P = rainfall in inches (use 1.0 inches for the water quality storm in Indiana) R_v = volumetric runoff coefficient A = total drainage area (acres)</p> <p>Water quality volume is expressed in inches simply as:</p> $Q_{wv} = P(R_v) \quad (29-12.4)$ <p>The designer should remember that the water quality volume is based on the total contributing drainage area to the respective stormwater pollution prevention BMP. Individual BMPs are sized for the total portion of drainage area directed towards the measure. If off-site runoff is not separated from runoff generated from within the project limits, the required BMP sizing may be significantly increased. However, in some cases it may not be possible to separate the runoff from off-site and on-site areas.</p>

PART II - INDOT Standard Specifications

No Recommended Revisions

PART III - INDOT Standard Drawings

No Recommended Revisions

PART IV - INDOT Recurring Special Provisions

No Recommended Revisions

Miscellaneous Recommendations

General:

This document is one part of a comprehensive review of INDOT documentation related to INDOT's Stormwater Quality Master Plan (SWQMP). The comments in this document are:

- comments that may apply to many construction phase or post-construction phase BMPs;
- important concepts or terminology changes related to construction phase or post-construction phase BMPs;
- procedural construction phase or post-construction phase items important to stormwater quality;
- other specific recommendations related to BMPs.

In general, the comments in this document are not specifically related to any one Construction Phase or Post-Construction Phase Best Management Practices (BMPs).

Documents Covered:

- INDOT Design Manuals
- INDOT Standard Specifications
- INDOT Recurring Special Provisions
- INDOT Standard Drawings

Organization:

Specific recommended revisions and additions to the above listed documents are summarized in the following tables. Comments have been grouped in the categories listed in the Table 1.

Table 1: Recommended Revision and Addition Categories

Recommended Revision and Addition Categories	
Rule 5 Permitting, NOI, & NOT	
Recommended Goals, Objectives, & Procedures	
Design Plan Components	
Terminology Updates and Definitions	
Water Quality & SWPPP	
Miscellaneous Recommendations	

BMP Comments –Miscellaneous Recommendations

Part I – Rule 5 Permitting, NOI, & NOT

It is the current understanding that INDOT is applying for an Individual Permit, rather than relying on the Regional Permit requirements governing specific MS-4 regions of the State. It is assumed that INDOT projects would be submitted directly to IDEM or the County SWCD as the permitting authority. Due to the current ongoing reorganization of the State government in relation to stormwater quality and erosion control plan review, it is unclear if this assumption would apply. However, if INDOT were required to submit to the MS-4 communities under Rule 13, additional minor revisions might be needed to address submittals or adherence to MS-4 community localized requirements.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	General
Proposed Revision	<ul style="list-style-type: none"> Change all references to 2 ha (5 acre) to <i>0.4 ha (1 acre)</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-1.0 GENERAL INFORMATION
Proposed Revision	<ul style="list-style-type: none"> INDOT's approved NPDES Phase II permit and associated permit conditions should be referenced in the third paragraph.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	Figure 37-1A
Proposed Revision	<ul style="list-style-type: none"> The figure should be updated to incorporate all the information shown on the attached <i>Sample Rule 5 checklist</i>.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-1.0 GENERAL INFORMATION
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence at the end of the third paragraph before <i>...The submittal should be...:</i> <i>The designer is responsible for all items listed in Figure 37-1A, including parts A, B, and C.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC
Reference Location	107.02 Permits, Licenses, and Taxes
Proposed Revision	<ul style="list-style-type: none"> In paragraph 3, add <i>Notice of Intent (NOI)</i> to the list of permits the Department may have acquired. Add the following text as paragraph 4: <i>When the project is substantially complete, the Contractor shall provide the Department information certifying that all conditions for the NPDES Notice of Termination (NOT) have been satisfied. The Department will apply for the NOT once the information has been provided by the Contractor.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC
Reference Location	107.23 Waiver of Legal Rights
Proposed Revision	<ul style="list-style-type: none"> Add as the second sentence, “<i>The NOT shall be accepted by IDEM prior to final inspection. See 107.02 for the Contractor’s NOT requirements.</i>”

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 108 – PROSECUTION AND PROGRESS
Reference Location	108.04 Prosecution of Work
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence at the end of the tenth paragraph: <i>Upstream areas must be stabilized before permanent sediment control BMP measures are installed unless sediment maintenance of such measures is to be performed by the Contractor on a more frequent basis, including immediately prior to providing the Department information for the NPDES Notice of Termination (NOT.)</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 109 – MEASUREMENT AND PAYMENT
Reference Location	109.08 Final Payment
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence as the last sentence in the third paragraph: <i>Final payment will not be made until IDEM has accepted the NOT which certifies that all conditions for the NPDES Permit have been met.</i>

Part II – Goals, Objectives, & Procedures

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 1 – INDOT Organization
Reference Section	1-3.01(02) Engineering Services Section
Proposed Revision	<ul style="list-style-type: none"> Possibly add the following item to list of Engineering Services Sections – Hydraulics Unit functions: <p><i>acting as a contact for questions and providing technical support regarding INDOT requirements for water quality, Stormwater Pollution Prevention Plans (SWPPPs), and Stormwater Best Management Practices (BMPs)</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 1 – INDOT Organization
Reference Section	1-3.01(02) Engineering Services Section
Proposed Revision	<ul style="list-style-type: none"> Add <i>Notice of Intent (NOI)</i> and <i>Notice of Termination (NOT)</i> to lists of example permits submitted by the Hydraulic Units listed as point <u>e</u> under <u>Section 1 Hydraulics</u>.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 3 – Project Design Coordination
Reference Section	3-1.01(01) Hydraulics Unit
Proposed Revision	<ul style="list-style-type: none"> Change Item 5. to <u>Stormwater Pollution Prevention Plan</u> Modify the paragraph under Item 5 to read: <p><i>The designer has the primary responsibility to develop the plan for construction phase Best Management Practices (BMPs) for temporary erosion and sediment control. The designer will also be primarily responsible for specifying design elements of post-construction BMPs for stormwater pollution prevention. Utilizing the elements of the construction and post-construction storm water quality BMPs, the designer will be responsible for preparing, submitting, and obtaining the stormwater quality technical review approval as applicable. Once approval is gained, INDOT will be responsible for submitting the NOI and NOT.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 5 – Engineering Assessment
Reference Section	5-1.0 Engineering Assessment Section
Proposed Revision	<ul style="list-style-type: none"> General comment. Under point 2 one of the section's mission is provided as: <p>2. integrate engineering/transportation and environmental objectives.</p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 5 – Engineering Assessment
Reference Section	5-2.03(03)
Proposed Revision	<ul style="list-style-type: none"> Add the following item to the end of point 6: <p><i>including existing stormwater pollution prevention or water quality features.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-12.0 LAND-LOCKED RETENTION
Proposed Revision	<ul style="list-style-type: none"> Add the following paragraph at the end of the section: <i>Under no circumstances should treated or untreated stormwater runoff be intentionally directed towards karst areas (sinkholes.) In general, natural drainage rates towards karst regions should not be modified.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 36 – Pavement/Storm Drainage Systems
Reference Section	36-2.01 Introduction
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence at the end of the first paragraph: <i>Stormwater pollution prevention requirements must be considered and addressed in the design process of storm drainage systems.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 36 – Pavement/Storm Drainage Systems
Reference Section	36-2.02 Bridge Decks
Proposed Revision	<ul style="list-style-type: none"> Add the following to the end of the second to the last sentence: <i>...applicable stormwater regulations and INDOT NPDES Phase II Stormwater Pollution Prevention (SWPPP) requirements.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 36 – Pavement/Storm Drainage Systems
Reference Section	36-5.03 Required Data
Proposed Revision	<ul style="list-style-type: none"> Change the last sentence in the first paragraph to read: <i>Water quality requirements should be considered in all areas, particularly in environmentally sensitive areas.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-1.0 GENERAL INFORMATION
Proposed Revision	<ul style="list-style-type: none"> Modify the first sentence of the second paragraph to read: <i>The goals of erosion and sediment control are different. The purpose of erosion control measures is to prevent sediment from being mobilized on the project site. Sediment control measures are designed to recapture soil that has been mobilized and prevent it from leaving the construction site.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 30 - Channels
Reference Section	30-1.02 Significance
Proposed Revision	<ul style="list-style-type: none"> Add the following as point number 7 <p><i>7. potential impacts to water quality</i></p>

Document	<i>INDOT Design Manual</i>
Reference Location	Chapter 33 – Bridge Deck Drainage
Reference Location	33-1.02(07) NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Add the following as section 33-1.02(07) as a design objective of bridge deck drainage: <p>33-1.02(07) Protection of Water Quality</p> <p><i>Stormwater pollution prevention treatment measures are needed in the design of bridge deck drainage systems if the overall construction project impacts more than 0.4 ha (1 acre) as indicated in Section 9-1.02. Measures must be placed accordingly such that a portion of runoff from all storm events and all the runoff from the water quality storm event are treated before the stormwater runoff leaves the INDOT right-of-way.</i></p> <p><i>If stormwater pollution prevention measures can not be added to the bridge deck drainage system or are determined to be cost prohibitive, stormwater pollution prevention mitigation must be performed within the same watershed. Such mitigation measures may include constructed wetlands, stream bank stabilization, or retrofitting of detention ponds.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-2.01 Introduction
Proposed Revision	<ul style="list-style-type: none"> Add the following item to the list of potential benefits of controlling the quantity of stormwater by using storage facilities: <p><i>5. improvement of downstream water quality through stormwater pollution prevention BMP design features.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 35 – Storage Facilities
Reference Section	35-4.01 General Criteria
Proposed Revision	<ul style="list-style-type: none"> Add the following item to the list of general design criteria for storage facilities: <p><i>6. water quality design requirements.</i></p>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-2.0 SITE ANALYSIS
Proposed Revision	<ul style="list-style-type: none"> Modify the following items under the list of principles of erosion and sediment control: <p>3. <i>Where reasonable, perimeter dikes and waterways should be used to divert/intercept off-site runoff. When evaluating the decision as to whether diversion/interception of off-site runoff is reasonable, the increased sizing of proposed BMP structures to treat off-site runoff if such diversion is not performed should also be considered.</i></p> <p>8. <i>The amount of disturbed area on the construction site should be minimized through construction phasing. Incremental final stabilization of areas should be promoted where such measures can adequately meet the intended use requirements of these areas.</i></p> <p>9. <i>The impervious surface should be kept at the minimum required to meet public safety needs. The use of porous material should be encouraged outside of the mainline pavement areas.</i></p> Replace the last sentence of the final paragraph with: <p><i>Within the construction clear zone, straw bales, fiber wattle rolls, or other approved means, should be used instead of riprap.</i></p>

Part III – Design Plan Components

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.01(03) Preliminary Field Check Plans
Proposed Revision	<ul style="list-style-type: none"> • Add “<i>post-construction stormwater pollution prevention BMPs</i>” as point 4i as an element to be included on the Plan and Profile Sheets for the Preliminary Field Check Plans Submittal. • Add “<i>post-construction stormwater pollution prevention BMPs</i>” as point 5j as an element to be included on the Detail Sheets for the Preliminary Field Check Plans Submittal. • Add “<i>post-construction stormwater pollution prevention BMPs, where applicable</i>” as point 9f as an element to be included on the Cross Section Sheets for the Preliminary Field Check Plans Submittal.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.01(07) Final Field Check Plans Submission
Proposed Revision	<ul style="list-style-type: none"> • Modify point 2d to read Detail Sheets. Ensure all details are completed and included with this submission. This includes traffic maintenance details and traffic design elements (e.g., intersections, signals, signing and lighting). <i>This also includes details and notes for the temporary erosion and sediment control and post-construction Stormwater Pollution Prevention Plans.</i> • Add the following to Part 4 Computation and Miscellaneous Documents “<i>erosion and sediment control feature design</i>” as point 4i. “<i>post-construction stormwater pollution prevention BMP design</i>” as point 4j.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.01(08) Final Check Prints Submission
Proposed Revision	<ul style="list-style-type: none"> • Revise Point 10 to read: <i>10. <u>NPDES Phase II Permit Review</u> If required under Section 9-1.02, include the completed set of details and notes for the post-construction Stormwater Pollution Prevention Plan and other supporting documentation used for the NPDES Phase II permit submittal, as described in Chapter Thirty-Seven.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.02(01) Grade Review Submission/Preliminary Field Check
Proposed Revision	<ul style="list-style-type: none"> • Add “<i>post-construction stormwater pollution prevention BMPs</i>” as point 6<i>l</i> as an element to be included on the Plan and Profile Sheets. • Add “<i>post-construction stormwater pollution prevention BMPs</i>” as point 8<i>l</i> as an element to be included on the Detail Sheets. • Add “<i>post-construction stormwater pollution prevention BMPs, where possible to show</i>” as point 14<i>g</i> as an element to be included on the Cross Section Sheets.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.02(03) Final Design Summary Submission
Proposed Revision	<ul style="list-style-type: none"> • Modify <i>Point 4</i> to state: 4. necessary permit <i>support and SWPPP</i> information; and

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.02(05) Final Check Prints Submission
Proposed Revision	<ul style="list-style-type: none"> • Modify point 3<i>d</i> to read Detail Sheets. Ensure all details are completed and included with this submission. This includes details for traffic maintenance details and traffic design elements (e.g., intersections, signals, signing and lighting). <i>This also includes details and notes for the temporary erosion and sediment control and post-construction Stormwater Pollution Prevention Plans.</i> • Add the following to Part 4 Computation and Miscellaneous Documents “<i>erosion and sediment control feature design</i>” as point 4<i>i</i>. “<i>post-construction stormwater pollution prevention BMP design</i>” as point 4<i>j</i>. • Add Point 11 as: <i>11. <u>Post-Construction Stormwater Pollution Prevention Plans.</u> Include the completed set of details and notes for the post-construction Stormwater Pollution Prevention Plan (SWPPP) and supporting documentation used for the NPDES Phase II permit submittal.</i> • Change existing Point 11 to Point 12 and modify to read: <i>12. <u>NPDES Phase II.</u> If required as described in Section 9-1.02, complete the NPDES Phase II Permit submission as described in Chapter Thirty-Seven.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.03(03) Preliminary Field Check Plans
Proposed Revision	<ul style="list-style-type: none"> • Add “<i>post-construction stormwater pollution prevention BMPs</i>” as point 4g as an element to be included on the Road Plan and Profile Sheets. • Add “<i>post-construction stormwater pollution prevention BMPs</i>” as point 5e as an element to be included on the Detail Sheets. • Add “<i>post-construction stormwater pollution prevention BMPs for bridge structure, if applicable</i>” as point 7f as an element to be included on the General Plan Sheet. • Change the last sentence in Point 9 to read: Also show the public road approaches and drive and, where possible, the <i>post-construction stormwater pollution prevention BMPs</i>.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.03(07) Final Check Prints Submission
Proposed Revision	<ul style="list-style-type: none"> • Add “<i>erosion and sediment control feature design</i>” as point 4s under Computation and Quantities to be provided to INDOT. • Add “<i>post-construction stormwater pollution prevention BMP design</i>” as point 4t under Computation and Quantities to be provided to INDOT. • Add “<i>post-construction stormwater pollution prevention BMP details</i>” as point 6d(3). • Change Point 8 to read: <i>Rule 5 / Rule 13 Submission</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-2.04(03) Preliminary Plans Submission
Proposed Revision	<ul style="list-style-type: none"> • Modify 4f to read: f. general rehabilitation recommendations (e.g., legend, material notes, <i>stormwater pollution prevention retrofits needed</i>). • Add “<i>post-construction stormwater pollution prevention BMPs</i>” as point 4g.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-3.07(01) Road Projects
Proposed Revision	<ul style="list-style-type: none"> • Modify Point 9i to read: i. Erosion and Sediment Control and <i>Post-Construction Stormwater Pollution Prevention Control Detail</i> (plan view);

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	14-3.07(02) Bridge Projects
Proposed Revision	<ul style="list-style-type: none">• Modify Point <i>6h</i> to read: i. Erosion and Sediment Control and <i>Post-Construction Stormwater Pollution Prevention Control Detail</i> (plan view);

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 14 – Plan Development
Reference Section	Figure 14-1A
Proposed Revision	<ul style="list-style-type: none">• Add Post-Construction Stormwater Pollution Prevention Detail (<i>Post-Construction SWPPP</i>) details to the table after <i>Erosion and Sediment Control Detail</i>.

Part IV – Terminology & Definitions

Document	INDOT Design Manual
Reference Chapter	General
Reference Section	General
Proposed Revision	<ul style="list-style-type: none"> • Change <i>Erosion Control Plan</i> to <i>Erosion and Sediment Control Plan</i> • Suggestion – provide the English unit equivalent where SI units are used

Document	INDOT Design Manual
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-4.0 Concept Definitions
Proposed Revision	<ul style="list-style-type: none"> • Add the following concepts to the list of hydrology concepts: <p><u>Curve Number</u>: NRCS (formerly SCS) Curve Number, denoted as CN. The Curve Number is a variable used in hydrograph based runoff calculations. It represents soil type and permeability characteristics, land use, and cover conditions of a given area.</p> <p><u>Volumetric Runoff Coefficient</u>: The volumetric runoff coefficient denoted as R_v is used in water quality calculations. It represents the portion of rainfall that becomes runoff and is dependent on percentage of impervious cover.</p> <p><u>Water Quality Curve Number</u>: The Water Quality Curve Number is used to determine the water quality treatment rate. It is denoted as CN_{wq} and is dependent on the water quality volume, Q_{wv}. The Water Quality Curve Number is typically greater than the NRCS Curve Number used for traditional hydrograph oriented peak runoff computations.</p> <p><u>Water Quality Volume</u>: Water quality volume is the treatment volume or accumulated direct runoff depth that should be treated to remove a significant percentage of the stormwater pollution load (approximately 80% of the average annual post-development total suspended solids loading). Water quality volume is denoted by WQ_v for units of acre-feet and Q_{wv} for units of inches. WQ_v is used to design detention-based water quality treatment systems such as a stormwater wetland, wet detention pond, or water quality swale.</p> <p><u>Water Quality Treatment Rate</u>: The water quality treatment rate, denoted by Q_{wq}, is the design flow rate for flow through water quality systems. Properly designed flow through systems, such as an infiltration trench or hydrodynamic separator, must be able to meet pollutant removal requirements at the design flow rate and be able to bypass inflows greater than the design treatment rate.</p>

Document	INDOT Standard Drawings
Reference Location	General
Reference Drawing	General
Code Meaning	General
Drawing Title	General
Proposed Revision	<ul style="list-style-type: none"> • The proposed revisions or additions discussed below should be made to both the English and Metric Standard Drawings. To facilitate document organization and to avoid confusion, where only metric drawings have been commented on, it should be understood the additional need to update the English drawing as well.

Document	INDOT Standard Drawings
Reference Location	General
Reference Drawing	General
Code Meaning	General
Drawing Title	General
Proposed Revision	<ul style="list-style-type: none"> Change “<i>Temporary Erosion Control</i>” to “<i>Temporary Erosion and Sediment Control</i>” where it occurs.

Document	<i>INDOT Standard Specifications</i>
Reference Location	General Comment
Reference Location	General Comment
Reference Location	General Comment
Proposed Revision	<ul style="list-style-type: none"> Replace Erosion Control plan with: <i>Erosion and Sediment Control Plan</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 101 – DEFINITIONS AND TERMS
Reference Location	101.01 Abbreviations
Proposed Revision	<ul style="list-style-type: none"> Add the following abbreviations to the current list: <i>BFM – Bonded Fiber Matrix</i> <i>BMP – Best Management Practice</i> <i>MS4 – Municipal Separate Storm Sewer Systems</i> <i>NOI – Notice of Intent</i> <i>NOT – Notice of Termination</i> <i>NPDES – National Pollutant Discharge Elimination System</i> <i>SWCD – Soil and Water Conservation District</i> <i>SWPPP – Stormwater Pollution Prevention Plan</i> <i>TRM – Turf Reinforcement Mat</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 101 – DEFINITIONS AND TERMS
Reference Location	Impacts existing Section 101.02 through 101.68
Proposed Revision	<ul style="list-style-type: none"> • Add the following items to the list of concept definitions to the alphabetical listings in Section 101, and renumber Sections 101.02-101.68 accordingly: <p>Best Management Practice (BMP). When referring to stormwater, best management practices are situation specific devices used during the construction and Post-Construction phase to prevent erosion, control sediment, prevent stormwater pollution, and improve water quality.</p> <p>Notice of Intent (NOI). A written notification form sent to IDEM and the local Soil and Water Conservation District or other permitting authority designated by the Department (Rule 13), where the land disturbing activity is to occur, that states the OWNER's intent to operate the proposed construction project in a manner consistent with the "permit conditions" established by Rule 5 or Rule 13, as appropriate.</p> <p>Notice of Termination (NOT). A written notification form sent to local Soil and Water Conservation District or other entity designated by the Department, where the land disturbing activity has occurred. The NOT either (1) certifies a change of ownership, (2) certifies the end of construction activities, or (3) applies for an early release from compliance with 327 IAC 15-5 (Rule 5) or 327 IAC 15-13 (Rule 13). Certain conditions apply. The request for termination is reviewed for concurrence and either returned to the OWNER or sent to IDEM for acceptance.</p> <p>Phase II (of the NPDES). Requires minimum control measures which include construction site stormwater runoff control and post-construction stormwater management for new development and redevelopment.</p> <p>Post-Construction. Period of time beginning once a construction site has been fully stabilized with established permanent vegetation or other measures capable of providing long-term erosion control protection.</p> <p>Rule 5. Part of the NPDES general permit program for Indiana, 327 IAC 15-5 is related to stormwater runoff associated with land disturbing activity. Updated in November 2002, this general permit applies to construction activities that result in the disturbance of 1 acre or more of land. Under Rule 5, a stormwater pollution prevention plan must be developed and followed for applicable projects.</p> <p>Rule 13. Part of the NPDES general permit program for Indiana, 327 IAC 15-13 is related to stormwater runoff from land disturbing activities within designated municipal separate storm sewer systems (MS4). Stormwater pollution prevention plans are also required to be developed and followed for areas subject to Rule 13 requirements.</p> <p>Stormwater Pollution Prevention Plan. Also known as SWPPP (pronounced swip). A plan describing proposed stormwater pollution prevention control measures during both construction and post-construction phases of a project. Also, include items such as maintenance requirements, and spill prevention. The CONTRACTOR is responsible for implementing and adhering to the SWPPP and amending the SWPPP as required or directed throughout the duration of the construction period.</p>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC
Reference Location	107.15 Erosion Control Plan and Proof of Publication
Proposed Revision	<ul style="list-style-type: none">In paragraph two, after Erosion Control Plan add: <i>Stormwater Pollution Prevention Plan (SWPPP)</i>

Part V – Water Quality & SWPPP

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 36 – Pavement/Storm Drainage Systems
Reference Section	36-2.02 Bridge Decks
Proposed Revision	<ul style="list-style-type: none"> Add the following paragraph at the end of this section: <i>The appropriate water quality parameter, either water quality volume or water quality treatment rate, should be determined for use in the design of stormwater treatment BMPs. Refer to Section 29-12.0 for water quality calculations related to hydrology.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 36 – Pavement/Storm Drainage Systems
Reference Section	36-2.15 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Add the following section: <u>36-2.15 Stormwater Quality Design</u> <i>Due to the area impacted within the construction limits, Stormwater Pollution Prevention (SWPPP) BMPs are needed for virtually all INDOT projects, as defined in Section 9-1.02. BMPs can be incorporated into inlets, manholes, ditches, swales, and storage facilities. The pollution prevention BMP system should be designed such that approximately 80% of the average annual post-development total suspended solids (TSS) load is removed from the runoff. The designer should attempt to minimize the overall number of BMPs, in order to reduce cost and maintenance needs. Section 39 describes specific types and applications of post-construction stormwater pollution prevention BMPs.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 36 – Pavement/Storm Drainage Systems
Reference Section	36-5.04 Preliminary Sketch
Proposed Revision	<ul style="list-style-type: none"> Add <i>water quality features</i> to the list of items to include in the preliminary sketch.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 36 – Pavement/Storm Drainage Systems
Reference Section	36-12.02 Design Procedures
Proposed Revision	<ul style="list-style-type: none"> Add the following paragraph as item 4 on the list of operations for the design of storm drainage systems. Renummer the other items accordingly. <i>Calculate the appropriate water quality parameter, either water quality volume or water quality treatment rate, for use in the design of stormwater treatment BMPs. Select stormwater pollution prevention BMPs to satisfy water quality requirements. Refer to Section 29-12.0 for water quality calculations related to hydrology.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-1.0 GENERAL INFORMATION
Proposed Revision	<ul style="list-style-type: none"> Add the following sentence to the end of the first paragraph: <i>All projects should be designed and constructed with the protection of water quality as a goal. Projects that have land disturbance of 0.4 ha (1 acre) or more are required to have a Stormwater Pollution Prevention Plan (SWPPP) that includes both construction phase and post-construction phase stormwater pollution prevention Best Management Practices (BMPs.) Post-construction BMPs are discussed in Chapter 39.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 30 - Channels
Reference Section	30-2.03 INDOT Policy
Proposed Revision	<ul style="list-style-type: none"> Add <i>water quality</i> to the list of potential environmental impact of channel modifications (Item 5).

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 30 - Channels
Reference Section	30-3.03(01) General
Proposed Revision	<ul style="list-style-type: none"> Add the following items as point number 4 on the list of general criteria that apply to roadside channels (side ditches): <i>4. Water quality considerations to address stormwater pollution prevention can be incorporated into roadside channels. Roadside channels can act as water quality swales to store the water quality volume or can have off-line diversion structures, such as infiltration trenches or hydrodynamic separators integrated into their design. Refer to section 39 for specific types and applications of post-construction stormwater pollution prevention BMPs.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 30 - Channels
Reference Section	30-3.04 Drainage Ditches
Proposed Revision	<ul style="list-style-type: none"> Add the following items as point number 4 on the list of criteria that apply to drainage ditches: <i>4. Water quality considerations to address stormwater pollution prevention can be incorporated into drainage ditches. Drainage ditches can store the full water quality volume or can have off-line diversion structures, such as infiltration trenches or hydrodynamic separators integrated into their design. Refer to Section 39 for specific types and applications of post-construction stormwater pollution prevention BMPs.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 33 – Bridge Deck Drainage
Reference Section	33-2.0 System Components
Proposed Revision	<ul style="list-style-type: none"> Modify the first sentence to read: The bridge deck drainage system includes the bridge deck itself, bridge gutters, inlets, pipes, downspouts, <i>and stormwater pollution prevention controls.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 33 – Bridge Deck Drainage
Reference Section	33-2.01(06) NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Add the following as section 33-2.01(06) as a system component of bridge deck drainage: 33-2.01(06) Stormwater Pollution Prevention Controls <i>Stormwater pollution prevention controls (BMPs) should be designed to provide an average annual post-development TSS removal rate of 80%. All stormwater controls must meet other design criteria listed in this section. Controls should not increase the spread of water into traffic lanes, function properly with minimum maintenance, and not interfere with the structural integrity of the bridge. Bridge design with downspouts should not be allowed to discharge untreated flow, unless such discharge is collected and treated on the receiving body beneath the bridge. No direct discharge of untreated stormwater runoff is allowed. Flow consolidation should be considered to reduce the number of multiple BMP installations and maintenance requirements.</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 39 – Post-Construction Stormwater BMPs
Reference Section	Recommended New Chapter
Proposed Revision	<ul style="list-style-type: none"> The Post-Construction Stormwater BMPs chapter should include the definition, BMP selection process, and design criteria for INDOT approved stormwater pollution prevention BMPs. This study suggests the following stormwater BMPs that can be implemented to satisfy INDOT's post-construction water quality requirements. Other BMPs can and should be added to this list in the future as new technologies of management practices are developed. <ol style="list-style-type: none"> 1. Wet Pond 2. Extended Detention Pond 3. Dry Pond 4. Dry Swale 5. Stormwater Wetland 6. Wet Swale 7. Infiltration Trench 8. Infiltration Basin 9. Bioretention 10. Filter Strip 11. Water Quality Structures

Document	INDOT Standard Drawings
Reference Location	Section 726 – Water Quality structures (NEW STANDARD DRAWING SECTION)
Reference Drawing	General Comment
Code Meaning	General Comment
Drawing Title	General Comment
Proposed Revision	<ul style="list-style-type: none"> Another proprietary structural BMP is a catch basin insert. Catch basin inserts come in many forms. Manufacturers will often have different systems based on the pollutant being targeted, for example, oil and grease versus sediment and oil and grease. The primary concern with the performance of catch basin inserts is maintenance. The actual maintenance of catch basin inserts is easy. The difficulty is the frequency of maintenance that may be required due to limited sediment storage. In addition, catch basin inserts are located “out of sight” and can easily be forgotten about. Because of this, it is recommended that INDOT consider the use of catch basin inserts only when other BMP methods are not feasible or practical (one such potential area would on bridge decks). It is therefore recommended that INDOT not make a Standard Drawing for this measure, as it would only encourage its use in inappropriate locations, increasing the maintenance burden on INDOT staff.

Document	INDOT Standard Drawings
Reference Location	Section 726 – Water Quality structures (NEW STANDARD DRAWING SECTION)
Reference Drawing	General Comment
Code Meaning	General Comment
Drawing Title	General Comment
Proposed Revision	<ul style="list-style-type: none"> INDOT may also wish to create Standard Drawings for other post-construction stormwater pollution prevention BMPs that are approved for use on INDOT projects. Some of the potential BMPs, such as stormwater wetlands, detention and retention facilities, bioretention areas, filter strips, and water quality swales can be constructed of materials and specifications that are already a part of the INDOT Standard Specifications; therefore an independent Standard Drawing may not be required. The Designer should refer to BMP Fact Sheets for specific design information. These figures should be located in the Design Manuals, not the Standard Drawings.

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 108 – PROSECUTION AND PROGRESS
Reference Location	108.04 Prosecution of Work
Proposed Revision	<ul style="list-style-type: none"> Modify the ninth paragraph to state: <i>The Contractor is legally responsible for adhering to and amending the SWPPP, including maintenance or stormwater pollution prevention measures. An amended SWPPP shall be submitted to the designated stormwater pollution prevention review entity in accordance with the NPDES Phase II permit for those areas not included in the Department submittal or as necessary for changes initiated by the Contractor. Items to include consist of sequencing of operations, borrow and disposal areas, and haul roads as well as any revision to the Department's submittal. Borrow and disposal areas may require a separate SWPPP as determined by the reviewing authority. All appropriate perimeter protection erosion control items shall be in place prior to disturbing the project site. A copy of the amended plan shall be provided to the Department and the Engineer.</i> Add the following sentence to the end of point (d) in the eleventh paragraph: <i>(d)...The Contractor shall follow the Spill Prevention and Response procedures described in the project SWPPP. In the event no procedures are outlined, the Contractor shall amend SWPPP with the appropriate project-specific procedures. These procedures should be applied to all stored chemicals or fuels.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 108 – PROSECUTION AND PROGRESS
Reference Location	108.11 Termination of Contractor's Responsibility
Proposed Revision	<ul style="list-style-type: none"> Add the following item as point (h): <i>(h) when the Contractor is unable or unwilling to update and adhere to the approved SWPPP and the requirements of the approved NPDES Phase II permit, including but not limited to maintenance of erosion and sediment control measures for stormwater pollution prevention.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 100 – GENERAL PROVISIONS
Reference Location	SECTION 108 – PROSECUTION AND PROGRESS
Reference Location	108.12 Contract Documentation
Proposed Revision	<ul style="list-style-type: none"> Add the following item at the end of the paragraph as documentation the contractor should have available and be able to furnish upon request: <i>Modifications or amendments to the SWPPP, SWPPP for disposal or borrow sites as required, and erosion and sediment control measure (BMP) inspection forms. The Contractor shall maintain such records for a period no less than three years from the date of the NOT.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 203 – EXCAVATION AND EMBANKMENT
Reference Location	203.08 Borrow or Disposal
Proposed Revision	<ul style="list-style-type: none"> Modify point (c) to state: <i>(c) an amended or separate SWPPP in accordance with the requirements of the NPDES Phase II permit submitted to the designated stormwater pollution prevention review authority (if not previously developed and approved);</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none"> Add the following at the end of the first paragraph in section 205.03(n) Retention Ponds: <i>If retention facilities are used as temporary sediment traps during construction, accumulated sediment shall be removed prior to the final acceptance of the project.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.03 Control Measures
Proposed Revision	<ul style="list-style-type: none"> Add the following as new section 205.03(r) Concrete Washout Area: <i>(r) Concrete Washout Area. Concrete washout areas shall be constructed as shown on the plans. Concrete washout shall be limited to the location shown on the plans.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL
Reference Location	205.04 Maintenance
Proposed Revision	<ul style="list-style-type: none"> Modify the end of the first sentence to state: <i>...Contractor at a minimum once every 7 days and after rain activities totaling ½ inch of rainfall in a 24 hour period. The Contractor shall install and keep a rain gauge in an unobstructed area on the project site for measuring daily rainfall accumulation. The daily rainfall totals should be recorded in the project documentation.</i>

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 200 – EARTHWORK
Reference Location	SECTION 215 – CHEMICAL MODIFICATION OF SOILS
Reference Location	215.04 Storage and Handling
Proposed Revision	<ul style="list-style-type: none"> Although it has already been included as a recommended change for Section 108.03, the Spill Prevention and Response plan included in the SWPPP should be followed for all chemicals stored on the project site. It may also be appropriate to restate this in Section 215.04.

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 400 – ASPHALT PAVEMENT
Reference Location	SECTION 404 SEAL COAT, SECTION 405 PRIME COAT, SECTION 406 TACK COAT, and SECTION 408 SEALING CRACKS AND JOINTS.
Reference Location	General
Proposed Revision	<ul style="list-style-type: none"> Although it has already been included as a recommended change for Section 108.03, the Spill Prevention and Response plan included in the SWPPP should be followed for all chemicals stored on the project site, including those used for asphalt paving or batching operations. It may also be appropriate to restate this in Sections 404, 405, 406, and 408.

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 500 – CONCRETE PAVEMENT
Reference Location	General
Reference Location	General
Proposed Revision	<ul style="list-style-type: none"> Although it has already been included as a recommended change for Section 108.03, the Spill Prevention and Response plan included in the SWPPP should be followed for all chemicals stored on the project site, including those used for concrete paving, batching operations, curing, or sealing. Suggested revisions to Section 205.03 include a provision for limiting concrete washout. It may be appropriate to restate these provisions in Section 500.

Part VI – Miscellaneous Recommendations

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	Table of Contents
Proposed Revision	<ul style="list-style-type: none"> Add the following sections: <p><i>29-12.0 HYDROLOGY CALCULATIONS FOR WATER QUALITY</i></p> <p><i>29-12.1 Water Quality Volume Calculation</i></p> <p><i>29-12.2 Water Quality Treatment Rate Calculation</i></p> <ul style="list-style-type: none"> Renumber section <i>29-12.0 REFERENCES</i> to <i>29-13.0 REFERENCES</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 29 - Hydrology
Reference Section	29-12.0 NEW SECTION
Proposed Revision	<ul style="list-style-type: none"> Renumber Section <i>29-12.0 REFERENCES</i> to <i>29-13.0 REFERENCES</i>

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 37 – Temporary Erosion and Sediment Control
Reference Section	37-2.0 SITE ANALYSIS
Proposed Revision	<ul style="list-style-type: none"> Add “<i>soil types</i>” to the list of items in the second paragraph the designer should look at during a site analysis. Add “<i>and soil types.</i>” to the last sentence of the second paragraph.

Document	<i>INDOT Design Manual</i>
Reference Chapter	Chapter 85 – Right-Of-Way Plan Preparation
Reference Section	GENERAL COMMENT
Proposed Revision	<ul style="list-style-type: none"> While modifications to other INDOT Designer Manual sections have addressed that new designs shall incorporate post-construction stormwater pollution prevention BMPs, additional right-of-way needs that may be required should be considered by the designer and checked by the INDOT review consultant.

Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 621 – SEEDING AND SODDING
Reference Location	621.05 Applying Fertilizer, Seed, and Mulch
Proposed Revision	<ul style="list-style-type: none"> It is recommended that for (d) <i>Excelsior Blankets</i>, (e) <i>Paper Mats</i>, and (f) <i>Straw Mat</i>, the text be changed to state the anchoring, overlapping, and staple patterns used to install and secure the respective erosion control blankets be completed by following the most recent manufacturer installation guidelines based on slope, particular material and application.

Document	<i>INDOT Standard Specifications</i>
Reference Location	SECTION 600 – INCIDENTAL CONSTRUCTION
Reference Location	SECTION 622 – PLANTING TREES, SHRUBS, AND VINES
Reference Location	622.02 Materials, General Comments
Proposed Revision	<ul style="list-style-type: none"> INDOT should perform a review of all their tree, shrub, and vine types to ensure that species known to be noxious or invasive in the State of Indiana are not recommended. Some references list <u>crown vetch</u> in the list of species invasive to the State of Indiana.

Document	<i>Erosion Control Technology Council (ECTC) Department of Transportation Training Courses</i>
Reference Location	General Comment
Reference Location	General Comment
Proposed Revision	<ul style="list-style-type: none"> The Erosion Control Technology Council offers two courses to DOTs in the United States and Canada. The first course is a two hour introductory that covers broad topics such as designing with rolled erosion control products (RECP), installation on RECPs, and how to use the ECTC website to evaluate products. The second course is a full day seminar that takes an in-depth look at regulations, structural and non-structural erosion and sediment control measures, and selection, design, installation, and inspection of RECPs. These courses are offered at nearly a 75% discount to DOTs. INDOT may want to further investigate the training opportunity.

Supporting Documentation

Figure 29-12A

Figure 9-2: Indiana SWCD Contact Number by County

Indiana Soil and Water Conservation Districts Contact Numbers by County			
Adams Co. SWCD (219) 724-3763	Franklin Co. SWCD (765) 647-2651	Lawrence Co. SWCD (812) 279-8117	Rush Co. SWCD (765) 932-2813
Allen Co. SWCD (219) 426-4637	Fulton Co. SWCD (219) 223-3220	Madison Co. SWCD (765) 644-4249	Scott Co. SWCD (812) 752-2269
Bartholomew Co. SWCD (812) 378-1280	Gibson Co. SWCD (812) 385-5033	Marion Co. SWCD (317) 780-1765	Shelby Co. SWCD (317) 392-1394
Benton Co. SWCD (765) 884-1090	Grant Co. SWCD (765) 668-8985	Marshall Co. SWCD (219) 936-2024	Spencer Co. SWCD (812) 649-9136
Blackford Co. SWCD (765) 348-1404	Greene Co. SWCD (812) 384-4781	Martin Co. SWCD (812) 247-2423	Starke Co. SWCD (219) 772-3066
Boone Co. SWCD (765) 482-6355	Hamilton Co. SWCD (317) 773-2181	Miami Co. SWCD (765) 473-6753	Steuben Co. SWCD (219) 665-3211
Brown Co. SWCD (812) 988-2211	Hancock Co. SWCD (317) 462-2283	Monroe Co. SWCD (812) 349-2046	St. Joseph Co. SWCD (219) 291-2300
Carroll Co. SWCD (765) 564-4480	Harrison Co. SWCD (812) 738-8124	Montgomery Co. SWCD (765) 362-1194	Sullivan Co. SWCD (812) 268-5157
Cass Co. SWCD (219) 753-4705	Hendricks Co. SWCD (317) 745-2555	Morgan Co. SWCD (765) 342-5594	Switzerland Co. SWCD (812) 427-3126
Clark Co. SWCD (812) 256-2330	Henry Co. SWCD (765) 529-2303	Newton Co. SWCD (219) 285-6889	Tippecanoe Co. SWCD (765) 448-1805
Clay Co. SWCD (812) 448-1108	Howard Co. SWCD (765) 457-2114	Noble Co. SWCD (219) 636-7682	Tipton Co. SWCD (765) 675-2316
Clinton Co. SWCD (765) 659-1223	Huntington Co. SWCD (219) 356-6816	Ohio Co. SWCD (812) 438-1241	Union Co. SWCD (765) 825-4311
Crawford Co. SWCD (812) 338-3224	Jackson Co. SWCD (812) 358-2367	Orange Co. SWCD (812) 723-3311	Vanderburgh Co. SWCD (812) 867-0729
Daviess Co. SWCD (812) 254-4780	Jasper Co. SWCD (219) 866-8008	Owen Co. SWCD (812) 829-2605	Vermillion Co. SWCD (765) 492-3705
Dearborn Co. SWCD (812) 926-2406	Jay Co. SWCD (219) 726-4373	Parke Co. SWCD (765) 569-3551	Vigo Co. SWCD (812) 232-0193
Decatur Co. SWCD (812) 663-8685	Jefferson Co. SWCD (812) 273-2070	Perry Co. SWCD (812) 547-4686	Wabash Co. SWCD (219) 563-7486
DeKalb Co. SWCD (219) 925-5620	Jennings Co. SWCD (812) 346-3411	Pike Co. SWCD (812) 354-6120	Warren Co. SWCD (765) 762-2443
Delaware Co. SWCD (765) 747-5531	Johnson Co. SWCD (317) 736-9540	Porter Co. SWCD (219) 464-1049	Warrick Co. SWCD (812) 897-2840
Dubois Co. SWCD (812) 482-1171	Knox Co. SWCD (812) 882-8210	Posey Co. SWCD (812) 838-4191	Washington Co. SWCD (812) 883-3704
Elkhart Co. SWCD (219) 533-3630	Kosciusko Co. SWCD (219) 267-7445	Pulaski Co. SWCD (219) 946-3243	Wayne Co. SWCD (765) 966-0191
Fayette Co. SWCD (765) 825-4311	LaGrange Co. SWCD (219) 463-3471	Putnam Co. SWCD (765) 653-7454	Wells Co. SWCD (219) 824-1930
Floyd Co. SWCD (812) 945-9936	Lake Co. SWCD (219) 663-0588	Randolph Co. SWCD (765) 584-4505	White Co. SWCD (219) 583-5962
Fountain Co. SWCD (765) 793-3651	LaPorte Co. SWCD (219) 362-6633	Ripley Co. SWCD (812) 689-6410	Whitley Co. SWCD (219) 244-6266

Construction/Stormwater Pollution Prevention Plan Technical Review and Comment (*Form 1*)

Project Information	Project Name:					County:				
	Plan Submittal Date:					Hydrologic Unit Code:				
	Project Location Description:									
	Latitude and Longitude:									
	Civil Township:		Quarter:		Section:		Township:		Range:	
	Project Owner Name:									
	Contact:									
	Address:									
	City:		State:		Zip:					
Phone:		FAX:		E-Mail:						
Plan Preparer Name:										
Affiliation:										
Address:										
City:		State:		Zip:						
Phone:		FAX:		E-Mail:						

Plan Review	Review Date:									
	Principal Plan Reviewer:									
	Agency:									
	Address:									
	City:		State:		Zip:					
	Phone:		FAX:		E-Mail:					
	Assisted By:									

☐ **PLAN IS ADEQUATE:** A comprehensive plan review has been completed and it has been determined that the plan satisfies the minimum requirements and intent of 327 IAC 15-5.

☐ Please refer to additional information included on the following page(s).

☐ **Submit Notice of Intent (NOI):** *Attach a copy of this cover page when submitting the NOI to the Indiana Department of Environmental Management. Construction activities may begin 48 hours following the submittal of the NOI. A copy of the NOI must also be sent to the Reviewing Authority (e.g. SWCD, DNR).*

☐ A preliminary plan review has been completed; a comprehensive review will not be completed within the 28-day review period. The reviewing authority reserves the right to perform a comprehensive review at a later date and revisions to the plan may be required at that time to address deficiencies.

☐ Please refer to additional information included on the following page(s).

☐ **Submit Notice of Intent (NOI):** *Attach a copy of this cover page when submitting the NOI to the Indiana Department of Environmental Management. Construction activities may begin 48 hours following the submittal of the NOI. A copy of the NOI must also be sent to the Reviewing Authority (e.g. SWCD, DNR).*

☐ **PLAN IS DEFICIENT:** Significant deficiencies were identified during the plan review.

☐ Please refer to additional information included on the following page(s).

☐ **DO NOT** file a Notice of Intent for this project.

☐ **DO NOT** commence land disturbing activities until all deficiencies are adequately addressed, the plan re-submitted, and notification has been received that the minimum requirements have been satisfied.

☐ **Plan Revisions** ☐ **Deficient Items** should be mailed or delivered to the Principal Plan Reviewer identified in the Plan Review Section above.

Construction/Stormwater Pollution Prevention Plan - Technical Review and Comment (Form 1)

Project Name: 0
Date Reviewed: 01/00/00

The technical review and comments are intended to evaluate the completeness of the Construction/Stormwater Pollution Prevention Plan for the project. The Plan submitted was not reviewed for the adequacy of the engineering design. All measures included in the plan, as well as those recommended in the comments should be evaluated as to their feasibility by a qualified individual with structural measures designed by a qualified engineer. The Plan has not been reviewed for other local, state, or federal permits that may be required to proceed with this project. Additional information, including design calculations may be requested to further evaluate the Plan.

All proposed stormwater pollution prevention measures and those referenced in this review must meet the design criteria and standards set forth in the "Indiana Stormwater Quality Manual" from the Indiana Department of Natural Resources, Division of Soil Conservation or similar Guidance Documents.

Please direct questions and/or comments regarding this plan review to:

0

Please refer to the address and contact information identified in the Plan Review Section on page 1.

Assessment of Construction Plan Elements (Section A)

The Construction Plan Elements are adequately represented to complete a plan review:

☐ Yes ☐ No

The items checked below are deficient and require submittal to meet the requirements of the rule.

A		A	
☐	1 Index showing locations of required Plan Elements	☐	2 11 by 17 inch plat showing building lot numbers/boundaries and road layout/names
☐	3 Narrative describing the nature and purpose of the project	☐	4 Vicinity map showing project location
☐	5 Legal Description of the Project Site (Include Latitude and Longitude - NOI Requirement)	☐	6 Location of all lots and proposed site improvements (roads, utilities, structures, etc.)
☐	7 Hydrologic unit code (14 Digit)	☐	8 Notation of any State or Federal water quality permits
☐	9 Specific points where stormwater discharge will leave the site	☐	10 Location and name of all wetlands, lakes and water courses on and adjacent to the site
☐	11 Identification of all receiving waters	☐	12 Identification of potential discharges to ground water (abandoned wells, sinkholes, etc.)
☐	13 100 year floodplains, floodways, and floodway fringes	☐	14 Pre-construction and post construction estimate of Peak Discharge (10 Year storm event)
☐	15 Adjacent landuse, including upstream watershed	☐	16 Locations and approximate boundaries of all disturbed areas (Construction Limits)
☐	17 Identification of existing vegetative cover	☐	18 Soils map including soil descriptions and limitations
☐	19 Locations, size and dimensions of proposed stormwater systems (e.g. pipes, swales and channels)	☐	20 Plans for any off-site construction activities associated with this project (sewer/water tie-ins)
☐	21 Locations of proposed soil stockpiles and/or borrow/disposal areas	☐	22 Existing site topography at an interval appropriate to indicate drainage patterns
☐	23 Proposed final topography at an interval appropriate to indicate drainage patterns		

Construction/Stormwater Pollution Prevention Plan - Technical Review and Comment (Form 1)

Project Name: 0
Date Reviewed: 01/00/00

Assessment of Stormwater Pollution Prevention Plan (Sections B & C)

Stormwater Pollution Prevention Plan - Construction Component (Section B)

Adequate	Deficient	Not Applicable		
			B	<i>The construction component of the Stormwater Pollution Prevention Plan includes stormwater quality measures to address erosion, sedimentation, and other pollutants associated with land disturbance and construction activities. Proper implementation of the plan and inspections of the construction site are necessary to minimize the discharge of pollutants. The Project Site Owner should be aware that unforeseen construction activities and weather conditions may affect the performance of a practice or the effectiveness of the plan. The plan must be a flexible document, with provisions to modify or substitute practices as necessary.</i>
☐	☐	☐	1	Description of potential pollutant sources associated with construction activities
☐	☐	☐	2	Sequence describing stormwater quality measure implementation relative to land disturbing activities
☐	☐	☐	3	Stable construction entrance locations and specifications (at all points of ingress and egress)
☐	☐	☐	4	Sediment control measures for sheet flow areas
☐	☐	☐	5	Sediment control measures for concentrated flow areas
☐	☐	☐	6	Storm sewer inlet protection measure locations and specifications
☐	☐	☐	7	Runoff control measures (e.g. diversions, rock check dams, slope drains, etc.)
☐	☐	☐	8	Storm water outlet protection specifications
☐	☐	☐	9	Grade stabilization structure locations and specifications
☐	☐	☐	10	Location, dimensions, specifications, and construction details of each stormwater quality measure
☐	☐	☐	11	Temporary surface stabilization methods appropriate for each season (include sequencing)
☐	☐	☐	12	Permanent surface stabilization specifications (include sequencing)
☐	☐	☐	13	Material handling and spill prevention plan
☐	☐	☐	14	Monitoring and maintenance guidelines for each proposed stormwater quality measure
☐	☐	☐	15	Erosion & sediment control specifications for individual building lots

Stormwater Pollution Prevention Plan - Post Construction Component (Section C)

Adequate	Deficient	Not Applicable		
			C	<i>The post construction component of the Stormwater Pollution Prevention Plan includes the implementation of stormwater quality measures to address pollutants that will be associated with the final land use. Post construction stormwater quality measures should be functional upon completion of the project. Long term functionality of the measures are critical to their performance and should be monitored and maintained.</i>
☐	☐	☐	1	Description of pollutants and their sources associated with the proposed land use
☐	☐	☐	2	Sequence describing stormwater quality measure implementation
☐	☐	☐	3	Description of proposed post construction stormwater quality measures (Include a written description of how these measures will reduce discharge of expected pollutants)
☐	☐	☐	4	Location, dimensions, specifications, and construction details of each stormwater quality measure
☐	☐	☐	5	Description of maintenance guidelines for post construction stormwater quality measures

APPENDIX 10

SUGGESTED FURTHER RESEARCH – NEW DOCUMENTS

Future Document	Contractor SWPPP Assistance Manual
Description and Reason	<ul style="list-style-type: none"> Under new regulations, the Contractor will be required to update the SWPPP, provide notification of actual work beginning dates, and to provide information to INDOT as the project is finalized to attain the NOT and final payment. It is anticipated that some Contractor's may need assistance in this transition period A Contractor SWPPP Assistance Manual should be developed. This document will provide step-by-step instructions for the Contractor-initiated SWPPP changes that are required for INDOT construction projects. In the event that the Contractor is required to amend the SWPPP or develop a separate SWPPP for a borrow or disposal site, they may refer to standard SWPPP details, specifications, and maintenance considerations that will be included in this document. This document should also contain a checklist for NOT information that must be submitted by the Contractor to the Department to gain final acceptance and payment. This manual may also contain BMP inspection checklists and forms, maintenance checklists, and a daily rainfall log form.
Future Document	Contractor(s) NOI Certification Statement Subcontractor(s) NOI Certification Statement
Description and Reason	<ul style="list-style-type: none"> For applicable construction projects with land disturbance activities greater than 1 acre, a certification form should be developed and signed by the Contractor(s) and Subcontractor(s) certifying that they have read and understand the NPDES General Permit rule for construction site stormwater discharges. For Indiana, this will be 327 IAC 15-5 which corresponds to Rule 5. This certification should further state the Contractor has read and understands the SWPPP, plans to implement the SWWP, and will amend the SWPPP as required by project conditions. This form should also make the Contractor(s) and Subcontractor(s) aware of the legal ramifications and monetary fines that can be imposed for a construction site stormwater discharge violation. It should be the Contractor's responsibility to pay any such fines that may results from their erosion and sediment control violations. It should be the Contractor(s) responsibility to obtain this certification from their Subcontractor(s).
Future Document	NOI Guidance for Utility Relocation with INDOT Right-of-Way
Description and Reason	<ul style="list-style-type: none"> When utility relocation or clearing and grubbing for utility relocation is being completed as part of an INDOT project, a Rule 5 permit NOI will be required when the overall disturbed area of the project is greater than 1 acre. This document should present some sequencing considerations for the utility relocation process as they relate to erosion and sediment control.

Future Document	INDOT Vegetation Establishment Manual with Indiana Native Species
Description and Reason	<ul style="list-style-type: none"> • A vegetation establishment guide that promotes the use of species native to Indiana should be developed. This information is particularly important in wetland planting and duneland areas where the spread of invasive species is a significant concern. Seed mixtures should also be reviewed as they relate to soil types common to the State of Indiana (ex. seed mixtures for sandy areas). • As previously discussed, current INDOT seed mixtures and planting recommendations should be reviewed. The use of invasive and noxious species should be restricted only to situations where it can be shown that alternative native vegetation types will not thrive. • A good reference for native species is the <u>Roadside Use of Native Plants</u> published by the Federal highway Association. This document is available (as of November 14, 2005) at http://www.fhwa.dot.gov/environment/handbook.htm • Another useful reference is the <u>2003 Seeding Manual</u> from the Minnesota Department of Transportation Office of Environmental Services Erosion Control Unit. The format of this document is user friendly and well organized. If used as a reference or seeding guide, the seed mixes suggested in this publication should be cross referenced and verified as applicable to Indiana conditions. This document is available (as of November 14, 2005) at : http://www.dot.state.mn.us/environment/pdf_files/SeedingManual2003.pdf

Future Document	Erosion and Sediment Control Inspector Certification Program
Description and Reason	<ul style="list-style-type: none"> • Similar to the other Certified Technician Program Training Manuals, a training program for erosion and sediment control inspection should be developed for INDOT employees and field personnel. • Training information contained in this manual should include: <ul style="list-style-type: none"> • Introduction to Stormwater Pollution Prevention • Background Regulations - NPDES • Stormwater Pollution Prevention Plan (SWPPP) Basics <ul style="list-style-type: none"> • What is a SWPPP • Amending a SWPPP • Notice of Intent (NOI) • Notice of Termination (NOT) • Construction Phase BMPs - Erosion and Sediment Control <ul style="list-style-type: none"> • Types of BMPs • BMP Inspection • BMP Maintenance • BMP Documentation • Common Deficiencies • Post-Construction Phase BMPs – Long Term Stormwater Pollution Control <ul style="list-style-type: none"> • Types of BMPs • BMP Inspection • BMP Maintenance • BMP Documentation • Common Deficiencies • Retrofitting Needs • Construction and Post-Construction Inspection Forms

Future Document	SWPPP Preparation and Submittal Policy
Description and Reason	INDOT should establish a policy of who may prepare and submit or modify an approved SWPPP. INDOT may wish to limit this to Professional Engineers registered in the State of Indiana. In this case, the SWPPP should be stamped and signed. Other potential credential requirements include a Certified Professional in Erosion and Sediment Control (CPESC) and/or Certified Professional in Stormwater Quality (CPSWQ), sponsored by the International Erosion Control Association.