



**Qualified Professional Inspector
Training Manual**

Southern Indiana Stormwater
Advisory Committee

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1.0 Qualified Professional Inspector Program

1.1 PROGRAM OVERVIEW

This Qualified Professional Inspector Program is sponsored by the Southern Indiana Stormwater Advisory Committee (SWAC). The SWAC provides a forum for public education, outreach, participation and involvement, as well as coordinated implementation of the MS4 program in participating communities.

The Qualified Professional Inspector (QPI) program is tailored to address stormwater concerns and key issues of Indiana Department of Environmental Management (IDEM) and includes, but is not limited to, the following SWAC communities: Clark County, Floyd County, the City of Jeffersonville, the City of New Albany, the City of Madison, the Town of Clarksville, the Town of Sellersburg, and the Oak Park Conservancy District. The course will focus on inspection of stormwater best management practices (BMPs).

The goal of this program is to provide consistent training for active construction site inspectors responsible for inspections of stormwater best management practices (BMPs) installed at development or re-development sites regulated under Rule 5 (327 IAC 15-5) and Rule 13 (327 IAC 15-13) in communities participating in the SWAC. A thorough understanding and implementation of these requirements will lead to fewer delays, avoiding or minimizing costly compliance issues.

Construction Site Runoff Control Ordinances adopted by SWAC communities include requirements for construction site self inspections to be performed by a Qualified Professional Inspector. The QPI program provides a system to qualify persons to inspect stormwater BMPs at construction sites, document and report inspection results as required by local ordinances, and will provide a mechanism for consistent and comprehensive inspections throughout this region.

The QPI program consists of four major elements: training course; resource materials; qualifying examination; and, at the discretion of the MS4 community, registration or licensing of Qualified Professional Inspectors. These program elements are described in the sections that follow.

Note: Participation in the QPI program is **required** for those who perform construction site stormwater self-inspections in SWAC communities. Participation in the QPI program is recommended for plan developers including developers, site designers, development engineers, and contractors.

1.2 TRAINING COURSE

A one-day training course has been developed to provide participants with an opportunity to learn the requirements for stormwater BMP self-inspections in a classroom setting. The training course consists of lectures and practical exercises designed to prepare participants for the exam. The course is taught by a licensed professional engineer experienced with erosion prevention and sediment control.

Applicants are not required to attend the training course before the first exam attempt; however, attendance is strongly encouraged. The classroom setting provides an excellent opportunity to obtain assistance with stormwater questions and to interact with other stormwater professionals prior to taking the exam. The training course is scheduled to be held in the spring and fall of each year if fifteen (15) or more students have registered.

Course attendance is required under the one or more of following circumstances:

- Applicant did not attend the training course before the first exam attempt and did not pass the exam;
- Applicant attended the training course before the first exam attempt and did not pass the exam, or;
- A participating community revoked the registration or license of the applicant.

To receive credit for attendance, you must present a government-issued photo ID and be present for at least 90% of the total class time. If an applicant misses more than 10% of the total class time, the applicant will be required to register and pay for a subsequent training course and satisfactorily attend the course to receive credit for attendance.

1.3 RESOURCE MATERIALS

Several useful resource materials have been developed to assist with preparing for the exam and with implementing the duties of a Qualified Professional Inspector, including:

- **Qualified Professional Inspector Training Manual** – This Qualified Professional Inspector Training Manual includes a description of local stormwater programs, factors that affect erosion prevention and sediment control, selection of stormwater best management practices, and responsibilities of the Qualified Professional Inspector.
- **Stormwater Best Management Practices Design Manual** – Each SWAC community developed and adopted a Stormwater Best Management Practices Design Manual. The manuals include fact sheets describing appropriate uses, siting, design, installation, inspection, and maintenance for specific BMPs.

- **Qualified Professional Inspector Training Slides** – The Qualified Professional Inspector Training slides include a brief summary of the information taught in the training course as well as numerous photographs of BMPs under a range of real-world conditions. These slides were designed to assist QPIs with preparation for the exam as well as to assist with site inspections.

These resource materials will be provided to candidates who register for the exam, regardless of whether they attend the training class.

1.4 QUALIFIED PROFESSIONAL INSPECTOR EXAM

A standardized examination is required to fairly and thoroughly assess the qualifications of course applicants to conduct stormwater BMP inspections on construction sites in participating communities. The exam is based on the contents of this manual, the training presentation, Rule 5, Rule 13, and the Stormwater Best Management Practices Design Manual.

The exam is “open book”, i.e., the applicant may use the reference materials identified above while taking the exam. A score greater than or equal to seventy-five percent (75%) is required to pass the exam. The exam is available in two formats: on-line and paper.

On-line exam: The applicant receives the website, user name and password information after payment of the registration fee. A high-speed internet connection (cable or DSL) is recommended. Applicants should allow up to two (2) hours to complete the exam. The exam must be finished without interruption once testing has been initiated. On-line exams are scored automatically and results are downloaded by the Qualified Professional Inspector program representative.

Paper exam: The paper exam may be taken on the same day as the training class or at the offices of the Qualified Professional Inspector program representative. Please contact the appropriate Qualified Professional Inspector program representative to schedule a two-hour appointment to take the exam.

The examination scoring process is designed to treat examinees equally. Therefore, the applicant and participating communities will receive written notification of the pass/fail status of an applicant. Neither the applicant nor participating communities will be provided with the exam score. Applicants who pass the exam will be added to the list Qualified Professional Inspectors maintained by the community’s MS4 Coordinator (**Appendix H**).

Applicants who did not pass the exam are required to attend the training course prior to re-examination. The registration fee may be waived if the applicant attends the training course and completes the second attempt to pass the exam within six (6) months of the original examination date. To arrange for re-examination, contact the QPI program representative (**Appendix H**).

1.5 LOCAL REGISTRATION OR LICENSING

Participating MS4 communities maintain lists of applicants who have attended the training course, taken the exam, and their pass/fail status. At their discretion, MS4 communities may require those who pass the exam to obtain a registration or license prior to performing inspections in that community. At their discretion, participating MS4 communities may collect a fee for obtaining a Qualified Professional Inspector registration or license. Qualified Professional Inspector requirements are included in local ordinances, which may also specify the time frame that the registration or license is valid and the reasons that the registration or license may be revoked. As per local ordinances, Qualified Professional Inspector registration or license may be revoked by the community for reasons including, but not limited to the following:

- Does not comply with federal, state and local laws, ordinances, or resolutions governing Qualified Professional Inspector activities;
- Fails to perform the duties of a Qualified Professional Inspector;
- Unable to properly perform an evaluation of a stormwater quality management system;
- Found to be negligent in duties by a participating community;
- Submit false or misleading information; or
- Fails to maintain certification under any change in the law pertaining to Qualified Professional Inspectors.

A Qualified Professional Inspector may appeal the revoked registration or license and, if eligible, may re-enroll in the program based on that community's procedures.

1.6 LOGISTICS

The Qualified Professional Inspector training course is scheduled to be held in the spring and fall of each year, if fifteen (15) or more students have registered.

The registration fee for 2009 is \$250.00. Contact the QPI program representative listed in **Appendix H** for the current registration fee.

For those who chose to attend the training class, the registration fee includes:

- One-day training class, certificate of completion if applicable. Lunch and refreshments are included.
- Resource materials (Qualified Professional Inspector Training Manual, Stormwater Best Management Practices Design Manual, Qualified Professional Inspector Training Slides).
- Exam (on-line or paper), written notification of pass/fail exam results. For those who pass the exam, a Qualified Professional Inspector certificate will be issued.

For those who chose not to attend the training class, the registration fee includes:

- Resource materials (Qualified Professional Inspector Training Manual, Stormwater Best Management Practices Design Manual, Qualified Professional Inspector Training Slides).
- Exam (on-line or paper), written notification of pass/fail exam results. For those who pass the exam, a Qualified Professional Inspector certificate will be issued.

The registration fee may be waived if the applicant attends the training course and completes the second attempt to pass the exam within six (6) months of the original examination date.

Registration forms may be downloaded from the following sources:

- Clark County Soil and Water Conservation District: <http://clarkswcd.org/>
- Floyd County Soil and Water District: <http://www.floydswcd.org>
- Stantec Consulting Services Inc.
350 Missouri Avenue, Suite 100
Jeffersonville, Indiana 47130
812-485-4060

2.0 Southern Indiana Phase II Program

2.1 PROGRAM BACKGROUND

Stormwater runoff is generated when precipitation from rain and snowmelt flows over land or impervious surfaces and does not percolate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated. The primary method to control stormwater discharges is the use of best management practices (BMPs). In addition, most stormwater discharges are considered point sources and require coverage under an NPDES permit.

In 1987, amendments to the Clean Water Act (CWA) established a legal framework and requirements for the United States Environmental Protection Agency (USEPA) to develop a comprehensive, phased program for regulating municipal and industrial stormwater discharges under the National Pollutant Discharge Elimination System (NPDES) permit program. In response, the USEPA instituted Phase I of the NPDES Stormwater Program in November of 1990. The Phase I program required medium to large communities, with populations of at least 100,000 people, and with municipal separate storm sewer systems (MS4s) to develop programs to address the quality of their stormwater discharges. These amendments to the CWA also placed stormwater management requirements on many industries based upon standard industrial classification (SIC) codes, including stormwater permitting requirements on construction activities that disturbed five or more acres of land.

The NPDES Phase II Stormwater regulations were promulgated in December 1999. The Phase II stormwater requirements affect smaller communities with municipal separate storm sewer systems (MS4s) serving populations of less than 100,000 people, as well as construction activities that disturb one or more acres of land. Only those small MS4s located in “urbanized areas”, as defined by the U.S. Bureau of the Census, are required to apply for a stormwater NPDES permit and develop a Stormwater Quality Management Program (SWQMP).

The State of Indiana regulates stormwater quality for active construction sites and urbanized municipalities through Rule 5 (*327 IAC 15-5*) and Rule 13 (*327 IAC 15-13*), respectively. The regulations are administered through the Indiana Department of Environmental Management (IDEM).

2.1.1 Rule 5 – Stormwater Run-Off Associated with Construction Activity

Rule 5 (*327 IAC 15-5*) addresses **construction runoff**. This rule requires construction site owners to obtain a permit before construction begins, including water quality protection plans which are to be implemented before and during construction. Under Phase I, the rule applied to construction activities disturbing five (5) or more acres. Under Phase II, this rule's applicability

requirements were extended to construction activities disturbing one (1) or more acres. This rule establishes the State of Indiana's construction site permit process for stormwater water quality. Rule 5 requires on-going site management through self-inspections conducted on a regular basis and after certain storm events.

2.1.2 Rule 13 – Stormwater Run-Off Associated with MS4 Conveyances

Rule 13 (327 IAC 15-13) addresses **municipal separate storm sewer systems (MS4s)**. These are the portions of a stormwater conveyance system that are not combined with sewage conveyances, and which municipalities, including counties, cities, and towns, are generally responsible for maintaining. MS4s can include roads with drains, catch basins, municipal streets, storm drains, ditches, tunnels, curbs, and gutters. Rule 13's Phase I applied to MS4s that served a population greater than 100,000 people. In Indiana, Indianapolis met this criterion.

Phase II extended the regulation to include mapped urbanized areas, as defined by the US Census Bureau. Other areas were included in the Phase II program in Indiana based on population, population growth, and documentation of water quality impairments. Numerous counties, cities, towns, and other entities were designated as Phase II MS4s, and thus were required to develop and implement a Stormwater Quality Management Plan (SWQMP) beginning in November 2003.

Rule 13 establishes six **minimum control measures (MCMs)**, or program elements, that must be included in a community's SWQMP. The plan must include the development and implementation of measurable goals for these MCMs, including three that are applicable to the construction and development industries. A general overview of the requirements is provided below. Specific requirements are contained in local stormwater ordinances.

- **Illicit Discharge Detection and Elimination** – Includes development and implementation of a plan to detect and eliminate illicit discharges to the stormwater system. This includes prevention of trash, debris, and hazardous wastes such as paints, cleaning solvents, and other potentially harmful chemicals from entering storm drains.
- **Construction Site Stormwater Runoff Control** – Includes development, implementation, and enforcement of a program for construction sites that disturb one (1) or more acres of land. While emphasis is placed on erosion and sediment control, other construction site pollutants must be addressed, from waste debris to equipment fueling.
- **Post-Construction Stormwater Management** – Includes development, implementation, and enforcement of a program to address discharges of post-construction stormwater runoff from new development and re-development areas. This includes protecting sensitive areas (e.g., wetlands) and requires permanent Best Management Practices to treat stormwater from new development and re-development.

These MCMs are the driving force behind the local permitting process for stormwater quality. Rule 13 does not change construction permitting requirements, but requires municipalities to implement a more comprehensive permitting process.

2.1.3 Which Rule Applies?

Both Rule 5 and Rule 13 are intended to control pollution and sediment in stormwater runoff. These two rules work together to establish requirements for stormwater collection systems and construction sites.

Both Rule 5 and Rule 13 apply if all of the following conditions are met:

- The construction project disturbs one (1) or more acres;
- The construction project is located within a designated MS4 area; and
- The permit application was filed after the MS4 community's ordinance regulating construction site runoff was passed.

Rule 5 applies under the following conditions:

- The construction project disturbs one (1) or more acres and
- The project is located outside a designated MS4 area, or
- The project is located within a designated MS4 area, but the permit application was filed before the MS4 community's ordinance regulating construction site runoff was adopted.

The flowchart in **Figure 2.1** was designed to clarify the distinctions.

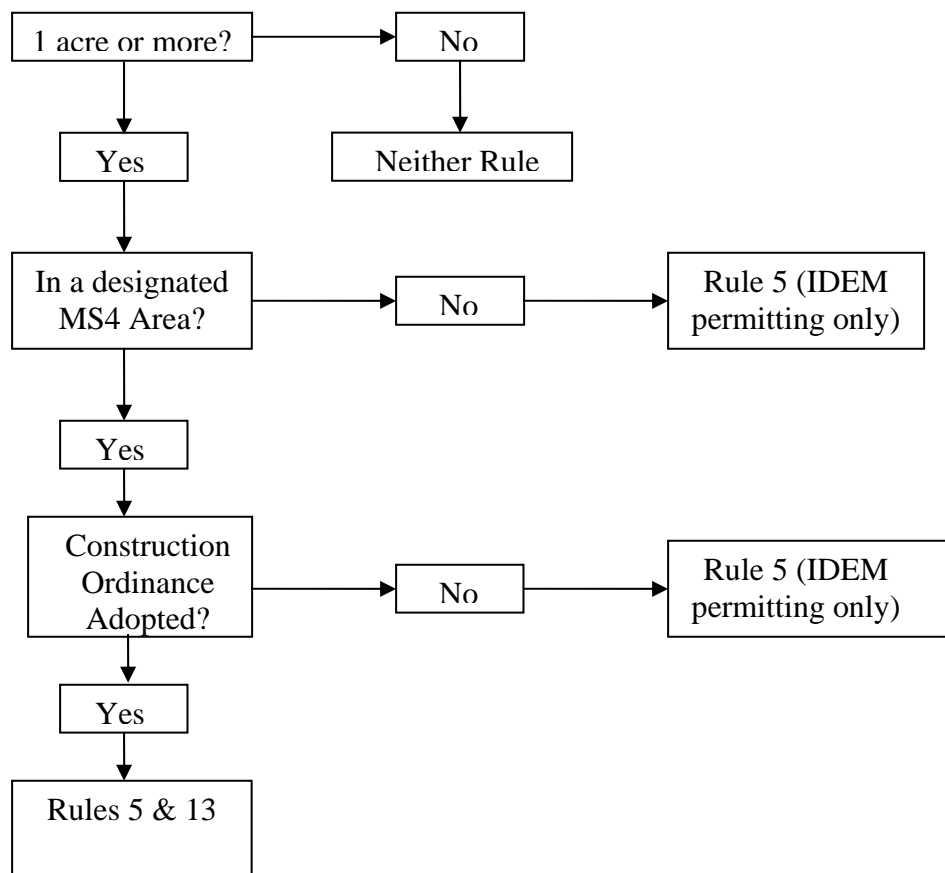


Figure 2.1. Rules 5 and 13 Flowchart

The distinction between the rule(s) used to permit a construction site is highlighted here because requirements for inspector qualifications differ. Construction sites permitted under Rule 13 require stormwater quality self-inspections to be conducted by a Qualified Professional Inspector. Construction sites permitted under Rule 5 do not require stormwater quality self-inspections to be conducted by a Qualified Professional Inspector.

2.2 LOCAL IMPLEMENTATION

Rule 13 requires that all MS4 operators develop plans to prohibit illicit discharges to the MS4 collection system and to manage stormwater from construction activities, and developed areas. Several Southern Indiana communities have developed similar ordinances regulating these discharges, including:

- Clark County
- Floyd County

- City of New Albany
- City of Jeffersonville
- City of Madison
- Town of Clarksville
- Town of Sellersburg
- Oak Park Conservancy District

These communities have developed a similar set of requirements governing **illicit discharges**, or discharges which are not allowed to enter the stormwater system. In these communities, it is illegal to allow non-stormwater discharges into the MS4, including the following:

- Construction materials, such as sediment.
- Chemicals including acids, alkalis, bases, petroleum or automotive products, paints, stains, resins, lacquers, varnishes, degreasers, solvents, drain cleaners, pesticides, herbicides, fertilizers, steam cleaning wastes, detergents, soaps, ammonia, chlorinated swimming pool discharge, chlorine or other disinfectants, dyes, toxic materials from paved or unpaved areas, or other chemicals not normally found in uncontaminated water.
- Washwater from fresh concrete; from cleaning, finishing, or exposing aggregates; from cleaning auto repair facilities and gas stations; from mobile commercial and industrial cleaning operations, such as carpet cleaning; or from cleaning restaurant mats, roof vents, grease traps, or other equipment.
- Water from areas devoted to machinery repair or storage for materials containing grease, oil, or hazardous materials.
- Flammable, explosive, or radioactive materials.
- Trash, debris, or junk vehicles.
- Sewage and wastes from leaking sanitary sewers, leaking solid waste disposal containers, recreational vehicles, animals, animal carcasses, food, medical establishments.
- Bark and other fibrous materials; collected lawn clippings, leaves, or branches.
- Metals.
- Batteries.
- Heated water.

Allowable non-stormwater discharges are from emergency firefighting activities; diverted stream flows; rising groundwater; discharges from potable water sources for system maintenance such as drinking water line flushing; air conditioning condensate; lawn watering; de-chlorinated swimming pool discharges; and other uncontaminated or treated water sources.

These communities have also developed similar requirements governing construction site activities and post-construction activities and agreements, which are outlined in **Section 2.3**. Ordinances for Clark and Floyd County MS4 communities can be found online through the SWCD or community website. These websites are provided in **Appendix G**.

2.3 WATER QUALITY PROTECTION PLANS AND PERMIT REQUIREMENTS

This section provides a summary of the permit requirements for construction sites.

Table 2.1 provides an overview of construction stages and their associated plans, permits, and agreements. Each MS4 community has its own reviewing authority(s) and fee structure, as outlined in **Appendix B**.

Table 2.1. Construction Stages, Plans, and Permits / Agreements

Construction Stage	Plans	Permits / Agreements
Site Preparation	Perimeter Control Plan (PCP)	Perimeter/Outfall Protection Permit (PPP)
Active Construction	Stormwater Pollution Prevention Plan (SWPPP) Grading Plan Drainage Plan	Stormwater Quality Management Permit (SWQMP)
Post-Construction	Post-Construction Stormwater Pollution Prevention Plan	Long-Term Maintenance and Operations Agreement (LMOA)

Questions regarding compliance with Rule 5 and Rule 13 can be directed to the local stormwater coordinator or SWCD representative.

2.3.1 Pre-Construction

There are a number of steps that must be taken before any construction may begin on a site. These include public notice, plan submission, and submission of a Notice of Intent (NOI) letter. The pre-construction permitting process is illustrated in **Figure 2.2**.

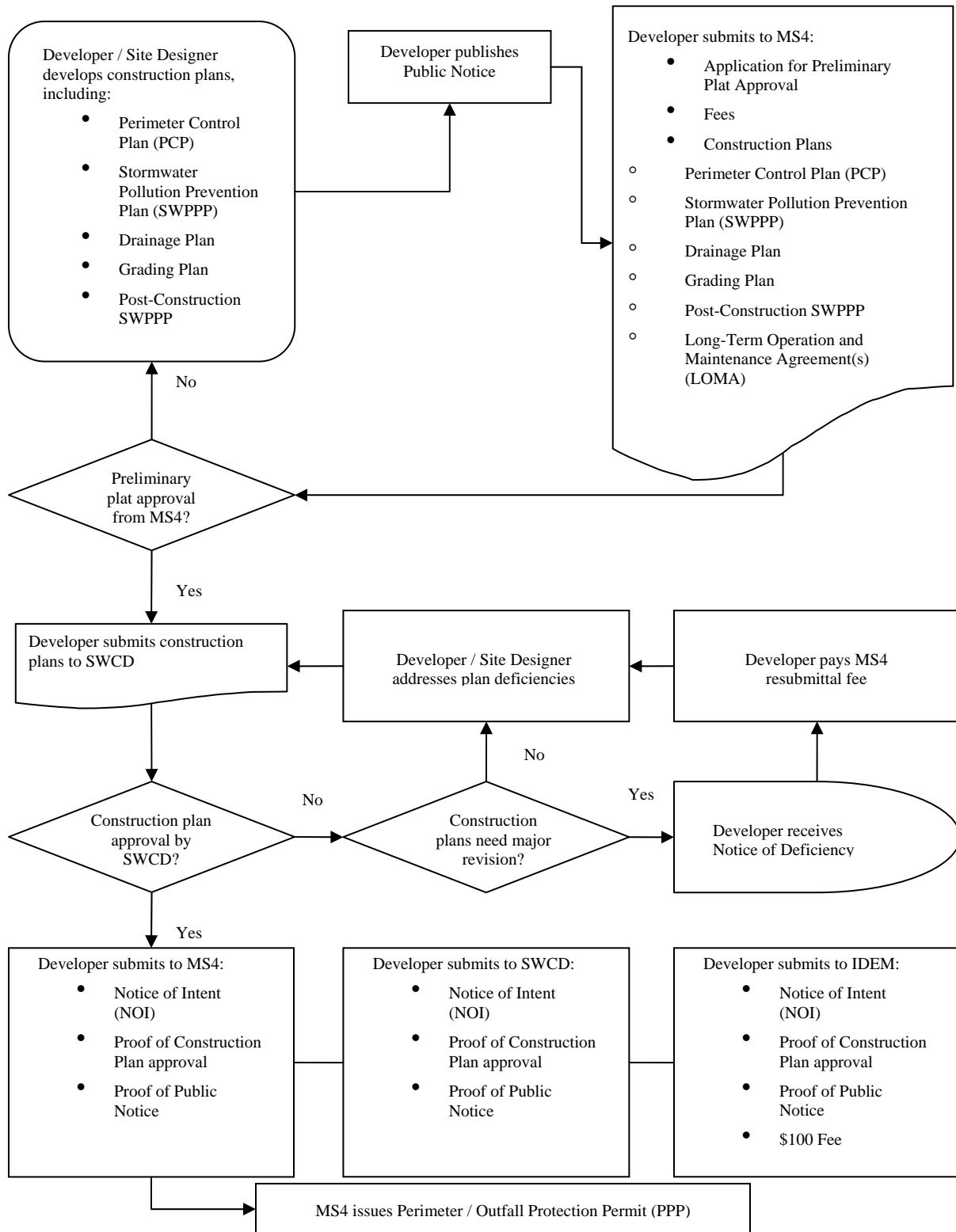


Figure 2.2. Pre-Construction Permitting Process

2.3.1.1 Public Notice

A public notice must be placed in a newspaper that is in circulation in the project site area. The public notice must state, according to *327 IAC 15-5-5(a) (9)*:

(Company name, address) is submitting an NOI letter to notify the Indiana Department of Environmental Management of our intent to comply with the requirements under 327 IAC 15-5 to discharge stormwater from construction activities for the following project: (name of the construction project, address of the location of the construction project). Run-off from the project site will discharge to (stream(s) receiving the discharge(s)).

The public notice should be complete or the Indiana Department of Environmental Management (IDEM) will require a new notice to be placed in the paper. Proof of publication must be submitted with the Notice of Intent (NOI) letter.

2.3.1.2 Plan Submission

Construction plan submission is the next step in obtaining a permit. The plan should include all of the plans to be used on site. Specifically, it includes: a narrative of the project site that includes the Hydrologic 14 Unit Codes (HUC14); vicinity map; existing and final project site layouts; perimeter control plan; grading plan; drainage plan; stormwater pollution prevention plan; post-construction stormwater pollution prevention plan; and long-term operation and maintenance agreement, when applicable. These plans are explained in more detail below with the applicable phase of construction. The construction plan should be submitted to the appropriate MS4 and SWCD office in the county where the construction will take place for review and approval. The reviewing authority has 28 days after submittal to review the plan. If the plan is deficient and the project site owner receives a Notice of Deficiency (NOD) letter, the owner has to make the corrections and resubmit the construction plan. The 28-day review period will start over once resubmitted. If the project site owner does not receive a NOD letter after 28 days, the owner may submit the Notice of Intent letter.

2.3.1.3 Notice of Intent (NOI)

After construction plans are approved, a Notice of Intent (NOI) letter is submitted by the project site owner to the MS4 entity or entities with jurisdiction over the site, the County SWCD, and IDEM at least 48 hours before any land disturbance occurs. The NOI provides the following information: site location; site owner, company, and contact information; site acreage; impervious area after construction is completed; duration of the project; MS4 entities affected by the construction; and receiving waters for any discharge. When submitting the NOI letter, proof of publication, proof of construction plan approval, and applicable permit filing fees should also be submitted. The standard NOI form can be found in **Appendix C**.

Indiana requires that the NOI be signed by a responsible corporate officer, general partner/proprietor or their duly authorized representative (*327 IAC 15-4-3*). A duly authorized representative must be designated in writing by the responsible corporate officer or general

partner/proprietor and must have a position of responsibility. The person signing the NOI is responsible for certifying that the NOI and its attachments were prepared under his or her direct supervision and accepts responsibility for penalties for knowing violations.

2.3.2 Site Preparation

Initial site disturbance activities can cause erosion and lead to sediment accumulation on adjacent properties. To address this issue, local stormwater ordinances require development and approval of a Perimeter Control Plan. The purpose of the Perimeter Control Plan is to set up a boundary to trap sediment before it leaves the site once site construction begins. In this way, adjacent streams and properties will be protected from sedimentation from the moment construction begins. The Perimeter Control Plan (PCP) is implemented under a Perimeter/Outfall Protection Permit (PPP). The site preparation permitting process is illustrated in **Figure 2.3**.

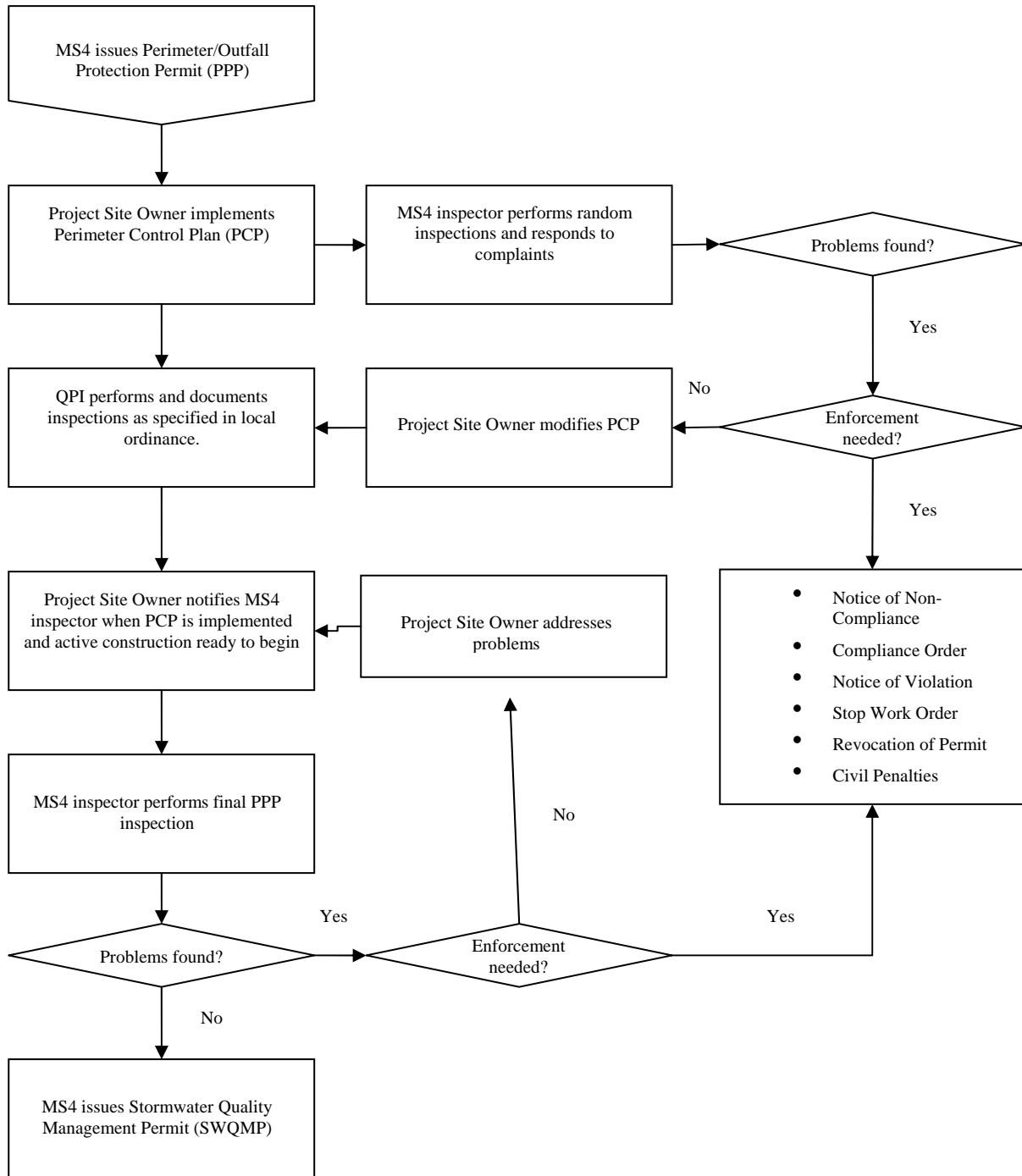


Figure 2.3. Southern Indiana Construction Permitting Process, Site Preparation Stage

2.3.2.2 Perimeter Control Plan (PCP)

The **Perimeter Control Plan (PCP)** establishes a boundary before construction begins to prevent sediment from leaving the site. This plan should include methods to be used (best management practices, or BMPs), locations onsite, and the maintenance of these BMPs. The PCP includes sediment management BMPs such as vegetated buffers, silt fence, sediment basins, or rip-rap to prevent sediment from leaving the site at its drainage outlets. The PCP should also include stabilized construction entrances and roads to keep sediment from leaving the site. The only earthmoving activities that can be performed to implement the PCP are activities for installation of the perimeter BMPs.

2.3.2.3 Perimeter / Outfall Protection Permit (PPP)

The **Perimeter / Outfall Protection Permit (PPP)** gives the developer permission to implement the PCP. Issuance of this permit indicates that the PCP includes measures necessary to prevent erosion and to control sediment from being washed off-site with runoff. The MS4 inspector will determine if the PCP implementation is satisfactory or not. Once PCP implementation is determined to be satisfactory, the MS4 will issue the Stormwater Quality Management Permit (SWQMP). Active construction may begin after the SWQMP is issued.

2.3.3 Active Construction

During active construction, several complimentary plans are required that address drainage, grading, and water quality on the site. These plans work together to ensure that water leaving the site will not carry excessive pollutant loads and will not flow at a rate that can cause damage downstream from the site. Active construction is governed by a Stormwater Quality Management Permit (SWQMP). The active construction permitting process is illustrated in **Figure 2.4**.

2.3.3.1 Stormwater Pollution Prevention Plan (SWPPP)

The **Stormwater Pollution Prevention Plan (SWPPP)** is the key to controlling the pollution and sediment resulting from disturbed land. The purpose of the SWPPP is to establish which BMPs are to be used to protect the site from erosion and control offsite sedimentation during active construction. It is a blueprint for the location, installation, and maintenance of temporary and permanent BMPs. It documents the potential for erosion on a site and the steps to mitigate this hazard. The SWPPP should state any possible pollutants at the construction site and how they should be handled. The plan should have protocols to prevent pollution from spreading and directions for cleaning up any potential problems. The plan is typically a working document – it may not remain the same over the course of active construction, and should be updated to reflect current conditions and problems encountered at the site. SWPPP development and implementation is illustrated in **Figure 2.5**.

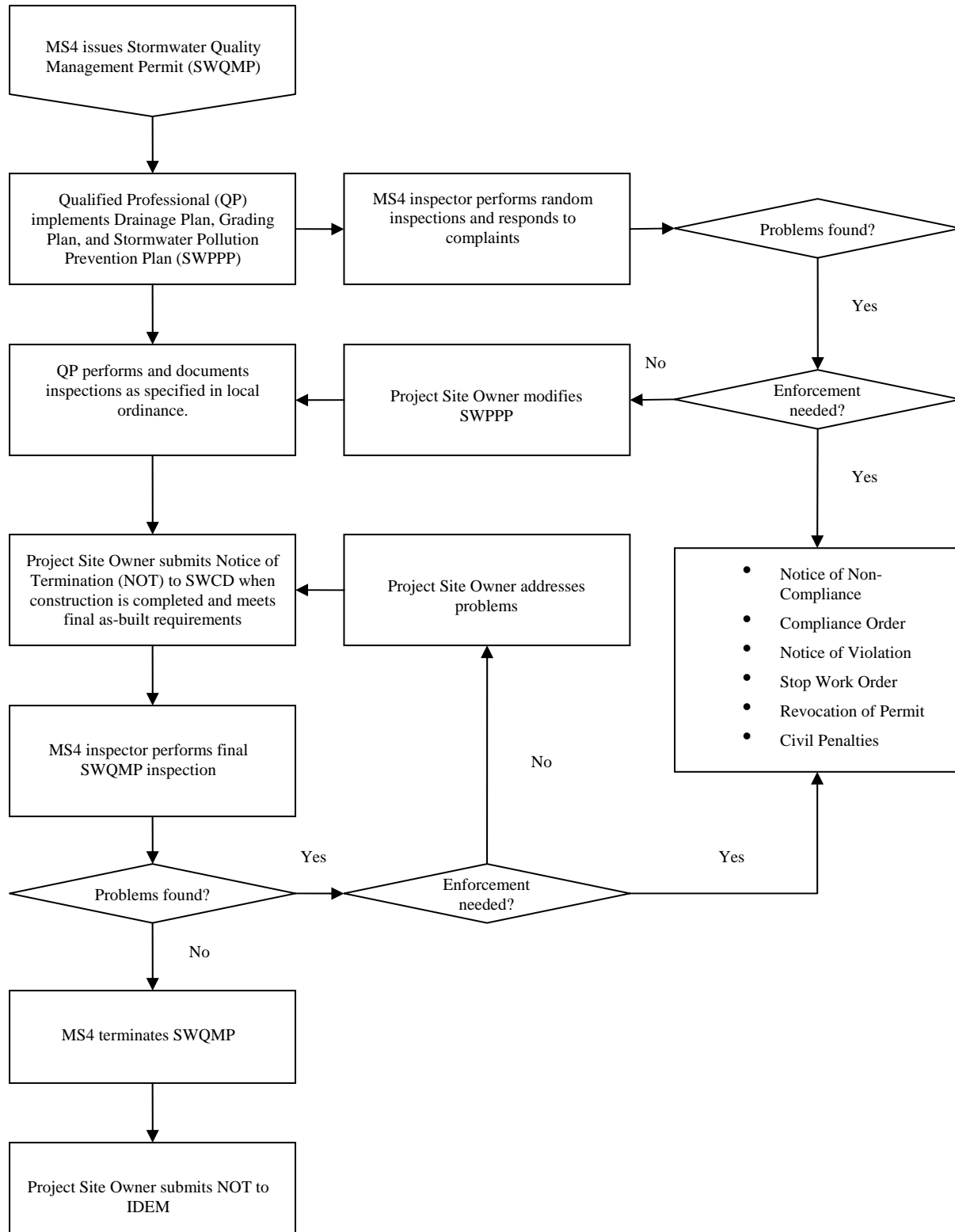


Figure 2.4. Southern Indiana Construction Permitting Process, Active Construction Stage

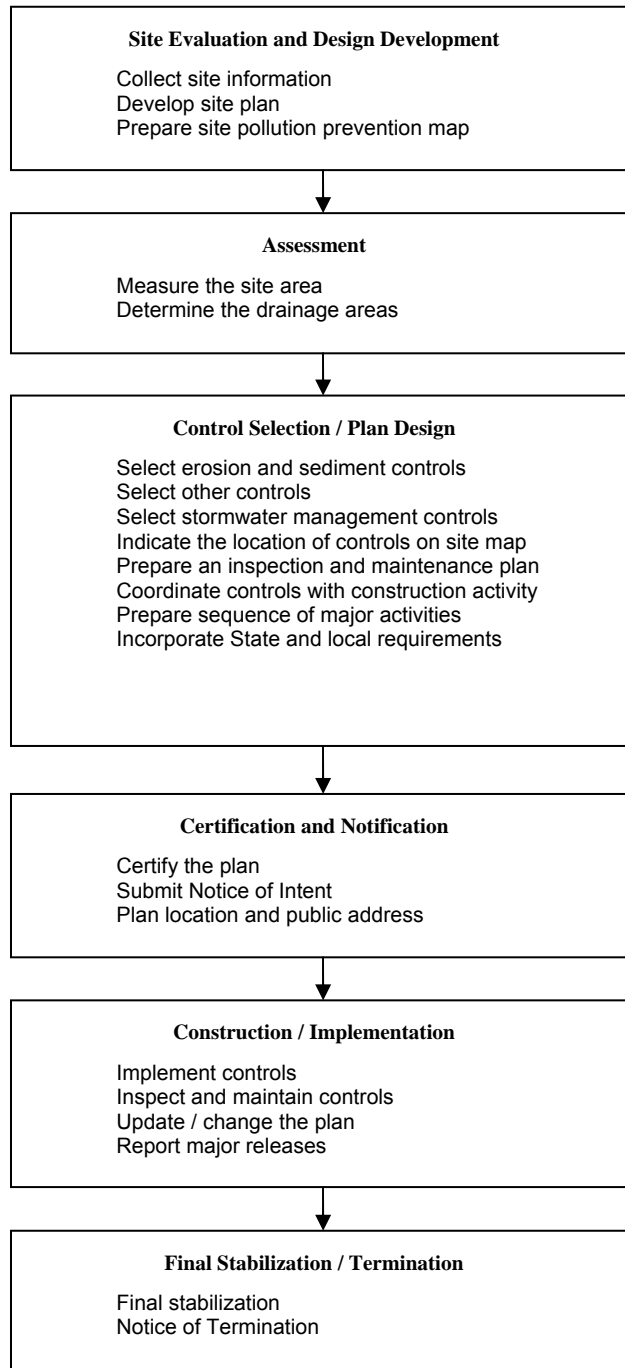


Figure 2.5. Phases of Developing and Implementing a SWPPP

A plan for a small subdivision on a level grade will not be nearly as complex as a plan for a large subdivision, a commercial park, or a subdivision on steep slopes. The highest level of planning is required for sites located near waterways or wetlands, in densely populated areas or areas upslope from dense populations, on steep slopes, or on high-value properties where damage may be particularly costly. It is important that the SWPPP be incorporated into the design of the site layout in order to minimize necessary controls.

2.3.3.2 Grading Plan

A **grading plan** is required to show how the proposed construction will affect the topography of the site. The revised grades can be shown on the same topographic map as the existing grade. Two separate symbols can be used to differentiate the contours. The grading plan is used to determine the areas that will be disturbed for re-grading.

The grading plan is important for erosion and sedimentation control in that it contains instructions for construction phasing, schedule for BMP implementation, no-disturbance areas (such as vegetated buffers and wooded areas), soil stockpile stabilization instructions, and slope stabilization. It addresses sediment as a pollutant, and is designed to ensure that slopes remain stable throughout construction.

2.3.3.3 Drainage Plan

The **drainage plan** shows the drainage patterns of the site after the major grading activities have occurred. This should be shown on a topographic map that designates the drainage basins, channels, or pipes. The drainage boundaries should be drawn as closed lines or polygons which start and end at a common outlet. They typically follow the high points of elevation. The drainage areas should not overlap each other. The drainage plan is required by Rule 5 to describe peak runoff for both pre- and post-development. Local ordinances may specify an allowable change between these conditions that is designed to protect downstream properties from flooding and minimize in-stream erosion.

2.3.3.4 Stormwater Quality Management Permit (SWQMP)

After the perimeter and outfalls have been inspected by the MS4 entity or their agent, a **Stormwater Quality Management Permit (SWQMP)** will be issued. This permit grants permission to break ground on the remainder of the site and indicates that necessary provisions for water quality have been made in the grading plan, drainage plan, and SWPPP. At this point, the QPI is required to inspect all the provisions of these plans, including perimeter and onsite maintenance, inspections of BMPs, evaluation of stormwater runoff and BMP effectiveness, and updates to the plan to reflect changing site conditions. Self-inspection forms can be found in **Appendix C**. While the project site owner is ultimately responsible for the quality of water leaving the site during active construction, the QPI is responsible for providing accurate and timely inspections to identify problem areas before they become compliance issues.

2.3.4 Post-Construction Management

In addition to the plans for pre-construction and active construction, a plan needs to be submitted for post-construction stormwater management. The purpose of this plan is to control pollutants including sediment, oil and gas, trash, and others after construction is completed.

2.3.4.1 Post-Construction Stormwater Pollution Prevention Plan (SWPPP)

The Post-Construction SWPPP provides a description of the proposed land use. This includes the amount of impervious area, directly connected impervious area, and the nature of the development. The plan also lists the location, dimensions, detailed specifications, and construction details of post-construction BMPs. A timeline for post-construction BMP installation and maintenance should be included.

2.3.4.2 Notice of Termination (NOT)

The **Notice of Termination (NOT)** is required to be submitted and approved before occupancy permits will be issued. The NOT is also required if there is a change in ownership of the site which requires new permits to be issued. This standard form is a statement that land-disturbing activities have been completed on the site and no new land-disturbing activities will take place; all permanent BMPs are in place and in working order; and all temporary BMPs have been removed. The standard NOT form can be found in **Appendix C**.

The NOT is submitted at the end stage of construction to the local SWCD where the construction is taking place. After approval of the NOT letter from the local SWCD, the NOT letter should then be submitted to IDEM for final approval. Upon final written approval of the NOT from IDEM, the developer is released from responsibility for erosion control on the site, including the responsibility to have self-inspections performed by a QPI. Any responsibilities for post-construction BMPs are documented in the Post-Construction Long-Term Operations and Maintenance Agreement.

2.3.4.3 Long Term Operations and Maintenance Agreement (LTOMA)

The **Long Term Operations and Maintenance Agreement (LTOMA)** contains the operations and maintenance requirements for the post-construction BMPs. It is a contract between the MS4 community, the current site owner, and future site owners that assigns responsibility for operation and maintenance of post-construction (i.e., permanent) BMPs to the MS4, the developer, the owner, or another entity such as a homeowners association. The LTOMA is recorded with the deed and exists in perpetuity. The LTOMA is submitted for approval with the Post-Construction SWPPP, and it becomes effective when the Notice of Termination has been approved.

2.4 ROLES AND RESPONSIBILITIES

There are a number of people and entities involved in new development or re-development projects. These people and entities have typical roles and responsibilities with regard to stormwater management at a construction site.

Property Owners: Property owners physically own the site of construction. The property owner may or may not be the “operator” of the project. If the property owner is the operator, he or she is responsible for the construction plans and day-to-day operations of the site. The owner can also designate someone as the operator of the site.

Developers: Developers are responsible for the site work. They may have been the designer for the site, and may be an operator of the project. The developer is responsible for submitting the application and plans to the MS4 entity for preliminary plat approval and construction plans, including the stormwater quality management plans. The developer is likely to be the person with whom the QPI will interact on a day-to-day basis.

Site Designers: Site designers develop the site layout and structural designs. They have the responsibility of providing accurate and safe designs to the developer and owner. They may be responsible for the preparation of the PPP and SWPPP. If there are drainage or water quality issues occurring on the site after stormwater quality BMPs have been implemented, findings of the QPI inspection should be reported to the site designer. If significant changes are proposed for retention or detention facilities onsite, a designer or engineer may be required to sign off on these changes before they are implemented.

Contractors: In addition to their construction responsibilities, contractors and subcontractors are responsible for the physical implementation, and possibly maintenance, of permanent stormwater controls on the site. They are also responsible for utilizing BMPs such as construction entrances, truck tire washes etc.

MS4 Entities: MS4 entities approve construction plans, including stormwater quality protection plans. The MS4s are required under Rule 13 to inspect construction sites to ensure that the PPPs and SWQMPs are being properly implemented. Some of the participating MS4s in this area have contracted with the Clark and Floyd County SWCDs to provide this service; others have a stormwater coordinator that inspects the construction sites. The MS4 inspector has the authority to enforce local ordinances if a site is found to be in non-compliance with its stormwater quality management plans, or is otherwise in violation of the stormwater ordinances.

Qualified Professional Inspectors: The role of the Qualified Professional Inspector is explained briefly below and in more detail in **Chapter 5**.

A Qualified Professional Inspector is qualified to inspect, document and report on the status of stormwater quality BMPs at a construction site. A QPI must successfully pass the Qualified Professional Inspector examination and register or obtain a license (if required) by the local MS4 community. The Qualified Professional Inspector is responsible for:

- **Inspecting** stormwater BMPs at construction sites on a regular basis and after storm events of a certain size. Specific requirements for inspection frequencies are contained in local ordinances.
- **Documenting** inspection results using forms approved by the local MS4 community.
- **Reporting** inspection results to appropriate personnel associated with the development project (e.g., developer, site designer, contractors, etc.).

As shown in **Figure 2.3** and **Figure 2.4**, inspections for the PPP and SWQMP are required by local stormwater ordinances, which may vary from community to community. The QPI is responsible for understanding the inspection requirements for the community in which they are working. The QPI is responsible for inspecting all drainage and stormwater BMPs and documenting the inspections. The QPI is responsible for reporting inspection results to appropriate project personnel, including reporting on BMP maintenance needs and erosion problems on the site.

Through ordinances and LTOMAs, some communities require post-construction BMPs to be inspected on a regular basis by a Qualified Professional. In this case, the Qualified Professional Inspector should have a thorough understanding of post-construction stormwater infrastructure and BMPs in order to effectively and comprehensively evaluate the facility performance. The Qualified Professional Inspector should also have detailed information about the site and specifications of the BMP in order to adequately assess infrastructure performance and to determine if maintenance or improvements are necessary. Please note that this course does not qualify individuals as a QPI for post-construction stormwater management BMPs.

2.5 ENFORCEMENT

The MS4 entity in which the site is located, as well as the state authorities, are responsible for the enforcement of the stormwater regulations. There are several mechanisms of enforcement that are typically used in an escalating manner to facilitate compliance with the terms and requirements of the PPP and SWQMP, including:

- A letter may be issued outlining deficiencies identified by the MS4 inspector or their agent. Typically a timeframe to correct the deficiencies is stated and the site is re-inspected.
- A Notice of Violation (NOV) is sent to the site owner. Within a specified time of receiving the NOV, the violation should be explained and a plan to correct the violation and future prevention should be submitted.
- The PCP or SWQMP can be revoked for any failure to comply with the regulations.
- A Stop Work Order can be issued to halt construction on the site.

- A Compliance Order notifies the owner of the violation and has a scheduled period that the activities in violation must be stopped.
- If there is imminent danger to the public, the activities in violation must be stopped immediately.
- Fines may be issued for each day that the violation or violations occur. The amount of the fine is specified in the MS4 community's ordinances regulating construction sites. Other civil penalties include requiring that the violator clean and restore the land to its condition before the violation.

As a Qualified Professional Inspector, your role is to perform self-inspections, document the findings, and report the results of those inspections so the site owner can work to address stormwater issues in an efficient and timely manner, and before enforcement actions are taken by the MS4 entity.

3.0 Water Quality and Storm-Related Processes

3.1 WATER QUALITY OVERVIEW

The purpose of the stormwater rules is to establish requirements for stormwater discharges so that public health, existing water uses, and aquatic biota are protected. Public health may be affected by swimming or otherwise contacting water with elevated levels of bacteria and / or elevated levels of toxic chemicals. Existing water uses may include water supply for drinking water, irrigation, industrial or agricultural purposes.

The stormwater program is designed to reduce and minimize the potential impacts from construction that can affect water quality. These include erosion prevention and sediment control and good housekeeping measures that reduce the risk of chemical or other spills.

As a QPI, construction site and development practices are the main concern. There are several events that occur during construction that increase the potential for impacting streams and rivers, such as grading, clear cutting, and other soil disturbances. It is important that the QPI understand how water quality is related to site development in order for the QPI to ensure that water quality is not degraded by the effects of construction on the site. The sections that follow outline some of these key considerations.

Erosion is the weathering away of the soil via wind and/or water. Erosion occurs naturally, but when the land is altered, the process can be accelerated and can be detrimental to streams. Vegetation, including grass, weeds, trees and brush, helps to protect soils from erosion. These plants and their roots help to keep soils in place by reinforcing their structure and providing canopies that protect soil surfaces from disturbance. During active construction, vegetation is removed from construction sites, making the soils vulnerable to erosion.

Soil that is eroded from a site and deposited elsewhere is called sediment. An excessive amount of sediment is considered to be a pollutant because it can cause harm to humans, animals, property, and the environment. This classification may be difficult to understand at first, because some erosion and sedimentation processes are natural – all streams, rivers, and lakes contain some sediment. However, high concentrations of sediment can contribute to flooding that threatens life and property, impact drinking water supplies, and degrade aquatic habitats.

Sediment can also bond with other harmful substances and carry them into streams where other adverse effects may occur. Products that occur at construction sites include paint, adhesives, solvents, cleaners, and sealants; wood and paper from packaging; fertilizers, herbicides, pesticides, and other landscaping chemicals; heavy metals from galvanized metal materials; gasoline, diesel oil, grease, and other petroleum products from machinery and equipment, and other pollutants included in the area's illicit discharge ordinances. These products may become pollutants if they bond with sediment or contaminate stormwater and are carried to a stream or other waterbody.

Sediment and other pollutants can affect the aquatic life in a stream by reducing the survival rate of eggs, covering spawning areas, and reducing habitat for fish, mussels and other aquatic life. In addition, numerous studies have shown that property values are higher and people prefer to live near clean waterbodies with high recreational and aesthetic value.

Sediment can clog storm drains and accumulate in streams, which can cause or contribute to flooding and increase municipal maintenance costs. When sediment is deposited in a stream, it affects the stream's ability to handle heavy rains and can lead to flooding, property damage, and increased maintenance costs associated with dredging and structural repair and replacement.

Excessive amounts of sediment can affect the quality of rivers and lakes used for water supplies, including those used as a drinking water source. If water becomes contaminated, additional, and potentially costly, treatment may be required. The financial benefits alone are reason enough to protect waterbodies from the erosion of disturbed soil.

Good construction site management and erosion control planning can have positive effects on water quality and the community. By protecting a construction site from excessive erosion and off-site sedimentation, a QPI helps to keep streams safe for aquatic life and recreation, prevent damage to municipal stormwater infrastructure, protect neighborhoods from flooding and property damage, and safeguard drinking water sources from contamination. Erosion controls can help establish good relations with construction site neighbors by preventing damage to their property and keeping sediment from covering nearby roadways.

Natural rainfall and its interaction with the terrain and materials present on site can affect water quality. It is essential to understand the mechanics behind water flow and soil composition in order to make educated decisions in the implementation of erosion and sedimentation controls. The following sections will provide you with an introduction to hydrology, hydraulics, soils, and best management practices. This information should prepare you to make sound inspections.

These sections will also help you to understand the Excel workbook that has been developed by Southern Indiana SWAC communities to choose BMPs based on site conditions and assist with construction scheduling. BMP design work typically performed by a licensed professional engineer. A QPI is not required to design BMPs. However, familiarity with the types of BMPs, appropriate selection, and principles of BMP design will assist the QPI with observing, documenting, and communicating the inspection results to the appropriate parties.

3.2 STORMWATER HYDROLOGY

Hydrology is the study of the properties, distribution, movement and effects of water on the earth's surface, in the soil and underlying rock formations and in the atmosphere. **Stormwater hydrology** is the branch of hydrology that deals with rainfall and its interaction with the earth's surface during and immediately following rainstorms. Stormwater hydrology methods are used to estimate the volume or quantity and rate of surface runoff and its impact on streams, channels, and drainage systems.

Figure 3.1 illustrates the cycle of stormwater hydrology. In problems and solutions associated with stormwater management, we are primarily interested in estimates of surface runoff volumes and rates and their effects on stream flows and processes.

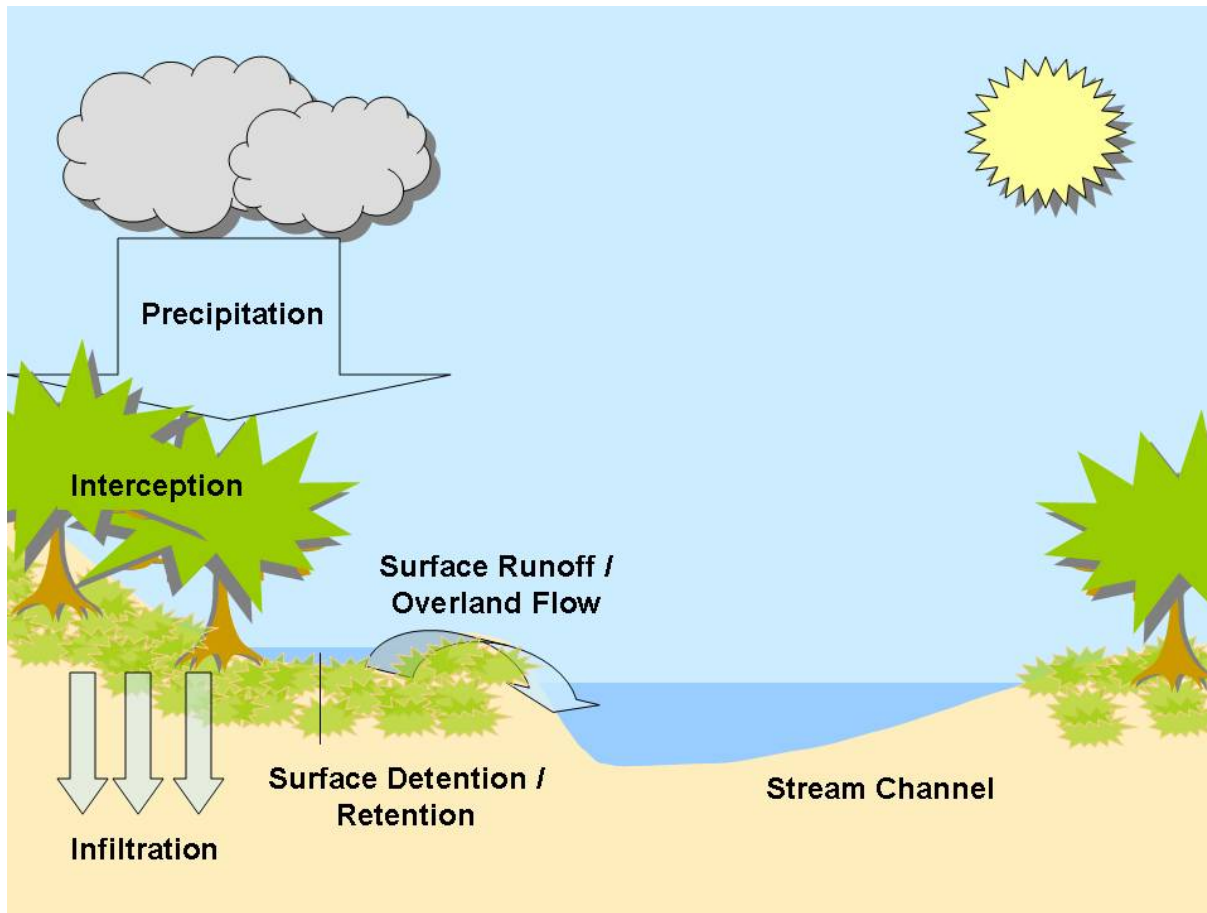


Figure 3.1. The Processes of Stormwater Hydrology

Precipitation is the falling to earth of any form of water, including rain, snow, and hail. Rainfall striking the ground will either infiltrate into the soil or become runoff. Runoff is the flow of stormwater over land surfaces.

Infiltration is the movement of rainfall through the soil surface into the soil. As soil becomes wetter, its capacity to absorb water is reduced. Once the rainfall rate exceeds the infiltration capacity of the soil, water will pond on the surface until enough accumulates to initiate runoff. Surface retention is stormwater that is held in puddles and depressions that does not run off.

Surface retention reduces both the volume and rate of runoff. This water seeps into the soil or evaporates following the storm.

Surface detention is water held in puddles and on the land surface for shorter periods of time, but is able to run off. Surface detention delays runoff and reduces runoff rates but does not reduce runoff volume. Interception is stormwater that collects and is held on the surfaces of trees, grasses and other vegetation. Interception reduces runoff volumes and rates.

The volume, rate, duration, area patterns, and time distribution of rainfall all impact the volume and rate of surface runoff. Rainfall volumes are measured as depths of rainfall over an area. The rate of rainfall is called the **rainfall intensity**. It is the depth of rain falling over a unit of time. The **duration** of a storm is the length of time between the start and end of an event. In reality, storm durations can be less than a minute or last for several days. The rainfall pattern refers to variations in precipitation depths and intensities over an area. Rainfall intensities also vary with time throughout the duration of a wet weather event.

Given the variability of rainfall, stormwater management decisions and designs are based on average depths and intensities over an area, the probability of a rainfall depth or intensity being exceeded and temporal (with time) patterns that are representative of storms in a general area.

3.2.1 Rainfall and Erosion

Splash erosion is caused by the impact of raindrops on soil, which loosens small particles of soil. This type of erosion has a minimal effect on undisturbed soil protected by vegetation or other cover, but in areas where soil is disturbed it can quickly loosen many soil particles. Construction activities increase the amount of exposed and disturbed soil, which increases erosion potential from rainfall.

As rain falls and begins to run off, the runoff is sometimes referred to as sheet flow. Sheet flows are fairly slow-moving and do not carry much soil when traveling over undisturbed and vegetated areas. However, when traveling over exposed and disturbed soil, the result is sheet erosion, wherein runoff picks up soil loosened by rainfall and construction activities.

As stormwater runoff continues to move down-slope unobstructed, the stormwater picks up more soil, especially over disturbed areas. Runoff can begin to form channels and to cut grooves into the terrain called **rills**, which are less than one foot deep. The result is rill erosion (**Figure 3.2, small grooves**). Once rills are formed, if no measures are taken to curb runoff velocities, the rills will join together to create **gullies**, which are grooves like rills that are cut into the earth, but are too big to step across (one foot or greater in depth). **Gully erosion** can cause major damage quickly, removing soil at an accelerated rate and creating trenches up to 100 feet deep (**Figure 3.2, large groove**). When working near the banks of a stream or within a stream as when constructing a stream crossing, exceptional care must be taken to prevent erosion, as rill and gully erosion can quickly wear away a stream bank.

Stream erosion occurs when the volume and velocity of water wears away the banks and bed of a waterway. This type of erosion can be devastating for plant and animal life downstream, and can threaten the stability of structures located near the waterway, including bridges and

roads. It can be caused by lack of erosion controls at a construction site, or by inadequately controlled runoff from developed areas.



Figure 3.2. Rill and Gully Erosion

3.2.2 Storm Frequency and Design Storms

Storm frequency is used to express the probability of a storm being equaled or exceeded in a year. The frequency, expressed in terms of the return period in years (YR) is the inverse of the probability:

$$F = \frac{1}{P}$$

where F is the frequency or return period and P is the probability.

For example, a storm with a 1% chance of being equaled or exceeded has a probability of 0.01. Its frequency is:

$$F = \frac{1}{0.01} = 100 \text{ YR}$$

A storm with a 50% chance of exceedance has a probability of 0.5 with a frequency of:

$$F = \frac{1}{0.5} = 2 \text{ YR}$$

It is important to remember that the frequency of a storm has nothing to do with the length of time between storms. It is only a convenient (and sometimes confusing) way of expressing probability. If we were able to look at a long record of rainfall, we would expect there to be one storm that equals or exceeds the 100YR storm per 100 years of rainfall data. Similarly, we would expect there to be 1 storm that equals or exceeds the 50YR storm per 50 years of data. The actual storms may occur any number of years apart. It is possible (although of low probability) that two 50YR storms could occur in the same year. A good way to think of storm frequency is that a 1YR storm occurs more frequently than a 100YR storm.

For a given drainage area or site, different land use scenarios will generate different stormwater related calculations. Different storms will yield unique runoff rates and volumes based on different land use scenarios on a given site. Pre-construction, active construction and post-construction land use conditions are usually compared. For complicated or long range projects, there may also be interest in runoff during different stages of construction.

Storm duration is used to identify the time length of a storm. Based on the type and size of the site, different storm durations should be considered in order to effectively estimate the various flow conditions. Though every storm is unique, timeframes have been standardized to aid in site evaluation. Common storm durations used include 1HR, 6HR, and 24HR duration events.

Design storms are developed based on both frequency and duration. It is assumed that rainfall is uniform over the drainage area and varies with time following a distribution that is representative of storms in the region. Examples of local design requirements include specifications for the 2YR-24HR, 10YR-24HR, 100YR-1HR, and 100YR-24HR storms.

3.2.3 Runoff Volume

Runoff volume is the total amount of surface water from a drainage area that a given rainfall event produces. Runoff volume is equal to the depth of rainfall minus all losses from infiltration and other causes, multiplied by the drainage area. Losses are determined by the type of soil, type of vegetative cover, land use, soil moisture, and land roughness. Communities often require that stormwater storage facilities provide a storage volume for a certain design storm.

3.2.4 Flow Rates and Roughness

The **flow rate (discharge)** of water is defined as the volume flowing through a point in a given amount of time. This can be found theoretically by using the equation:

$$Q = AV$$

where Q is the flow rate, A is the cross-sectional area of the channel, and V is the velocity, or speed, of the water through the cross-section. As the cross-sectional area of the channel decreases, the velocity of water in the channel increases. Smaller cross-sectional areas often occur because of sediment being carried downstream. When water carrying sediment flows through a channel, it deposits sediment in some areas, obstructing parts of the channel. This results in higher, more destructive velocities, as illustrated in **Figure 3.3**. Flow rate can also be found by using a gauging station. These are data collectors that record the stream flow continuously. Flow rate is used to design structures such as culverts, channels and other drainage systems.

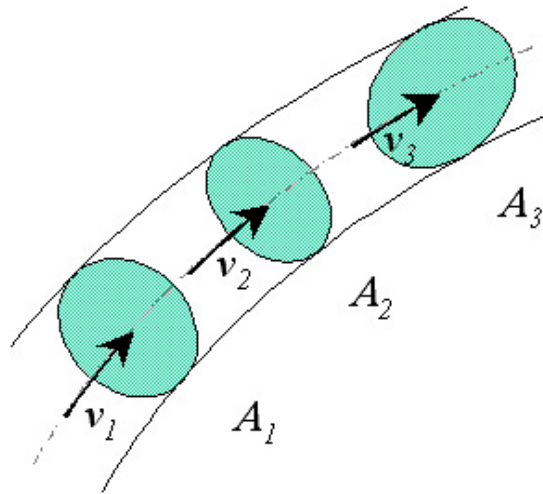


Figure 3.3. Illustration of Flow Rates

There are two main types of flow – **open channel flow** and **pipe flow**. Water running through plumbing and out of a faucet is an example of pipe flow. Stormwater runoff, however, usually flows in an open channel. Examples of open channel flow include streams, drainage ditches, and culverts.

The **roughness** of the channel's lining plays a significant role in calculating the discharge through the channel. Rough surfaces offer resistance to flow, causing a decrease in flow rates. Vegetative, flexible, and rigid linings can be used when designing an open channel. These linings and their uses are summarized in **Table 3.1**.

Most stormwater travels over land surfaces towards streams and other stormwater conveyances. This type of flow is called **overland flow**. Overland flow can be compared with open channel flow. Although it is not contained within a channel, it does not undergo the constrictions that apply to pipe flow. Developed land uses and increased impervious area decrease the roughness to which runoff is exposed, which leads to increased flow rates.

3.2.5 Peak Runoff and the Stormwater Hydrograph

Peak runoff is the maximum flow rate, or maximum volume of water passing a single point in a watershed at a given time. This includes all stormwater runoff that has developed in the drainage area for that point. Development including new construction increases the amount of impervious area, which increases the volume of stormwater runoff. The increase in volume leads to an increase in the rate of stormwater flow over the land. The flow rate also increases, in part because most impervious areas are less rough than vegetated areas. Because of increased volume and velocity, the volume of runoff peaks earlier during a storm event than would have occurred if the stormwater flow in the watershed was more natural. This leads to flash flooding downstream, and can carry away tons of soil from a construction site.

Table 3.1. Types of Lining

Lining Type	Uses
Vegetative (Grass)	Low velocities, available sunlight, allows for temporary water routing/storage, needs to be maintained
Flexible (Riprap, Rubble)	High velocity, low flow, low maintenance
Rigid (Concrete)	High flow, low velocity, low maintenance

Peak runoff is often shown graphically as a curve depicting flow or discharge versus time called a **hydrograph (Figure 3.4)**. The horizontal axis represents the time that has passed during the storm, and the vertical axis represents the rate of flow. Prior to development, flow rates are much lower and it takes longer for the stormwater to reach its peak flow rate (black line). Following development, if no controls are introduced, the peak flow rate is much greater and occurs much sooner than it would under natural conditions (red line). If controls are not implemented, flash flooding could occur downstream of construction.

The runoff volume is represented on the hydrograph as the area under the curve. Note that the volume of runoff also changes before and after development due to changes in imperviousness and infiltration. The example provided in **Figure 3.4** represents the 2YR-24HR design storm for an 80-acre site with a 1000-foot slope length at a 5% gradient. Before development, the land was primarily cultivated farmland. The site was developed into a retail or commercial center with approximately 85% impervious area. The storm itself has not changed, so the amount of rainfall flowing over the site is the same. However, in the un-controlled post-development scenario, rainfall in contact with the large impervious area quickly runs off and significantly less rainfall infiltrates into the soil.

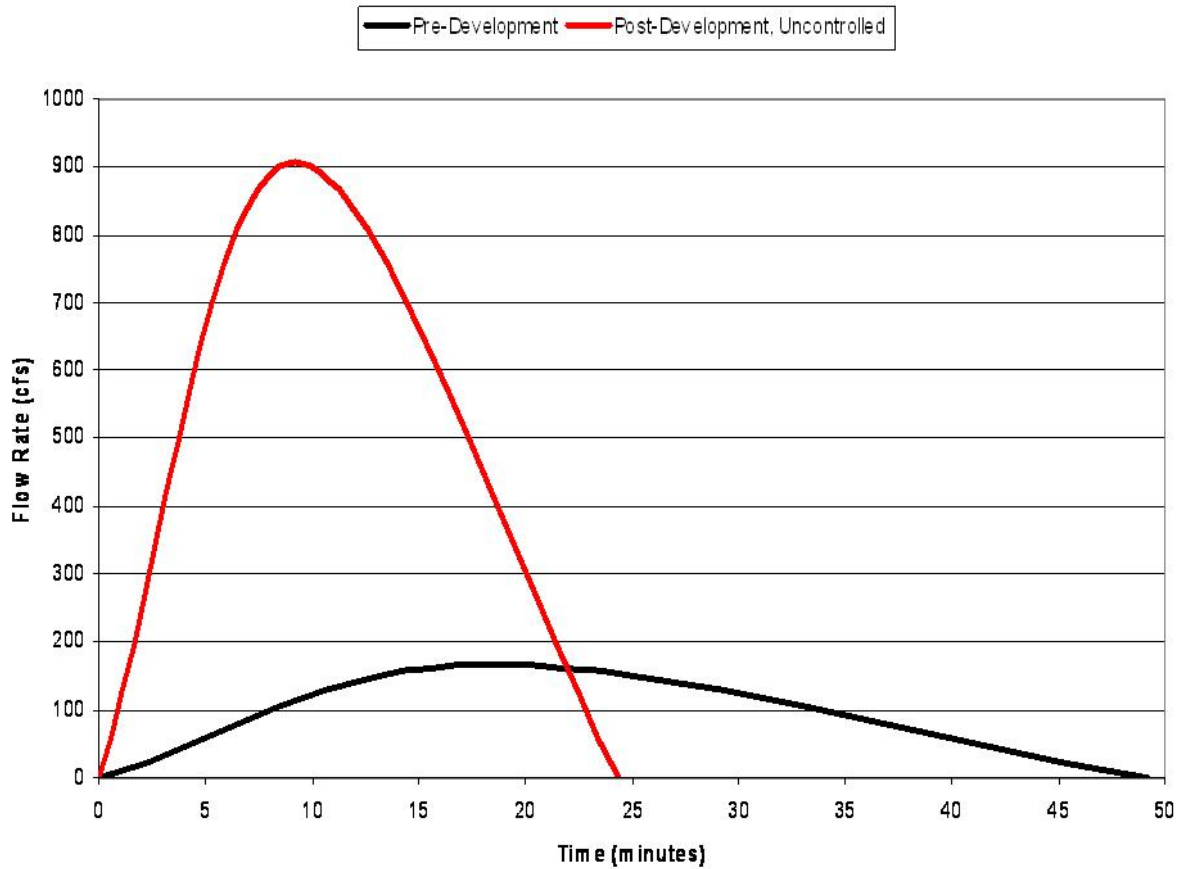


Figure 3.4. Stormwater Hydrograph, Uncontrolled

The Erosion Control and Site Planning Workbook, discussed in **Section 4.4**, provides you a hydrograph for the 2YR-24HR, 10YR-24HR, and 100YR-24HR design storms, before and after construction, showing the peak runoff rate and volume.

3.2.6 Surface Storage

When designing the temporary layout of a construction site or the permanent layout of a project, designers try to mimic the natural hydrology of a watershed. To do this, they need to slow the stormwater runoff flow rate and regulate the volume of water that flows over a point at any given time, bringing the hydrograph closer to its original pre-development shape. The blue line in **Figure 3.5** represents this flow pattern and volume. The peak flow of the controlled post-development site is equal to the pre-development peak flow (black line). However, the shape has changed because the volume of water has increased – it is the same volume of water as the uncontrolled post-development site (red line). If you were to calculate the area under the red and blue lines, which represents the runoff volume, these volumes would be equal.

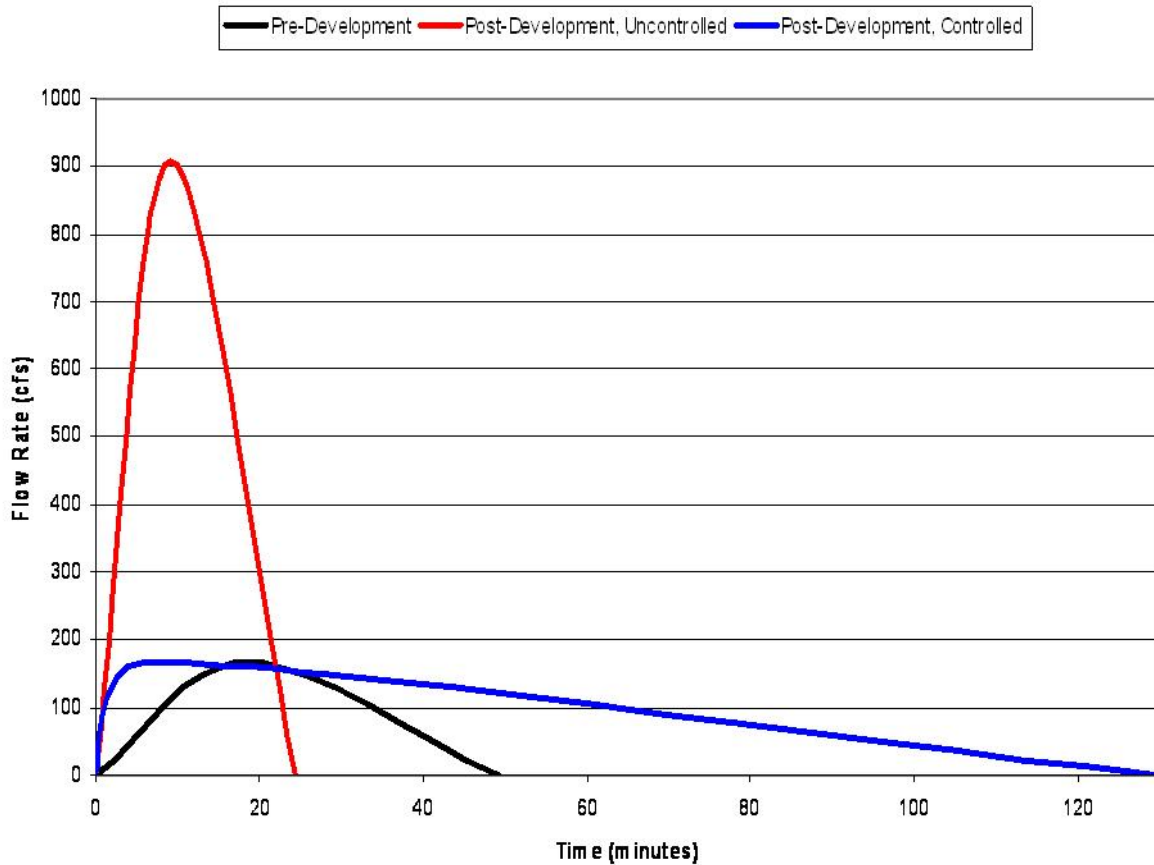


Figure 3.5. Stormwater Hydrograph, Controlled

Designers use **surface storage** devices as one way to accomplish these goals. The volume of water held by surface storage must be at least as much as the maximum difference in volume at any given time. Looking at the hydrograph, this volume is represented by the area above the blue line but below the red line. This volume begins to accumulate after the flow rate reaches its maximum – i.e., the peak pre-development flow rate. A flow regulation device allows the storage facility to drain at or below this rate until the water in the facility is back to pre-storm event levels.

There are two kinds of surface storage: detention and retention. You should recall from the beginning of **Section 3.2** that surface detention and retention occur naturally during a storm event. Designers use large-scale detention and retention basins to achieve favorable results.

Detention basins are used for short-term water storage. They are also referred to as dry ponds and wet ponds. During construction, these ponds are placed where stormwater runoff may leave the site or enter waterways such as a stream or a storm sewer. A weir, riser, outlet pipe or other outlet device is used to regulate the rate at which the water is released from the

pond. These may remain in place after construction as a permanent form of stormwater control if properly seeded and adapted for permanent use. Permanent detention may also be built underground using large pipes or other containment structures in areas where land value or other factors prevent the use of above-ground structures. Detention basins are discussed in further detail in the Best Management Practices Manual (SMP-07 for temporary use; STP-02 and STP-03 for permanent use).

Retention basins also provide runoff attenuation by storing collected runoff. However, these facilities do not contain a discrete outlet to release runoff. As the name implies, these structures retain runoff. Some facilities do contain an emergency overflow spillway, which provide a safeguard for very large and intense storm events, but for the majority of storms, these BMPs retain and release collected runoff through infiltration and evaporation. Retention basins are discussed further in Best Management Practices Manual, STP-02. **Figure 3.6** illustrates a completed post-construction retention basin.



Figure 3.6. Wet Detention Basin in Clarksville, IN

3.3 SOILS

Soils are important to stormwater management because land disturbing activities can affect the structure of the soil. Soils typically become compacted during grading and other activities, which reduces the space between soil particles that can hold water and reduces the ability of soil to absorb water. This change in soil structure reduces infiltration, which increases runoff volumes and rates. Bare soils tend to seal due to breakdown of the surface structure by raindrop impact which further reduces infiltration capacity. Removal of vegetation also increases runoff by eliminating interception. Site grading can eliminate depressions that provide surface retention and detention. Smooth, bare surfaces offer less resistance to flow, which increases runoff flow rates. Infiltration capacity is reduced by the construction of asphalt and concrete pavements and rooftops that are impervious to rainfall.

Loss of soil at a construction site can create unnecessary work and add costs to a project. Top soil is rich in nutrients and is important to any type of vegetation that would eventually be grown on the site. Unprotected top soil, along with its nutrients, can be washed away in a rainfall event. If an area has been graded or seeded without any erosion control, a storm can wash away the seeding and ruin the grading, costing the construction company time and materials.

Off-site deposition of soil from construction sites is prohibited under local ordinances and is a violation of stormwater permits, potentially triggering the enforcement actions described in **Section 2.5**. In addition, landowners may seek legal action for damage to their property.

3.3.1 Soil Texture

Soils are made up of several size classes, or **textures**. From largest to smallest, they are stone, gravel, sand, silt, and clay; the smaller particles are illustrated in **Figure 3.7**. Stones and gravel are easily recognizable and can be seen with the naked eye. While stone and gravel will erode, the smaller size particles are of greater concern for erosion risk because they are generally present in great quantities on construction sites. The majority of erosion problems are due to the smaller particles, since they are harder to prevent from eroding or capturing in runoff.

Sand is defined as a coarse particle, ranging in size from 0.05-2.0 mm. Sand is loose and gritty when dry, and very loose and gritty when wet. Sandy soils generally have a higher permeability than fine-textured soils, which means water is allowed to pass through it more quickly. The amount of runoff is lower, and since the particles are relatively large (and thus heavy), they are not carried far in any runoff that does occur. Sand particles will settle out of runoff at the bottom of a slope or in a channel with a gentle slope. Very fine sand particles, however, behave like silt particles.

Silt is finer than sand, but coarser than clay, with particle sizes ranging from 0.002-0.05 mm. A microscope is required to see silt particles. Silt is powdery when dry with clods of particles stuck together, and smooth when wet. Silt is the most important particle size class when soil erodibility is evaluated. When soil has higher silt content, it is more susceptible to erosion. Silt-sized particles are small enough to reduce the permeability of a soil and are also easily carried by runoff. Eroded silt is too small to settle out on a gentle slope, unlike sand. It will travel with stormwater runoff until settling out in streams. Silt is very easily eroded, but its particles can usually be trapped through sediment control measures such as a silt fence. Control measures should be designed to prevent the erosion of silt, or at least to contain it onsite. Soils in this area tend to be silty, which can be very dangerous, especially when construction takes place on steep slopes as found in Floyds Knobs.

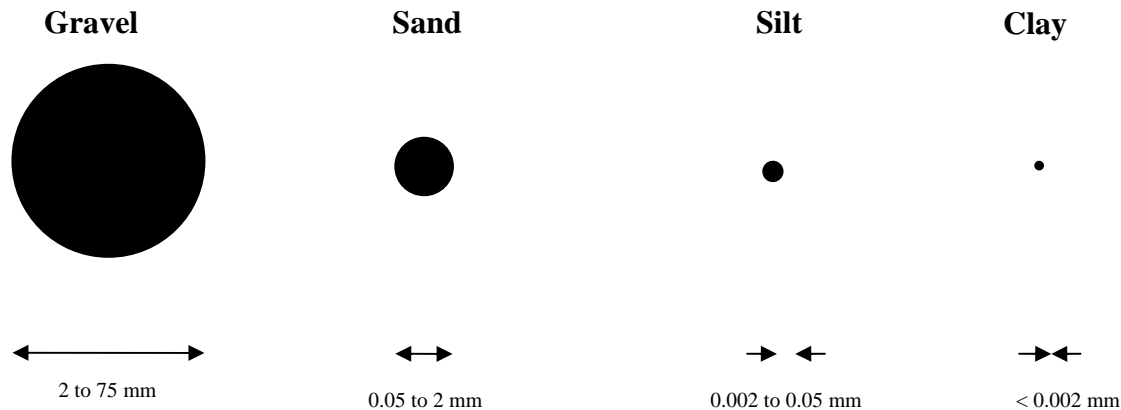


Figure 3.7. Size Classes of Soil Particles

Clay is the smallest particle size class. Clay particles are smaller than 0.002 mm and cannot be seen with a regular microscope. A soil with a high clay content tends to be quite cohesive – the particles stick together in hard clumps when dry, and are still sticky when wet. Because of this cohesiveness, runoff does not pick up clay particles as easily as it does silt. However, clays are the most difficult to trap once erosion has occurred, so control measures must focus on preventing their erosion in the first place. Once clays are suspended in runoff, they will not settle out until they reach a large, calm water body. The suspension of clay particles in streams increases the turbidity, or cloudiness, of the water, which can be dangerous for fish and other aquatic life. These very small particles have such a low settling velocity that they will be carried long distances until still water is reached or until salt water increases precipitation by causing them to clump together again in **aggregates**, or large clumps of particles. This means that clay soils from the construction site in Indiana may not settle out until they reach the Gulf of Mexico.

The particle size of a soil is important because it affects the ability of a sediment basin or fabrics to trap eroded soil. The smaller the particle, the larger the basin must be to capture it so that the sediment will have time to settle out. Each sediment basin should be designed to capture a certain size particle called the **design particle**. If a soils analysis is done on a site, the site designer should request that the design particle size be a threshold in the analysis (i.e., specify the percent, by weight, of particles larger or smaller than that size). Fabrics used to trap sediment can capture large particles of sand and silt, but do little to trap clays and fine silts. It is easiest to prevent erosion of coarse sandy soils. Small sand particles and silts are most susceptible to erosion and are therefore of interest in erosion control planning. It should also be noted that soils consisting of pure clay or a clay/silt combination are easily eroded unless they have formed in aggregates, and that both size particles require larger sediment ponds to trap.

Soil texture gives a good indication of how soils will behave. Soils are not generally 100% sand, silt, or clay, and soil texture is determined by the proportion of each kind of particle contained in the soil. The texture triangle is a graphic way of showing this relationship. Soils in the bottom left corner of the triangle are mostly sand; soils in the bottom right corner are mostly silt; and soils at the top are mostly clay. Many soils are classified as loams – soils of medium texture having roughly equal parts of clay, sand and silt.

The major textural classes are illustrated in **Figure 3.8**. Those soils that are listed as sand, silt, or clay in the texture triangle will behave as stated in the previous section. The textural classes named for particle sizes – sand, silt, and clay – are dominated by these particles. They behave more like there is only one particle size found in the soil, and will interact with water as stated in the previous section. If the proportion of one of the ingredients is high, the term can be modified to, for example, clay loam or sandy loam. For our general purposes, sandy and clayey soils are less erodible than loam or silt loam.

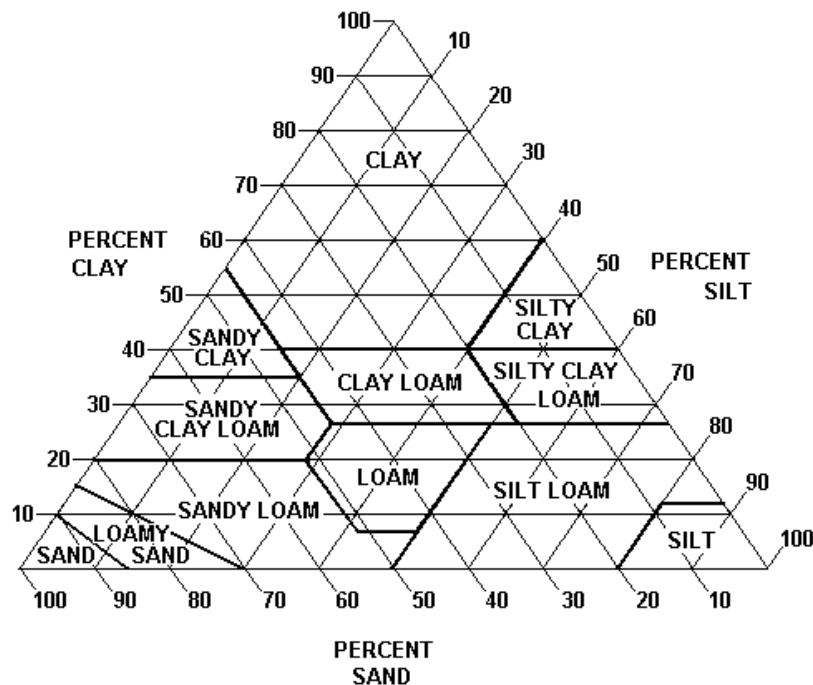


Figure 3.8. Soil Texture Triangle

The texture of a soil affects the way water moves through it. Sandy soils have large pores which allow water to drain quickly. Silty soils have less space between particles, and so water drains more slowly. Clayey soils have the smallest pores, and tend to absorb and hold water rather than allowing it to pass through.

When heavy equipment is driven over soil at a construction site, it compacts the soil and reduces its ability to absorb water. If heavy equipment is driven over wet soils, the compaction occurs at deeper soil levels. Dense, clayey layers found naturally in the soil or soils that have been compacted are called restrictive layers, because they restrict the flow of water through them. Restrictive layers found near the surface can reduce the ability of the site to handle runoff or support plant life when construction is completed. Restrictive layers further down in the soil reduce the drainage capacity of the soil and can reduce the ability of septic systems to drain properly, causing backups and failure.

3.3.2 Soil Surveys and Erosion

Soil surveys are published for counties across the US by the Natural Resources Conservation Service (NRCS). They include maps and soil descriptions and provide information about the properties of soils in each county. Soil surveys include representative physical soil properties such as permeability and erodibility, and information about suitability for building site development and sanitary facilities. Countywide soil surveys are available online in map form from the USDA Soil Survey website (**Appendix G**). Construction plans submitted by the site designer will include a description of the soils on the particular site. The information below will help the QPI to better understand the site plans.

Each soil survey contains information for the particular soils found in that county. These soils have each been assigned a **map unit name** and a corresponding abbreviation. These names often indicate some of the attributes of the soil, such as texture. For instance, Shircliff silt loam, abbreviated SfyB, has a silt loam texture, and Markland silty clay loam, McpC3, has a silty clay loam texture. These map unit names link the soil to the associated attributes in the survey, including hydrologic soil group and erodibility factor. These factors are used in several calculations used in the Excel workbook, described in detail in **Section 4.4**.

A **hydrologic soil group** (HSG) is a classification made by the USDA which is based on estimates of runoff potential. These groups are based on the texture of the soil as defined by the texture triangle. Soils are assigned to a group based on the rate of infiltration when the soils are un-vegetated, thoroughly wetted, and receive precipitation from a long-duration storm.

- **Group A** is sand, loamy sand or sandy loam types of soils. These soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels, and have a high rate of water transmission.
- **Group B** is silt loam or loam. These soils have a moderate infiltration rate when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils, with moderately fine to moderately coarse textures.
- **Group C** soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of

water and soils with moderately fine to fine structure. These soils have a moderate to high runoff potential.

- **Group D** soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This group has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface and shallow soils over nearly impervious material.

Hydrologic soil groups are one factor used in developing a hydrograph and for calculating peak flows. Another is the soil **erodibility factor** or **K factor**, an estimation of the sensitivity of soils to the forces of erosion. These factors range from 0.05 to 0.69, with 0.69 indicating the most highly erodible soil. K factors in Clark and Floyd Counties range from 0.24 to 0.55, which are generally moderately to highly erodible. The K factor is unique to each soil type and is used to calculate soil loss in the workbook.

3.4 TOPOGRAPHY AND SITE CHARACTERISTICS

The **topography** of an area includes aspects of elevation, slope, and orientation. Topography is represented two-dimensionally on a map as contours, or lines that connect points of equal elevations. Contours are drawn on intervals, i.e. five feet, and are used to represent the slope or steepness of the land. Closely-clustered contour lines indicate a relatively steep slope; distant contour lines indicate a relatively flat slope. **Figure 3.9** is an example of a topographical map. On this map, the blue shaded areas indicate the boundaries of Clark and Floyd Counties. The curved black lines are contours that indicate a change in elevation.

3.4.1 Drainage Areas

A **drainage area** or watershed is an area of land for which all stormwater runoff drains to a particular point. Drainage areas include large land areas which feed large rivers and lakes, such as the Ohio Valley which feeds the Ohio River, as well as smaller areas that feed smaller streams and tributaries. A drainage area does not necessarily need to include a stream; it simply refers to the area of land uphill from a particular location which drains through that point. **Figure 3.10** shows the drainage area for Silver Creek, which includes portions of Clark and Floyd Counties. Note that the area has been divided into smaller areas which drain to smaller tributaries, which in turn drain to Silver Creek.

Drainage areas can be delineated or outlined by examining the topography. For more information about reading topographic maps, delineating drainage areas, and estimating their size (see **Appendix F**).

The size and characteristics of the drainage area(s) of a site affect the choices of the calculations used to design stormwater controls. Drainage areas are delineated from the lowest point on the site perimeter, where the majority of the runoff traveling over the site is likely to exit the site, up to the highest point in the watershed. Large sites or sites with more complex

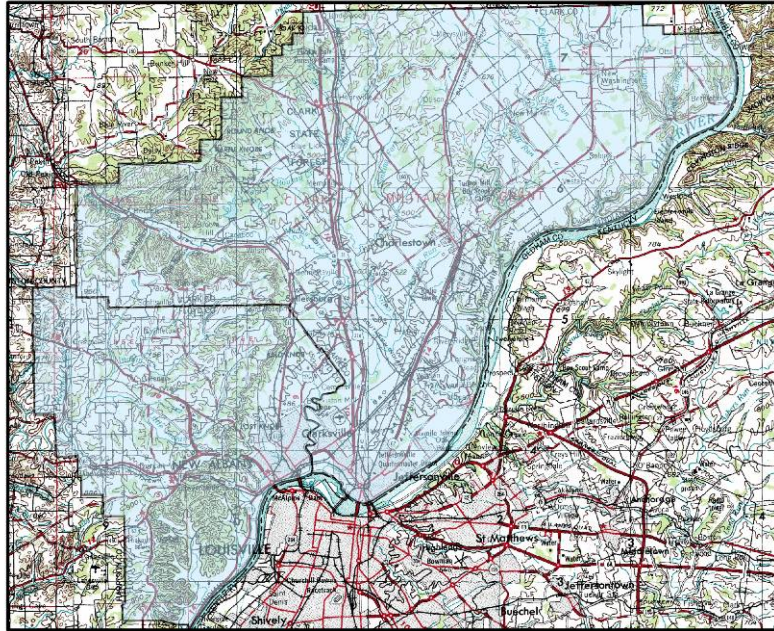


Figure 3.9. Topographic Map of Clark and Floyd Counties

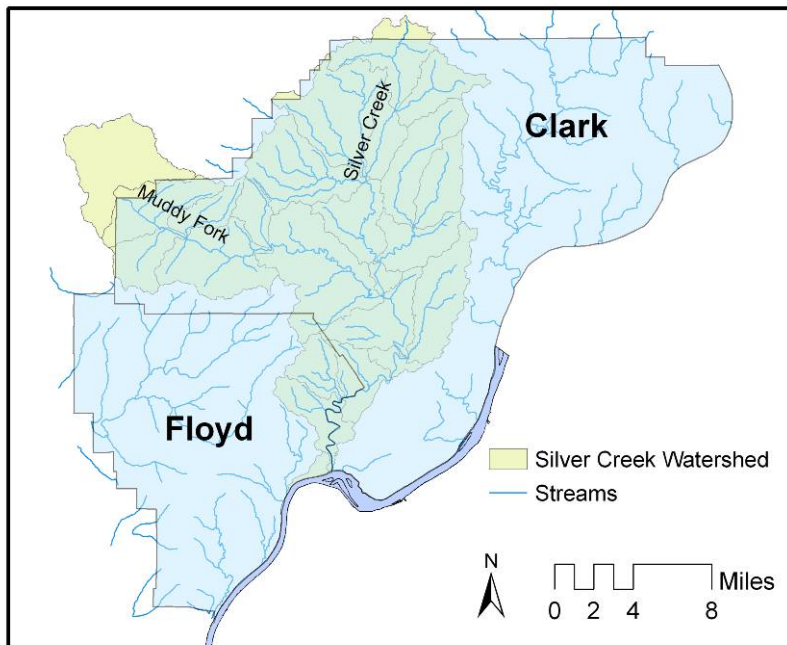


Figure 3.10. Silver Creek Drainage Area

drainage, such as different land use or characteristics, may have multiple low points which will need to be analyzed separately. For instance, there may be a depression on the project site where water concentrates and ponds, or there may be more than one exit point from the site.

3.4.2 Slope

Slope is composed of two parts: elevation change and slope length. Change in elevation, or rise, is the difference between the highest and lowest point on the site or drainage area. In practice, use the elevation of the point where water will exit the site or drainage area as the lowest point, and the highest point of elevation should be the highest point of the site that drains to that area.

Slope length, or run, is the horizontal distance between these two points. It is not always easy to find the horizontal distance; sometimes the easiest way to get this distance is indirectly using the overland distance or elevation change and angle between the horizontal and the terrain (see **Figure 3.11**). To determine the slope length from the overland distance d and survey angle θ , the formula is:

$$\text{Slope Length} = d \cos \theta$$

To determine the slope length from the elevation change e and survey angle θ , the formula is:

$$\text{Slope Length} = e \sin \theta$$

Likewise, to determine the elevation change from the slope length l and survey angle θ , the formula is:

$$\text{Elevation Change} = l \sin \theta$$

Slope gradient, or steepness, is the ratio of elevation change to slope length, or rise over run. For instance, if the elevation at point 1 is 450 feet and at point 2 is 500 feet, and point 2 is 1,000 horizontal feet from point 1, then the elevation change, or rise, is $500 - 450 = 50$ feet and slope length, or run, is 1,000 feet. The slope gradient is the ratio of these two values, or $50/1000 = 5/100 = 0.05$, or 5% (**Figure 3.11**).

The survey angle can also be used to determine gradient directly using the formula:

$$\text{Slope Gradient} = \tan \theta$$

If you use this formula, you will need to multiply the gradient by 100 to express the gradient as a percent.

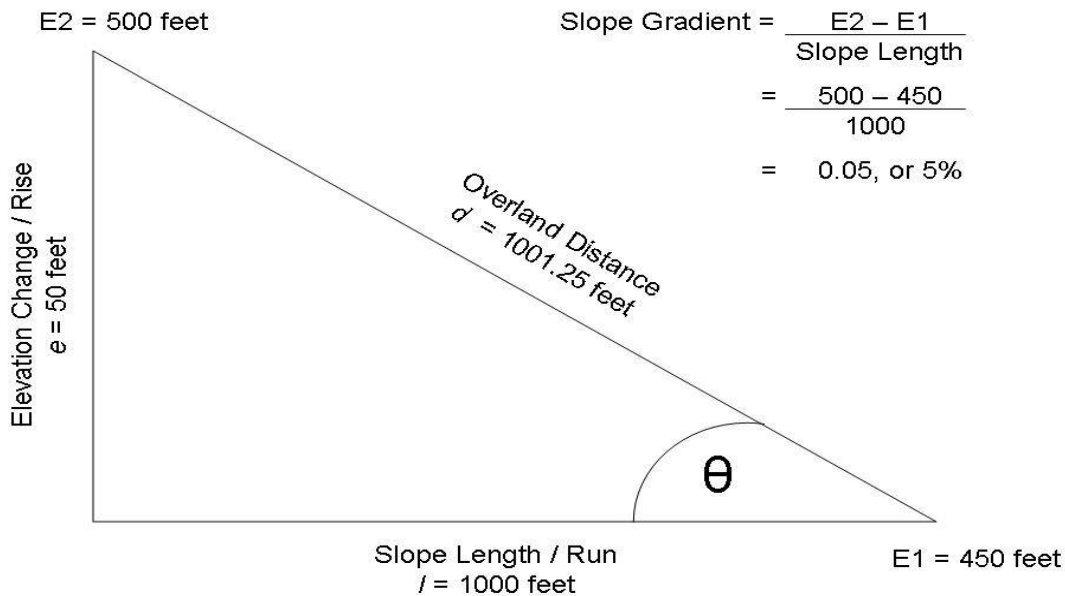


Figure 3.11. Slope Gradient

It doesn't matter if you go from high elevation to low elevation or low to high; the slope gradient will have the same value, but opposite sign. The sign of the slope only reveals whether elevation is increasing or decreasing and is irrelevant for our purposes. We will always use a positive slope.

The likelihood of erosion is increased on longer slope lengths; the longer the runoff has to move down slope, the greater its velocity potential, and the more likely it is to accumulate as channels. When soil is disturbed on a slope, extra caution needs to be taken to minimize erosion. In addition, soil disturbances at the bottom of steep slopes should be protected from the higher-velocity runoff to which it will be exposed. Critical slope lengths are listed in **Table 3.2**. As a general rule, the erosion hazard become critical if the critical slope length is exceeded or if the gradient is steeper than 12%. Extra steps should be taken to prevent erosion and break up flow if the slope length meets or exceeds the critical length.

Table 3.2 Critical Slope Lengths

Erosion Hazard	Slope Gradient	Critical Slope Length
Low to medium	0-6%	200'
Medium to high	6-12%	100'
Severe	Over 12%	50'

3.4.3 Other Site Considerations

There are five other site characteristics that need to be taken into consideration when choosing BMPs for a site and laying out or changing the site design.

Wetlands: Wetlands are watery areas that contain soils that are at least sometimes saturated with water. Wetlands support a diverse and vital ecosystem which can be damaged by sedimentation and other pollution. They also provide the benefit of retaining and filtering water. Care should be taken near wetlands to prevent sediment and other pollutants from entering the wetland. Projects that disturb wetlands may require special permits.

Streams: Similar to wetlands, streams are sensitive to sediment and other pollutants, and care should be taken near streams to prevent sediment and other pollutants from leaving the project site and impacting streams. There are several BMPs that can be used to protect streams, including a no-disturbance buffer. Buffer widths and other requirements may be specified in local ordinances and recommendations for stream buffer BMPs are included in the Stormwater BMP Design Manual. The QPI should be familiar with local requirements for buffers.

Karst: Karst terrain includes areas in which the bedrock is composed of a carbonate compound, such as limestone or dolomite. As groundwater flows under the earth's surface, it can cause rock dissolution, resulting in voids and passages developing underground and at the surface. Point sources of infiltration or injection, such as infiltration trenches and dry wells, can cause groundwater contamination if stormwater runoff is polluted. This is due to the fact that karst regions often directly inject stormwater and do not promote the natural filtration of runoff. Infiltration practices that allow stormwater to enter the ground over a wide-spread area must be carefully applied in karst regions. Injection wells, occasionally used (though not encouraged) in karst areas, are regulated under the United States Environmental Protection Agency's (USEPA) Underground Injection Control (UIC) program.

Wellhead Protection Areas: Wellhead protection areas (WPAs) include areas in which the groundwater is used to supply drinking water. These areas are delineated based on the water supply's groundwater recharge area, or the area in which stormwater runoff and other water that infiltrates the ground will enter the groundwater used to feed the well. Because of the risk of contaminants entering the groundwater from which the drinking supply is drawn, no infiltration practices are allowed in WPAs.

Proposed Vehicular Activities: Although proposed use for vehicles is not a part of the terrain of the site, it is important to note that this should be considered during final site design. Sites that will be used for vehicular maintenance, including gas stations, car washes, and garages, as well as marinas and airports, have specific water quality requirements to meet through post-construction controls. These controls should separate oil and grease from stormwater runoff, etc. Best Management Practices

4.0 Best Management Practices

This chapter provides an introduction to Best Management Practices (BMPs). While the QPI is not likely to be responsible for selecting, designing and implementing BMPs, some background knowledge of this aspect of the development process will assist with performing inspections.

The Southern Indiana Stormwater Advisory Committee developed the Stormwater Best Management Practices Design Manual to assist development engineers with the process of selecting, designing and implementing BMPs. This manual provides guidance for specific BMPs using a fact sheet format for quick reference. The fact sheets include a description of the BMP, design criteria, target pollutants, applications, installation procedures, and maintenance and inspection procedures. The manual is divided into sections that reflect different types of BMPs for each stage of construction. This BMP manual is provided as one of the resource materials to assist the QPI with preparations for the exam and performance of inspection duties.

4.1 BEST MANAGEMENT PRACTICES OVERVIEW

Best Management Practices (BMPs) are controls that reduce the impacts of development on water quality and aquatic habitats. The term originated from the Clean Water Act. There are three main methods to prevent sediment and other pollutants from leaving the site:

- **Erosion controls** prevent soil from becoming adequately loose or exposed to be picked up by stormwater runoff. These are the most effective in keeping sediment and other pollutants from leaving the site because the soil will remain in place during wet weather events.
- **Sediment controls** filter stormwater runoff or slow the flow enough that the sediment has time to settle out before it leaves the site. These are less effective than erosion controls in preventing sediment and other pollutants from leaving the site, because it is difficult to filter small sediment particles and they require large areas of still water to settle out. It may not be possible to remove other pollutants suspended in the water using these methods.
- **Pollutant controls** filter stormwater to prevent pollutants from entering waterways. These are a last resort, as pollutant controls are often more expensive to install and require more maintenance than the other two methods. It is often easier to prevent sedimentation and pollution through erosion control rather than attempting to capture these pollutants.

BMPs can be divided into two categories: structural or nonstructural. A **Structural BMP** is a facility or structure designed to prevent or reduce stormwater pollution during or after construction. Structural BMPs generally remove pollutants using gravitational settling, infiltration, or filtration. Detention/retention facilities, silt fence, catchbasins with filters, check

dams, and infiltration trenches are a few examples of common structural BMPs. Structural BMPs can be installed in series to create a **treatment train**. Treatment trains are typically more effective than using one BMP, especially in complex situations in which several pollutants are being targeted or when control of several particle sizes is required.

A **Nonstructural BMP** improves stormwater quality during or after construction without using a structure or facility. Examples include site design that incorporates natural land features; construction phasing that minimizes soil disturbance, and stormwater quality and BMP education and training for site personnel.

Each construction project is unique. Therefore, an understanding of the pollution risks of the construction activity is essential for selecting and implementing BMPs. Defining these risks requires review of the characteristics of the site and nature of the construction, information which should be assembled for the construction plans.

Which BMP you use depends on the type of pollutant, the pollutant source, and the terrain of the job site. The variety and specifications of BMPs can be overwhelming at first, so the MS4 communities have adopted a guidance document to be used in designing the site and in the field for implementation. The Stormwater Best Management Practices Manual provides guidance for specific BMPs. It is laid out in fact sheet format for quick reference. The fact sheets include a description of the BMP, design criteria, target pollutants, applications, installation procedures, and maintenance and inspection procedures. The manual is divided into sections that reflect different types of BMPs for each stage of construction.

Site Planning and Design BMPs are built into site design before construction begins. They are designed to protect sensitive features and minimize impervious surfaces. These consist of mostly nonstructural BMPs, including no-disturbance buffer zones, construction phasing, permeable pavements, alternatives to curb-and-gutter street design, and minimizing disturbance of stream corridors.

Erosion Prevention BMPs are designed to prevent the loosening of soil on the construction site during the construction phase. These are also mostly nonstructural BMPs such as stabilized construction entrances and soil cover such as seed, mulch, and erosion control nets and mats.

Sediment Management BMPs are designed to trap soil that has been eroded on the site, before it leaves the site. These are mostly structural BMPs including silt fences, straw bales, sand bags, sediment detention basins, check dams, and brush or rock filters.

Good Housekeeping BMPs are designed to contain sediment and other pollutants found on the construction site. They include procedures to make sediment and pollutant control systematic and organized, such as spill prevention and control; materials handling, storage, and usage standards; vehicle and equipment fueling, cleaning and service standards; and employee or subcontractor training.

Post-Construction Stormwater Pollution Prevention BMPs are designed to keep stormwater from becoming polluted after construction is completed. These are permanent measures, including buffer zones, outlet protection, bank stabilization, and permanent vegetation.

Post-Construction Stormwater Pollution Treatment BMPs are designed to treat stormwater after construction is completed. They are also permanent measures and include wet or dry detention ponds, constructed wetlands, swales, filter strips, water quality inlets, and oil and water separators.

4.2 FACTORS FOR BMP SELECTION

Best Management Practices (BMPs) have a wide variety of functions. The primary functions of BMPs are runoff control, soil stabilization, and sediment control. Some BMPs may be better suited for one application over another. For example, on a small construction site with limited area, a silt fence would be more appropriate than a sediment basin. This is because the sediment basin requires a larger area for the structure than a silt fence, and can handle the higher flow rates and sediment volume associated with larger sites. There may also be other factors involved that are more specific to an individual site. Selection of BMPs for a site requires the evaluation of the factors influencing runoff and erosion on the site. **Appendix D** contains tables that list BMPs from the Southern Indiana BMP Manual and the factors to be considered in their selection. These factors include:

- **Slope:** This column provides restrictions on the slope of land draining to a BMP.
- **Drainage Area:** Limits on the size of the area draining to a BMP are given in this column.
- **Level of Maintenance:** Maintenance costs and effort relative to installation or capital costs for each BMP are provided in this column. Relative costs are not given for BMPs with low maintenance requirements.
- **Estimated Unit Cost:** Ranges and average costs for the installation of each BMP are provided in this column. Information from this table can be used to compare the costs of different BMPs.
- **Design Life:** The design life of BMPs is given in this column. A BMP needs to be reinstalled or reconstructed when it has reached the end of its design life. Good maintenance practices can help extend the life of a BMP.
- **Habitat Quality:** A relative comparison of the wildlife habitat potential for each BMP is given in this column.
- **Slope Length Restriction:** This column provides restrictions based on the combination of slope and slope length of an area draining to a BMP.

- **Soils:** A description of the restrictions due to soil conditions is given in this column. Most restrictions are related to the internal drainage conditions on the soil based on Hydrologic Soil Groups (HSG) and/or infiltration rates.
- **Other Factors:** Other factors critical to the success of a BMP are listed in this column.

There are three basic strategies in erosion and sediment control: soil stabilization, runoff control, and sediment control.

Soil stabilization involves the use of BMPs that either protect or reinforce the soil to prevent erosion. Soil stabilization BMPs include vegetative and non-vegetative soil covers and structural practices that stabilize unstable slopes and surfaces. Soil stabilization is generally the most effective strategy in erosion and sediment control because its goal is to prevent soil erosion. If soils do not erode, there is no sediment control problem. Soil stabilization BMPs are listed in **Appendix D, Table D.1**.

Runoff control is a strategy that uses BMPs that divert the flow of runoff from disturbed areas, slow the velocity of surface runoff, or stabilize flow channels and storm water inlets and outlets. Runoff controls prevent erosion and the mixing of runoff from undisturbed and disturbed areas. Soil stabilization BMPs are listed in **Appendix D, Table D.2**.

Sediment control strategies utilize BMPs that trap, retain, or convey sediment, prevent tracking of mud onto roadways, or control dust on the construction site. Sediment controls in some form are required on all sites; however, they should not be relied on to meet all of the site's erosion control needs, because they are generally less effective, more expensive, and require more maintenance than soil stabilization and runoff control methods. Soil stabilization BMPs are listed in **Appendix D, Table D.3**.

Figure D.1 in **Appendix D** is a flow chart to determine the BMP methods to use for soil stabilization. Soil stabilization is used to control raindrop, sheet, and rill erosion. Under the header, there are two choices for the types of slope on the site: graded or steep. For graded areas, protecting the surface is the preferred strategy. In order to protect the surface, there are three choices given: vegetative soil cover, non-vegetative soil cover, and structural support. For vegetative soil cover the options are: temporary or permanent seeding, top soiling, sod, no disturbance buffer and filter strip. Non-vegetative cover options include: mulch, straw, riprap, nets and mats, and geotextiles. Structural support methods include: retaining wall, land grading, roughening, and bank stabilization. If steep slopes are present, methods to stabilize the soil can fall under protecting the surface or strengthening the surface. In order to strengthen the surface, structural methods must be used as described above.

Runoff control BMPs can be determined by using **Figure D.2** in **Appendix D**. Runoff control BMPs are used to prevent gully, channel, and stream erosion. This is accomplished by using waterways. The options under waterways are: to divert runoff, convey runoff, or stabilize the inlet or outlet. Diverting runoff leads to the method of diversions, which include swales, diversions, or terracing. In order to convey runoff, waterways are used. Waterway options

include concrete paved channel, grassed waterway, and rock-lined waterway. If an inlet or outlet needs to be stabilized, rock protection is the method listed.

Figure D.3 in **Appendix D** is a flow chart to determine the BMP methods to use for sediment control. Sediment control is used to protect off-site areas from sediment deposition. Under the header, there are choices for sediment control for various site sizes. If the site is a large area, there are two options for sediment control: sediment retention or conveyance. If sediment is to be retained on the site, there are several options to accomplish this goal. Alternatives include check dams, sediment traps, rock filters, berms, detention ponds, and sediment basins. If the site is a small area, sediment should be filtered rather than retained. To filter sediment, straw bale filters, silt fences, and sand bag barriers are used. The methods used to provide mud and dust control on site are stabilized construction entrances, tire washing facilities, and construction road stabilization.

4.3 REQUIRED BMPS

While many BMPs can be selected based on site conditions and the nature of the project, several BMPs may be required by local ordinances. These are described briefly below. The QPI is required to understand the requirements associated with specific BMPs contained in construction plans and/or local ordinances. This understanding is essential to appropriately inspect compliance for these BMPs.

Stabilized Construction Entrance / Exit: Local ordinances may require a stabilized construction entrance/exit made of coarse graded stone to reduce the amount of sediment transported onto nearby roadways and potentially to waterways. Requirements may include protection of public right of way, alley, sidewalk or parking lots, in addition to roadways. Check local ordinances and the BMP manual for specific requirements for dimensions, stone size and filter fabric underlayments.

No-Disturbance Buffers: Streams with a drainage area greater than one-hundred (100) acres or streams that are shown on a USGS map as a solid or dashed blue line may be required by local ordinance to utilize a twenty-five foot (25') no disturbance waterway buffer in the grading plan. Buffer width is measured from the top of the stream bank. Note that EPA's proposed construction general permit contains additional buffer requirements. If adopted by EPA in the final construction general permit, these buffer requirements will become effective in Indiana in the future.

Soil Stabilization: Local ordinances may require stabilization of denuded areas with permanent or temporary soil stabilization within 15 days of achieving final grade or within 15 days if the area will remain dormant for over 60 days. Soil stockpiles, if left undisturbed for more than 15 days, must also be stabilized.

4.4 BMP SELECTION PROCESS

In order to select which BMPs should be used on site, it is important to follow these steps to adequately assess the site for potential erosion or sediment problems. The first step is to look at the site plans and develop a site description. Then determine if there are any site considerations that might affect which BMPs are needed. Select BMPs based on these considerations and the site description.

- **Utilize the site description.**
 - o Determine drainage patterns – Where is the water flowing to during a rainfall event?
 - o Identify storm water outlets – Where is the runoff being conveyed?
 - o Identify receiving waters and potential offsite impacts – What can be done to eliminate impacts to these areas?
 - o Identify construction stages – In what order do the BMPs need to be established?
 - o Determine drainage areas – How much runoff will result from the site?
 - o Identify the slopes – Are there steep slopes or is the site evenly graded?
- **Evaluate site considerations.**
 - o Where is the site located? Is it a rural, suburban, or urban setting? Some BMPs may not be practical for urban settings, such as a buffer strip located in a high traffic area.
 - o What is the size of the site? Some BMPs are meant only for larger sites due to the space that they require, such as detention basins.
 - o Is the soil stable? BMPs may be needed to stabilize the soil to prevent erosion.
- **Identify necessary BMP strategies.**
 - o What issues need to be addressed: runoff control, soil stabilization, and/or sediment control? It is possible to need all of these BMP methods on a site?
 - o When would BMPs need to be in place on site? Some methods should be established prior to construction.
 - o What is the maintenance schedule? How often will the BMPs need to be monitored for maintenance? Some BMPs require more frequent maintenance than others.
- **Select BMPs based on site conditions and control strategies.**
 - o BMPs should be selected by the goal they should accomplish; runoff control, soil stabilization, or sediment control.

- o Select BMPs appropriate for the size of the site and for the slope of the site.
- o A construction sequencing plan should be in place to determine the timing of the BMP's placement.
- o BMPs should be placed to optimize their effectiveness. An example of this includes placing silt fence in all areas where stormwater could interact with disturbed areas and then potentially leave the site versus disjointed silt fence in isolated areas.
- o BMPs should be regularly monitored for any necessary maintenance.

The selection information from **Section 4.2** has been incorporated in the Erosion Control and Site Planning Workbook. By inputting accurate site information, the workbook will display appropriate BMPs for your site. However, you will still need to understand the issues behind erosion and sedimentation in order to determine the correct control strategies to use and to place BMPs in appropriate areas of the site.

4.5 GUIDANCE FOR EROSION AND SEDIMENT CONTROLS

Many of the BMPs rely on common sense. Stormwater runoff flows downhill, and with it comes sediment and other pollutants that need to be managed onsite. Set up BMPs to prevent runoff from traveling downhill, or break up its path and slow it down. Be smart about construction techniques used onsite. For instance, if the site is graded against the contour, the grooves from the grading equipment will be against the contour, providing a place for runoff to collect as it travels downhill, potentially contributing to erosion. If grading is done with the contour, this will be less problematic.

When working on a construction site, remember that it is much easier to prevent soil loss than to capture lost soil and replace it. The goal should be erosion control rather than sediment removal – it's much easier to maintain. If silt fences are used to capture soil rather than taking steps to prevent soil loss at its source, the fence will require constant maintenance and the site will be losing soil in the process.

The following general principles, adapted from the Indiana Handbook for Erosion Control in Developing Areas, are the foundations for erosion and sediment control on the site.

- **Fit the development to the existing terrain and soil.** The developer or site designer should assess the physical characteristics of the site, including topography, soils, and drainage, to determine how best to develop the site with minimal environmental damage. Utilization of existing topography and natural drainage, when possible, will minimize grading.
- **Retain existing vegetation** on the construction site wherever possible. If existing vegetation must be cleared, retain and protect it until the area must be disturbed. To the extent possible, maintain a buffer strip around the site perimeter to reduce off-site erosion and sedimentation.

- **Divert offsite runoff away from disturbed areas** by installing diversions, perimeter dikes, or swales before construction begins.
- **Reduce runoff velocity** by maintaining vegetative cover and implementing appropriate BMPs, especially down slope of the project on the perimeter.
- **Minimize the length and steepness of slopes** to slow runoff and allow deposition of sediment. Use terracing, diversions, and sediment barriers to break up long slopes.
- **Minimize the extent and duration that soil is disturbed** using construction phasing to reduce the amount of disturbed area to the absolute minimum needed for immediate construction activities. Remember that prevention of erosion is much easier and more desirable than trapping sediment.
- **Stabilize disturbed areas** as soon as possible using vegetative practices and geotextiles.
- **Keep sediment on the construction site.** Retain sediment from unavoidable erosion using BMPs such as sediment basins, vegetated buffers, or silt fence. Install these measures before construction begins.
- **Keep pollutants out of the path of runoff.** Be sure to follow OSHA and other applicable standards for chemicals and spills. Designate areas for cleaning paint brushes, buckets, and other tools that come into contact with chemicals. Designate areas for concrete washout, and dispose of the extra material properly. Perform on-site vehicle and equipment maintenance only when absolutely necessary in order to prevent pollutant spills on the site.
- **Remove BMPs when they are no longer needed.** Remove BMPs when they are no longer necessary so that vegetation can be reestablished where needed.

Observing the practices outlined in this manual will assist with responsible and efficient construction site management that will benefit the community and the environment. The Qualified Professional Inspector serves an incremental part of implementing a responsible development. Through the cooperation and active participation among all involved parties, including the developer, design engineer, community representative, and Qualified Professional, proper site development will serve the goals of establishing the final site, while protecting the health and safety of the community and environment.

4.6 BMP SELECTION EXAMPLES

The following examples demonstrate the use of this information in site planning.

4.6.1 Home Site Development

Site Description

The construction area for a single family detached home is one acre. The site has a level slope with residential properties adjacent on both sides. The back of the site has a small stream. There are some trees and vegetation along the property line adjacent to the stream.

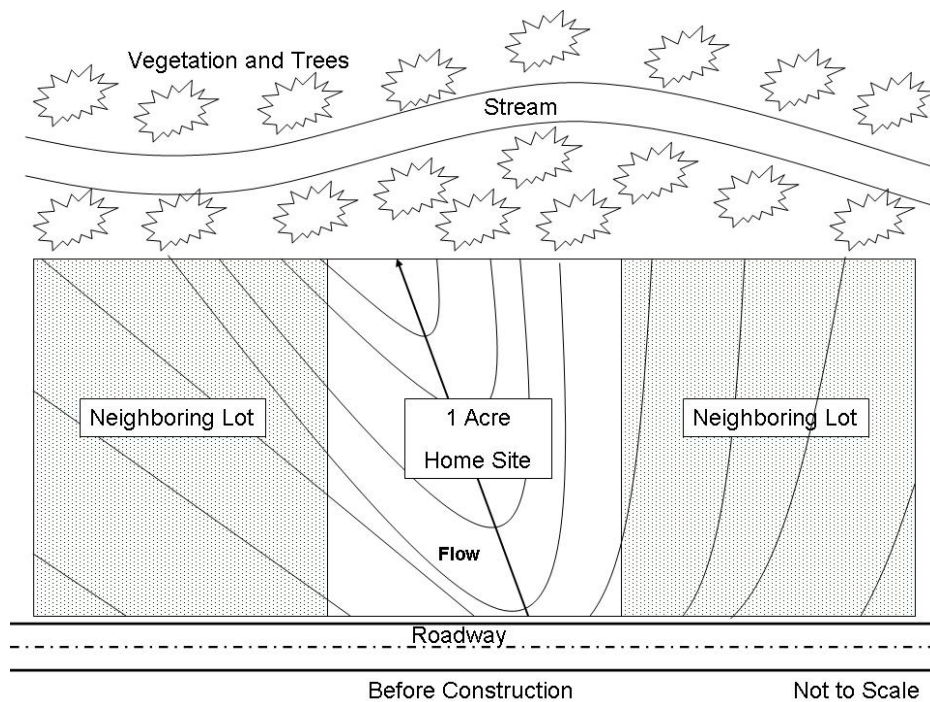


Figure 4.1. Home Site Development, Before Construction

Considerations

- The small area for construction.
- The need to keep all sediment and excess runoff from the neighboring property.
- Protecting the stream from sediment and excess runoff.
- Protecting the trees and vegetation buffer already established.

Necessary BMP Methods

- Soil Stabilization
- Sediment Control

Selecting BMPs

In order to provide soil stabilization and increase sediment filtration, the present vegetative buffer should be left in place. To choose which soil stabilization BMPs will be needed, go to **Figure D.1**, which outlines BMP options for graded areas or slopes. Because the construction site is graded, surface protection is suggested. Available BMPs include vegetative soil cover, non-vegetative soil cover, and structural support. The site may not be large enough to use structural support methods. A combination of vegetative and non-vegetative soil covers could be used. To decide which BMPs to use, go to **Table D.1** to see which BMPs are appropriate for the site. A buffer strip adjacent to the stream may be required by local ordinance. Permanent seeding with nets and mats or mulching can also be used. Sod is another option since the site is evenly graded. The decision can then be based on expense, maintenance, or aesthetics.

To decide which sediment control BMPs need to be implemented, go to **Figure D.3**. Because the construction site is small, sediment filtration is the appropriate option. The available BMPs include straw bale filter, silt fence, and sand bag barrier. Refer to the drainage area requirements on **Table D.3**. For a site of this size, a silt fence or straw bale filter may be appropriate, and the design lifetime of these BMPs are potentially long enough to complete construction without replacement, as long as upstream stabilization practices are reasonably observed.

A stabilized construction entrance is required to control the transport of mud and dust the main road. After construction, the stabilized construction entrance may remain in place as a driveway.

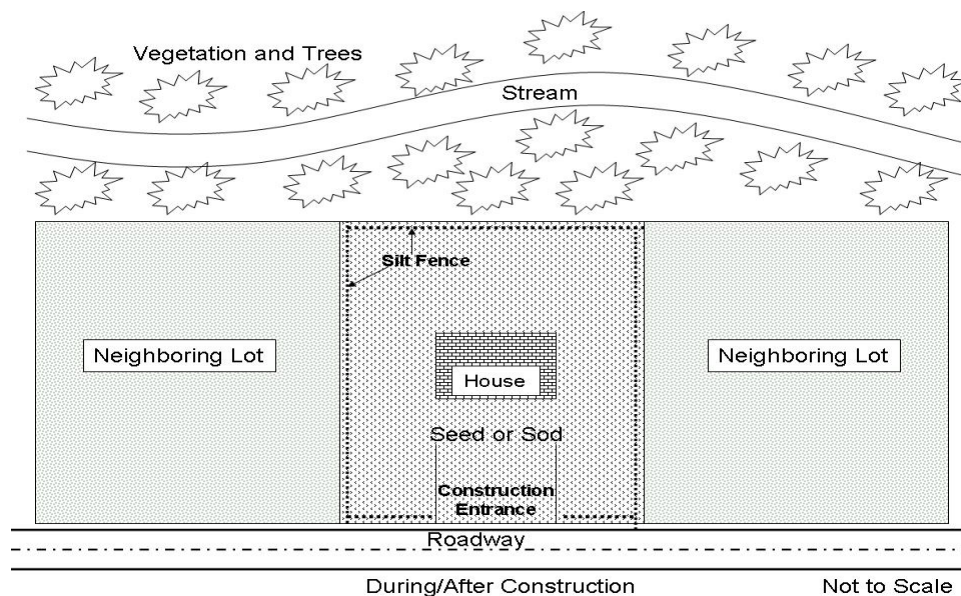


Figure 4.2. Home Site Development, Active Construction

4.6.2 Large Retail Development

Site Description

The construction site is approximately five acres. The slope is 4:1. The finished site will consist of a strip mall and parking areas. There are two drainage ditches located on the lower ends of the site. One drainage ditch conveys water into the city’s storm sewer. There is not a stream adjacent to the property, but the city’s storm sewers drain into a local waterway. Paving the parking lot will begin as soon as grading of the slope is completed.

Considerations

- Size of the site
- The slope of the land to provide for drainage
- Routing site storm water to enter the city storm sewer without allowing the sediment to enter

Necessary BMP Methods

- Soil Stabilization
- Runoff Control
- Sediment Control

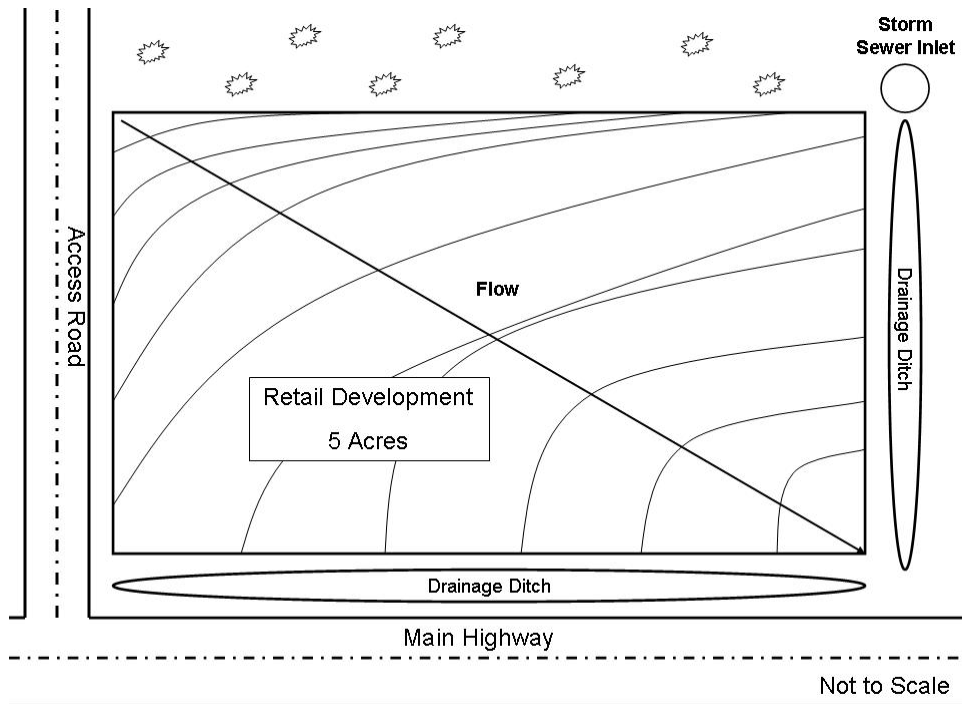


Figure 4.3. Large Retail Development, Before Construction

Selecting BMPs

To determine what soil stabilization methods, refer to **Figure D.1**. The retail site is a graded area, and the surface will need to be protected within 15 days or as required by local ordinance. There are two options to protect the surface, including vegetative and non-vegetative cover. Under these options there are several BMPs to choose from. Since the site will eventually be paved, mulching may be the best option. From **Table D.1**, mulching is acceptable at the site.

To determine which runoff control measures should be implemented, refer to **Figure D.2**. Runoff will be diverted towards the drainage ditches. The available runoff diversion BMPs include swales, diversions, and terracing. Using **Table D.2**, terracing is used for slopes greater than 3:1 and is therefore inappropriate for this level site. A temporary diversion is chosen because its slope requirements are consistent with site conditions. The maximum drainage area is two acres per pipe, so more than one pipe will be needed for this site. Another consideration for runoff control is the stabilization of the storm sewer inlet. **Figure D.2** indicates that rock protection at the inlet is the only option. This is acceptable for this site because the requirements for this BMP from **Table D.2** are met.

To choose sediment control measures for the site refer to **Figure D.3**. The site is relatively large, but small site BMPs may be appropriate. Options to retain sediment on the site include check dams, constructed wetlands, rock filters, berms, detention ponds, and sediment basins. Consult **Table D.3** for specific requirements. A check dam is not needed because it is typically for high velocity flow areas and there are none on the evenly graded surface. Use of constructed wetlands in an urban environment may be limited by the area needed for the wetland. Rock filters and berms would work for the site may not be aesthetically pleasing. Using a sediment basin is the best method to choose in this case.

After construction is completed, the sediment basin can be converted into a retention or detention basin to control the increase in runoff from the pavement. Since the basin will be a permanent feature, a permanent diversion is needed to convey water to the drainage ditch. As needed, the permanent diversion should use material to prevent erosion of the channel. Riprap may be a better option than erosion control blanket due to its longer design life.

Looking at the small area BMPs, silt fence or straw bales may be appropriate for the site. However, since straw bales have a shorter design life, silt fence are often more practical. It should be placed along the low end of the slope on the perimeter of the site. For mud and dust control, there are three methods listed on **Figure D.3**. The stabilized construction entrance is required. From **Table D.1**, a tire washing facility may be used in conjunction with the stabilized entrance on large sites. Since there are no construction roads for the site, this method will not be used.

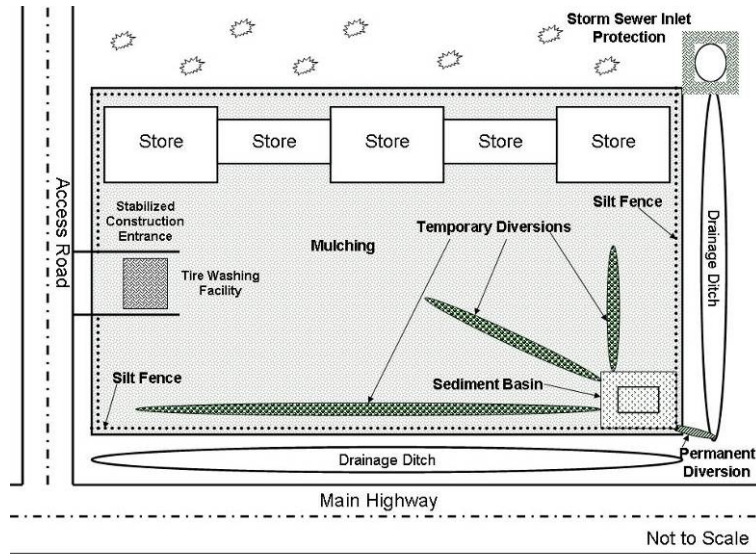


Figure 4.4. Large Retail Development, Active Construction

4.6.3 Constructing a New Water Pipe Line

Site Description

A new water pipe line is being installed. It is 5,000 feet in length. The area has two places with steep slopes at 2:1. The rest of the site is evenly sloped. The new pipe line is being constructed parallel to a main roadway. There are commercial developments on one side of the pipe line. The site will be cleared and the pipe installed directly after clearing. The project will be completed in three months.

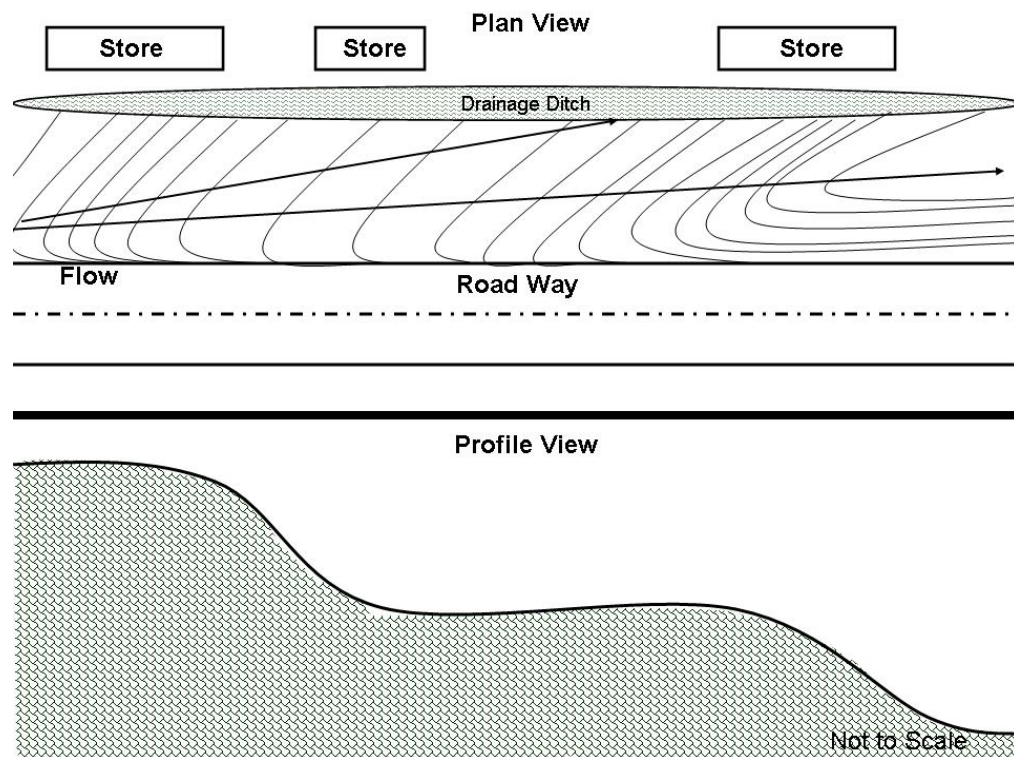


Figure 4.5. Pipe Line Development, Before Construction

Considerations

- Preventing soil being tracked onto the main road by machinery.
- Preventing erosion on the steep slopes.
- Preventing erosion and establishing vegetation after construction is completed.

Necessary BMP Methods

- Soil Stabilization
- Sediment Control

Selection of BMPs

To determine the soil stabilization BMPs refer to **Table D.1** and **Figure D.1**. Since part of the site is level and there are two steep slopes, both need to be considered when selecting the BMPs. After the pipe has been installed, measures to protect the surface will be needed. For the evenly graded areas, permanent seeding and mulching should be used in conjunction to

provide coverage until the vegetation becomes established. On the steep slopes, mulch can still be applied, but will need a tacking agent according to. Another option would be to use erosion control blankets on the steep slopes. Deciding between these two options depends on the budget for the project and the individual cost of the methods.

To determine the sediment control BMPs, go to **Figure D.3**. The site covers a large area, but is linear. Therefore, a silt fence would be appropriate to use around the perimeter of the site. A sediment trap would be appropriate, as it does not take up as much space as the other options listed under the large areas section on **Figure D.3**.

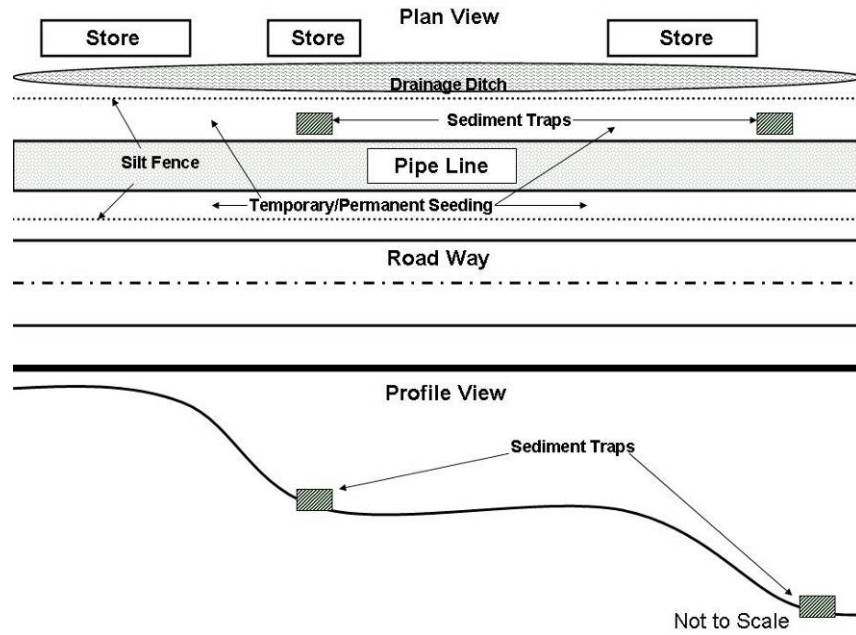


Figure 4.6. Pipe Line Development, Active Construction

4.6.4 New Roadway Construction

Site Description

Two lanes are being added onto a main highway on the outer edge of a city. The new lanes are five miles in length. The construction will take a year to complete. Currently there are drainage ditches parallel with the current road which conveys the storm water into the storm sewer system. The road is evenly graded with no steep slopes.

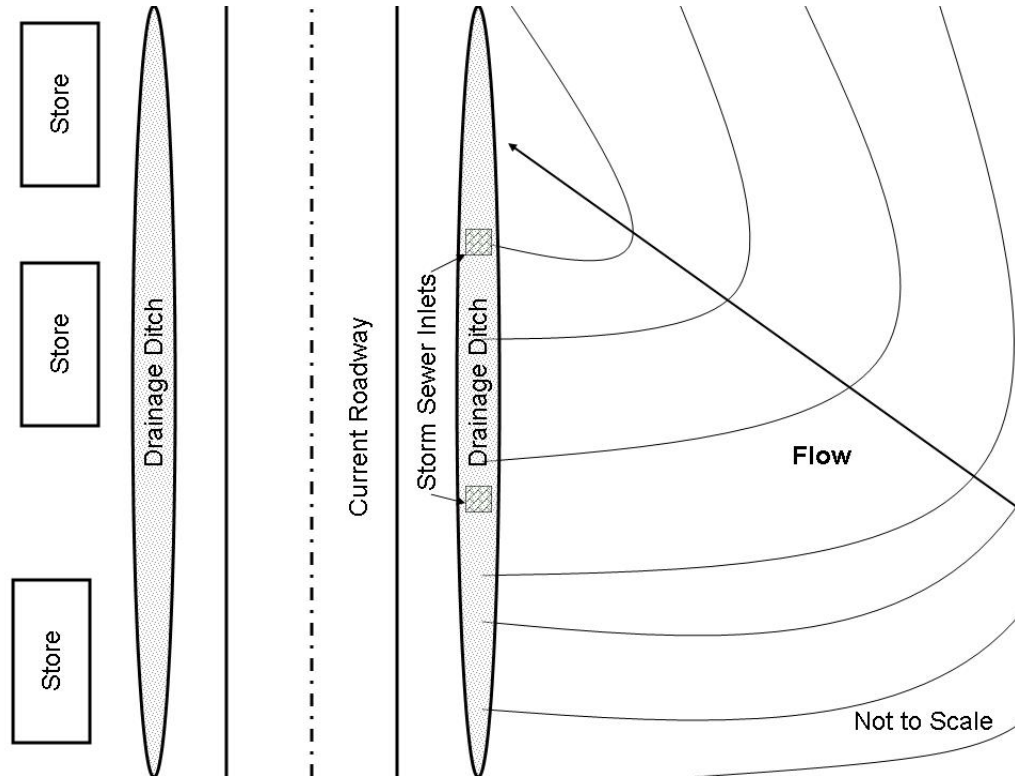


Figure 4.7. Roadway Development, Before Construction

Considerations

- Prevent sediment from entering the drainage ditches and storm sewers.
- Keep sediment off the main highway.
- Length of time for soil to be exposed.

Necessary BMP Methods

- Soil Stabilization
- Runoff Control
- Sediment Control

Selection of BMPs

Figure D.1 shows how to select the soil stabilization BMPs. Since this site has graded areas, the surface needs to be protected. Using **Table D.1**, a combination of vegetative and non-vegetative cover is recommended. The long project timeline may trigger requirements for soil stabilization to be triggered. If so, BMPs to stabilize bare areas and soil stockpiles should be implemented. Temporary seeding may be applied along with mulch for areas that are disturbed after preliminary grading. Other areas that will not be re-disturbed may receive permanent seeding and erosion control mats. On a site of this size, sod is likely to be cost prohibitive.

To determine which runoff control measures are needed, refer to **Table D.2.** and **Figure D.2.** Runoff needs to be diverted from the roadway construction to the drainage ditches. To accomplish this, diversions should be installed along the perimeter of the site. They should be installed to allow only two acres of drainage per pipe. Terracing is not necessary because of the shallow slope. There is a storm sewer inlet located in a drainage ditch. The inlet should be protected with rock.

To determine which sediment control measures should be used, refer to **Figure D.3.** Although the site is large in area, it is linear with a small width. Therefore, small area sediment controls can be used. Since the construction will take place over a long period of time, silt fences should be used as opposed to straw bale filters (**Table D.3**).

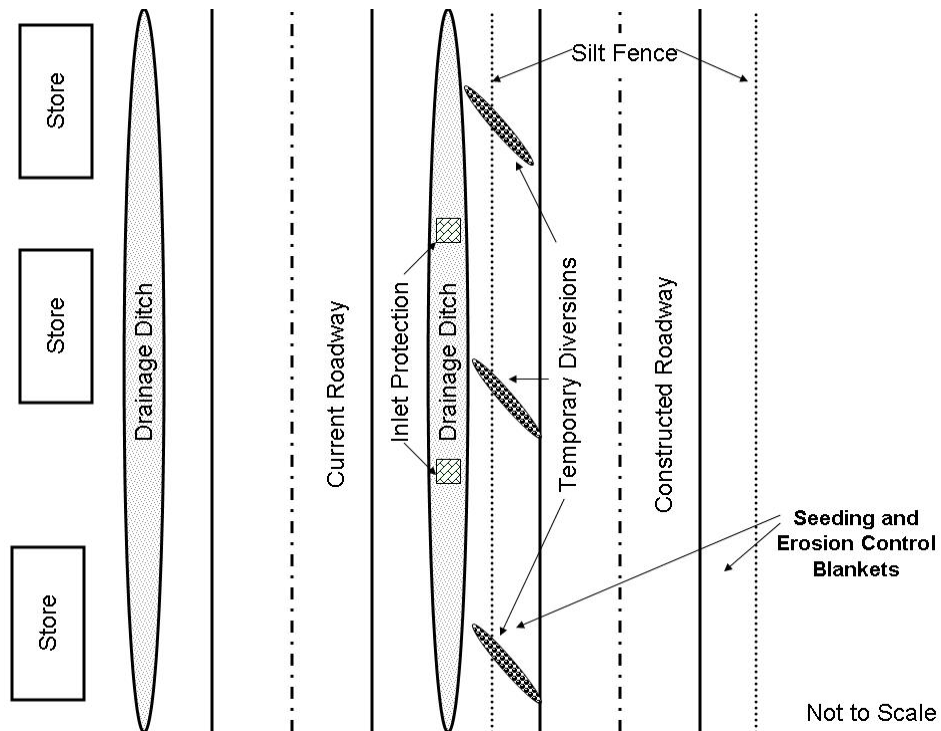


Figure 4.8. Roadway Development. Active Construction

4.6.5 Subdivision Development

Site Description

A subdivision development is approximately 20 acres. There is a road that splits the site into two sections. This road is only an access road for the subdivision. It connects to a main highway. One section of the site is 5 acres and the other is 15 acres. On the section with 15 acres, there is a stream. The drainage is divided by the roadway. One section drains to the stream, the other to the opposite direction. The slopes are gently graded on both sides of the site. All homes will be built consecutively. A majority of the homes will be sold after construction is completed.

Considerations

- Do not allow sediment to enter the stream.
- There are two drainage areas.
- The size of the drainage areas.
- Do not allow sediment onto the main roadway.

Necessary BMP Methods

- Soil Stabilization
- Sediment Control

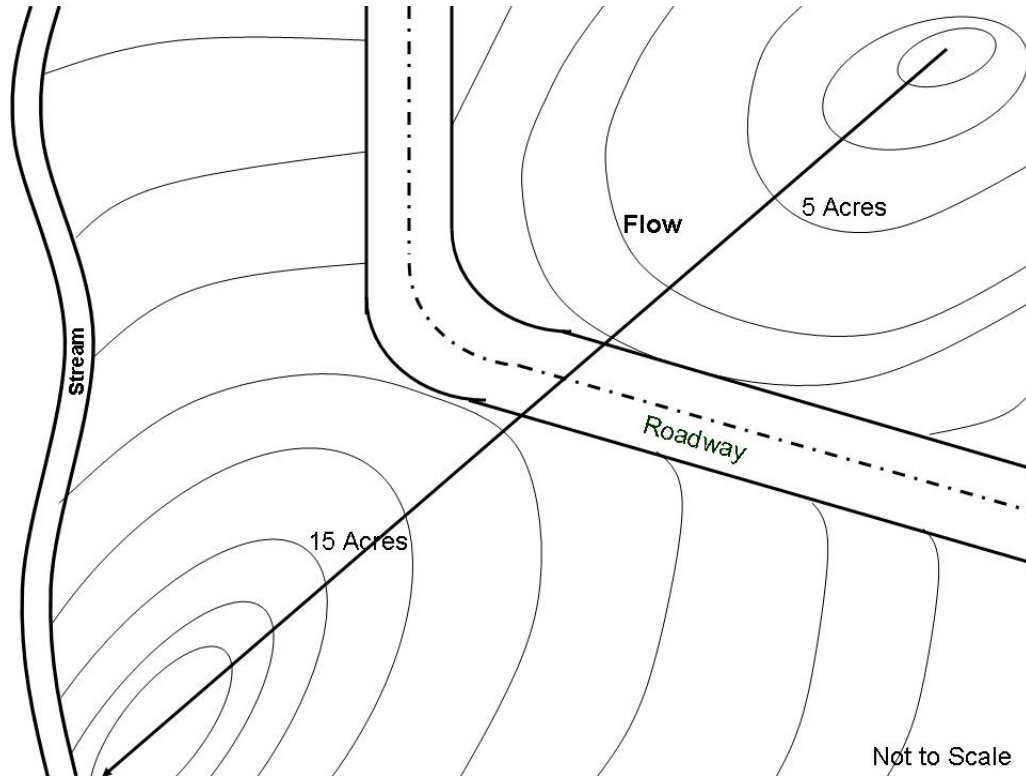


Figure 4.9. Subdivision Development, Before Construction

Selection of BMPs

Soil stabilization methods are determined by using **Figure D.1**. The site has graded areas without steep slopes. The surface needs to be protected during construction of the homes. A combination of vegetative and non-vegetative BMPs can be used to decrease erosion. Since home construction will be completed at approximately the same time, temporary vegetation is not likely to be needed. However, mulching would be a good method to reduce erosion during construction. Mulching is an acceptable practice because the site meets the requirements outlined in **Table D.1**. After construction is completed, permanent seeding or sod could be considered. Sod provides immediate ground cover is more expensive than seed and may require more irrigation.

Local ordinances may require a no-disturbance vegetative buffer along the stream. These buffers will provide soil stabilization and act as a filter strip for sediment. The vegetation will also provide established vegetation for the future homeowners.

Figure D.3 is used to determine which sediment control measures should be used. The subdivision is a large site and needs to retain sediment to protect the stream and other off-site areas. Of the options listed for retaining sediment, a sediment basin is the best choice for this

site because of aesthetics. Berms and rock filters will also accomplish the same job, but are unsightly and more difficult to fully remove after construction. Once construction is completed, the sediment basin can be converted to a retention or detention pond to control stormwater runoff. The site also needs to filter sediment. A silt fence would be more appropriate for this site because of the minimization of maintenance and design life when compared with straw bales.

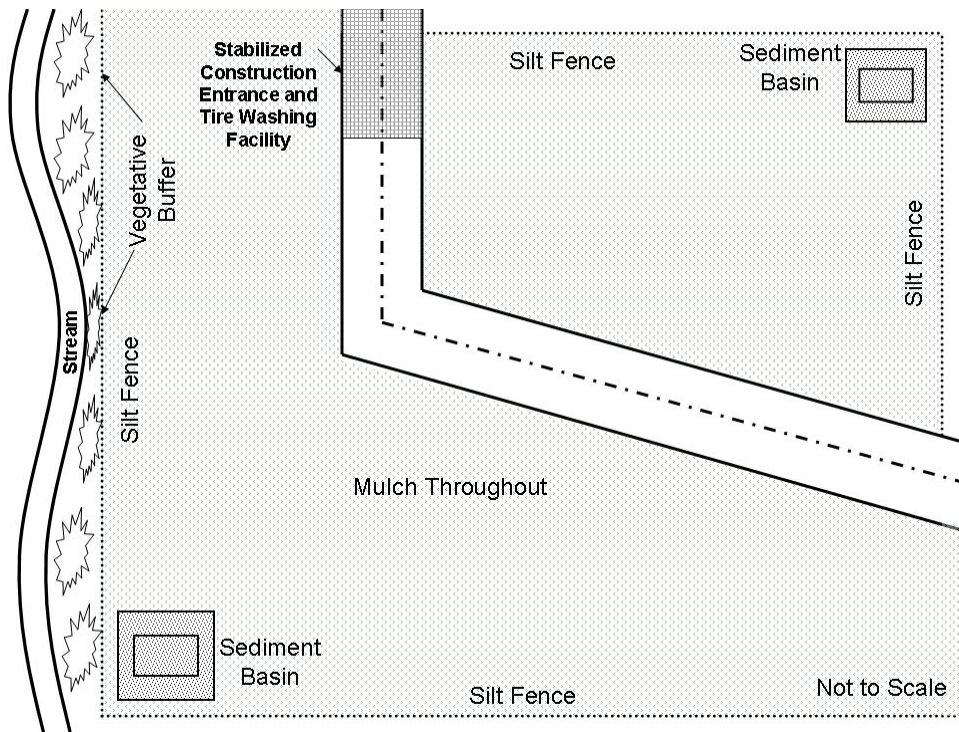


Figure 4.10. Subdivision Development, Active Construction

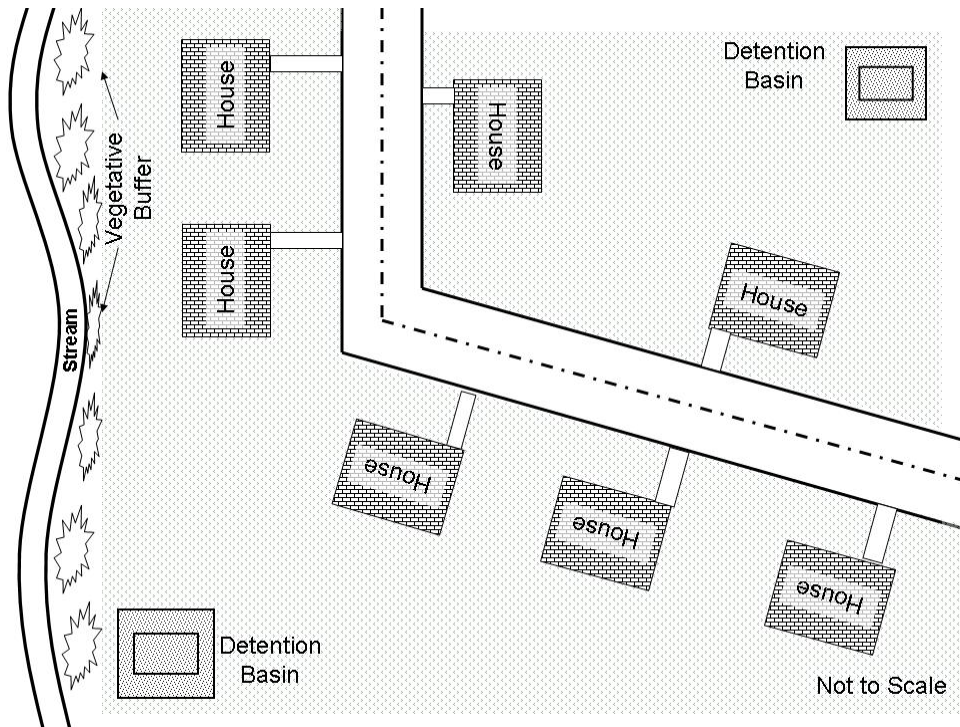


Figure 4.11. Subdivision Development, After Construction

4.7 EROSION CONTROL AND SITE PLANNING WORKBOOK

The Erosion Control and Site Planning workbook was designed as a site planning tool. The workbook is available for download from the SWCDs' websites (**Appendix G**). It is written in Microsoft Excel, which should be readily available on most computers. This section explains the basics of using the workbook for site planning.

4.7.1 Running Macros in Excel

It is important that you enable macros in Excel to allow the workbook to calculate. This can be done by setting your macro security to "Medium". To do this, go to Tools → Macro → Security (**Figure 4.12**) and select the appropriate level. Close Excel and reopen for the settings to take effect.

When you open the workbook, a security warning will appear explaining the risk of macros (**Figure 4.13**). Select "Enable Macros" to allow the workbook to perform calculations. This will not harm your computer if you trust the source of the workbook.

At this point you should see a welcome screen. You may close this box and begin to use the workbook.

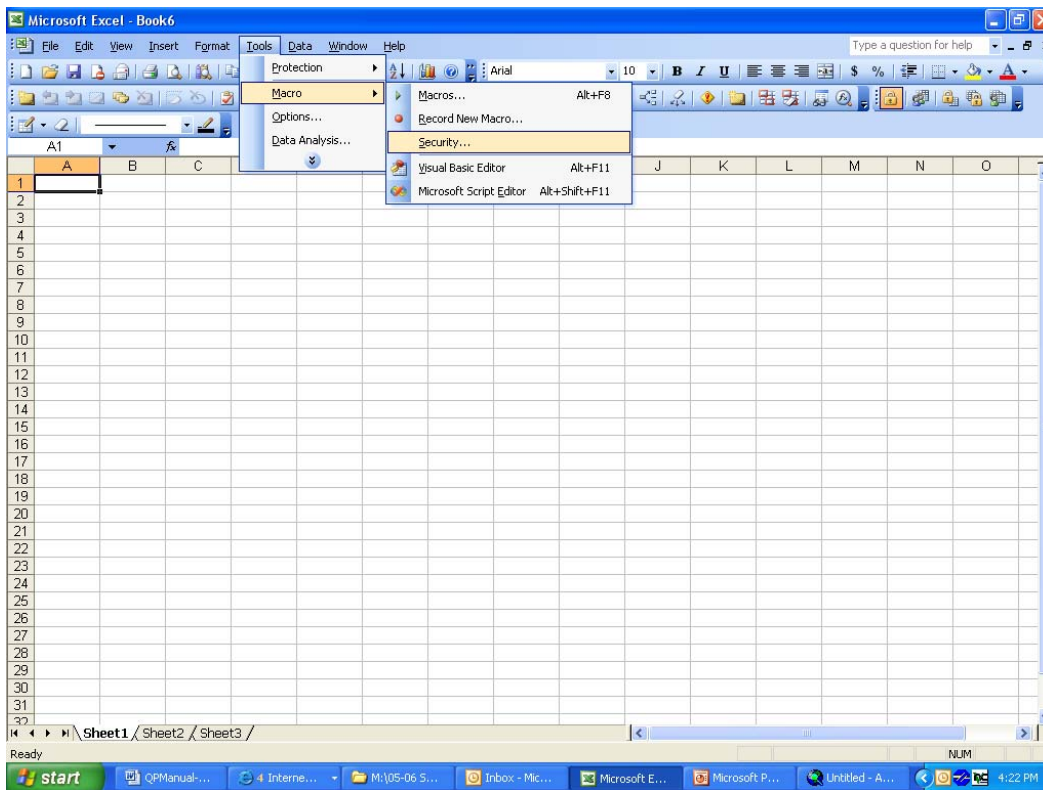


Figure 4.12. Macro Security Settings

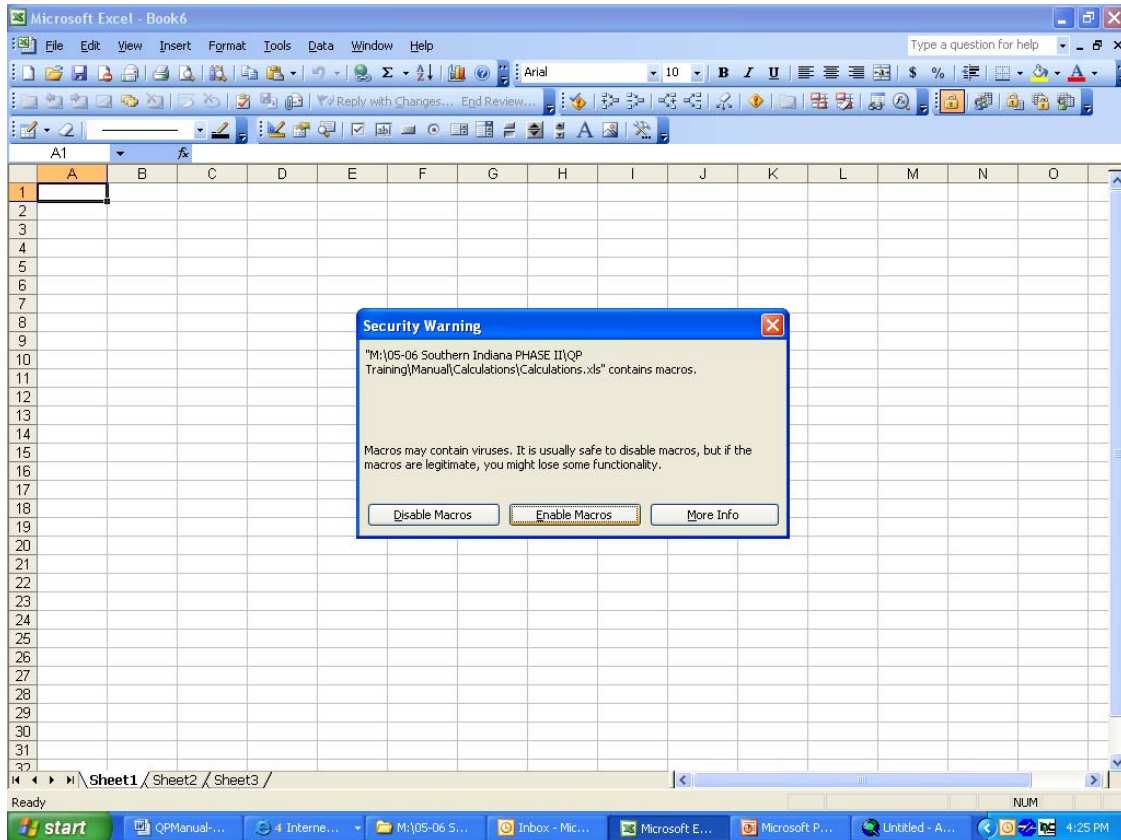


Figure 4.13. Enabling Macros

4.7.2 Site Information

The first worksheet in the workbook is entitled “Site Information”. The user is prohibited from proceeding to another worksheet until the site information is filled in correctly. If the worksheet is not completed, error message such as “Please fill in the pre-construction slope length”, and a message box that says “The workbook will not be updated” will appear on the screen.

The fields available for data input are shaded in blue. Fields include:

- **Site Name**
- **Developer**
- **Community** – This is a drop-down box. Please select the community in which the site is located; if it is located in more than one community, select the community in which the greatest percentage of the site is located.
- **Drainage Area** – Use acres.

- **Special Issues** – These are drop down boxes. Please select all special issues that affect the site.
- **Slope Length** – Use feet. This value should be the same pre- and post-construction unless drainage flows to a large surface storage facility or is otherwise interrupted.
- **Slope Steepness** – Use a percent rather than a decimal – i.e., $50/1000 = 0.05 = 5\%$. If the slope steepness is 0 (flat ground), use 0.001.
- **Soil Group Name** – This is a drop down box. Please select the soil map unit abbreviation from the soil survey.
- **Land Use / Coverage** – This is a drop-down box. The choices are as follows:
 - o Commercial / Business Districts, ~85% impervious area
 - o Industrial Districts, ~72% impervious area
 - o 1/8-acre residential units, ~65% impervious area (includes driveways and homes)
 - o 1/4-acre residential lots, ~38% impervious area
 - o 1/2-acre residential lots, ~25% impervious area
 - o 1-acre residential lots, ~20% impervious area
 - o Paved Parking Lots, Roofs, Driveways
 - o Streets and Roads
 - o Open Spaces – Lawns, parks, golf courses, etc.
 - o Cultivated Land – Farmland that is actually used for crops
 - o Pasture – Meadow used for grazing cattle
 - o Meadow – Grassy areas, can be mowed for hay or left uncultivated
 - o Woods and Forests
- **Percent** – Use a percent rather than a decimal – i.e., $50/1000 = 0.05 = 5\%$. The total in this column must add to 100.

Input is required for all blue fields except those under “Land Use / Coverage.” At least one line of “Land Use / Coverage” data must be completed, and the percent column must add to 100.

The most difficult section to complete will be the “Land Use / Coverage” section. You will need to determine the locations and names of each soil map unit located on your site. Determine the land use pre- and post-construction and percent of site acreage for each soil map unit on the

site plan. If there is more than one land use before or after construction for a single map unit, you will need to divide that unit accordingly. For example, soil BcrAQ is found on 48% of your site. Of this area, 100% is “Woods and Forests” before construction. However, 26% will be “1/2 acre residential lots,” 34% will be “Open Spaces”, and 40% will remain “Woods and Forests” (**Figure 4.14**). You will need to enter BcrAQ on 3 separate lines, one for each post-construction scenario, as shown in **Figure 4.15**. To find the correct percentage, multiply the soil percentage times the land use percentage and divide by 100. For instance, to find the correct percentage of residential lots, use $26 \times 48 / 100 = 12.48$. Once all information is entered correctly, you are ready to proceed by selecting a tab at the bottom of the workbook, including Hydrograph, BMPs or Soil Loss.

4.7.3 Hydrograph

The second worksheet generates a hydrograph based on the information entered on the “Site Information” worksheet. No further entry is needed. The hydrograph includes pre- and post-construction hydrographs for the 2YR-24HR; 10YR-24HR; and 100YR-24HR storms.

4.7.4 BMPs

The third worksheet organizes available BMPs according to their uses and rules out inappropriate BMPs. This worksheet uses your input from the “Site Information” worksheet to identify BMPs that are affected by drainage area, steep slopes, sensitive areas, and other criteria. No further entry is needed. BMPs that appear in bold are required; those that are not bold are available to use onsite. Information is included in this sheet to allow you to compare BMP alternatives based on factors such as maintenance needs, costs, lifespan, suitability for habitat, and other information.

4.7.5 Scheduling

This worksheet produces a groundcover / grading schedule and includes the calculation soil loss based on factors you input on the Site Information worksheet. Soil loss calculations can

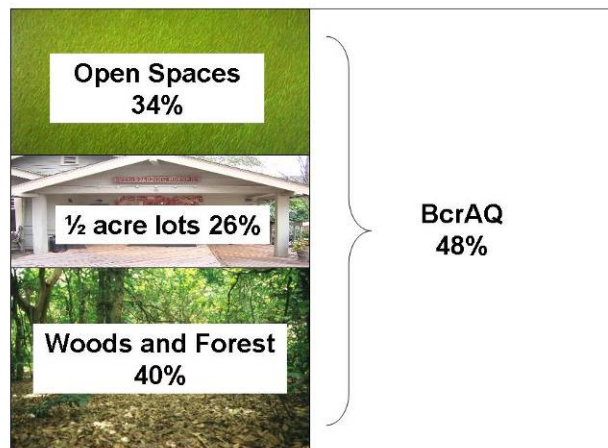


Figure 4.14. Soil Map Unit Division Example

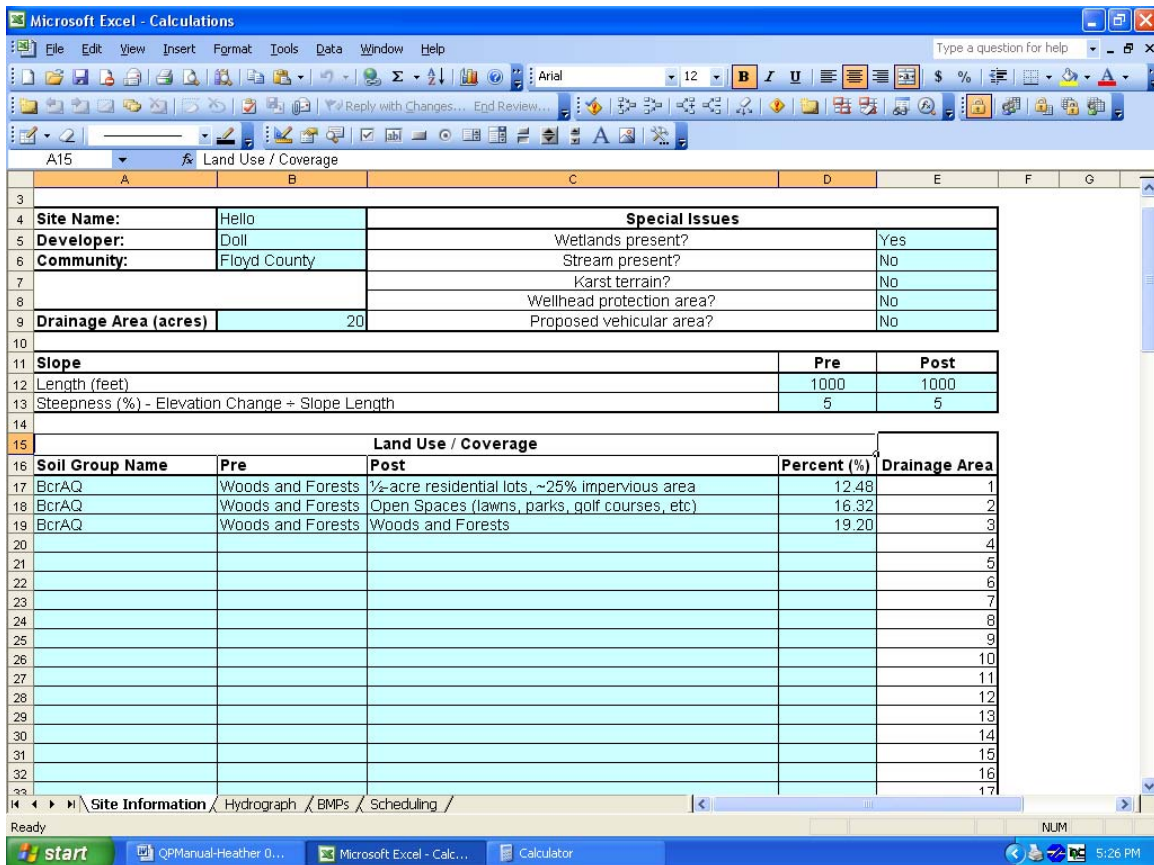


Figure 4.15. Entering Multiple Land Use Categories

help you to determine whether graded areas are left bare for too long, causing unnecessary erosion and sedimentation. This can also help you to determine the kinds of BMPs you want to use onsite – the greater the soil loss, the more likely you are to use BMPs to stabilize outlets and retain and filter sediment compared with soil cover alone. The following fields are available:

- **Grading / Coverage Activity** – This is a drop down box. The choices are as follows:
 - o Bare Ground
 - o Mulch
 - o Seed
 - o Seed and mulch
 - o Geotextiles – with or without seed
 - o End – This is required at the end of the project.

- **Begin Date** – Enter the date that the activity begins. For all except the first entry, this is the end date for the previous activity.

Soil loss will be calculated when the form is filled in correctly, including a project end date. If soil loss exceeds recommended limits, a message will display when soil loss is calculated. Even if the soil loss is within acceptable standards, steps should be taken to prevent erosion and control sedimentation onsite.

4.8 SPILL PREVENTION CONTROL AND COUNTERMEASURES

In addition to requirements for water quality protection through erosion prevention and sediment control, construction sites are required to prevent the discharge of illicit substances, as described in **Section 2.2**. In addition to local requirements, the USEPA and the State of Indiana require some larger construction sites to develop plans for spill prevention control and countermeasures (SPCC). These construction sites may have large onsite storage for gasoline or fertilizers, or may perform vehicle maintenance onsite. These sites may not be governed by Rules 5 and 13, but by the more stringent Rule 2 - NPDES General Permit Rule Requirements or Rule 6 - Stormwater Discharge Exposed to Construction Activity. Even if your site is not required to have a formal SPCC plan, it is good practice to evaluate your site for potential spills and to plan accordingly. Work with the site safety manager to take steps to minimize the risk of spills and properly remediate areas where a spill has occurred. The following includes some methods you can use onsite to prevent spills:

- Designate an area(s) onsite for material delivery and storage away from waterways.
- Storage areas for hazardous materials such as fertilizers, herbicides, pesticides, paints, paving materials and other chemicals should be covered or indoors when possible.
- If chemicals are not stored indoors, store in areas where they are unlikely to encounter runoff from a storm. Utilize secondary containment structures such as a spill pallets and containment mats as protective measures against a spill.
- Do not store hazardous materials containers directly on the ground – use a spill pallet or other device.
- Monitor storage areas and areas of vehicle maintenance and fueling for issues of concern, including leaks, spills, and vandalism.
- Designate areas onsite for concrete washout and dispose of the extra materials properly.
- Designate areas onsite for cleaning paintbrushes and other tools that come into contact with chemicals and dispose of this washwater properly.
- Clean up spills and leaks immediately. Avoid using water to prevent material spread. For larger spills, use as many site personnel as necessary to contain the spill.

- If a spill is hazardous or otherwise requires outside intervention, do not attempt to clean up. Do only what is reasonable to contain the spill and dial 911.

Refer to **Section 2.4** in the Best Management Practice Design Manual for more information about SPCC and other pollution prevention techniques.

5.0 Qualified Professional Responsibilities

A Qualified Professional Inspector who is qualified to inspect, document and report on the status of stormwater quality BMPs at a construction site. A QPI must successfully pass the Qualified Professional Inspector examination and register or obtain a license (if required) by the local MS4 community. The Qualified Professional Inspector is responsible for:

- **Inspecting** stormwater BMPs at construction sites on a regular basis and after storm events of a certain size. Specific requirements for inspection frequencies are contained in local ordinances.
- **Documenting** inspection results using forms approved by the local MS4 community, and
- **Reporting** inspection results to appropriate personnel associated with the development project (e.g., developer, site designer, contractors, etc.).

5.1 PRE-CONSTRUCTION MEETING

For large or complex sites, a pre-construction meeting is recommended. Depending on the personnel involved in the project, the meeting may include the site owner, developer, site designer, construction foreman, QPI and MS4 inspector. If possible, meet at the project site so everyone can physically see the planned BMP locations. The QPI should review the PCP, SWPPP, and SWQMP prior to the meeting. These plans and permits should be discussed at the meeting to gain a common understanding of the project and how stormwater will be managed. This is a good time for the QPI to ask questions of the site designer and the MS4 inspector and for the QPI to clarify for others the nature of inspections and steps that they can take to help keep the stormwater BMPs functioning properly.

5.2 SITE ORGANIZATION

As a QPI, you may be responsible for inspecting stormwater BMPs on large or complex project sites and you may not be present at the site on a daily basis. In these situations, it may be useful to seek help with plan implementation. Involving others on the site allows for better implementation of the erosion control plans. This can be as simple as posting site maps around the project site and asking people to circle any areas where they have observed water quality concerns, or asking one person on the site to be your eyes and ears. If communication channels are open, then the job of managing stormwater quality should be easier.

You may also consider posting good housekeeping methods in areas where spills could occur, including vehicle maintenance and materials storage areas. You may be asked to make sure

resources are readily available to contain spills, especially near stormwater inlets and outfalls. Ask contractors and subcontractors to include stormwater awareness, spill containment, and proper spill cleanup in safety and OSHA meetings.

5.3 PREVENTIVE MAINTENANCE

An ounce of prevention is worth a pound of cure. On construction sites, an ounce of prevention may be worth several tons of soil. The QPI should pay attention to weather reports, and check BMPs before an expected rain event to make sure they are in working order, especially any that have had problems in the past. To the extent possible, perform maintenance and repairs before the storm occurs to avoid malfunctions, clogging, and flooding.

5.4 EMPLOYEE / SUBCONTRACTOR EDUCATION

The QPI may benefit from participating in a construction meeting to introduce new contractors or subcontractors to the PCP, SWPPP, and SWQMP as well as the BMPs on the site and their functions. As the QPI, you are able to explain how contractors and subcontractors can minimize stormwater pollution. Remind them where to drive, construction entrances and roads, and areas to avoid, such as stormwater inlets, silt fences, and buffer zones. Let contractors and subcontractors know how to reach you if there is a question or problem with stormwater or a change to the construction plans that may impact stormwater management.

5.5 ESPC PLAN IMPLEMENTATION

Keep in mind that not all BMPs in use during active construction are temporary. For instance, a sediment basin used to trap sediment during construction may be used as a retention or detention basin after construction is completed, if designed and maintained properly. Permanent BMPs such as catchbasins may also be installed before active construction is completed.

5.6 INSPECTIONS

An inspection form is provided in **Appendix C**. This form, or another form approved by the MS4 inspector, should be used to document all stormwater BMP inspections.

Inspection requirements are specified by local ordinance. Therefore, the QPI is responsible for understanding federal, state and local inspection requirements. Several communities require inspections every 14 days and within 24 hours of a one-quarter inch ($\frac{1}{4}$ ") precipitation event; others require inspections every 7 days and within 24 hours of a one-half inch ($\frac{1}{2}$ ") rain event. Depending on site conditions and issues, more frequent informal inspections may help the QPI identify problems on the site, which can improve BMP functionality and decrease chances of failure and enforcement actions. The basic idea behind inspections is to check that:

- All BMPs in SWPPPs are installed and maintained;
- Erosion is being controlled throughout the site;
- Sediment is not being transported or deposited offsite;
- No sediment is entering nearby streams or MS4 stormwater conveyances.

If the QPI is not present on the site at all times, a brief conversation with the foreman may assist with identifying problem areas and areas of new work on the site. This will help with the efficiency of the inspection.

It is recommended that the QPI carry a reduced-size site plan, as well as the PCP and SWPPP as references to assist with identifying what BMPs should be in place, their location on the site and at what phase of construction.

The fact sheets in the Stormwater BMP Design Manual include an inspection checklist and a list of routine maintenance measures. This document is a valuable reference during the inspection process.

It is recommended that you begin the inspection at the lowest point of elevation and work up to find sources of erosion. Inspect each BMP with regards to proper installation, maintenance needs and any other stormwater issues in the surrounding area. What works one week may fail the next, and detailed notes can help you find the problem. It may be useful to take digital photographs to document BMP conditions and performance before and after storms.

The entire project site should be inspected. This will help to identify areas that are affected by sedimentation that were not covered by the original PCP and SWPPP or that have been affected by changes that have taken place since construction began. Check areas with bare soil or stockpiled soil to ensure that BMPs are installed as required within the timeframes specified by local ordinance.

Inspect the construction site entrance/exit BMPs. Sediment tracked onto adjacent roadways is often highly visible and can trigger complaints, inspections by the MS4 inspector and potentially enforcement actions. Inadequate maintenance of the construction site entrance can be a quick indicator of a poorly maintained construction site to any MS4 representative. If there is a lot of traffic at the construction site entrance/exit or if site conditions are wet or muddy, it is recommended to check these areas daily. While not required, these more frequent checks can help the entrances stay clean and avoid sediment build-up on the public roadway. This can be as easy as driving past the site and calling the foreman with instructions.

Check materials storage areas that are exposed to rainfall for possible sources of pollution. Inspect discharge points and outlets for visible signs of erosion and off-site sedimentation. Include observations about areas with no BMPs in the inspection documentation. Any problems onsite relating to water must be documented. These notes can help identify areas where

additional controls need to be implemented. Note all BMPs on the sketch; highlight BMPs that need modification or maintenance, or areas in need of further protection as the inspection is conducted.

As you inspect the site, note any signs of flooding, including flooding not caused by sedimentation. Flooding issues may need to be addressed by the site engineer and may result in changes to the SWPPP.

5.7 RECORD KEEPING

Good record keeping is almost as important as the inspections, maintenance, and plan updates. If there is no log, it is like the inspection never happened! Without a paper trail of inspections, maintenance, and plan changes, it may very challenging for someone else to understand the situation on your site.

Inspection findings must be documented using the inspection form provided in **Appendix C** or another form approved by the MS4 inspector. As discussed previously, it may be helpful to take digital photographs, particularly of problem areas. Print copies of any photographs and attach them to the inspection form. If additional notes are taken during the inspection, it will be helpful to attach these to the inspection form as well.

5.8 REPORTING

Local ordinances may require that the inspection results be kept on-site, if suitable facilities such as a building or project trailer are available. If an appropriate facility is not available, a copy of the most recent inspection may be required to be displayed at the site along with other documents that must be displayed to the public as per other local, state and federal regulations. Options in this situation include using a PVC tube or other waterproof container at the site entrance. Inspection reports may be required to be submitted to the MS4 inspector if specified in the permit. Inspection reports may also be requested by the MS4 inspector and/or IDEM. If such a request is made, reports must typically be provided with 48-hours of the request.

Failure to comply with the posting or submittal requirements may be deemed a violation of the permit and may result in enforcement action.

In addition to these reporting requirements, it is essential to communicate the results of the inspections to the site owner or developer. They are responsible for ensuring that any necessary maintenance is performed. They are also responsible for addressing more serious issues through plan updates.

Communication with the MS4 inspector may also be useful. It is often better to notify the inspector about problems so they may assist with a solution, rather than to have the inspector discover problems during their own oversight inspection.

5.9 PLAN UPDATES

Unforeseen issues may arise during the construction project that results in changes to the SWPPP. Construction plans may change due to weather and other delays, such that the phasing portion of the plan may need to be updated. Upstream sites may increase runoff beyond the BMPs' capacities, requiring modifications or new BMPs to adequately treat stormwater. Water may not behave as expected on the site due to localized soil conditions or other factors. If frequent maintenance of one or more BMPs is needed, it may signal the need to modify existing BMPs or install additional BMPs. If modifications or additional BMPs are needed, the site engineer may update the SWPPP and the QPI will alter inspections to include these changes.