FINAL

TECHNICAL REFERENCE MANUAL

FOR

MCHENRY COUNTY
STORMWATER MANAGEMENT ORDINANCE

MARCH 2004

TECHNICAL REFERENCE MANUAL

FOR

MCHENRY COUNTY
STORMWATER MANAGEMENT ORDINANCE

Approved by the McHenry County Stormwater Committee

January 20, 2004

Approved by the McHenry County Board

January 20, 2004

Prepared for:

McHenry County Stormwater Committee
2200 North Seminary Avenue
Woodstock, IL 60098

Prepared by:

McHenry County Planning and Development Department
and
CDM

Contents

Section 3
Permit Submittal Checklists

Section 4
Inspection Procedures

Section 5
Applicable Local, State, and Federal Permits

Section 6
References

Appendices

Figures

Tables

Section 1
General Provisions and Regulated Development

The McHenry County Technical Reference Manual is a technical guide to provide assistance in complying with the Stormwater Management Ordinance (herein referred to as SMO) and the technical requirements of a stormwater permit application. The purpose of the Technical Reference Manual (herein referred to as TRM) is to supplement the McHenry County SMO by providing background, detail, and intent of the technical requirements in the SMO. This manual contains discussions, tables, figures, and exhibits covering high priority topics found in the SMO to assist the applicant in preparing a complete and concise Watershed Development Permit Application.

Many requirements of the McHenry County SMO were taken from countywide ordinances developed for stormwater programs in neighboring Lake and Kane Counties. Overlap in the stormwater ordinances is appropriate due to the many similarities between McHenry County and its neighbors. McHenry County was able to develop a SMO that is unique to its own needs while maintaining a degree of regional consistency. Where appropriate, portions of this manual were taken or adapted from TRMs prepared by neighboring counties through the cooperation of the Lake County Stormwater Management Commission and the Kane County Stormwater Management Committee.

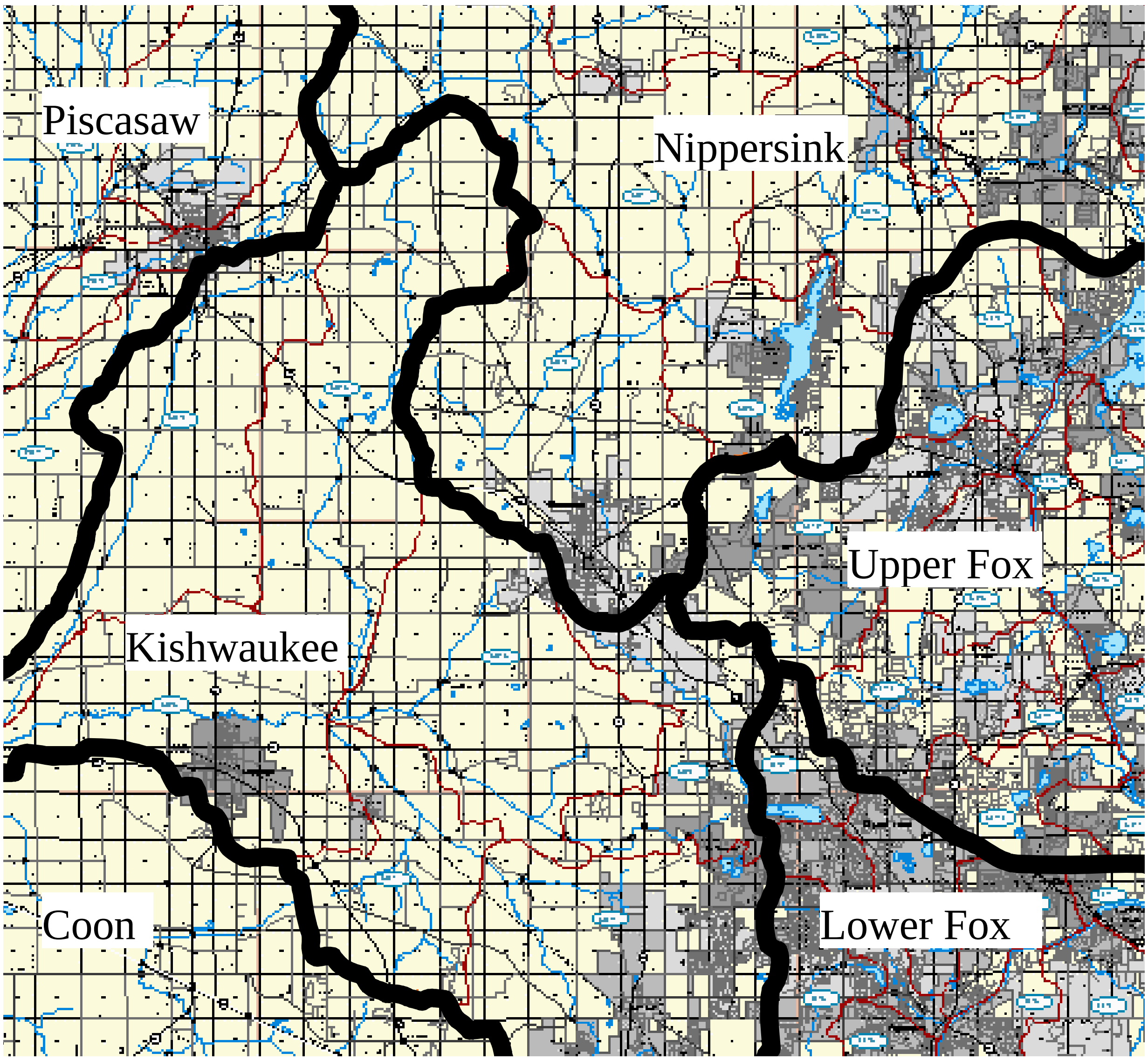
The SMO sets forth the minimum development requirements for watershed development within McHenry County. McHenry County has been divided into six primary watersheds: Nippersink Creek, Upper Fox River, Lower Fox River, Piscasaw Creek, Kishwaukee River and Coon Creek. Nippersink Creek is a tributary to the Fox River. The Piscasaw and Coon Creeks are tributaries to the Kishwaukee River. The six watersheds are shown in Figure 1-1.

This TRM provides guidance to achieve the objectives and standards of the SMO. This document has no authority to mandate new criteria and provides a conservative approach for complying with the intent and letter of the criteria. Other techniques may exist that will meet the criteria with less effort or at a lower cost. The applicant accepts the burden of demonstrating the technical adequacy of the development design and is completely responsible for conformance with the criteria of the SMO. This TRM is not intended to specify limitations on the creative design process. Designers have flexibility in devising solutions within the requirements of the SMO. Use of this TRM or issuance of a permit does not release the designer from responsibility of the stormwater design. Sound engineering methods and good technical judgment are always required during the permit process.

The material contained herein is intended to provide guidance to the engineering and design community in developing solutions to stormwater management problems.

When unusual or complex problems are encountered, it is the responsibility of the designer to identify such conditions and to notify the appropriate permitting agency. In such cases, the designer shall propose an alternative higher standard, criteria, solution or methodology consistent with good planning and engineering practice. The designer shall obtain approval of the proposed alternative methodology before continuing with the design.

Figure 1-1: McHenry County, Illinois Watershed Boundaries (McHenry County, 2001)



1.1 Purpose of the TRM

The goal of the SMO is to ensure uniform and consistent treatment for developments and establish a minimum standard for minimizing impacts to watersheds throughout McHenry County. The focus of this document is for typical developments in McHenry County, and the purpose of the TRM is to provide the technical tools and guidelines to correctly apply the current SMO and to promote uniformity, consistency and efficiency throughout the permit and enforcement process.

The **purpose of the TRM** includes the following components:

- Provide technical background and reference information
- Provide supporting documentation for enforcement officers
- Provide direction to assist in uniform and comprehensive permit applications
- Provide design guidelines
- Provide information as a useful resource for planning purposes
- Provide interpretation for the SMO

The TRM is structured to provide clear direction for a wide variety of regulated development projects throughout McHenry County. Sections are organized to identify information that is required to be submitted with the watershed development permit application. Additionally, various tools including checklists, representative examples, forms, and spreadsheets are provided within the TRM to assist the users in preparing uniform and comprehensive submittals.

Large-scale projects such as major highways, dams and reservoirs or large basin master plans require special considerations beyond the scope of this document. Individuals involved in such projects should contact the McHenry County Planning and Development Department from the inception of the project to ensure that stormwater issues are properly addressed.

Who is this TRM for?

- County and Municipal Planners
- County and Municipal Engineers
- Community Officials and Leaders
- Enforcement Officers
- Consulting Engineers
- Developers and/or Property Owners
- Environmentalists

The TRM references numerous sources to obtain additional information. These references are arranged as applicable to the TRM in Section 6 References. Additionally, valuable websites are referenced throughout the TRM where more specialized information can be found for certain topics.

The analytical procedures and techniques presented herein are consistent with available data and the hydrologic cycle, as it is currently understood. Procedures selected for use in McHenry County are taken from commonly used and recognized sources. Users of the TRM are responsible for the integrity and design of the various facilities proposed and should consult the original references cited at the end of most sections for more comprehensive information. The standards established by the SMO are intended to be the minimum requirements within McHenry County. The applicant is responsible for reviewing the requirements of the local community to determine whether more restrictive measures are required.

Note: This Manual and the information contain herein is based upon the Stormwater Management Ordinance effective January 20, 2004. Future revisions may contain requirements or information that supersede this TRM. Users should always make sure that the most current Stormwater Management Ordinance is referenced.

1.2 Community Certification Criteria and Process

The community certification process describes the way by which a municipality within McHenry County and within the jurisdiction of the McHenry County SMO can become certified to review, approve, and issue Watershed Development Permits. Individual communities within McHenry County will determine if they will issue watershed development permits, or if they will allow the MCSC to issue watershed development permits on their behalf. *Certified communities shall petition for recertification every three years. Communities with provisional certification shall petition for certification as stipulated in the interagency agreement but not more than one year from receiving provisional certification.*

Each community within McHenry County may adopt the SMO by reference, or adopt an ordinance specific to the community. A community is not precluded from adopting regulations more stringent than those specified in the SMO, but the community’s ordinance must demonstrate that the minimum standards set by the SMO are met.

Communities choosing to become Certified Communities receive all permitting authority that the SMO may delegate. Permitting for all projects within McHenry County watershed areas is included.

With the Certified Community option:

1. The community will review, issue, and enforce all aspects of the SMO.

2. No permit review by the MCSC is required.

3. The certified community must notify the MCSC of permits issued by the community.

With the Provisional Certified Community option:

1. The community will not have sufficient capacity to implement all provisions of the SMO by the effective date.

2. The community intends to develop full capacity within a reasonable period of time.

3. An interagency agreement is required between the MCSC and the provisional certified community.

In order to become a certified community, a municipality has to submit the following items for approval by the MCSC:

- A letter of intent to petition for certification from the MCSC.

- A copy of the community's adopted ordinance shall be included with the petition.

- A copy of the community's process of reviewing, rejecting, issuing, and recording permits is submitted.

- Submit the resume of the enforcement officer, who should be at a minimum, a CFM (Certified Floodplain Manager, as outlined by the Illinois Association of Floodplain and Stormwater Managers) or ideally, a Registered Professional Engineer in the State of Illinois.

- Submit a copy of a letter from the most recent calendar year from FEMA, outlining the community's continued participation in the NFIP (National Flood Insurance Program.)

Upon receipt of the Petition for Certification, the MCSC begins a 90-day review period. The MCSC may extend this time period by an additional 30 days, if necessary. During this review period, the MCSC will continue to enforce the SMO in the community. The MCSC will notify the community in writing concerning its decision. Figure 1-2 is a flowchart outlining the certification process.

The Illinois Department of Natural Resources/ Office of Water Resources (IDNR/OWR) shall be copied on all communications regarding community certification status. This will better enable the IDNR/OWR to review a community's compliance with FEMA and state regulations. The MCSC reviews state and federal regulations that cannot be delegated to the local level.

All certified communities must maintain records for all watershed development permits issued and all variances granted. The SMO requires that the MCSC review the community's program implementation and performance every 3 years. An annual audit of McHenry County Certified Communities will most likely occur during the infant stages of the SMO.

The MCSC Chief Engineer will rescind the certification or provisional certification of a community for the following reasons:

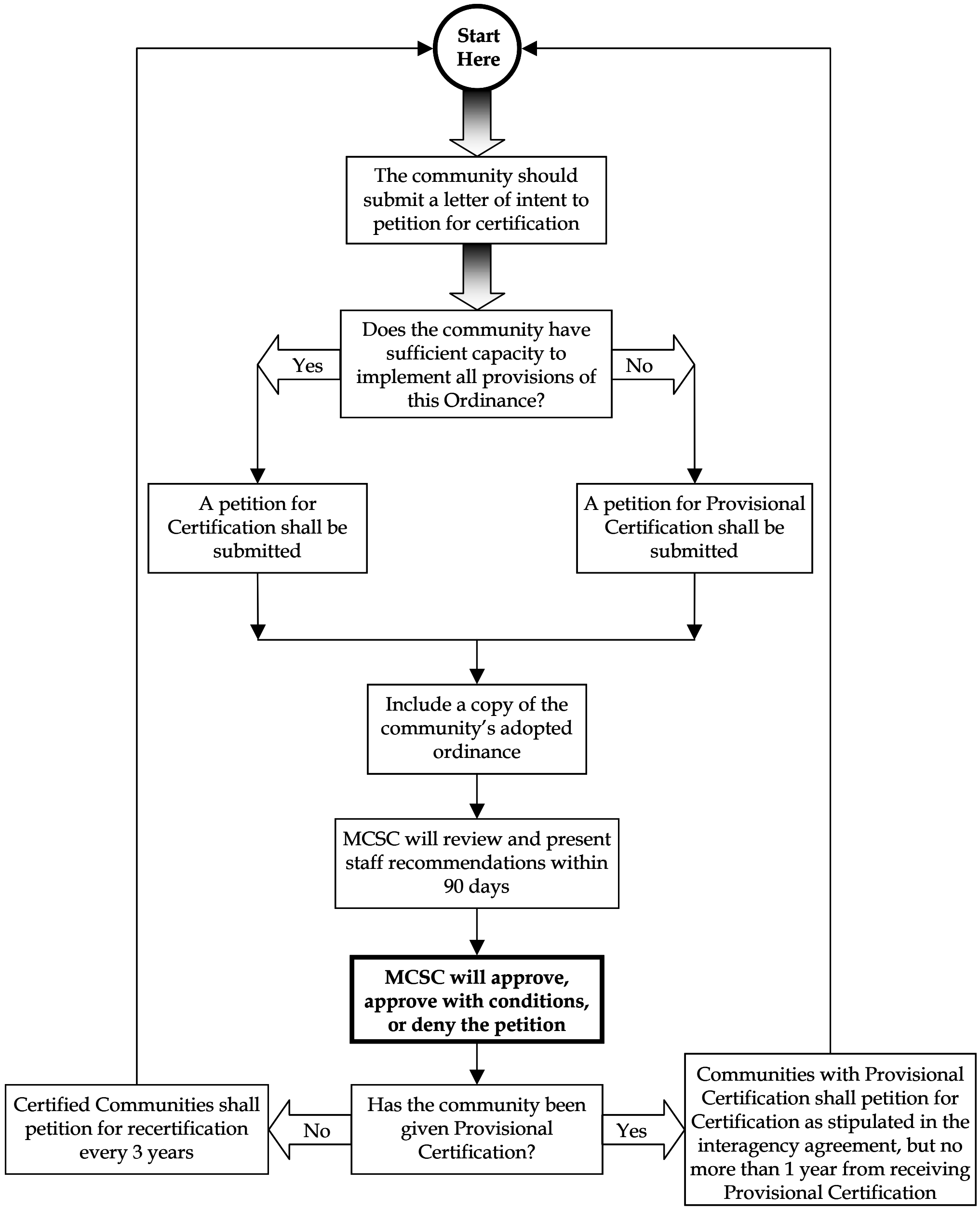
1. The community is no longer a participant in the National Flood Insurance Program.

2. The community adopts a Stormwater Management Ordinance or amends its ordinance so that its ordinance is less restrictive than the MCSC Stormwater Management Ordinance.

3. The community fails to enforce the provisions of the Watershed Development Permit or issues a permit not in accordance with the Stormwater Management Ordinance.

4. The community issues a regulatory floodway development permit not in accordance with the Stormwater Management Ordinance.

Figure 1-2: SMO Community Certification Process Flowchart



1.3 Developments and Approvals

1.3.1 Regulated Development

Many factors affect the application requirements for each development. Identifying and understanding the various factors and the Watershed Development Permit process is the first step in applying the SMO. The information contained in this section can be used to determine what development activity requires a Watershed Development Permit under the SMO. Before determining whether a development requires a permit, it must be determined whether the activity is considered to be a regulated development. The SMO defines Regulated Development in Article IV.A.

Specifically, there are eight criteria that are used to determine if a development is regulated. *Development that meets any of the following criteria is considered Regulated Development:*

1. *Any development that is located partially or completely in a Regulatory Floodway; or,*
2. *Any development that is located partially or completely in a Regulatory Floodplain; or,*
3. *Any development that is located partially or completely in a flood prone area; or,*
4. *Any development that results in an additional 5,000 square feet of impervious area from the original effective date of this ordinance; or,*
5. *Any development which hydrologically disturbs 5,000 square feet or more; or,*
6. *Any development that results in change in the direction of stormwater runoff from a site; or,*
7. *Any land disturbing activity that will affect an area in excess of 500 square feet if the activity is within 25 feet of a lake, pond, stream, or wetland; or,*
8. *Excavation, fill, or any combination thereof that will exceed 100 cubic yards; or*
9. *Any activity resulting in a wetland impact.*

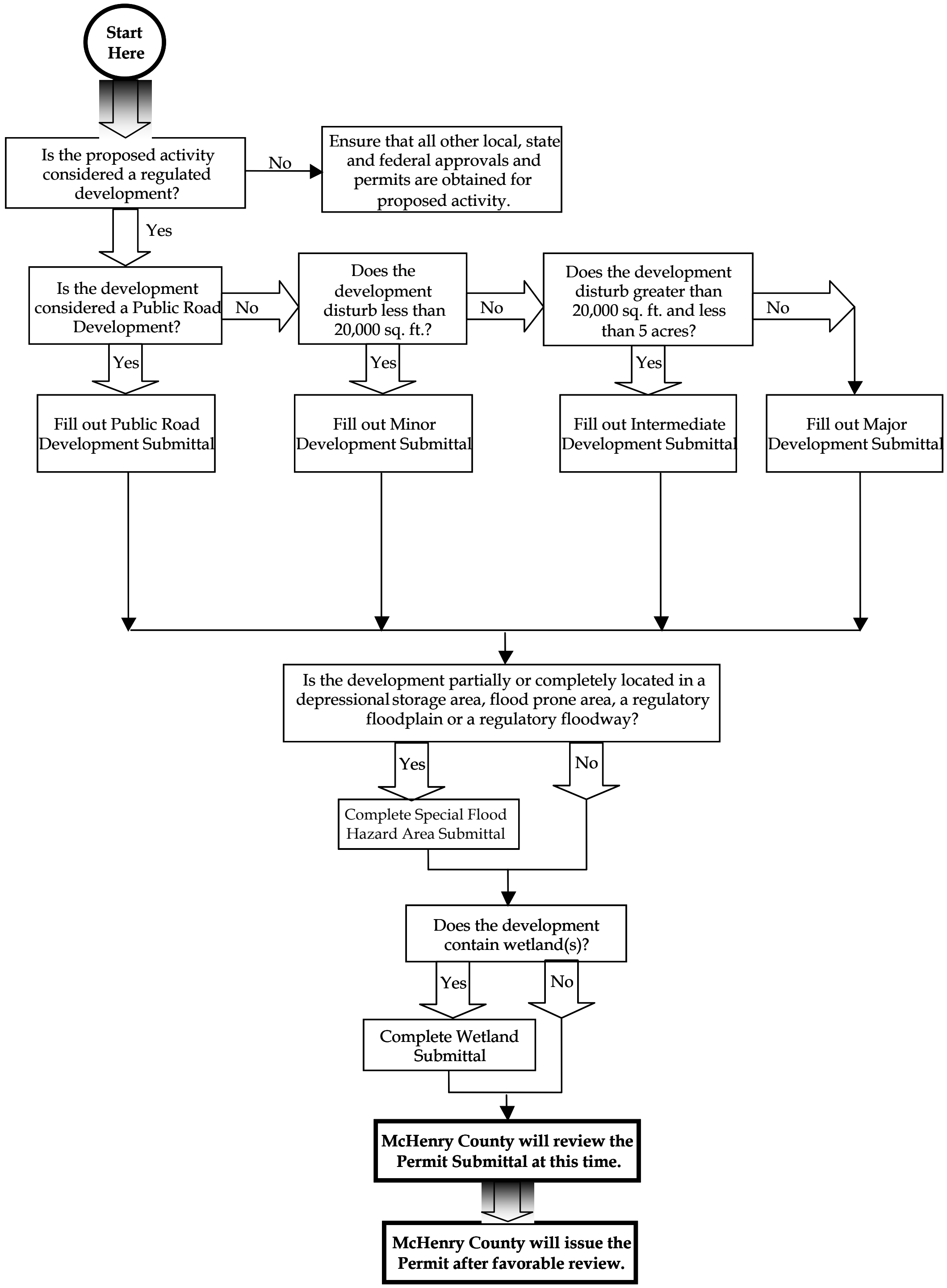
As implied in the definition of regulated development, activities such as fence installation, pole placement, drilling, or auxiliary construction activity which does not significantly affect stormwater runoff rates or volumes is not considered regulated development as long as the activity is not located in a Regulatory Floodplain, Regulatory Floodway, flood prone area, or wetland area. Activity that is not considered regulated development does not require a Watershed Development Permit. However, activities not considered regulated development must still meet and obtain the required permits for all minimum state, federal and local watershed development regulations, stormwater regulations and floodplain regulations.

There are specific cases when a Regulated Development may be considered an exempted development. Those cases are addressed in Section 1.3.3.

1.3.2 Development Classification

There are five classifications of development, which are regulated by the SMO. All activities requiring a Watershed Development Permit will be classified as either minor, intermediate, major, public road development, or special flood hazard area development. Figure 1-3 shows a permit submittal flowchart.

Figure 1-3: Typical Permit Submittal Flowchart



Five Development Classifications

1. Minor
2. Intermediate
3. Public Road
4. Major
5. Special Flood Hazard Area

1. Minor Development

A minor development is typically associated with smaller residential development sites that have simple drainage characteristics and minor impacts to non-riverine, riverine and wetland areas. A minor development is defined as regulated development that:

a. *Is not partially or completely located in a depressional storage area, flood prone area, a regulatory floodplain, or a regulatory floodway; and,*

b. *Consists of hydrologic disturbance of less than 20,000 square feet; and,*

c. *Is not a public road development.*

2. Intermediate Development

Intermediate development is defined as regulated development that:

a. *Is not partially or completely located in a depressional storage area, flood prone area, a regulatory floodplain, or a regulatory floodway; and,*

b. *Consists of hydrologic disturbance between 20,000 square feet and 5 acres; and,*

c. *Is not a public road development.*

3. Public Road Development

The classification of Public Road Development was established to specifically address improvement of a linear nature. Although typically understood as a road improvement project, several other types of improvements would fall under this classification. Some of these improvements would include bike paths, nature or walking trails, golf cart paths, sidewalk installation, utility or railway projects.

The submittal requirements for a Public Road Development are indicated on the Public Road Development Checklist located in Section 3 of the TRM. Public Road Development is defined as regulated development that:

a. *Takes place in a public right-of-way or part thereof; and,*

b. *Does not include the construction of a building; and,*

c. *Consists of culverts, bridges, roadways, sidewalks, bike paths and related construction.*

4. Major Development

By default, a development that does not meet the criteria to classify as a minor development, intermediate development, or public road development is classified as a major development.

5. Special Flood Hazard Area Development

A development that is partially or completely located in a depressional storage area, flood prone area, floodplain or floodway is considered a special flood hazard area development. Flood prone areas are identified as any location (regardless of the tributary drainage area) that is inundated by the base flood. In the event that the base flood is established according to the FIRM or an MCSC previously approved study, the flood prone area is delineated by projecting the Base Flood Elevation onto the topographic map for the development site. If a Base Flood Elevation does not exist for the site, a study is required to establish the elevation. Section 2.4 of the TRM outlines the proper procedures required to perform the hydrology and hydraulics analysis and determine the Base Flood Elevation of a flood prone area.

1.3.3 Exempted Development

The SMO sets forth specific cases when a Regulated Development can apply for exemption from specific SMO performance standards. The Exempted Development criteria are outlined in the SMO.

If the applicant is requesting an exemption for previously approved plans and the associated engineering study for the stormwater management system, the submittal must reflect conformance with the previously applicable regulations. Additionally, any significant changes to the proposed development, which were approved under old regulations, should be reviewed and approved under the new regulations. The new regulations should only be required for the proposed changes to the development, not the entire development.

Several examples are presented below to help illustrate the interpretation of three conditions that qualify for Exempted Development status.

Example 1. A 120-acre commercial subdivision was developed in a Village in 1998. The stormwater management facilities were constructed according to the stormwater requirements in effect in the Village at that time. Three 10-acre parcels have remained undeveloped. A developer now desires to combine these three parcels into a single office complex while at the same time maintaining the originally anticipated seventy five percent (75%) area of impervious. Can this development apply for exemption from the provisions for effective detention and water quality under the current SMO?

Explanation: The development is considered exempt from providing additional detention and water quality treatment because the stormwater management systems are functioning and compliant with the requirements at the time of development in 1998, and also the development was substantially completed within 5 years of the approval of the development.

Example 2. A 40-acre undeveloped site was annexed into a Village in 2001. Currently, the owner desires to develop the site based upon the concept plan approved at the time of annexation. Can this development apply for exemption from additional requirements specified under the current SMO?

Explanation: If a tentative plat was approved by the local unit of government, then the development can apply for exemption from any additional requirements implemented since the time of approval (except for soil erosion/sediment control, Regulatory Floodplain, Regulatory Floodway and wetlands provisions). However, the plans and design must be in conformance with the Village stormwater ordinance effective at the time of annexation and development must be initiated within one year of the approval.

Example 3. The final plat for an 80-acre residential development was being debated by residents of a Village in 1999. It appeared the subdivision was fully in compliance with the Village's stormwater regulations at the time of review. Nearby residents disagreed, and with their attorney, landed in court with the developer and the village. A judge rules in favor of the developer, and rules that the development is specifically exempted from the SMO. Can this development apply for exemption from the current SMO requirements?

Explanation: The residential development is considered exempt from the current SMO because a judge ruled specifically that it is exempt.

The process of exempt development starts by action of the community. The community must recognize a project as being far enough along in whatever development process they have in place in order to place the project on their "list of exempt developments". To be considered exempt, the plan for the project must identify how stormwater from the project is to be managed and the communities review authority must concur that sufficient engineering has been performed to show that the plan is viable. For very large sites, this can take the form of review and approval (or substantial approval) of a stormwater management master plan.

Legally binding contracts, entered into by the community and developer in good faith that address stormwater management, will also be honored provided that they have been entered into prior to June 1, 2004 and the project, tentative plat, preliminary plat, etc. have a sunset clause or expiration date.

The community should also note the requirement for posting signs on exempt properties and publishing notice of the list of exempt developments. Each community's list is submitted with their application to become a certified community and must be submitted with the Application for Certification. The lists are then reviewed by the MCSC. The MCSC is made up of an equal number of municipal and county government representatives divided into representative zones. The municipal or county representatives within each zone have the right to "remove" a project from the list, which falls within their zone. Removal from the list means the project will be reviewed individually. Otherwise, all other projects on the list are passed, unless a majority of the MCSC approves the removal of a project from the official exempt list.

Projects, which are "in-process" at the time of the SMO adoption and effective date, pose a particular dilemma. Vast amounts of time and resources go into developing a good site plan both from the developer and their consultants and from the staff of a municipality or county. There are also often extensive legal negotiations that occur between the community and the developer regarding annexation, which create an agreement between the community and the developer. Many communities in McHenry County already have adopted stormwater management standards and these projects are generally in conformance with those standards. However, those standards may not be fully in accordance with the provisions of the SMO. Therefore, a classification of projects, which is called "grandfathered", is created from strict application of this SMO. The responsibility for final determination of the status of a project as exempt from the provisions of the SMO is ultimately up to the MCSC.

1.3.4 Approval Prior to Permitting

The Watershed Development Permit may not be issued by the Enforcement Officer until all required local, State and Federal permits have been received. However, the Enforcement Officer may issue approvals prior to receipt of a permit at the applicant's request. The SMO allows for the issuance of a **Conditional Approval** prior to obtaining a Watershed Development Permit.

Conditional approvals may only be issued if another permitting agency, such as IDNR/OWR, requires a sign-off from the MCSC for that agency to issue their permit. A conditional approval enables other permitting agencies to issue their permits. Conditional approvals can be granted for the following sections of a permit submittal:

- Regulatory Floodplain
- Flood Prone Area
- Regulatory Floodway Delineation
- Overland Flow Path
- Wetland Delineation
- Detention and Bypass Computations for a Development

The purpose for this provision in the SMO is to allow the MCSC to provide approvals as may be required by other agencies. The condition approval is not an authorization to commence construction. Construction may only commence upon the approval of a Watershed Development Permit.

1.4 Permit Submittals

The level of detail and the extent of the submittal vary depending upon the development classification and the specific issues located on the site. Submittal checklists are provided in Section 3 of the TRM for the various development types. These checklists outline the information required for each type of submittal. A completed checklist should accompany each permit submittal in order to promote consistency and ensure a thorough and expedient review. Once all the components of a submittal are determined, it should be prepared in a standard format. A submittal should include the following items:

Watershed Development Permit Application – One signed original permit application should be submitted for every watershed development permit. A brief description of the type of development and name of development should always be included on the permit application. A Watershed Development Permit application form can be found at the end of this section.

Watershed Development Report – The Watershed Development Report should include a narrative summary of the development, along with supporting data and calculations. The report should follow the applicable sections of the SMO and rely on guidance provided in the TRM. Refer to the appropriate Development Checklist in Section 3 for specific format and requirements. Project area drainage plans should be at a reasonable scale with clear and legible existing and proposed contour information.

Application Permit Fee – The amount for the permit fee will be assessed after the first review by the MCSC. It is recommended that the developer contact the Certified Community directly to discuss fee arrangements for developments within their jurisdiction. The total permit fee is not determined until the scope and magnitude of the development is established.

1.4.1 Single Family Homes

If a home is proposed on a single parcel or is part of a subdivision that is not included under a current Watershed Development Permit, a determination will have to be made regarding the requirement of a Watershed Development Permit. Several sources are available to determine whether a Permit is required. The Enforcement Officer is the first point of contact. Additionally, the County Recorder or a McHenry County Planning and Development Department staff member can assist an applicant. A single family home is generally considered a minor development under the SMO. A minor development submittal checklist is provided in Section 3. A minor development requires fewer submittal items than a major development.

McHENRY COUNTY WATERSHED DEVELOPMENT PERMIT APPLICATION

Date Application Received: / / Date Permit Issued: / /

Names, Addresses & Phone Numbers:

Applicant:	Owner(s):	Developer:
________________________	________________________	__________________________
________________________	________________________	__________________________
________________________	________________________	__________________________
(______) ______--_________	(______) ______--_________	(______) ______--___________

Title:____________________

Indicate which Submittals apply to application (see Figure 1-2: Permit Flowchart):

- ❑ Minor Development Submittal
- ❑ Intermediate Development Submittal
- ❑ Public Road Submittal
- ❑ Major Development Submittal
- ❑ Wetland Submittal
- ❑ Special Flood Hazard Area Submittal
- ❑ Exempted Development

Please attach a list of names, addresses and telephone numbers of all adjoining property owners within 250 feet of the development.

Common Address of Development:

____
Street Address

____
Community

____
Name of local governing authority

____
Watershed planning area and tributary

Legal Description (attach):

____
¼, Section, Township, Range

____
P.I.N.

Site Location Map (attach separately)

Is any portion of this project now complete?____Yes ____No. If "Yes", please explain in the description.

Please provide a brief description of the project (use additional sheets if necessary):

____
____
____

I hereby certify that all information presented in this application is true and accurate to the best of my knowledge. I have read and understood the McHenry County Stormwater Management Ordinance, and fully intend to comply with these provisions.

____ _________________
Signature of Developer Date

I have read and understood the McHenry County Stormwater Management Ordinance, and fully intend to comply with these provisions.

____ _________________
Signature of Owner Date

Section 2
Performance Standards

The performance standards found in Section 2 are the most important part of the McHenry County Technical Reference Manual. Guidance provided for these performance standards will assist permit applicants in fully understanding and comprehending the primary technical requirements of the Stormwater Management Ordinance. These primary technical requirements include:

Section 2.1: Water Quality Protection

Section 2.2: Soil Erosion and Sedimentation Control

Section 2.3: Stormwater Management

Section 2.4: Floodplain Management

Section 2.5: Wetlands

Section 2.6: Subsurface Drainage Requirements

These standards have been specifically selected for use in McHenry County and are taken from commonly used and recognized sources. The performance standards are presented as minimum design standards. When unusual or complex problems are encountered, it is the responsibility of the designer to identify such conditions and to notify the appropriate permitting agency. In these types of cases, the design engineer should propose an alternative standard or solution consistent with good planning and engineering practice and shall receive approval of the change before continuing with the design. Use of these performance standards does not release the design engineer of the responsibility of the final design.

2.1 Water Quality Protection

The quality of stormwater runoff is only recently being addressed by local, state and federal regulatory agencies. Previous efforts to address stormwater management issues concentrated primarily upon the management of stormwater quantity with relatively little attention given to quality issues. However, state and federal regulatory programs (e.g. National Pollutant Discharge Elimination System, NPDES) aimed at the control of point discharges have resulted in dramatic improvements in surface water quality. With this improvement of point source discharges comes the realization that non-point pollution represents a significant contribution of pollutants. Non-point source related problems in Illinois include soil erosion and sedimentation from agricultural and urban lands, livestock wastes, agri-chemicals, hydrologic/habitat modification, urban stormwater, resource extraction, and others. In addition to potential human health concerns, degraded water quality leads to impaired aquatic ecosystems. In northeastern Illinois, the greatest causes of aquatic use impairment are stream flow alteration, streambank erosion and manmade channel modifications, which are almost exclusively caused by development activities and urban runoff.

The quality of rivers and streams plays a fundamental role in the overall health of the environment and has a direct bearing on both the economic and recreational opportunities available to the citizens of McHenry County. Consequently, public interest in the value of water quality has increased significantly in recent years.

The complete results of the IEPA's assessment of streams and lakes in Illinois were most recently published in the "Condition of Illinois Water Resources 2000" report. This report identifies potential uses of waterways, use impairments, causes of use impairment and sources of impairments. Of the 15,304 miles assessed statewide in 2000 for overall resource quality, 62.5 percent were rated as "good," 36.1 percent were rated as "fair," and 1.4 percent was rated as "poor." In McHenry County, only one stream and no lakes were rated as poor. Various causes and sources of water quality problems are identified during the assessment process. For rivers and streams, the principal causes of impairment are nutrients, habitat alterations, organic enrichment/low dissolved oxygen and siltation. The principal sources of impairment are agriculture, hydrologic/habitat modifications, and municipal point sources. Point sources originate culturally, usually pipes from sewage treatment plants, stormwater discharges or industry. The NPDES program defines them as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, containers…. from which pollutants are or may be discharged." Agricultural stormwater discharges and return flows from irrigated agriculture are excluded from the definition of point source. Non-point source pollution cannot be traced to one source. Non-point sources are far more difficult to assess quantitatively, and more difficult to control. The major sources and causes of non-point source pollution in Illinois are pesticide and fertilizer runoff from agriculture, construction site erosion, urban runoff, hydrologic modifications, soil erosion and sedimentation, livestock waste, and resource extraction.

The non-point source discharge, urban runoff, is the portion of rain that falls on urban surfaces and flows into the drainage system. Urban runoff may contain contaminants such as sediment, suspended solids, nutrients, heavy metals, pathogens, toxins and oxygen-demanding substances. These pollutants contribute to the degradation of water quality in our waterways. Water quality degradation may lead to the impairment of beneficial uses of the receiving waters. The Illinois Environmental Protection Agency (IEPA) has identified several McHenry County water bodies as having impaired water quality (fair or poor ratings). However, in general, water quality in McHenry County is among the highest in the six-county area of northeastern Illinois.

McHenry County has some of the highest rated water bodies in the state. Correct implementation of the SMO provisions is necessary to prevent future degradation of resources in the County. The Water Quality requirements will assist in the preservation of water quality in McHenry County through implementation of water quality treatment facilities. Soil Erosion and Sedimentation Control is also an important aspect of water quality treatment and is addressed in Section 2.2.

2.1.1 Acceptable Water Quality Treatment Methodologies

The SMO requires that all regulated development shall provide water quality treatment for runoff from increased impervious areas. Certain public road developments (less than 1.5 acres or 1.5 acres per linear mile of increase impervious area) may implement water quality and buffer standards to the maximum extent practicable.

Adverse impacts of development and redevelopment will be controlled through the application of Best Management Practices (BMPs). Best Management Practices are schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices, that when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to receiving waters. Structural control BMPs are physical, structural, or mechanical devices or facilities that are intended to prevent pollutants from entering stormwater. The SMO specifically requires treatment methods that use structural control BMPs for protection of water quality. The following are acceptable treatment methods and are summarized below in Table 2-1.

1. Wet Detention Facilities
2. Sedimentation Facilities
3. Infiltration Basins
4. Infiltration Trenches
5. Filter Strips
6. Vegetated Swales

The use of alternative treatment methods shall be as effective as the above methods and must be approved by the Enforcement Officer. The engineer should provide an explanation of the intended use and evidence of the applicability of the method before it is used. A list of other structural and non-structural BMPs that may be considered for use in addition to primary methodologies is included in Section 2.1.1.7.

The following descriptions of water quality practices are substantially based on information in the *Best Management Practice Guidebook for Urban Development* prepared by Dreher, D. and T. Price and available through the Northeastern Illinois Planning Commission.

Table 2-1: Water Quality Treatment Measures Summary

Recommended Water Quality Treatment Measure	Typical Application			Additional Information Available in:			
	Type of Development	Development Size	Usage	Illinois Urban Manual	Green Book	NIPC BMP Guidebook	EPA BMP Fact Sheets
Wet Detention Basins	New development and redevelopment	Greater than 2 acres	New residential development, etc.			X	X
Sedimentation Facilities	Sites with exposed soils subject to erosion	Trap (1-5 acres), Basin (more than 5 acres)	Construction sites, land undergoing development, etc.	X	X	X	
Infiltration Basins	Suitable for most types, but most effective for large lot residential or office/industrial campuses	Less than 10 acres	Alternative or supplement to detention basins			X	X
Infiltration Trenches	Suitable for most types, but most effective for large lot residential or office/industrial campuses	Less than 5 acres	Alternative or supplement to detention basins	X		X	X
Filter Strips	Suitable for most types, but most effective for residential and office campuses	Area unlimited (i.e.-road), but should be less than 150 feet wide	Construction sites, land undergoing development, buffer zones, etc.	X	X	X	X
Vegetated Swales	Suitable for many types, but most practical for large lot residential and office/industrial campuses	Less than 5 acres.	Roadside ditches, channels at property edges, etc.	X		X	X

2.1.1.1 Wet Detention Facilities

Wet detention facilities are widely applicable stormwater management structures. Detention basins temporarily store runoff from a site and release it at a controlled rate to minimize increases in downstream flooding. Most dry detention basins are not designed specifically for water quality benefits. Wet detention facilities are detention basins with a permanent pool of water. They are particularly effective at treating runoff from small storm events when the volume of runoff simply displaces the permanent pool volume, which is relatively clean. For the purposes of achieving control of both water quantity and quality benefits, wet detention facilities can be the most effective. Figure 2-1 shows a typical plan view of a wet detention basin.

Detention basins rely primarily on settling to remove pollutants. Additional removal can occur via biological uptake or transformation by aquatic organisms and wetland vegetation. The removal efficiency of detention basins is primarily a function of the detention time. Wet basins generally have greater detention times than equivalent extended detention basins since most runoff events, particularly small events whose volume is less than the volume of the permanent pool, simply displace the resident water which is relatively clean. As a result, wet basins are generally more effective at pollutant removal than extended detention dry basins, although effectiveness is highly dependent on specific design characteristics. Pollutant removal effectiveness is quite good for well-designed basins, both wet and extended detention dry basins. Effectiveness is greatest for suspended sediment and related pollutants such as heavy metals. Lower effectiveness is expected for soluble constituents and nutrients.

Wet detention basins are most suitable where the soils are sufficiently impermeable or the ground water table is high enough to support a stable permanent pool. In looser soils, the permeability can be reduced through compaction or by lining the pool bottom with clay or an impermeable membrane. A minimum drainage area of 2 acres is needed to maintain a permanent pool, unless the facility is supported by groundwater. Wet ponds are ideal where the multiple purposes of recreation, aesthetic enhancement, water quality mitigation, and flood control are desirable.

Wet ponds that intersect the ground water table should not be used in situations where land use or activities generate highly contaminated runoff such as a gas station. Wet detention basins may be used for these situations, but need significant separation from the ground water. Clay or an impermeable membrane may also be used to accomplish this separation.

Effective pollutant removal depends on providing adequate detention time to allow for the settling of pollutants. Pollutant removal and control of excessive flow variability, which could contribute to hydrologic instability downstream, are facilitated by designing the basin outlet structure to throttle small, high frequency runoff events.

Stormwater wetlands are also considered wet detention basins. A one acre wetland with a depth of one foot can hold over 330,000 gallons of water. Wetlands provide many functions including:

- Improve water quality
- Store runoff
- Encourage habitat
- Enhance landscape

Wetlands can play a vital role in the treatment of non-point source pollution. Construction or man-made wetlands are able to remove suspended solids, BOD, bacteria and nutrients through the use of plants. The use of deep-rooted plants is highly encouraged in the removal of nutrients and BOD.

Constructed wetlands are either surface or subsurface systems. Surface water wetlands have shallow water depths and typically consist of a soil basin designed to support the roots of the vegetation. Subsurface wetlands are designed to force the water flow through a substrate that is typically sand or gravel.

Constructed wetlands are most suitable for agricultural areas where they are able to treat agricultural runoff composed of nutrients and bacteria.

More information on the design and construction of wet detention facilities can be found in the following sources:

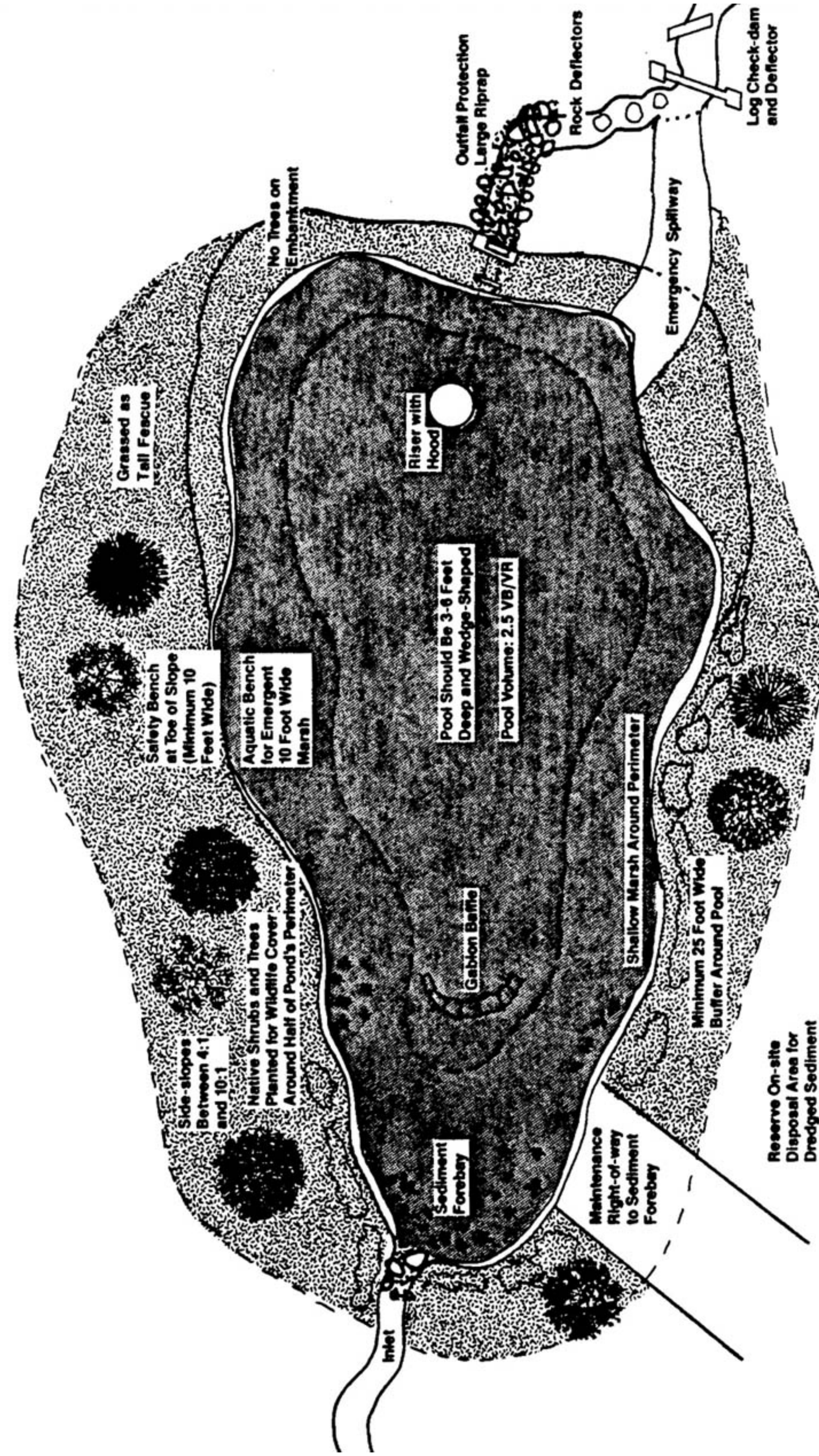
Center for Watershed Protection, Inc. *Stormwater Practices in Cold Climates*. No longer available in print, available at www.cwp.org (Protecting Watersheds/Stormwater BMPs)

Center for Watershed Protection, Inc. 2000. Stormwater Manager's Resource Center (SMRC) Website www.stormwatercenter.net Location: Ellicott City, MD

Dreher, D. and T. Price. July 1992. Best Management Practice Guidebook for Urban Development. Northeastern Illinois Planning Commission.

United States Environmental Protection Agency Office of Water. *Post Construction Stormwater Management BMP Fact Sheets Website*.
www.epa.gov/npdes/stormwater/menuofbmps/post.cfm

Figure 2-1: Design Schematic of a Wet Detention Facility (Schueler, 1987)



2.1.1.2 Sedimentation Basins

A sedimentation basin is a basin that is constructed to collect and store debris and sediment. The purpose of a sedimentation basin is to preserve the capacity of reservoirs, ditches, canals, diversions, waterways, and streams; to prevent undesirable deposition on bottom lands and developed areas; to trap sediment originating from construction sites; and to reduce or abate pollution by providing basins for deposition and storage of silt, sand, gravel, stone, agricultural wastes, and other detritus materials. Sediment basins are typically used for areas draining more than 5 acres. Basins are more substantial than sediment traps, and are similar in design to a detention basin. An example sedimentation basin can be found in Figure 2-2.

The sedimentation basin should be located to obtain the maximum storage benefit from the terrain and for ease of cleanout of the trapped sediment. It should also be located to minimize interference with construction activities and construction of utilities. The sediment basin should comply with all state and local laws, ordinances, rules, and regulations. A sediment basin plan should be developed to indicate methods of disposing of the sediment removed from the basin. The sediment should be placed in such a manner that it will not erode from the site. The sediment shall not be deposited adjacent to a stream or floodplain unless a detailed soil erosion and sedimentation control plan and permanent stabilization measures are developed to prevent the sediment from entering the waterway.

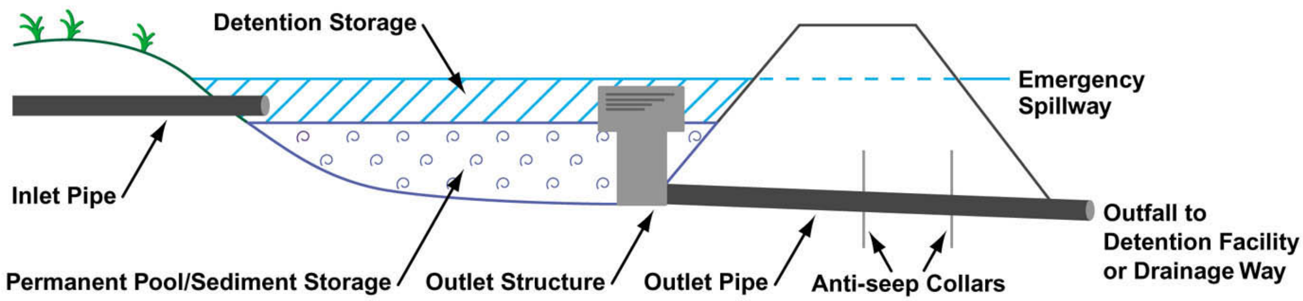
The following are typical steps recommended in the design of a sediment basin:

1. Determine the total volume of runoff to the basin.
2. Determine the maximum allowable release rate.
3. Determine the volume of temporary detention storage required based on the maximum allowable release rate.
4. Determine the volume of sediment storage required.
5. Size the basin to provide the sediment, detention, and any permanent pool storage volumes below the crest of the emergency spillway.
6. Size the principal spillway to discharge the designed release rate and add such safety, debris, and energy dissipation devices as the circumstances dictate.
7. Compute the discharge to be carried by the emergency spillway.
8. Determine final dimensions and elevations for the embankment.
9. Provide for safe entry of water into the basin.
10. Provide for safety of the basin.

11. Choose the type of vegetation to be used around the basin.

12. Provide for cleanout, modification, or disposal of the structure after it has served its purpose.

Figure 2-2: Sedimentation Basin Schematic



More information on design standards and construction details can be obtained from the following sources:

Dreher, D. and T. Price. July 1992. Best Management Practice Guidebook for Urban Development. Northeastern Illinois Planning Commission.

Illinois Environmental Protection Agency. 1987. *Standards and Specifications for Soil Erosion and Sediment Control.*

Natural Resources Conservation Service. 1995. *Illinois Urban Manual. A*vailable online at www.il.nrcs.usda.gov/technical/engineer/urban (includes Sediment basin dewatering device detail).

The Urban Committee of the Association of Illinois Soil and Water Conservation Districts. July 1998. *Procedures and Standards for Urban Soil Erosion and Sedimentation Control in Illinois* (the Green Book).

2.1.1.3 Infiltration Basins

Infiltration basins are acceptable water quality treatment methods. An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater into the ground water. Infiltration basins enhance the infiltration of runoff and thereby reduce the need for downstream conveyance and storage capacity. Infiltration basins are detention-type basins with no outlet that drain only by infiltration through the bottom and sides. Infiltration practices are most practical when soils are permeable and the water table is situated well below the bottom of the basin. The benefits of infiltration measures include effective removal of both soluble and particulate pollutants and preservation of pre-development hydrologic conditions. Ground water recharge helps to maintain low flows in the stream system. Infiltration measures are not intended for trapping sediments because the solids will prematurely clog the device.

Infiltration basins are potentially the most effective BMPs for keeping urban runoff pollutants out of surface water bodies. Approximately 50 percent or greater removal is estimated for suspended solids, heavy metals, and nutrients for infiltration structures designed to capture and exfiltrate the "first-flush" or runoff after a storm. Even greater removal, in excess of 80 percent, is estimated for infiltration facilities which are designed to store and exfiltrate the 2-year event. This effectiveness is achieved by essentially converting surface runoff to subsurface flow and filtering pollutants through the soil.

Infiltration basins, where feasible, are the most effective way of preserving pre-development hydrologic conditions on developed sites. They are very effective at reducing runoff volumes and rates, particularly for smaller events where the entire storm may be infiltrated. Specific hydrologic benefits include groundwater recharge, low flow augmentation, and stabilization of flow fluctuations, which cause streambank erosion.

Infiltration basins are appropriate for both large and small drainage areas as an alternative or supplement to detention basins. They are particularly suitable for large lot residential or campus type developments which are outfitted with filter strips and swales as preliminary sediment trapping structures. However, it is critical that adequate precautions are taken to minimize sediment loadings to infiltration basins. An important constraint to infiltration practices is soil permeability. Infiltration basins are generally only suitable in soils in hydrologic groups "A" and "B". Class B Soils are not uncommon in McHenry County. The primary constraint to using infiltration basins in tight soils is that stormwater may not have sufficient opportunity to exfiltrate between rain events. This constraint may compromise their ability to consistently provide the water quality and hydrologic functions described above and can potentially create nuisance conditions. Care also must be taken to prevent groundwater contamination by not siting infiltration basins in highly permeable sand or gravel seams which are directly connected to underlying aquifers. This is a particular problem if contaminated impervious runoff is routed directly into an infiltration device without effective pretreatment. In this situation, surface water quality is improved at the direct expense of groundwater quality which is unacceptable.

As indicated above, it is critical that infiltration facilities are well protected from excessive sediment loading to ensure reasonable effectiveness and life expectancy. Infiltration basins will function well only if they are located in relatively well drained soils. Therefore, it is also important that soil permeability be protected by minimizing compaction during construction. Perhaps the most important factor in the design of infiltration basins is the provision of adequate sediment filtration measures upstream. This should start with the provision of effective erosion and sediment control during construction, with the installation of the infiltration basin occurring as the last step in the construction process. A filter strip or vegetated swale may be installed to precede the infiltration basin. If site runoff is expected to contain heavy sediment loads, it also is advisable to install a settling basin at the upstream end of an infiltration device. Figure 2-3 shows a schematic of an example infiltration basin that includes a settling pond for the removal of sediment prior to the infiltration basin.

Infiltration basins should be placed safely above bedrock or seasonal high groundwater levels. They should be set back from building foundations. Infiltration basins also should be set back from water supply wells. Infiltration basins are configured much like detention basins except they drain by infiltration rather than through an outlet pipe. Infiltration basins can be sized based on the infiltration rate of the underlying soil. Infiltration basins should be designed to drain within 72 hours to avoid killing of bottom vegetation. Figure 2-4 shows an infiltration basin with the inclusion of a backup underdrain.

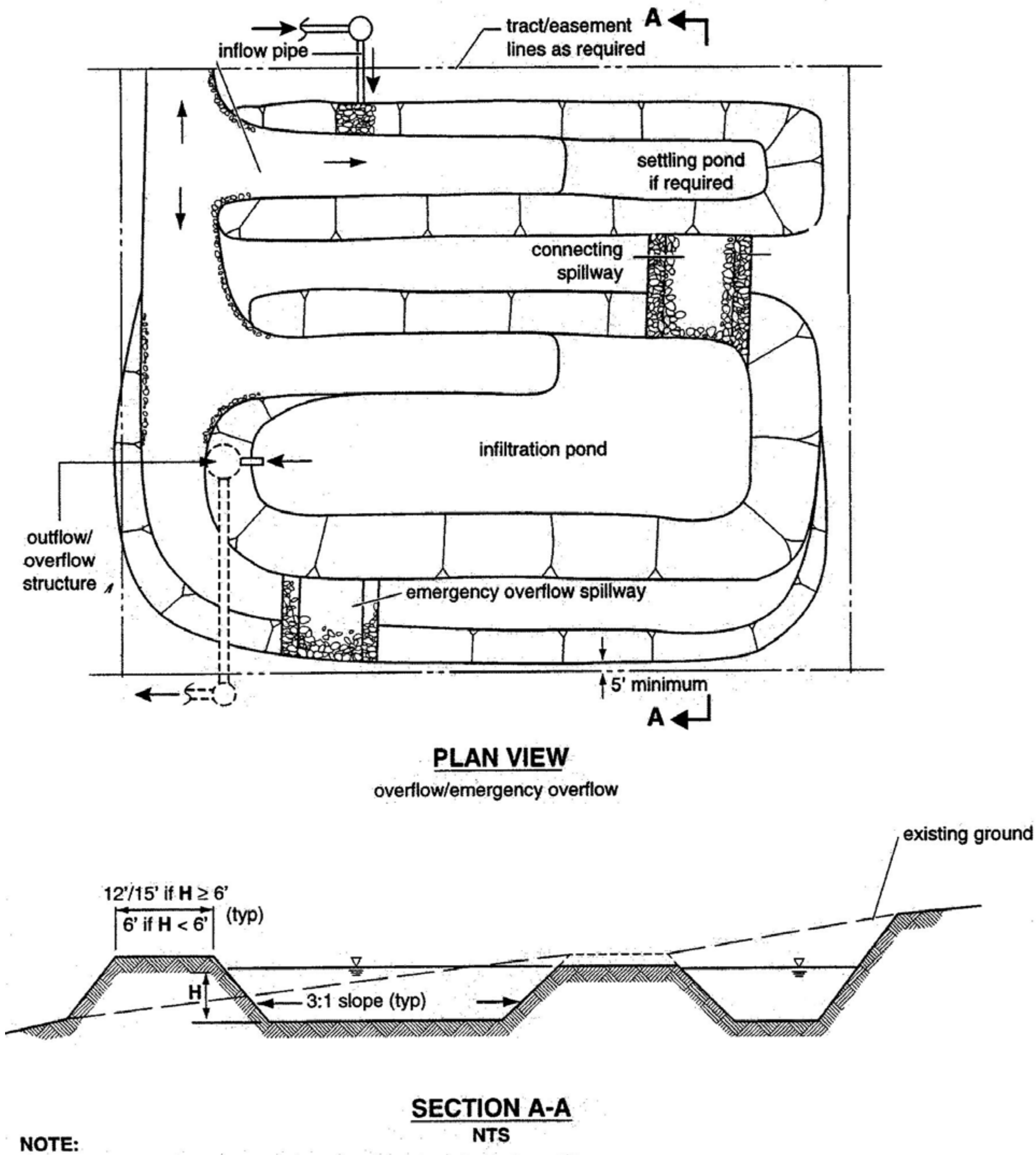
More information on design standards and construction details can be obtained from the following sources:

Center for Watershed Protection, Inc. *Stormwater Practices in Cold Climates*. No longer available in print, available at www.cwp.org (Protecting Watersheds/Stormwater BMPs)

Dreher, D. and T. Price. July 1992. Best Management Practice Guidebook for Urban Development. Northeastern Illinois Planning Commission.

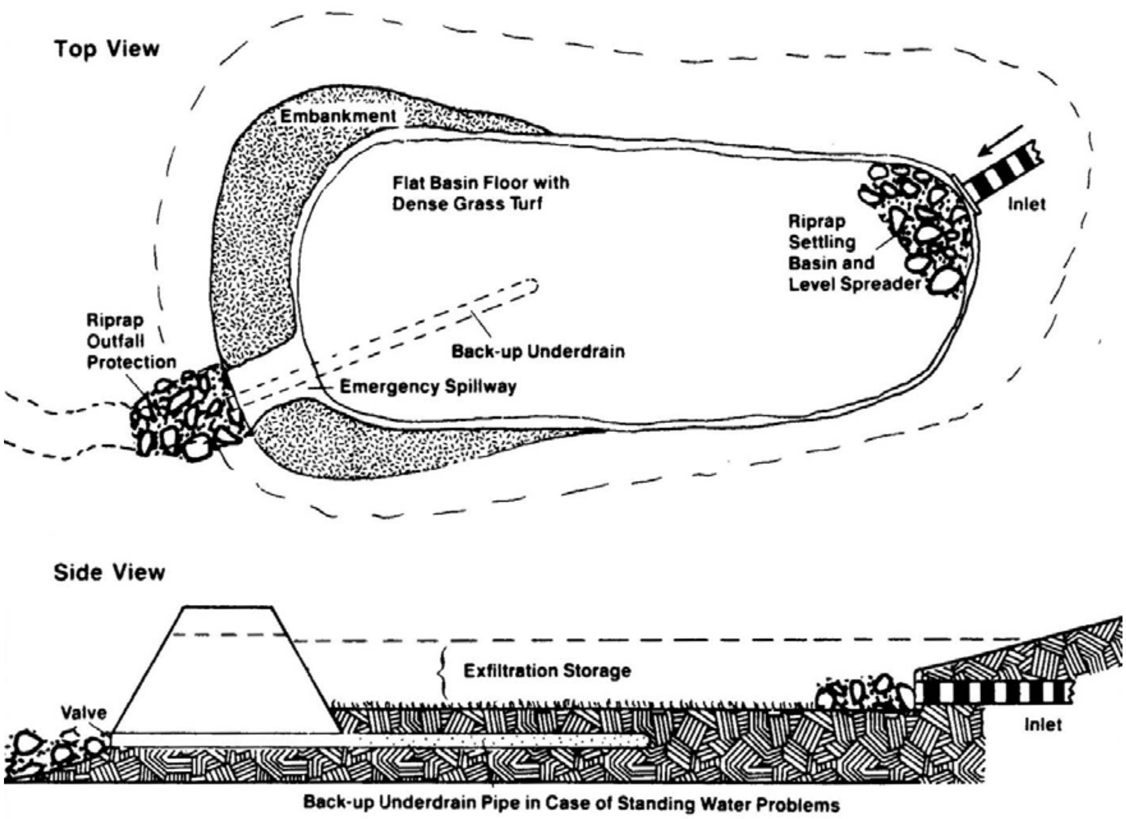
United States Environmental Protection Agency Office of Water. *Post Construction Stormwater Management BMP Fact Sheets Website*.
www.epa.gov/npdes/stormwater/menuofbmps/post.cfm

Figure 2-3: Infiltration Basin with Pretreatment Settling Pond (Washington State Department of Ecology, 2001)



NOTE:
Detail is a schematic representation only. Actual configuration will vary depending on specific site constraints and applicable design criteria.

Figure 2-4: Schematic of Infiltration Basin with Back-up Underdrain (Schueler, 1987)



2.1.1.4 Infiltration Trenches

An infiltration trench directs the runoff into the soil thus recharging the groundwater and extracting any pollutants through the trench. Figure 2-5 shows a sample infiltration trench. These infiltration trenches are located below ground and are filled with coarse aggregate (IDOT CA-1, 2 or 3). The bottom 6-inch layer in the trench is filled with sand (IDOT CA 17, 18 or 19). The trenches can be lined with filter fabric having an apparent opening size of at least 30 for non-woven and 50 for woven. Runoff is directed into the trenches where it infiltrates.

The infiltration process is the method by which pollutants are removed. Suspended solids, sediment, and bacteria are removed. Dissolved compounds can travel through the system with no or very limited removal. Infiltration trenches can remove up to 90% of sediments and bacteria, up to 60% of nutrients and between 70 and 80% for BOD.

There are various parameters that should be considered when designing infiltration trenches, including soil infiltration rate and structure size. Soil infiltration rate is a critical parameter, which can be measured prior to implementation of the structure. Infiltration trenches are not suitable for areas with impermeable soils containing clay and silt or in areas with fill. Infiltration trenches require sites with soils in the A and B hydrologic groups. Design capacities for the trench can range between 0.5 and 2.0

inches per acre of drainage area, which is dictated by the void ratio of the aggregate used in the system.

The structure is designed with no outlets and hence runoff enters the infiltration trench until it is full and excess runoff is discharged away. An infiltration trench should be designed to remove pollutants and drain in a short period of time. Infiltration trenches generally apply for drainage areas less than 5 acres. The drainage area slope impacts the velocity of runoff, which influences the loads of pollutants picked up with the runoff. Infiltration trenches typically work best when the up-gradient slope is less than 5%. The down-gradient slope should be no greater than 20% to minimize slope failure and seepage.

A vegetated filter strip should be constructed adjacent to the trench as shown in Figure 2-5 to collect solids entrained in the runoff. The strip can be installed using sod and should be sloped between 0.5 and 15% to maintain sheet flow into the trench.

Infiltration trenches typically require periodic cleaning to remove solids and other pollutants that have accumulated in the trench. Pretreatment measures can enhance the quality of influent water and hence reduce cleaning requirements.

Negative impacts of infiltration trenches include the potential for groundwater contamination, which can investigated prior to implementation. A separation distance between the bottom of the infiltration facility and seasonal high groundwater of at least four feet should be present.

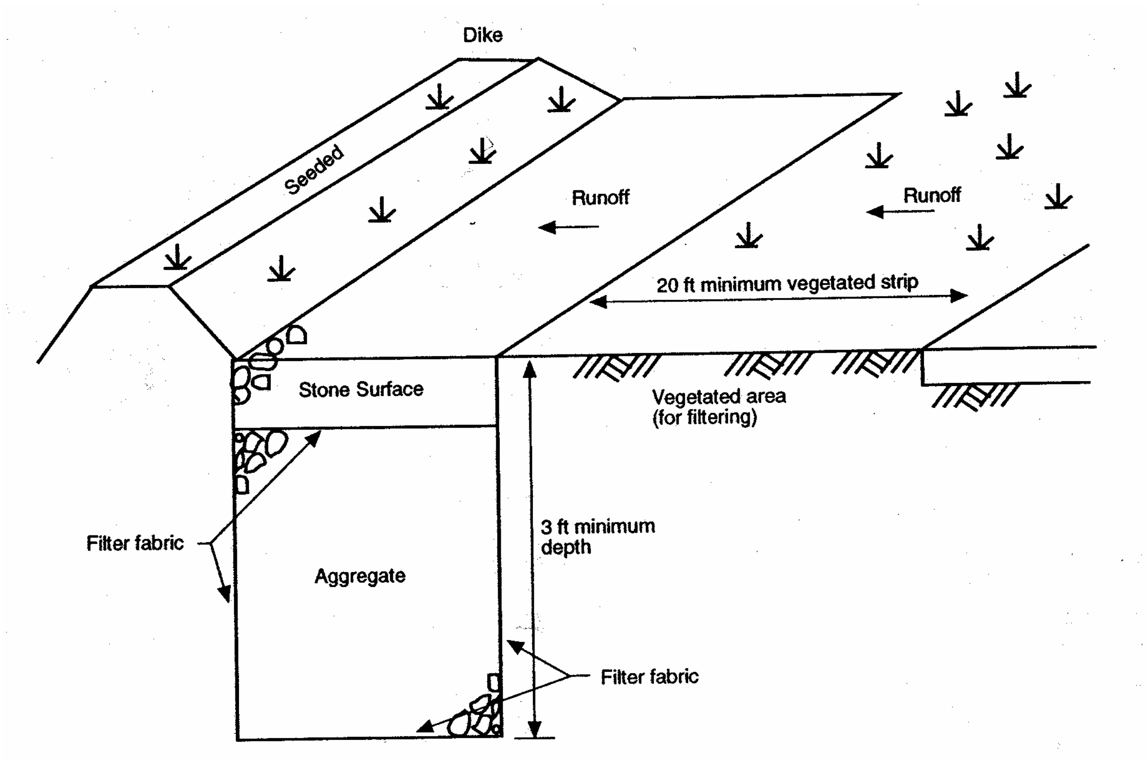
More information on design standards and construction details can be obtained from the following sources:

Natural Resources Conservation Service. 1995. *Illinois Urban Manual. A*vailable online at www.il.nrcs.usda.gov/technical/engineer/urban

United States Environmental Protection Agency Office of Water. September 1993. *Urban Runoff Pollution Prevention and Control Planning Handbook.*

United States Environmental Protection Agency Office of Water. *Post Construction Stormwater Management BMP Fact Sheets Website***.**
www.epa.gov/npdes/stormwater/menuofbmps/post.cfm

Figure 2-5: Infiltration trench (Livingston et al., 1988)



2.1.1.5 Filter Strips

Vegetated filter strips are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Vegetated filter strips convey sheet runoff from impervious surfaces to drainage swales or other conveyance devices. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants. Filter strips are the recommended means to achieve disconnection of impervious surfaces from storm sewers and channels. They can provide effective infiltration and filtration of runoff if the flow is uniformly distributed over the length of the strip. However, it is difficult to maintain sheet flow, so the practice may be short circuited by concentrated flows, receiving little of no treatment. Filter strips of native vegetation also can serve as effective buffers between developments and sensitive features such as streams, lakes, and wetlands.

The effectiveness of vegetated filter strips for pollutant removal is a function of their ability to vegetatively filter, transform, and utilize pollutants as well as to infiltrate runoff through the soil. Removal effectiveness is highest for pollutants associated with sediments and lowest for soluble constituents. Reported pollutant removal effectiveness ranges from 0 to 40 percent for narrow turf strips to 80-100 percent for wide forested strips. The use of deep-rooted native plants greatly enhances pollutant removal. Filter strips may also be effective in reducing runoff volumes depending on the soil permeability and the relative size and slope of the strip.

The pollutant removal effectiveness of filter strip systems, relative to curb and gutter/storm sewer systems, is greatest for small runoff events. With a traditional drainage system, pollutants are washed from impervious surfaces directly into storm sewers with no opportunity for infiltration or pollutant filtering. If impervious runoff is disconnected from the storm sewer system and routed across a filter strip or swale system, small storms are literally soaked up in the soil and the effective pollutant removal approaches 100 percent.

Filter strips are suitable on most types of development but are probably most effective on developments where there are relatively wide expanses of pervious area adjacent to impervious surfaces. In particular, roads, highways, roof downspouts and parking lot runoff can be distributed over the width of lawn areas to promote infiltration and filtering. In higher density developments, such as commercial sites with a large percentage of impervious areas, filter strips can be used to convey flow uniformly to drainage swales or to protect infiltration trenches. The strips can often be incorporated into landscaping features such as parking lot islands. Filter strips also are strongly recommended in buffer zones between developed areas and sensitive aquatic environments. They are particularly important as buffers for land uses which generate high pollutant loads, such as roadways, parking lots, and golf courses and are useful in controlling erosion and sediment wash off during construction.

The effectiveness of filter strips is dependent on a number of factors, including: the drainage area served, the width and slope of the strip, the permeability of the soils, and the type of vegetation. It is generally recommended that filter strips be at least 20 feet wide, although there is no absolute design criterion for width. Filter strips are best suited to areas where the runoff is not highly concentrated or channeled. The limiting design factor is not the amount tributary area but the length of flow (typically less than 150 feet) leading to the filter strip. Ideally, the slope of the strip should be less than 5 percent since flatter slopes maximize the time of contact between the runoff and the filtering vegetation.

Forested filter strips appear to be more effective than turf strips, partly because of their ability to take up constituents, such as nutrients, from the root zone and store them in their biomass. Recently, there has been growing acceptance of the use of prairie vegetation for landscaping purposes. Limited available information suggests that such species, because of their deep root zones and extensive biomass, are preferable to traditional turf in filter strip applications. Where high concentrations of salt are expected due to roadway deicing, salt tolerant vegetation should be utilized.

Level spreaders can increase the effectiveness of filter strips by distributing runoff over the length of the strip to prevent flow concentration and short-circuiting. A level spreader, such as a shallow gravel filled trench, should be at the top of the filter strip and parallel to the contour line.

For residential applications, roof downspouts should be placed such that their discharge is distributed over a wide area rather than concentrating in a side yard swale. Best results will be obtained if yards are graded with minimal side yard swales and the only significant concentration of flow is along the rear lot lines. Where possible, downspouts draining the front half of the house should be placed such that they drain to the back yard.

Another way to maximize the effectiveness of filter strips, and pervious surfaces in general is to protect the infiltration capacity of soils. This capacity is often greatly reduced by compaction during construction, resulting in reduced ability to filter and infiltrate runoff. The best ways to avoid loss of infiltration capacity is to minimize the area subject to compaction by heavy equipment during construction and to utilize construction equipment which applies less pressure per unit area. Where the use of heavy equipment cannot be avoided, restoration of the compacted soil may be possible. Tilling of soils compacted during construction, prior to placement of topsoil, can significantly increase their capacity to absorb rainfall and runoff. Compaction should be minimized during placement of the topsoil, and seeding and mulching should be done as quickly as possible. Rain falling on bare soil breaks up soil aggregate, leaving a compact, dense layer that is not conducive to infiltration. Figure 2-6 shows a schematic of a typical filter strip.

More information on design standards and construction details for filter strips can be obtained from the following sources:

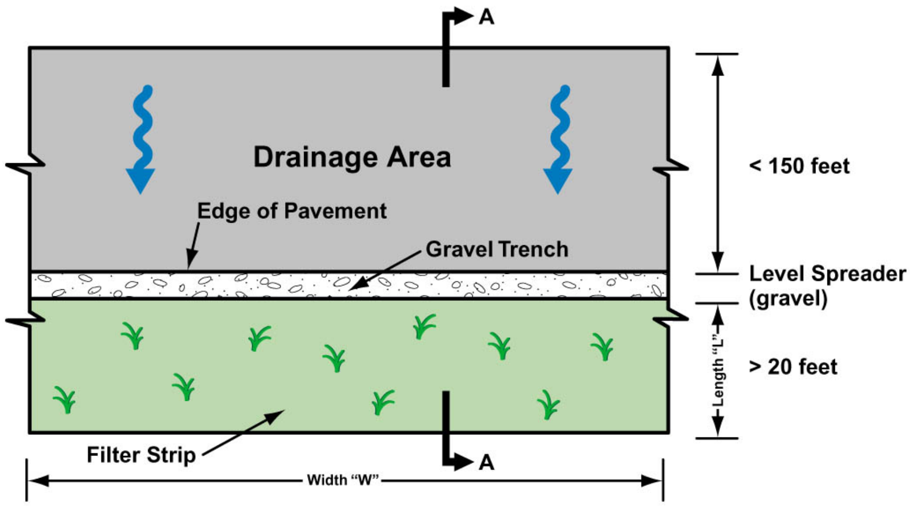
Dreher, D. and T. Price. July 1992. Best Management Practice Guidebook for Urban Development. Northeastern Illinois Planning Commission.

Natural Resources Conservation Service. 1995. *Illinois Urban Manual. A*vailable online at www.il.nrcs.usda.gov/technical/engineer/urban

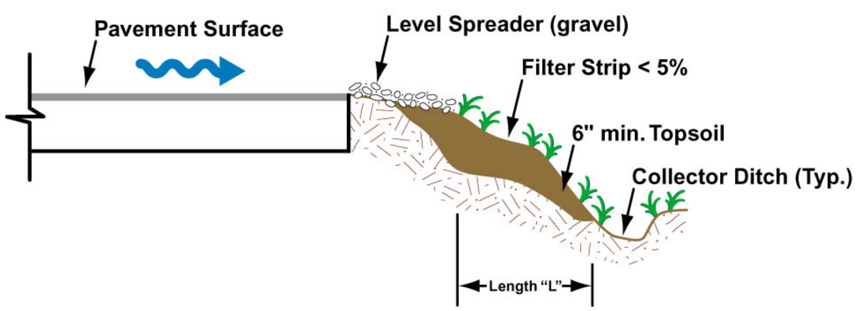
United States Environmental Protection Agency Office of Water. *Post Construction Stormwater Management BMP Fact Sheets Website***.**
www.epa.gov/npdes/stormwater/menuofbmps/post.cfm

The Urban Committee of the Association of Illinois Soil and Water Conservation Districts. July 1998. *Procedures and Standards for Urban Soil Erosion and Sedimentation Control in Illinois* (the Green Book).

Figure 2-6: Typical Filter Strip



Plan (Not to Scale)



Section A-A
Plan (Not to Scale)

2.1.1.6 Vegetated Swales

Swales vegetated with grass or other suitable plants are useful as both runoff conveyance facilities and as pollutant filtering and infiltration devices. From a pollutant removal perspective, vegetated swales work much like filter strips, increasing infiltration opportunities and filtering pollutants. Where possible, natural drainage ways on the development site should be maintained and used as part of the swale drainage system.

Swales reduce runoff velocities relative to storm sewers thereby lengthening the time of concentration and reducing peak discharges. Swales increase infiltration potential and increase storage. As stormwater runoff flows through these channels, it is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix and infiltration into the underlying soils. The effectiveness of vegetated swales is a function of the drainage area served, including the amount of imperviousness, the gradient of the channel, the infiltration capacity of the soils, and the density of vegetation in the swales. Swales are most effective when they are flat and densely vegetated. In addition, the use of deep-rooted native plans greatly enhances treatment performance.

Pollutant removal by swales is highly variable. As indicated for filter strips, however, the pollutant removal effectiveness tends to be much greater for small runoff events for which substantial infiltration occurs.

Grassed swales are suitable for many types of development, but are most practical on large lot residential sites and industrial sites where the number of driveway crossings is not large. Swales also are recommended for highway drainage where right-of-way widths are adequate. Swales are most easily implemented on rolling to gently rolling topography which is common in northeastern Illinois.

The effectiveness of vegetated swales for pollutant removal is largely dependent on the area to be drained relative to the surface area of the swale. For residential developments, the effectiveness can be enhanced by grading lots such that the runoff is distributed relatively evenly between front and rear yard swales. This generally means the roof drains and the back yards should drain to the rear yard swale and the street and front yard should drain to the roadway swale. For commercial or other high density developments, parking medians should be utilized, where practical, for swale drainage to maximize the amount of swale contact area for impervious runoff. Runoff can be routed into parking lot swales through slotted curbs. This approach represents a departure from common parking lot design which places landscaped islands or medians at the high points in the lot and storm sewer inlets at the low point. Use of swale drainage in parking lots can dramatically reduce the need for storm sewers. Also, swales in parking lot medians are useful for the disposal of plowed snow.

Ideally, swale slopes should be less than 4 percent; 1 to 2 percent slope is recommended. The swale should be sized to flow at less than 1.5 feet per second during the water quality design event to promote settling and allow time for infiltration. Higher velocities are acceptable during larger flood events, although maximum velocities should not exceed erosive levels. The effective slope of swales can be reduced where steep grades exist naturally through the use of drop structures. Swales should generally have a trapezoidal or parabolic cross section where runoff flowing through the swale is in contact with the vegetated sides and bottom of the swale. Increasing the wetted perimeter slows runoff velocities and provides more contact with vegetation to encourage filtering and infiltration. If high salt concentrations are expected in runoff, salt tolerant plant species should be utilized. Compaction of soils in the swale should be avoided during construction or soil permeability should be restored during final grading.

The effectiveness of vegetated swales can be improved by building in shallow depressional storage to temporarily hold runoff and enhance infiltration. Depressional storage can be implemented by purposely excavating depressions below the finish grade of the swale or by placing small, perforated check dams across the swale bottom. Check dams may also be used to slow velocities on slopes greater than 4 percent. In areas with type C and D soils where the depressions may not drain within three days, the swale should be planted with wetland vegetation. The wetland vegetation will better tolerate extended wet conditions, will filter pollutants, and will conceal standing water that may be objectionable to some residents. Mosquitoes and odors should not be a problem since the standing water will be exchanged with each rainfall event. Figure 2-7 shows a schematic of a typical of vegetated swales.

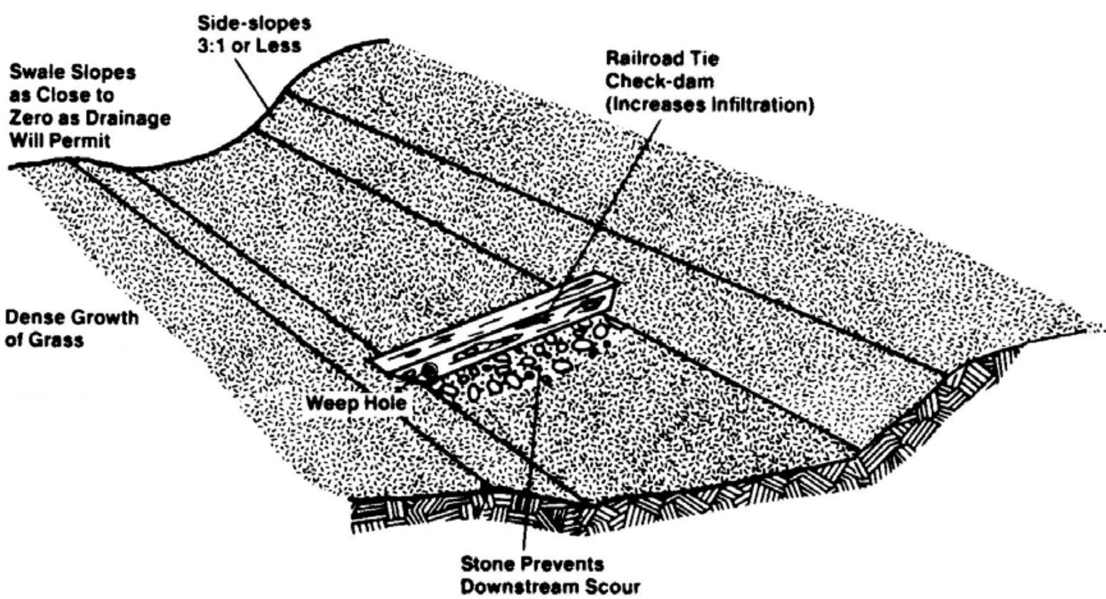
More information on design standards and construction details for vegetated swales can be obtained from the following sources:

Dreher, D. and T. Price. July 1992. Best Management Practice Guidebook for Urban Development. Northeastern Illinois Planning Commission.

Natural Resources Conservation Service. 1995. *Illinois Urban Manual. A*vailable online at www.il.nrcs.usda.gov/technical/engineer/urban

United States Environmental Protection Agency Office of Water. *Post Construction pStormwater Management BMP Fact Sheets Website*. www.epa.gov/npdes/stormwater/menuofbmps/post.cfm

Figure 2-7: Schematic of Grassed Swale (Schueler, 1987)



2.1.1.7 Additional BMPs for Water Quality Protection

There are a number of additional BMPs that may be used for water quality protection in McHenry County. These BMPs include structural and non-structural methods that can be used for soil erosion and sediment control during construction or for post-construction permanent water quality protection. A detailed (but not exhaustive) list of additional BMPs that may be considered for construction or post-construction application is included below.

1. Bioretention
2. Catch Basins/Catch Basin Inserts
3. Diversion
4. Diversion Dike
5. Dust Control
6. Erosion Blanket
7. Extended Detention Ponds
8. Impoundment Structure – Full Flow
9. Impoundment Structure – Routed
10. Infiltration Trench
11. Inlet Protection – Block and Gravel
12. Inlet Protection – Excavated Drain
13. Inlet Protection – Fabric Drop
14. Land Grading
15. Level Spreader
16. Mulching
17. Permanent Seeding
18. Porous Pavement
19. Portable Sediment Tank
20. Right-of-Way Diversion
21. Rock Outlet Protection
22. Sand Filters
23. Sediment Trap
24. Silt Fence
25. Sodding
26. Stabilized Construction Entrance
27. Stormwater Wetlands
28. Straw Bale Barrier
29. Structural Streambank Stabilization
30. Subsurface Drain
31. Sump Pit
32. Temporary Diversion
33. Temporary Sediment Trap
34. Temporary Seeding
35. Temporary Slope Drain
36. Temporary Stream Crossing

37. Temporary Swale
38. Topsoiling
39. Tree and Shrub Planting
40. Tree Protection
41. Vegetative Streambank Stabilization

More information on application of BMPs can be obtained from the following sources:

Dreher, D. and T. Price. July 1992. Best Management Practice Guidebook for Urban Development. Northeastern Illinois Planning Commission.

Natural Resources Conservation Service. 1995. *Illinois Urban Manual. A*vailable online at www.il.nrcs.usda.gov/technical/engineer/urban

United States Environmental Protection Agency Office of Water. *Post Construction Stormwater Management BMP Fact Sheets Website*.
www.epa.gov/npdes/stormwater/menuofbmps/post.cfm

2.1.2 Buffer Areas

McHenry County is fortunate to still have a number of high quality water resources. As discussed in the wetlands section of this document, many streams, wetlands and lakes in McHenry County have received an ADID (Advanced Identification) designation. An ADID designation signifies high quality resources for which increased effort must be implemented to protect their quality, functions, and biodiversity.

Source:
Biological Stream Characterization: Biological Assessment of Illinois Stream Quality
Illinois Environmental Protection Agency. November 1996

Many McHenry County stream systems also possess significant environmental quality, which have been documented by various agencies. The Illinois Environmental Protection Agency (IEPA) utilizes a process developed in conjunction with Illinois Department of Natural Resources (IDNR) biologists to classify streams.

The Biological Stream Characterization (BSC) was designed to include a range of attributes of fish assemblages. Data obtained at a given site is evaluated in light of what might be expected at a similar un-impacted or relatively un-impacted stream located in a similar geographical region. An overall score is calculated and assigned to the site. The BSC utilizes an Index of Biotic Integrity (IBI) to classify streams as A, B, C, D, or E based on the following ranges shown in Table 1. Streams ranked as "A" are considered unique aquatic resources, while "B" streams are considered highly valued resources. The exhibit at right shows the location and extent of "A" and "B" quality streams in the Chicago area. Most of the major stream systems in the County qualify as unique or high quality resources. It should be noted that a direct correlation exists between the location of high quality streams, and the lack of urban development.

One of the most significant impacts resulting from development activities is the change in the quantity and quality of surface water runoff entering local drainageways. Without proper planning and safeguards in place, urban development can often degrade water quality, and the biological integrity of the receiving waterbody.

In urban developments large enough to warrant stormwater management infrastructure, those impacts can be partially mitigated by the provision of multiple-benefit stormwater practices to intercept, detain, and pre-treat the stormwater runoff before it is discharged into the receiving waterway. However, with any size development activity, it is generally accepted that the best way to protect the quality of surface water features, such as streams, rivers, lakes, and wetlands, is to create buffer areas between these resources and areas being subject to development activity. The preservation, enhancement, or restoration of a diverse native plant community within these buffer areas is one of the simplest and most effective Best Management Practices to provide the best opportunity for reduction of runoff rates and nutrient uptake.

Maintaining a prairie or wetland buffer along creeks, streams, and rivers provides more than just an attractive landscape. Establishing grasses and shrubs, as well as trees along larger stream systems, helps replace the natural system that once protected most Illinois streams, creeks, and rivers. Each kind of vegetation offers a specific benefit, working together as a "living filter." Using hardy, native plants (such as switchgrass or prairie cord grass) can stop eroded soil from entering streams. A properly cared for buffer area also can moderate flooding, help recharge underground water supplies, prevent soil erosion, and preserve or enhance wildlife habitat.

As runoff flows over land, the tall, dense stems of native grass slows it down, allowing waterborne soil particles to drop into the buffer zone rather than getting to the stream. The root systems of some native grasses may penetrate up to 6 feet, providing deep pores for water to soak into rather than running off. The "sponge" effect also helps lessen the severity of floods and recharge groundwater. The mass of roots deep beneath the soil's surface provides an abundance of organic matter. This organic matter provides an ideal environment for microbes that break down the chemicals through natural processes.

It is also important to consider adding a constructed wetland component to the riparian buffer system to intercept stormwater and tile outlets. These structures carry runoff directly from cropped or developed areas, and "filtering" that drainage before it reaches the stream. This is a proven technique for reducing nitrogen loading in surface waters. The design for the wetland component is flexible and a riparian buffer system is a conservation technique that can provide significant long-term benefits at a very low cost.

There are also the benefits of government programs that protect water resources. The Conservation Reserve Program (CRP) and Wetland Reserve Program (WRP) are just two such programs administered by the USDA – Natural Resource Conservation Service. Landowners who install riparian buffer systems on their land under these programs may be eligible for cost-share and annual rental payments from the federal government for up to 15 years.

2.1.3 Design of Buffer Areas

The applicant shall be responsible for determining and identifying the location and extent of the buffer area required under the SMO. The applicant shall provide all necessary plans, maps, and other information as required by the SMO and the Enforcement Officer to make and support that determination. The Enforcement Officer shall review the information provided and either approve or disapprove it, and, if applicable, citing the reasons for such disapproval.

Additional information required as part of a buffer area submittal shall be a floristic assessment of the existing plant communities with planned buffer areas; proposed restoration or revegetation plans for planned buffer areas; and functional assessments of the existing /potential environmental functions of the planned buffer area.

Buffer characteristics can vary widely depending on local circumstances. However, it is important to understand certain basic, minimum criteria.

Buffer Width:

Any width of natural vegetation will provide some benefits; however, a 30-foot minimum width is required for any situation where the SMO requires a buffer to be provided. Wider buffers (e.g., 40 to 100 feet) are required to be provided adjacent to higher quality water resources, as specified in the SMO. The U.S. Department of Agriculture recommends "filter strips" of 66 to 99 feet for water quality protection. A recent national survey of local and state guidance for stream buffers observed a range of 20 to 200 feet (with a median width of 100 feet). It should be noted that other regulatory programs may also mandate buffer widths greater than those mandated within the SMO, but in no case will buffers with widths less than those mandated by the SMO be allowed, except in special circumstances.

Buffer Averaging:

It is recognized that the enforcement of buffer requirements onto a given parcel of land may create conflicts with other zoning setback, land use, or similar issues. The SMO does allow for buffer averaging to be utilized in certain circumstances.

> *For example, if a parcel has a one-half acre wetland on it, a thirty-foot buffer would have to be provided under the SMO. If the parcel has 500 feet of wetland frontage, the total surface area of the buffer would be 15,000 square feet (30 feet x 500 feet). If spatial circumstances prevented the intended development activity from occurring with a uniform buffer width of thirty feet, an applicant can propose a variance to reduce the buffer width in the critical area to no less than half the specified width, or in this example 15 feet. This reduction in buffer width must be mitigated, however, by expanding the buffer width to beyond 30 feet along non-critical sections of balance of the buffer. How this is achieved is up to the applicant to determine, but the net result must be that the minimum required surface area of buffer area (in this example 15,000 square feet) must be provided, with no portion of the overall buffer less than 15 feet in width.*

Because the buffers are being provided, in part, to provide water quality benefits, no reduction in buffer width can occur where concentrated stormwater flows will be passing through the buffer on the way to a receiving waterbody.

In the event that the imposition of buffer requirements precludes an otherwise buildable lot from being developed, the SMO authorizes the Enforcement Officer to allow the minimum variance from the buffer requirements required to make the parcel buildable. If approved, the Enforcement Officer will determine the type and amount of mitigation required to be provided by the applicant to offset the environmental impacts of the loss of the buffer area.

Buffer Intrusions:

While a continuous, uninterrupted buffer is preferable for protection of water quality and habitat, some flexibility may be needed to provide access to beaches, piers, and other uses. Access typically is provided via a mown footpath. Less intrusive pedestrian access could be provided via a stepping stone trail. Paving through a buffer is discouraged, unless surface runoff flows warrant a more durable surface.

Buffer Vegetation:

It is recommended that buffers be planted with native species that are indigenous to McHenry County. The Federal Land Survey, conducted in the mid-1800s, shows the general vegetation types that existed throughout the state prior to European settlement. It distinguishes between wetland, prairie, and woodland communities, and provides a good indication of the type of vegetation that is naturally acclimated to the soils, hydrology, and climate of an area.

Buffer vegetation also should reflect local needs and conditions. For example, a forested buffer may be appropriate if noise screening is desired—but it may not be appropriate if local residents desire an unobstructed lake view, or if sunlight must reach the streambank to allow the optimal plant species to thrive. Similarly, some property owners will prefer a greater mix of showy wildflowers that may be less functional than other prairie plants but will enhance the beauty of the shoreline.

A number of resources are available that can help determine the appropriate plant materials to use within buffer areas.

It is important to recognize that buffer areas along streams and rivers are typically located within floodprone areas, and are exposed to periodic high flows. In these circumstances, the use of seed as the predominant means of restoring native vegetation is somewhat questionable, as the seed is easily prone to being washed away, unless used in conjunction with a well-secured, heavy grade of erosion control blanket. The closer to the waterway the plant introduction will take place, the more likely it is that the use of rooted plant materials is the best approach.

Desirable Plant Species

Shrub/Brush Species	
Buttonbush	*Cephalanthus occidentalis*
Red-Osier Dogwood	*Cornus stolonifera*
Common Witchhazel[s]	*Hamamelis virginiana*
Chokeberry[s]	*Prunus virginiana*
Peach-Leaved Willow	*Salix amygdaloides*
Pussy Willow	*Salix discolor*
Sandbar Willow	*Salix interior*
Black Willow	*Salix nigra*
Elderberry	*Sambucus canadensis*
Lower Bank and Nearshore	
Sweet Flag	*Acorus calamus*
Water Plaintain	*Alisma subcordatum*
Bluejoint Grass	*Calamagrostis canadensis*
Creeping Spike Rush	*Eleocharis acicularis*
Blue Flag Iris	*Iris virginica*
Torrey's Rush	*Juncus torreyi*
Switch Grass	*Panicum virgatum*
Arrowhead	*Sagittaria latifolia*
Hardstem Bulrush	*Scirpus acutus*
Dark Green Rush	*Scirpus atrovirens*
River Bulrush	*Scirpus fluviatilis*
Prairie Cord Grass	*Spartina pectinata*
Blue Vervain	*Vebena hastata*
Common Cattail[+]	*Typha latifolia*

[+] Cattails are invasive and can become a problem. However, they are very effective at dissipating wave energy and can become established under difficult situations. Other plantings should be chosen accordingly.

Undesirable Plant Species!

Box Elder*	***Acer negundo***
Garlic Mustard*	***Allilaria officianalis***
Japanese Honeysuckle*	***Lonicera japonica***
Tartarian Honeysuckle*	***Lonicera tatarica***
Purple Loosestrife*	***Lythrum salicaria***
Reed Canary Grass*	***Phalaris arundinacea***
Common Buckthorn*	***Rhamnus athartica***
Glossy Buckthorn*	***Rhamnus frangula***
Multiflora Rose*	***Rosa multiflora***

Banks and Slopes	
Sideflowering Aster[s]	*Aster laterifolius*
Big Bluestem	*Andropogon gerardi*
Gray Sedge[s]	*Carex amphibola*
Common Wood Sedge[s]	*Carex blanda*
Pennsylvania Sedge[s]	*Carex pennsylvanica*
Brown Fox Sedge	*Carex vulpinoidea*
Canada Wild Rye	*Elymus riparius*
Streambank Rye	*Elymus villosus*
Silky Wild Rye	*Elymus virginicus*
Fowl Meadow Grass	*Glyceria striata*
Torrey's Rush	*Juncus torreyi*
Evening Primrose	*Oenothera biennis*
Switch Grass	*Panicum virgatum*
Indian Grass	*Sorghastrum nutans*
Prairie Cord Grass	*Spartina pectinata*
Blue Vervain	*Verbena hastata*
Wildflowers	
Columbine	*Aquilegia canadensis*
Jack-in-the-Pulpit[s]	*Arisaema triphyllum*
Green Dragon[s]	*Arisaema dracontium*
Swamp Milkweed	*Asclepias incarnata*
Turtlehead[s]	*Chelone glabra*
Shooting Star[s]	*Dodecatheon meadia*
Joe-Pye Weed	*Eupatorium maculatum*
Spotted Jewelweed[s]	*Impatiens capensis*
Cardinal Flower[s]	*Lobelia cardinalis*
Virginia Bluebells[s]	*Mertensia virginica*
Blue Phlox	*Phlox divaricata*
May Apple[s]	*Podophyllum peltatum*
Solomon's Seal[s]	*Polyganatum canaliculatum*
Swamp Buttercup[s]	*Rannuculus septentrionalis*
Bloodroot[s]	*Sanguinaria canadensis*
False Solomon's Seal[s]	*Smilacina racemosa*
Spiderwort	*Tradescantia ohiensis*
White Trillium[s]	*Trillium grandiflorum*
Prairie Trillium[s]	*Trillium recurvatum*
Big Merrybells[s]	*Uvularia grandiflora*
Culver's Root	*Veronicastrum virginicum*
Golden Alexanders	*Zizia aurea*
Cover Crops	
Annual Ryegrass*	*Lolium multiflorium*
Perrenial Ryegrass*	*Lolium perenne*
Smartweed	*Polygonum punctatum*
Yellow Coneflower	*Ratabida pinnata*
Blackeyed Susan	*Rudbeckia hirta*

* not native, [s]shade tolerant

Source: ***Lake Notes*** NIPC - 1996

Buffer Maintenance:

Buffer installation begins with the removal of existing, undesirable vegetation. Recommended native vegetation, listed in the same table, can be planted as live plants or seeds. Planting should begin at or below the normal water elevation with wetland species and should proceed up the shoreline slope with water-tolerant and upland species. While buffer vegetation is being established, mowing and/or selected use of approved herbicides may be necessary to control the spread of aggressive, non-native plants.

Once the buffer is well established (typically within 1-3 years), maintenance will involve occasional mowing or controlled burns to control weeds and maintain native plant diversity. If certain noxious weeds need additional control, limited use of approved herbicides may be appropriate in localized areas. Use of fertilizer is not necessary and should be avoided in the buffer strip.

For Additional Information:

The Illinois Buffer Partnership
http://www.cbmp.uiuc.edu/buffer.htm

Center for Watershed Protection
http://www.cwp.org/

Buffer Areas Special Easements and Covenants:

The creation of buffer areas is a critical step in protecting the water resources of McHenry County. However, buffer areas need to be monitored and protected from future encroachment by adjoining land uses, or by direct intrusion from anyone causing harm to the area by vehicular activity, unauthorized mowing, spraying, or brush/tree clearing, or the disposal of landscape waste or other materials.

For these reasons, the SMO mandates that a party be identified that will be responsible for the long term oversight of the buffer area. In the case of larger residential developments, easements or covenants are often held by Homeowner's Association. This is an acceptable arrangement as it also allows assessments to be levied upon all the landowners on that development who benefit from the presence of the protected open space to fund appropriate management practices. In the case of individual development sites, the creation of a conservation easement is often a preferred approach. A conservation easement is a legal mechanism by which a landowner gives up specific development rights to a portion of their property. The landowner still owns the entirety of their parcel, and does not have to allow any public access to the conservation easement. The conservation easement is recorded with the County, and is permanently attached to the plat of survey for that parcel of land.

Because the landowner is giving up something of value, there are often real estate tax benefits available through the local assessor, as well as Federal and State income tax benefits. A landowner interested in implementing a conservation easement should consult with their accountant and/or attorney to find out how their specific circumstances would affect the tax benefits potentially available.

A number of not-for-profit land trusts exist in northeastern Illinois. Any of these groups can provide information on how to provide protection for buffer areas and other sensitive natural areas.

For Additional Information:

The Land Conservancy of McHenry County
www.conservemc.org

The Fox Valley Land Foundation
www.fvlf.org

Corlands, Inc.
www.Corlands.org

The Land Trust Alliance
www.lta.org

2.1.4 Streams and Channels

Streambank erosion is a naturally occurring process; it only becomes a problem when the rate of erosion exceeds the ability of the stream to adjust, or when human-made improvements lie in the path of the stream adjustments. The following is a brief discussion of some of the factors potentially affecting the stability and function of waterways.

Watershed Development

Prior to the settlement of the area in the early 18th century, much of McHenry County not adjacent to major stream or river systems, likely drained to a shallow wetland / stream channels, flowing through dense stands of wetland and wet prairie species of vegetation. As agricultural pressure increased in the County, farmers sought to reclaim these areas as the organic soils present along these drainageways were extremely fertile and could produce high crop yields, provided the water table could be lowered. Human activities have altered the local land use, hydrologic characteristics, and plant communities of areas tributary to waterways. As a result, local streams were increasingly channelized and straightened to allow water to drain more quickly, and sub-surface drain tiles were installed in order to remove excess groundwater.

Many of the streams and wetlands in the county were originally altered by agricultural activities conducted to drain low-lying areas. To convert isolated depressional wetland or wet prairie areas into viable cropland, these areas were often drained by linking them together with excavated drainage ditches, creating an incised, linear stream system where none existed before. While these artificial stream systems were bordered by highly permeable agricultural cropland and pastures, and the farmers took an active role in maintaining them, these drainage ditches could often maintain an equilibrium. However, as the watershed areas served by these drainage ditches began to urbanize, and adjacent floodplain, wetland, and depressional storage areas were filled in, the resulting increase in the volume of stormwater runoff caused the rate of erosion to accelerate.

As watersheds develop and areas that could formerly absorb rainfall, such as pastures and woodlands, are converted to more impervious surfaces, such as rooftops and roadways, the amount of stormwater runoff increases. This also serves to increase the velocity of water moving through the stream. As the volume of stormwater runoff increases, the stream channel increases in size to provide additional capacity.

When McHenry County watersheds were primarily in agricultural production, the cropland would allow a significant amount of the yearly precipitation to infiltrate into the ground. As urban development moved into the watershed, roadways, buildings, and other impervious surfaces covered formerly permeable cropland. This resulted in an increase in the velocity and volume of stormwater runoff reaching the stream, and increased the erosive potential of the stream flow. These changes likely include an increase in the peak discharge of stormwater runoff, resulting in an increased erosion potential. The water quality of the runoff leaving developed areas, as well as from roadway surfaces may also be affecting the water quality of the subject stream.

Stream Geomorphology

Streams and rivers transport water and streamborne sediments, sands, gravels, and rocks (collectively referred to as “bedload”) in their attempt to maintain equilibrium between discharge and channel form. If a stream is artificially modified to enlarge its channel capacity, or is naturally modified to accommodate a larger flow, the next unmodified reach of upstream channel will immediately begin to respond to the new condition. Starting from the downstream end, the channel will generally first incise or lower itself in the landscape, effectively digging out a deeper channel to meet the elevation of the downstream modified stream channel. This incision process, known as "head-cutting", generally starts at the downstream end of a disturbed stream reach, and continues upstream until the stream reaches its desired slope equilibrium. However, "head-cutting" also results in streambanks that are too steep to support themselves, causing them to slump into the stream.

Therefore, one of the primary goals in restoring streams to a stable condition should be to reestablish "grade control" of the stream channel. Grade control refers to the presence of stable (reinforced) sections of streambed at specific intervals along the stream channel that allow the stream to drop in elevation in a controlled fashion. In a natural stream, these grade controls are provided by the presence of "riffles", stable accumulations of rock, stones, and gravel that allow the stream to descend in the landscape by having the streamflow cascade in a thin sheet of water over the stable rocks. To the untrained eye, these riffles could appear as accumulations of gravel and stone impeding the flow of water that should be removed. However, these riffles are highly desirable features that are helping to stabilize the stream channel, and should be retained, or constructed where needed. Numerous desirable species of fish use riffles, as well as gravel and sand bars for spawing and foraging, and these features should be protected from impacts of land development activities.

Over the years, landowners, highway departments, and government agencies have spent significant amounts of time and money removing sand and gravel bars from streams and rivers, only to have them re-form, often after the very next high flow event. The premise was that the presence of gravel bars was taking up flood storage, blocking conveyance, or otherwise destabilizing the streamflow. In reality, the creation of sand and gravel bars is how a stream system tries to achieve an equilibrium between the volume of water and bedload it must convey. While some sand and gravel bars that are diverting streamflows towards vulnerable infrastructure must be manipulated, in most circumstances, accepted practices in stream management now must take stream geomorphology into account.

Soils

When the soils of McHenry County were formed during the retreat of the last ice age, the resulting drainage network was often composed of shallow, braided waterways flowing through dense stands of emergent wetland and wet prairie vegetation, nourished by the rich organic soils. Due to the lowering of current day stream channels in the landscape, whether due to natural channel evolution, watershed development, or ditching and channelization, our current day streambanks often feature exposed areas of non-organic soils, which formed in lower soil horizons than the surface topsoil. While clayey soils often have a higher degree of internal cohesion, making them somewhat less prone to erosion, they are less likely to support a diverse assemblage of riparian plant species that can help protect streambank soils with dense foliage and deep, penetrating root systems.

Exposed or poorly vegetated streambanks can be rapidly scoured by high flows. The velocity and volume of stormwater moving through a stream channel during and immediately after a runoff event can rise and fall rapidly. The rapid draSMOwn of the water elevation of a stream following a high flow can also contribute to the slumping of saturated streambank soils.

As a result, to properly stabilize shorelines, it is often necessary to regrade overstep streambanks back to a more gradual slope, and installing adequate practices to allow a top-dressing of organic soil to be placed onto the graded streambank to allow appropriate native riparian vegetation to be established.

Vegetation

In McHenry County, it is likely that the two most predominat species of riparian vegetation are Box Elder (Acer negundo), a member of the Maple family, and Reed Canary Grass (Phalaris arundinacea), a grass introduced from Eurasia. Although a native specie, the Box Elder tree is commonly considered a "weed" tree because it rapidly colonizes disturbed areas. They are somewhat short-lived and produce a significant amount of woody debris as the branches and limbs break off quite readily. These trees are easily undercut by streambank erosion, causing them to fall into the stream, initiating debris jams. The dense shade produced by the trees also prevents desirable native vegetation from becoming established on the lower slopes, where it could help protect shoreline soils.

Reed Canary Grass, a noxious invader of disturbed wet areas, spreads rapidly and features a very shallow root system. These shallow roots do little to bind streambank soils together, unless the streambank slope is gentle enough to extend down to the normal water surface of the stream, preventing the roots from being undercut. Ironically, this grass was introduced for use in erosion control in grassed waterways in farm fields where its shallow root system was adequate, however, its aggressive spread into downstream waterways has caused many problems in managing native riparian plant communities.

Appropriate stream corridor management often requires that these and other nuisance species be controlled or eliminated to provide the best opportunity for restoration of riparian functions and wildlife habitat.

2.1.5 Streambank and Shoreline Restoration Practices

The traditional response to streambank or shoreline restoration has been to armor the eroding areas with large rock, concrete slabs, or other bulky objects. These practices often did not account for the action of constant water movement removing the underlying soils, causing these materials to become undermined and fail; the force of moving water, whether by streamflow, waves, or ice action, to physically displace the materials from its intended position; or the tendency for armored shorelines or streambanks to transfer the erosion energy that originally affected the treated area to adjacent untreated areas.

From an environmental standpoint, armored streambank and shoreline stabilization practices often have adverse impacts. For example, armored shorelines are not often conducive to the growth of vegetation, which can help bind shoreline soils together with their root systems. Properly installed riprap is usually underlain with a geo-textile fabric to prevent the soil under the riprap from being washed out. While the geo-textile may help hold soil in place if properly installed, the fabric also forms an impenetrable barrier to the roots of any plants that may colonize the riprap. Without having access to soil moisture reserves deeper in the shoreline soils, these plants are often stressed by the rapid loss of moisture within the riprap, caused by the solar heating of the riprap. If placed on too steep a slope, the geotextile can actually contribute to the slumping of installed rip-rap by creating a slick surface conducive to slippage.

The deflection of streamflows or wave action caused by armored practices also discourage the growth of off-shore aquatic and emergent plants, which can also provide valuable shoreline protection, fishery and wildlife habitat, and water quality benefits.

While there are still situations where traditional armored shoreline practices may be appropriate (for example, in heavily urbanized areas where land or infrastructure constraints exist), over the past few decades, there has been an upsurge in alternative streambank and shoreline restoration practices that try to replicate natural conditions.

There are three major categories of streambank and shoreline stabilization practices:

- Armor: Includes the use of rock riprap, poured concrete or concrete rubble, gabion baskets, vinyl or steel sheet piling, articulated concrete blocks, or other rigid practices.

- Biotechnical: Includes the use of various types of biodegradable and non-biodegradable erosion control products in conjunction with vegetative practices. Biotechnical practices can also include the use of A-jacks structures, lunker structures, artificial riffles, and vegetated geogrids. They may also include the limited use of armored practices for protection of the toe (base) of the treated slope.

- Bioengineering: Includes the use of native plant material and biodegradable erosion control products in a variety of combinations. Typical practices include dormant cuttings, willow facscines, coir fiber rolls, and brush mattresses.

The factors contributing to streambank and shoreline erosion problems can vary greatly from one site to another, even along adjacent sections of the same waterway or waterbody. Changes in bank heights and slopes, soil material, off-shore water depths, slope aspect, the composition and management of existing plant communities, adjacent land use, and numerous other factors can affect the selection of appropriate practices. As a result, no one group of stabilization practice will be applicable for all stabilization projects. However, the SMO assumes that a more environmentally appropriate biotechnical or bioengineering solution will exist, such that the burden of proof will be on the project designer to prove that the use of a traditional armored practice cannot be avoided.

The project designer will have to fully investigate all potential alternatives that might be appropriate for a particular site. The following is a <u>partial</u> list of design considerations that should be considered in the selection and design of streambank or shoreline stabilization practices.

Land Ownership - If the project area is located on a private parcel of land, one cannot automatically assume that the current landowner, or any subsequent landowners, will undertake the necessary management practices (selective herbiciding of invasive plants, controlled burn management, etc.) to sustain and perpetuate a stabilization project that is contingent on the successful establishment of a native plant community. Project areas that are located within a conservation easement, common open space area, or that are under public ownership may have a higher degree of success in maintaining a diverse, functional native plant community, particularly if a management plan is adopted and funded.

Watershed Land Use – As a watershed develops, the volume and velocity of stormwater runoff reaching local waterways increases, increasing the erosion potential of streamflow and creating a frequent "bounce" of water levels in lakes and ponds. As the degree of watershed urbanization increases, the need for more robust stabilization practices can also increase.

Wildlife Impacts – Canada Geese, Muskrats, and Carp can significantly impact the success of native planting by grazing pressure if the plants are not adequately protected until they have established.

Existing Plant Communities – If a project area, or the immediate watershed above it, is currently dominated by invasive or non-native plant materials, such as Reed Canary Grass, Box Elder trees, or Buckthorn and Honeysuckle shrubs, it is less likely that a stabilization project that is contingent on the long-term establishment of a native plant community will be successful. At times, the use of non-native, but non-aggressive plant materials (such as the use of Creeping Red Fescue grass in shady areas) may have to be utilized to provide a competitive edge against the established plants.

Often, new development or redevelopment activities present opportunities for restoration of degraded streams or shorelines on the development site. A highly degraded natural system is not only low in functional value but is also unaesthetic. Hence, a developer may see an opportunity to enhance the aesthetics of the property while also benefiting water quality and habitat values. Wetlands and natural streams can enhance property values, thereby offsetting the cost of restoration. Restoration opportunities are best evaluated in the site planning stage as the development is being fit into the landscape.

A highly channelized or disturbed stream system can be fully or partially restored using some combination of the following techniques: stabilizing or regrading steep, eroding streambanks; restoring native vegetation to the riparian zone; recreating a meandering pilot channel; or creating an entirely new channel. Channel restoration might be permitted as a mitigation alternative to the filling of a degraded isolated wetland.

Appropriate vegetation is the key to effective buffer strips and shoreline stabilization. These plant species provide beneficial habitat, anchor shoreline soils, dissipate wave energy, and enhance the beauty of shoreline property. Some of the species listed here may not be appropriate in all areas. You should consult with one of the organizations listed below to verify which plants will do best under your local conditions.

For Additional Information:

Streambank and Shoreline Protection Manual
http://www.lrc.usace.army.mil/co-r/StrmManual.pdf

Best Management Practice Guidebook for Urban Development
http://www.nipc.cog.il.us/pubslist.htm#plain

Landscaping Techniques and Materials for Urban Illinois Stream Corridors and Wetland Edges.
http://www.nipc.cog.il.us/pubslist.htm#plain

Restoring and Managing Stream Greenways: A Landowner's Handbook.
http://www.nipc.cog.il.us/pubslist.htm#plain

Biodiversity Recovery Plan
http://www.nipc.cog.il.us/new-pubs.htm#Nature

Conservation Design Resource Manual
http://www.chiwild.org/pubprod/inde.cfm

Center for Watershed Protection
http:/ /www.cwp.org

2.2 Soil Erosion and Sedimentation Control

Soil erosion is caused by the action of wind, rainfall, and runoff on bare or poorly vegetated soil. Clearing, grading, and other construction activities remove vegetation and compact the soil, increasing both runoff and erosion. Excessive runoff can create rills and gullies that can generate sediment and result in it being deposited on lower ground or in local waterways. The accumulation of development generated sediment in local waterways and lakes can cause adverse water quality impacts, stress desirable aquatic organisms, and displace flood storage capacity.

2.2.1 Soil Erosion and Sedimentation Control Principles and Standards

Effective erosion and sedimentation control can be achieved by careful attention to the following principles:

- Development should be related to the topography and soils of the site so as to create the least potential for erosion. Area of steep slopes where high cuts and fills may be required should be avoided wherever possible, and natural contours should be followed as closely as possible.

- Existing vegetation should be retained and protected wherever possible. Area immediately adjacent to natural watercourses, lakes, ponds, and Wetlands should be left undisturbed wherever possible. Temporary crossings of watercourses, when permitted, must include appropriate stabilization measures.

- Special precautions should be taken to prevent damages resulting from any necessary development activity within or adjacent to any stream, lake, pond, or Wetland. Preventative measures should reflect the sensitivity of these areas to erosion and sedimentation.

- The smallest practical area of land should be exposed for the shortest practical time during development.

- Sediment basins or traps, filter barriers, diversions, and any other appropriate sediment or runoff control measures should be installed prior to site clearing and grading and maintained to remove sediment from runoff waters from land undergoing development.

- The selection of erosion and sedimentation control measures should be based on assessment of the probable frequency of climatic and other events likely to contribute to erosion, and on evaluation of the risks, costs and benefits involved.

- In the design of erosion control facilities and practices, aesthetics and the requirements of continuing maintenance should be considered.

- Provisions should be made to accommodate the increased runoff caused by changed soil and surface conditions during and after development. Drainage ways should be designed so that their final gradients and the resultant velocities and rates of discharge will not create additional erosion onsite or downstream.

- Permanent vegetation and structures should be installed and functional as soon as practical during development.

- Those areas being converted from agricultural purposes to other land uses should be vegetated with an appropriate protective cover prior to development.

- All waste generated as a result of site development activity should be properly disposed of and should be prevented from being carried off the site by either wind or water.

- All construction sites should provide measures to prevent sediment from being tracked onto public or private roadways.

2.2.1.1 Protect the Land Surface

The contractor can control erosion most effectively by making sure the soil surface is protected from the action of rain, runoff, and wind. Attention to the following concerns will limit the erosion and reduce the burden of maintaining sediment control practices in the proper working order.

- Schedule construction activities to minimize the duration of soil exposure to the elements

- Limit the area disturbed. Grade no larger an area than necessary at any one time and leave an undisturbed buffer

- Divert runoff away from exposed slopes

- Stabilize and maintain construction roads, parking areas, and the construction entrance. Use the designated routes to limit the development of ruts and erosion

- Stabilize channels immediately

- Protect graded surfaces with temporary vegetation and mulch whenever work is interrupted for an extended period.

Erosion can be reduced and sediment controlled by timely installation of runoff control measures. The superintendent or project foreman is essential in making the water disposal system work. The foreman can handle day-to-day on-site details such as excluding runoff water from the work site and protecting highly erodible areas such as fill slopes and channels. Attention should be given to the following points:

- Protect the work area from off-site water with perimeter dikes or temporary diversions.
- Provide stable outlets to dispose of runoff water.
- Divert all runoff from disturbed areas to sediment traps or basins.
- Divert runoff from undisturbed areas to stable or protected outlets.
- Break long slopes with temporary diversions.
- Install the permanent water conveyance system early in the construction sequence and protect all inlets with inlet protection measures.
- Protect the work area from unexpected rain by putting up temporary diversions at the end of the workday.

2.2.1.2 Capture Sediment Near the Source

Sediment is controlled most easily and effectively near the source. Several sediment traps or barriers located at the edge of a graded area are more effective and less hazardous than a single large sediment basin near the site boundary.

Sediment traps, basins, and barriers, such as sediment fences, operate by reducing runoff velocity to allow deposition-not by filtering. Filtering runoff with fabric or gravel is not effective because filters clog too rapidly to remove much sediment. Therefore, the practices described here are designed to reduce flow velocity and form shallow pools for settling.

The contractor can make sediment control more effective by providing access to traps and barriers for maintenance. Anticipate where sediment will accumulate behind sediment fences, and plan to provide access for cleanout and maintenance. Traps and barriers must be inspected and cleaned frequently.

2.2.1.3 Scheduling

Erosion and off-site sediment problems are controlled most effectively by coordinating the construction sequence and the installation of erosion and sediment control measures. Key sediment control practices must be in place before any site disturbance occurs. A carefully planned construction access route with well-drained, stabilized surfaces improves erosion and sediment control and promotes efficient site development.

2.2.1.4 Inspection and Maintenance

Inspection and maintenance are vital to performance of the erosion and sediment control system. Lack of maintenance is the most common reason for failure. Low points in dikes or diversions can cause major gullies to form. A collapsed sediment fence or fabric inlet protection device can deliver large amounts of sediment off-site, and failure of a large sediment basin could have severe consequences. Inspect and repair all erosion and sediment control practices frequently.

2.2.2 Maintenance of Soil Erosion and Sedimentation Control Measures

The SMO outlines a recommended maintenance schedule for site SESC practices. Erosion control projects are very vulnerable to poor maintenance. A continuing maintenance program should be instituted for every project. Maintenance requirements depend on the type of project. SESC installation and maintenance activities, as well as the eventual removal of certain SESC practices, such as non-biodegradable silt fencing, should be individually specified and quantified as pay items on the contract with the SESC contractor, rather than paid as a lump sum amount.

The following are general recommendations for various types of SESC practices.

1. Systems With Permanent Vegetated Areas

   All bare or eroded areas should be repaired and re-seeded as soon as possible. Undesirable species of vegetation should be removed or controlled to prevent damage to the primary vegetation. Most vegetated areas designed to carry water should be mowed at least twice a year. The mowing prevents the channel from restricting water flow and it encourages a thick erosion resistant stand. Accidental spray application either by direct contact or runoff can destroy a vegetated area especially in the establishment stages. All spray operators should be cautious of this vulnerability.

2. Systems Utilizing Drop Pipe Inlet Spillways

   Excessive shifting, settlement or heaving of the structures should be monitored. It is an indication of potential problems. Inspection for pipe separation, breakage or crushing should take place after every major runoff event. A small internal hole can initiate water channeling along the pipe. Watch for erosion at the outlet of the spillway. This erosion can eventually undermine the outlet pipe. It should be repaired and an erosion resistant lining installed if the problem persists. Erosion at the inlet to the drop pipe structure may also be troublesome. It is caused by swirling and excessive velocities of water at the inlet. The swirling can be reduced by installing an anti-vortex device in the drop pipe and the velocity problem can be alleviated by reducing the slope in front of the inlet or by building an erosion resistant lining around the inlet. Plugging at the inlet must be avoided. After each usage any debris should be removed. If the debris presents a continual problem, the inlet grate should be changed to increase the entrance area, reduce the restriction or decrease the velocity of the water across the grate.

3. Systems Which Incorporate Berms

   Any movement or shifting of the berm must be stopped. Normally, the movement is caused by an unstable back slope. The stability of the back slope must be improved by reducing the slope, revegetating it, or by grubbing out any unsuitable soil and rebuilding the area with better soil. Mowing of the grass cover may be required to maintain a good stand and keep weeds under control.

4. Systems Which Use Emergency Spillways

   Always make sure that the lowest point in the emergency spillway is below the top elevation of the berm. A level instrument is needed to verify this. Many spillways have adequate protection only at the inlet area with erosion occurring in the main section of the spillway if under heavy usage. This erosion will have to be repaired to prevent further washouts during the next usage period. If repair is frequently necessary, an improved emergency spillway system will be required or the main spillway system will need to be increased in capacity. Some systems, such as terraces, use the vegetated flat top of the earthen berm as the spillway. With this system, it is essential that the berm top be level to spread out the overflow water and keep the velocities and eroding effects of the water to a minimum.

5. Systems Utilizing Chute Spillways or Other Linings

   Failure of this type of system is often caused by water finding a path around or under the structure. Look for base erosion caused by this water. Uneven settlement of blocks or riprap will indicate a problem. If found in an early stage, a cutoff wall can be installed at the inlet to the structure. The addition of a grout material between the rocks will also help stabilize them, preventing further movement.

6. Silting Problems

   Many erosion projects such as water and sediment control basin systems and grassed waterways can fill up with eroded silt. This silt will reduce the capacity of the structure. Removal of the silt or an increase of the structure size will then be necessary. The more desirable solution is to reduce the movement of silt into the structure. This is done by improving conditions upstream that may involve a change of maintenance practices or installation of additional SESC practices.

2.2.3 Special Precautions of the Soil Erosion and Sedimentation Control Plan

A comprehensive Soil Erosion and Sediment Control (SESC) control plan must be a living document to accommodate unforeseen changes in construction scheduling, climatic conditions, or design inadequacies. Any off-site sedimentation impacts caused by poorly designed, installed, or maintained SESC practices may result in civil and regulatory liability problems for the party causing those impacts.

2.2.4 Soil Erosion and Sedimentation Control Plan Sequencing

A specified work schedule should be prepared that coordinates the timing of land-disturbing activities and the installation of erosion and sedimentation control measures. On-site erosion and off-site sedimentation will be reduced by performing land-disturbing activities and installing erosion and sedimentation control practices in accordance with a planned schedule.

2.2.4.1 Construction Sequence Schedule

The removal of existing surface ground cover leaves a site vulnerable to accelerated erosion. Good planning will reduce land clearing, provide necessary controls, and restore protective cover in an efficient and effective manner. Appropriate sequencing of construction activities can be a cost-effective way to help accomplish this goal.

In planning construction work, it may be helpful to outline all land-disturbing activities necessary to complete the proposed project. Then list all practices needed to control erosion and sedimentation on the site. These two lists can then be combined in logical order to provide a practical and effective construction sequence schedule.

As a minimum, the construction sequence schedule should show the following:

- All erosion and sedimentation control practices to be installed,
- Principal development activities,
- What measures should be in place before other activities are begun,
- Compatibility with the general construction schedule of the contract.

Many timely construction techniques can reduce the erosion potential of a site, such as shaping earthen fills daily to prevent overflows and constructing temporary diversions ahead of anticipated storms. These types of activities cannot be put on the construction sequence schedule but should be used whenever possible. Follow the construction sequence throughout project development. When changes in construction activities are needed, amend the sequence schedule in advance to maintain management control.

2.2.4.2 Construction Activities

The generalized construction activities listed below do not usually occur in a specified linear sequence, and schedules will vary due to weather and other unpredictable factors. However, the proposed construction sequence should be indicated clearly in the erosion and sedimentation control plan.

1. Construction access is normally the first land-disturbing activity. Exercise care not to damage valuable trees or disturb designated buffer zones.

2. Next, install principal sediment basins and traps before any major site grading takes place. Erect additional sediment traps and sediment fences as grading takes place to keep sediment contained on-site at appropriate locations.

3. Locate key runoff-control measures in conjunction with sediment traps to divert water from planned undisturbed areas out of the traps and sediment-laden water into the traps. Install diversions above areas to be disturbed prior to grading.

4. Place necessary perimeter dikes with stable outlets before opening major areas for development. Install additional needed runoff-control measures as grading takes place.

5. Install the main runoff conveyance system with inlet and outlet protection devices early, and use it to convey storm runoff through the development site without creating gullies and washes. Install inlet protection for storm drains as soon as the drain is functional to trap sediment on-site in shallow pools and to allow flood flows to safely enter the storm drainage system. Install outlet protection at the same time as the conveyance system to prevent damage to the receiving stream.

6. Normally, install stream stabilization, including necessary stream crossings, independently and ahead of other construction activities. It is usually best to schedule this work as soon as weather conditions permit. Site clearing and project construction increases storm runoff, often making streambank stabilization work more difficult and costly.

7. Begin land clearing and grading as soon as key erosion and sediment control measures are in place. Once a scheduled development area is cleared, grading should follow immediately so that protective ground cover can be reestablished quickly. Do not leave any area bare and exposed for extended periods. Leave adjoining areas planned for development, or to be used for borrow and disposal, undisturbed as long as possible to serve as natural buffer zones.

8. Runoff control is essential during the grading operation. Temporary diversions, slope drains, and inlet and outlet protection installed in a timely manner can be very effective in controlling erosion during this critical period of development.

9. Immediately after land clearing and grading, apply surface stabilization on graded areas, channels, dikes and other disturbed areas. Stabilize any disturbed area where active construction will not take place for 30 working days by temporary seeding and/or mulching or by other suitable means. Install permanent stabilization measures immediately after final grading, in accordance with the vegetative plan. Temporary seeding and/or mulching may be necessary

during extreme weather conditions with permanent measures delayed for a more suitable time.

10. Coordinate building construction with other development activities so that all work can take place in an orderly manner and on schedule. Experience shows that careful project scheduling improves efficiency, reduces cost, and lowers the potential for erosion and sedimentation problems.

11. Landscaping and final stabilization is the last major construction phase, but the topsoil stockpiling, tree preservation, undisturbed buffer area, and well-planned road locations established earlier in the project may determine the ease or difficulty of this activity. All disturbed areas should have permanent stabilization practices applied. Unstable sediment should be removed from sediment basins and traps. All temporary structures should be removed after the area above has been properly stabilized. Borrow and disposal areas should be permanently vegetated or otherwise stabilized.

2.3 Stormwater Management

The stormwater management performance standards apply to all intermediate and major developments, except for the storm sewers and swales and overland flow paths, which apply to all regulated development. This section provides additional information on the provisions of Article V.F. Stormwater Management of the SMO. There following seven provisions of this section will be addressed:

Section 2.3.1: Stormwater Runoff

Section 2.3.2: Release Rates and Discharges

Section 2.3.3: Detention Facility Design

Section 2.3.4: Drainage into Wetlands

Section 2.3.5: Fee in lieu of On-Site Detention

Section 2.3.6: Storm Sewers and Swales

Section 2.3.7: Overland Flow Paths

Table 2-2 shows the applicability of these provisions to regulated developments.

Table 2-2: Applicability of SMO Provision to Types of Regulated Development

Provision of SMO	Minor	Intermediate	Major	Public Road	Special Flood Hazard Area
RUNOFF		X	X		
RELEASE RATES AND DISCHARGES		X	X		
DETENTION		X [1]	X [1]		
DRAINAGE INTO WETLAND		X	X		
NON-DETENTION		X	X		
STORM SEWERS AND SWALES	X	X	X	X	X
OVERLAND FLOW PATHS	X	X	X	X	X

[1] Detention required when development involves the creation of more than 20,000 square feet of new impervious area.

The SMO seeks to maintain existing flows and stages in McHenry County in order to:

- Minimize future flooding;
- Protect water quality and control erosion; and
- Preserve the flood management capacity of constructed protection measures.

The additional impervious area associated with development increases both the peak runoff rate and runoff volume. The objective of the runoff management approach is to control the timing or volume of runoff to preserve existing flows and stages at downstream locations in the watershed. The simplest and most effective runoff management approach is to limit the outflows from any development to a rate that would not cause any increases in flow or stage downstream. This approach, called a unit release rate approach, includes 2-year and 100-year rates that are applicable for all of McHenry County.

The primary objective of this section is to discuss the procedures and guidelines for evaluating the existing and proposed runoff characteristics through the use of various hydrologic techniques. The materials presented here can be used to help choose the appropriate level and detail of the analysis. Any data available for the watershed, including data from regional sources such as the United States Geological Survey and Illinois State Water Survey, should be used in the calibration of the hydrologic model.

2.3.1 Stormwater Runoff

2.3.1.1 Runoff Volume Reduction Hierarchy

Implicit with most developments is the net addition of impervious area on the site. This increase of impervious surface area on a site directly affects the increase in the volume of stormwater runoff. The stormwater is unable to infiltrate into the ground and results in an overall increase in the volume of stormwater discharged from the site. The runoff volume reduction hierarchy is a process of systematically approaching the planning and design of the site with the intent to minimize the volume of stormwater discharge of the site. This may be accomplished by two basic strategies (1) reduce the amount of impervious surface area, thereby reducing runoff; and (2) utilize the landscape to naturally filter and absorb runoff before it leaves the development site. The following runoff volume reduction hierarchy should be followed:

1. The preservation of floodplain and wetland areas.
2. Minimization of impervious surfaces to be created on the property.
3. Flow attenuation by use of open vegetated swales and retention of existing natural streams and channels.
4. Infiltration of runoff onsite.
5. The use of retention facilities.
6. The use of wet detention facilities.
7. The use of dry detention structures.
8. The construction of storm sewers.

The site should be planned and designed to minimize the increase in impervious surface to the greatest extent possible. Examples include the use of multilevel buildings and parking lots, the use of narrower streets, clustering of homes, smaller building setbacks to reduce driveway lengths, narrower sidewalks and use of planting medians in parking lots and roads. The site may also be planned to maximize infiltration through the use of infiltration practices, natural drainage measures, permeable paving, and natural landscaping.

As part of the application requirements for a Watershed Development Permit, the applicant should include a narrative describing how the Runoff Volume Reduction Hierarchy was used in evaluating the existing conditions and developing the Stormwater Management Plan for the site. Justification for the use of different components of the hierarchy might include the need to comply with local ordinances or specific design constraints of the site. The report shall state how each component was considered for reducing the runoff volume according to the priority explicit in the hierarchy described above.

A wide variety of resource material is available for design and planning guidance including *Conservation Design for Subdivisions, A Practical Guide to Creating Open Space* (Randall G. Arendt, 1996); *Conservation Design for Stormwater Management, A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use* (Delaware Department of Natural Resources and Environmental Control and The Environmental Management Center, Brandywine Conservancy, 1997); *Low-Impact Development Design Manual* (Department of Environmental Resources, Prince's George County, Maryland, 1997) and *Better Site Design and Stormwater Management Techniques for Phase II Communities* (Center for Watershed Protection, 2000).

2.3.1.2 Runoff Calculations

There are several methods for determining the appropriate storm runoff from a watershed. The applicability of each method or tool is based on the size of the site. Table 2-3 presents the applicability of each model.

Table 2-3: Hydrologic Model Applicability

Model	Calculate Peak Discharges for Drainage Area <20 acres	Calculate Peak Discharges for 20 acres < Drainage Area <100 acres	Calculate Peak Discharges for Drainage Area >100 acres	Compute Stormwater Storage Requirements for Drainage Area > 10 acres
Rational Method	X			
TR-55	X	X		
TR-20	X	X	X	X
HEC-1	X	X	X	X
HEC-HMS	X	X	X	X
Other MCSC Approved	X	X	X	X

The Rational Method may be used as the primary tool for the determination of peak stormwater runoff rates from drainage areas of less than 20 acres. This method is also useful for the design of storm sewer systems. However, the rational method shall not be used to determine detention storage requirements.

For areas draining less than 100 acres, TR-55 is accepted by the MCSC. A hydrograph producing hydrologic model is required to determine peak runoff rates for drainage areas of 100 acres or greater. TR-20, HEC-1, or an MCSC approved hydrologic model is required for computing stormwater runoff under these conditions. These models may also be used if detention storage, depressional storage or another determination of stormwater runoff volume is anticipated. TR-20 and HEC-1 are two models that allow for the temporal variation of rainfall intensity and describe the shape of a hydrograph in a realistic manner, which would be required for the cases outlined above.

Other hydrograph producing models include HSPF, SWMM, HEC-HMS and ILLUDAS. The other types of models may or may not be accepted by the Enforcement Officer. Due to program limitations or reviewing limitations, most proprietary models are not allowed for use in the submittal for a Watershed Development Permit. However, each reviewing entity has access to all public models and these are widely accepted. It is extremely important to check with the local Enforcement Officer to determine which hydrologic technique is appropriate and acceptable for the specific site.

2.3.1.2.1 Rational Method

The rational method is an empirical runoff formula, which has gained wide acceptance because of its simple intuitive treatment of peak storm runoff rates in areas less than 20 acres. The Rational Method is useful for the design of the following drainage facilities: Storm Sewers, Inlets, Swales and Roadside Ditches, Culverts, Erosion Control Features, and Overland Flow Paths. The rational method cannot be used in situations that require the computation of stormwater runoff volumes. In particular, it should not be used to size detention, retention, or depressional storage areas.

This rational method relates stormwater runoff to rainfall intensity, surface area and surface characteristics by the formula:

$Q = C\ i\ A$

where:

Q = peak runoff rate, cfs;
C = runoff coefficient representing a ratio of runoff to rainfall for a duration equal to the time of concentration;
i = average rainfall intensity, in/hr; and
A = drainage area of the tributary to the point under consideration, acres.

Runoff Coefficient, C - The runoff coefficient, C, is a variable of the Rational Method which is least susceptible to a precise determination and provides the engineer with an opportunity to exercise independent judgment.

$C_w = A_1C_1 + A_2C_2 + A_3C_3$
$A_1 + A_2 + A_3$
where:

C_w = Weighted runoff coefficient
A_n = Sub-area "n"
C_n = Runoff coefficient for sub-area "n"

This procedure can be applied to typical "sample" areas as a guide to the selection of usual values of the coefficient for the entire area. Table 2-4 shows the runoff coefficients for the Rational Method provided in the IDOT Drainage Manual.

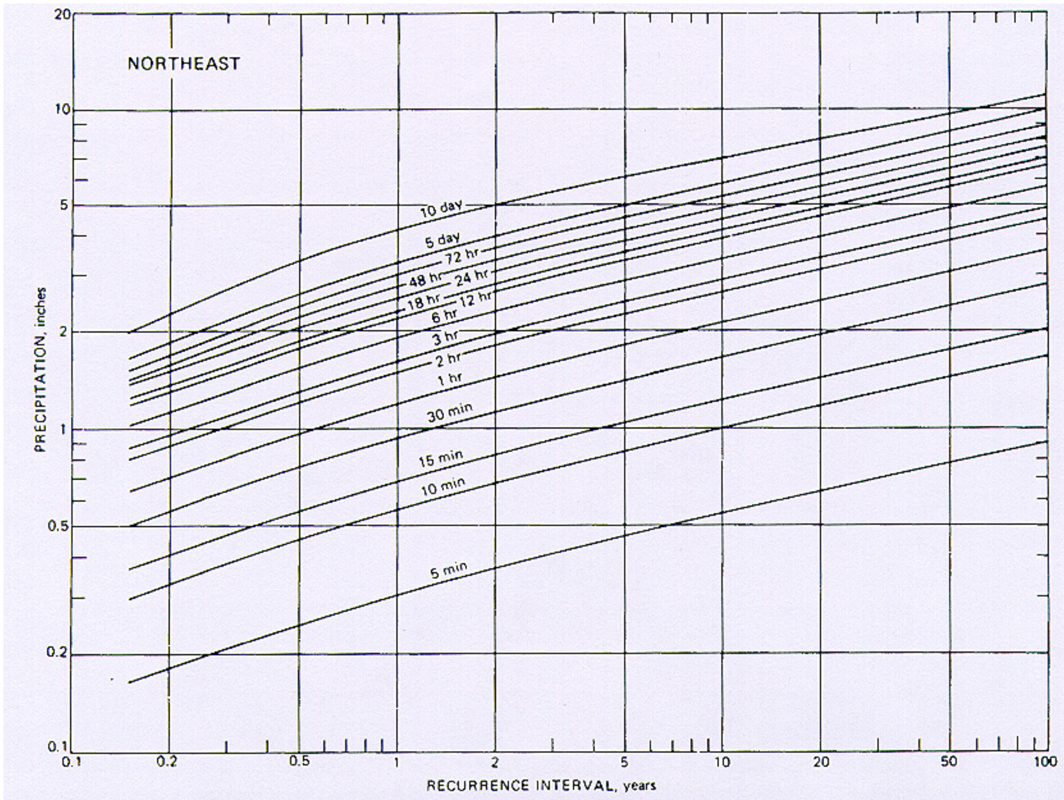
Table 2-4: Runoff Coefficients for the Rational Method

VALUES OF C = Runoff/Rainfall			RUNOFF COEFFICIENT C	
TYPES OF DRAINAGE AREA SURFACES			**MIN.**	**MAX.**
ROOFS, slag to metal			0.75	0.95
PAVEMENTS	Asphalt		0.70	0.95
	Concrete		0.80	0.95
	Gravel, from clean to loose to clayey and compact		0.25	0.70
RAILROAD YARDS			0.20	0.40
EARTH SURFACES	Sand, from uniform grain size, no fines to well graded some clay or silt	Bare	0.15	0.50
		Light Vegetation	0.10	0.40
		Dense Vegetation	0.05	0.30
	Loam, from sandy to gravelly to clayey	Bare	0.20	0.60
		Light Vegetation	0.10	0.45
		Dense Vegetation	0.05	0.35
	Gravel, from clean gravel and gravel sand mixtures, no silt or clay to high clay or silt content	Bare	0.25	0.65
		Light Vegetation	0.15	0.50
		Dense Vegetation	0.10	0.40
	Clay, from coarse sandy or silty to pure colloidal clays	Bare	0.30	0.75
		Light Vegetation	0.20	0.60
		Dense Vegetation	0.15	0.50
COMPOSITE AREAS	City, business areas		0.70	0.95
	City, dense residential areas, vary as to soil and vegetation		0.50	0.65
	Suburban residential areas, vary as to soil and vegetation		0.35	0.55
	Rural Districts, vary as to soil and vegetation		0.10	0.25
	Parks, Golf Courses, etc., vary as to soil and vegetation		0.10	0.35
LAWNS	Sandy soil, flat 2%		0.05	0.10
	Sandy soil, average 2% to 7%		0.10	0.15
	Sandy soil, steep 7%		0.15	0.20
	Heavy soil, flat 2%		0.13	0.17
	Heavy soil, average 2% to 7%		0.18	0.22
	Heavy soil, steep 7%		0.25	0.35
Note: Values of “C” for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice				

Rainfall Intensity, i Rainfall intensity, i, is the average rate of rainfall in inches per hour (in/hr). Intensity is selected on the basis of design frequency of occurrence, a statistical parameter established by design criteria, and rainfall duration. For the Rational Method, the critical rainfall intensity is the rainfall having a duration equal to the time of concentration of the drainage basin. Rainfall intensities for various return periods and durations are shown in Figure 2-8 and can also be obtained from the Illinois State Water Survey's Bulletin 70, Frequency Distributions and Hydroclimatic

Characteristics of Heavy Rainstorms in Illinois (ISWS, 1989). This document is available online at: http://www.sws.uiuc.edu/atmos/statecli/RF/rf.htm

Figure 2-8: Frequency Distributions of Rainfall for Northeast Illinois. (ISWS, 1989)



Time of Concentration, T_c One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the most hydraulically remote point of the drainage basin to the point under consideration. Time of concentration, t_c, is defined as the time it takes for runoff to travel from the hydraulically most distant part of the watershed to the point of reference. The t_c is usually computed by determining the travel time through the watershed. Several different methods currently exist for the computation of a time of concentration. Most of these methods compute the time of concentration by determining the total flow travel time considering the incremental travel times of overland (sheet) flow, shallow concentrated flow, and open channel flow. If the total t_c computed is less than 5 minutes, a minimum t_c of 5 minutes should be used. Time of concentration and curve numbers can be obtained by utilizing the worksheets in Appendix D of the TR-55 Documentation Manual.

Overland Sheet Flow The travel time can be obtained from the Manning's Kinematic Solution expressed as (NRCS, 1986):

$$t = \frac{0.007(nL)^{0.8}}{P_2^{\ 0.5}\ s^{\ 0.4}}$$

where:

t = travel time, hrs
L = overland flow length, ft
n = Manning roughness coefficient
P_2 = 2-yr, 24-hr (Bulletin 70 rainfall data)
s = average slope of flow path, ft/ft

Manning n values reported in Table 2-5 were determined specifically for overland sheet flow and are not appropriate for conventional open channel flow. The overland sheet flow travel time should be limited to 300 feet or less.

Table 2-5: Manning n for Overland Flow (NRCS, 1986)

Surface Description		**n[1]**
Smooth Surface (concrete, asphalt, gravel or bare soil)		0.011
Fallow (no residue)		0.05
Cultivated Soils	Residue Cover < 20%	0.06
	Residue Cover > 20%	0.17
Grass	Short Grass Prairie	0.15
	Dense Grasses[2]	0.24
	Bermudagrass	0.41
Range (natural)		0.13
Woods[3]	Light Underbrush	0.40
	Dense Underbrush	0.80

1. The n values are a composite of n values compiled by Engman (1986)
2. Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native mixtures.
3. When selecting n, consider cover to a height of about 0.1 foot. This is the only part of the plant cover that will obstruct sheet flow.

Shallow Concentrated Flow
Average velocities for shallow concentrated flow in rills and gutters can be obtained directly from Figure 2-9 if the slope of the segment is known. Alternate procedures for evaluating gutter flow velocities involve the use of the modified Manning's Equation as follows (IDOT Drainage Manual):

$$V = \frac{0.56\, S_x^{1.67}\, S^{0.5}\, T^{2.67}}{n\, A}$$

where:

V = flow velocity, fps
n = Manning roughness coefficient
S_x = cross slope
S = longitudinal slope, ft/ft
T = width of flow spread, ft
A = area of flow, sq ft

The time of concentration for the shallow channel flow section can be computed by dividing the length of the shallow channel flow by the computed velocity.

Main Open Channel Flow
Average velocities for main open channel flow can be evaluated using the standard Manning's equation.

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

where:
V = flow velocity, fps
n = Manning roughness coefficient
R = hydraulic radius
S = longitudinal slope

The time of concentration for the main channel flow section can then be computed by dividing the length of the main channel flow by the computed velocity. Manning n values for open channel flow may be obtained from *Open Channel Hydraulics* (Chow 1959).

2.3.1.2.2 TR-55
The Technical Release No. 55, "Urban Hydrology for Small Watersheds", TR-55 presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for detention structures. TR-55 has limited applications in McHenry County. It may be used to compute hydrographs to determine peak flows from drainage areas less than 100 acres. It may be also used in conjunction with pond routing programs such as TR-20 or HEC-1 to confirm stormwater storage requirements. TR-55 is also used to determining Runoff Curve Numbers and Times of Concentration for other hydrologic models applications. Tables 2-6 through 2-9 present Runoff Curve Numbers. Information is available for obtaining the software and support documentation by visiting the NRCS website at:
www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-tr55.html.

Figure 2-9: Average Velocities for Estimating Travel Time for Shallow Concentrated Flow (NRCS, 1986)

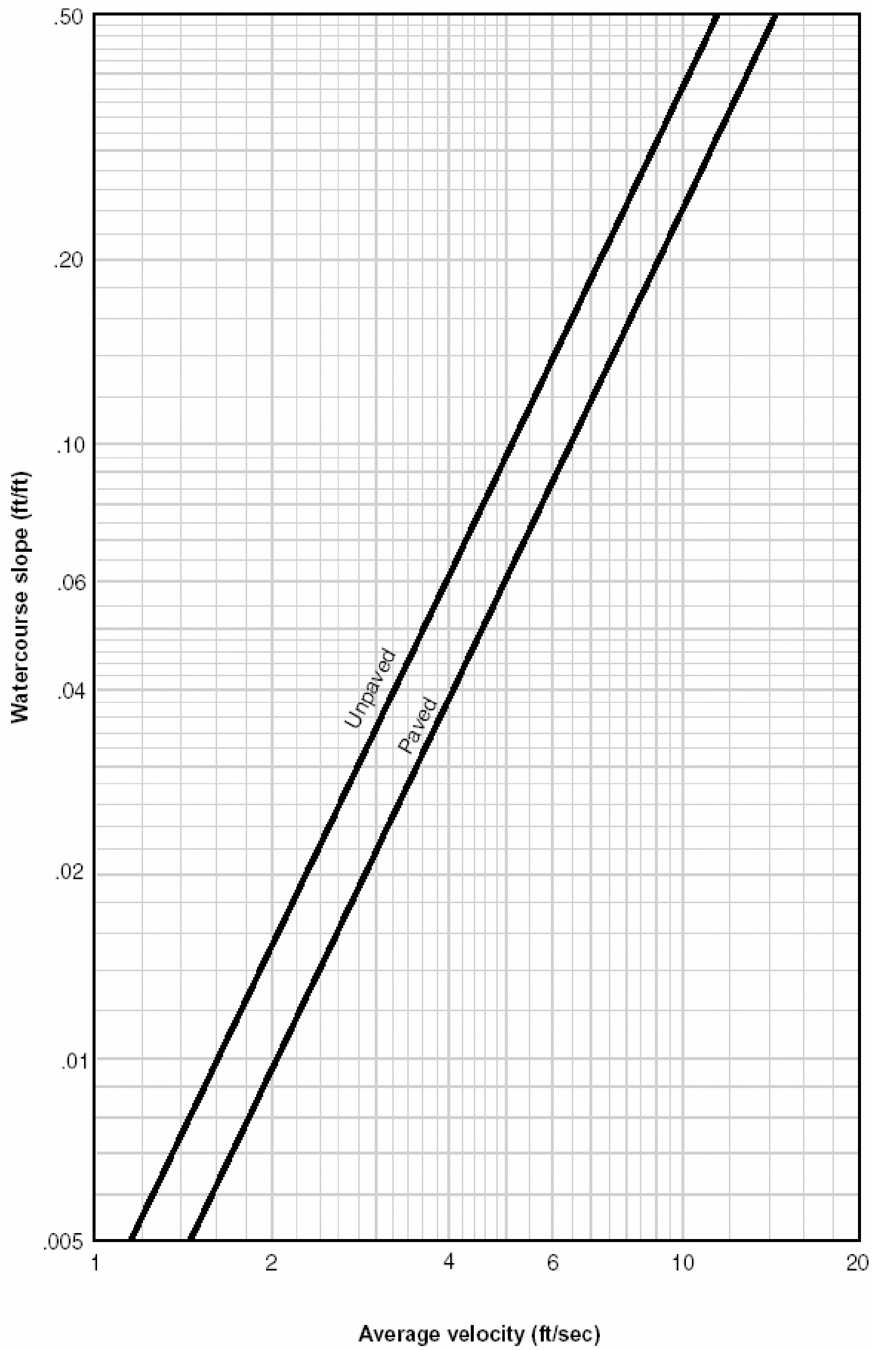


Table 2-6: Runoff Curve Numbers for Urban Areas (NRCS, 1986)

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.
[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-7: Runoff Curve Numbers for Cultivated Agricultural Lands (NRCS, 1986)

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S
[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.
[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-8: Runoff Curve Numbers for Other Agricultural Lands (NRCS, 1986)

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-9: Runoff Curve Numbers for Arid and Semi-Arid Rangelands (NRCS, 1986)

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2]	A [3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

2.3.1.3 Hydrologic Models

In hydrologic models, the transformation from rainfall excess to streamflow is accomplished either through unit hydrograph or kinematic wave routing procedures. These procedures allow hydrograph analysis concepts to be applied to watersheds through the development and application of generalized functions for estimating the amount of precipitation lost due to interception and infiltration, the unit hydrographs, and base flow.

The unit hydrograph is usually assumed to give a unique relationship between rainfall excess and surface runoff for a basin regardless of storm size, losses, or other factors. The unit hydrograph approach is currently used the most frequently. However, other methods of hydrograph generation are also becoming widely used, such as the kinematic wave approach to basin modeling. In addition to the software models providing important hydrologic information, the results are frequently utilized in the hydraulic analysis. Refer to Section 2.4 of the TRM for a discussion of available hydraulic programs.

A brief description of the different hydrologic models is provided below to assist in the selection process and obtain an understanding of their particular applications. Additional information is available by consulting the specific source for each of the programs. Certain programs have inherent problems or limitations. In addition, some communities do not recognize certain programs because that community does not possess or is not familiar with the program. The Enforcement Officer should be contacted first to verify acceptable methods for hydrologic modeling.

2.3.1.3.1 HEC-1

The Flood Hydrograph Package, HEC-1, was developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC). The model is designed to simulate the surface runoff response of a drainage basin to a given precipitation input for a single stormwater runoff event. The model represents the basin as an interconnected system of hydrologic and hydraulic components. Each component models an aspect of the precipitation-runoff process within a portion of the basin, commonly referred to as a subbasin. A component may represent a surface runoff entity, a stream channel, or a reservoir. Representation of a component requires a set of parameters that specify the particular characteristic of the component and mathematical relations that describe the physical process. The result of the modeling process is the computation of streamflow hydrographs at desired locations in the river basin. Information is available for obtaining the software and support documentation by visiting the US Army Corps of Engineer's website at: http://www.hec.usace.army.mil

Other hydrograph producing models include HSPF, SWMM, HEC-HMS and ILLUDAS. The other types of models may or may not be accepted by the Enforcement Officer. Due to program limitations or reviewing limitations, most proprietary models are not allowed for use in the submittal for a Watershed Development Permit. However, each reviewing entity has access to all public models and these are widely accepted. It is extremely important to check with the local Enforcement Officer to determine which hydrologic technique is appropriate and acceptable for the specific site.

2.3.1.3.2 HEC-HMS

The Hydrologic Modeling System (HEC-HMS) is a derivative of the HEC-1 performing similar calculations within a graphical context and covering a variety of precipitation and runoff processes. The precipitation modeling provides options to include historical or hypothetical storm event data or a specific weighted gage method. The basin modeling may be performed in a linear or consolidated manner utilizing various methods to determine losses including NRCS Curve Number. The modeling can analyze by either Kinematic Wave or unit hydrograph methods. One caution regarding this program is related to sharing the output files. Special care needs to be taken when providing the output files to ensure that the file path is properly defined in order for the reviewer to access the file. A disk of the input and output files will need to be submitted.

Information is available for obtaining the software and support documentation by visiting the U.S. Army Corps of Engineers website at: http://www.hec.usace.army.mil.

2.3.1.3.3 TR-20

The Technical Release No. 20, "Computer Program for Project Formulation - Hydrology", TR-20 was originally developed by the USDA, Natural Resources Conservation Service (NRCS) and has been modified by the NRCS and other groups. One advantage to this program is the capability to perform multiple storm events in a single computer run. TR-20 uses the procedures described in the NRCS National Engineering Handbook, Section 4, Hydrology (NEH-4), except for the newly revised reach routing procedure (Att-Kin method) which has superseded the Convex method. Information is available for obtaining the software and support documentation by visiting the NRCS website at:
http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-tr20.html

2.3.1.3.4 HSPF

The Hydrologic Simulation Program - Fortran (HSPF) developed by the U.S. Environmental Protection Agency performs continuous simulation of water quantity/quality processes of the hydrologic cycle. Due to the potential for massive data manipulation, HSPF software is planned around a time series management system operating on direct access principles. The program represents the components of the hydrologic cycle that affect streamflow. Rainfall, snowfall and snowmelt, infiltration, soil moisture storage, evapotranspiration, surface runoff, interflow, and ground water flow are represented mathematically by parameters characterizing watershed conditions. The system is designed so that the various simulation subroutines can be invoked conveniently, either individually or in tandem.

2.3.1.3.5 SWMM

Under the sponsorship of the U.S. Environmental Protection Agency (EPA), a comprehensive mathematical model capable of representing urban storm water runoff and combined sewer overflow phenomena was developed, named the Storm Water Management Model (SWMM). SWMM simulates the runoff of a drainage basin for any prescribed rainfall pattern. A total watershed is segmented into a number of smaller basins or subcatchments that can be readily described by its hydraulic or geometric properties. Manning's equation is used to route the excess uniform rainfall across overland surfaces, and through gutters, pipes and streams. SWMM is generally used for modeling drainage from urban areas served by storm sewers. The SWMM model simulates both water quantity and quality aspects that are associated with urban runoff and combined sewer systems.

2.3.1.3.6 ILLUDAS

The Illinois Urban Drainage Area Simulator (ILLUDAS) was developed by the Illinois State Water Survey using the method initially developed by the British Road Research Laboratory. ILLUDAS uses an observed or specific temporal rainfall pattern uniformly distributed over the basin as the primary input. The basin is divided into subbasins, which is commonly located at a design point. Paved-area and grassed-area hydrographs are produced from each subbasin by applying a rainfall pattern to the appropriate contributing areas. ILLUDAS was developed for use with drainage basins served by storm sewers.

2.3.1.4 Design Rainfall

The rainfall depths listed in Table 13 of Illinois State Water Survey (ISWS) Bulletin 70 rainfall shall be used for all hydrologic analyses. Table 2-10 lists the Bulletin 70 rainfall depths for various durations and recurrence intervals for the Northeastern Region of Illinois. When designing for storage volume the 24-hour duration must be used.

Table 2-10: Bulletin 70 Rainfall Depths (ISWS, 1989)

Duration	Frequency						
	1-year	**2-year**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
5 min	0.30	0.36	0.46	0.54	0.66	0.78	0.91
10 min	0.55	0.67	0.84	0.98	1.21	1.42	1.67
15 min	0.68	0.82	1.03	1.21	1.49	1.75	2.05
30 min	0.93	1.12	1.41	1.65	2.04	2.39	2.80
1 hour	1.18	1.43	1.79	2.10	2.59	3.04	3.56
2 hour	1.48	1.79	2.24	2.64	3.25	3.82	4.47
3 hour	1.60	1.94	2.43	2.86	3.53	4.14	4.85
6 hour	1.88	2.28	2.85	3.35	4.13	4.85	5.68
12 hour	2.18	2.64	3.31	3.89	4.79	5.62	6.59
18 hour	2.30	2.79	3.50	4.11	5.06	5.95	6.97
24 hour	2.51	3.04	3.80	4.47	5.51	6.46	7.58
48 hour	2.70	3.30	4.09	4.81	5.88	6.84	8.16
72 hour	2.93	3.55	4.44	5.18	6.32	7.41	8.78
120 hour	3.25	3.93	4.91	5.70	6.93	8.04	9.96
240 hour	4.12	4.95	6.04	6.89	8.18	9.38	11.14

2.3.1.5 Design Runoff Rate

Peak runoff rates will be used to design for conveyance capacity in the stormwater system. For drainage areas less than 100 acres, peak runoff rates shall be based on either the critical duration storm, or the 24-hour NRCS (SCS) Type II distribution. For drainage areas greater than 100 acres, peak runoff rates shall be based on critical duration storms. The critical storm duration evaluates a single frequency or a series of frequency storms by comparing the peak flows for the 1-, 3-, 6-, 12-, 18-, 24-, 48-, 72-hour storm events. The greatest flow for a specific frequency and duration is considered the critical storm.

The Huff Distributions are recommended for distribution of rainfall. These distributions were obtained from the ISWS Circular 173, Time Distribution of Heavy Rainstorms in Illinois (Huff, 1990) Circular 173 is available online at: http://www.sws.uiuc.edu/atmos/statecli/RF/circular173.htm

Table 2-11 lists the First, Second, Third, and Fourth Quartile Huff distributions for drainage areas less than 10 square miles, 10 to 50 square miles, and 50 to 400 square miles. The distributions are listed as cumulative rainfall as a function of time. The distributions are recommended for use as follows:

Duration ≤ 6 hours	1st Quartile
6 hours < Duration ≤ 12 hours	2nd Quartile
12 hours < Duration ≤ 24 hours	3rd Quartile
Duration > 24 hours	4th Quartile

Table 2-11: Huff Quartiles for Time Distribution of Heavy Rainfall

Cumulative Percent of Storm	Drainage Area under 10 Square Miles				Drainage Area 10 to 50 Square Miles				Drainage Area 50 to 400 Square Miles			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
05	16	03	03	02	12	03	02	02	08	02	02	02
10	33	08	06	05	25	06	05	04	17	04	04	03
15	43	12	09	08	38	10	08	07	34	08	07	05
20	52	16	12	10	51	14	12	09	50	12	10	07
25	60	22	15	13	62	21	14	11	63	21	12	09
30	66	29	19	16	69	30	17	13	71	31	14	10
35	71	39	23	19	74	40	20	15	76	42	16	12
40	75	51	27	22	78	52	23	18	80	53	19	14
45	79	62	32	25	81	63	27	21	83	64	22	16
50	82	70	38	28	84	72	33	24	86	73	29	19
55	84	76	45	32	86	78	42	27	88	80	39	21
60	86	81	57	35	88	83	55	30	90	86	54	25
65	88	85	70	39	90	87	69	34	82	89	68	29
70	90	88	79	45	92	90	79	40	93	92	79	35
75	92	91	85	51	94	92	86	47	95	94	87	43
80	94	93	89	59	95	94	91	57	96	96	92	54
85	96	95	92	72	96	96	94	74	97	97	95	75
90	97	97	95	84	97	97	96	88	98	98	97	92
95	98	98	97	92	98	98	98	95	99	99	99	97

2.3.1.6 Hydrologic Analysis

The hydrologic conditions are analyzed for the existing and proposed conditions as an integral part of the stormwater management for the site. This section will provide guidelines for the steps involved in the analysis, direction for various issues that may be encountered and outline a format for the analysis. Hydrologic conditions are modeled to represent the land use of the basin on-site and off-site tributary areas for both the existing and proposed conditions.

2.3.1.6.1 Existing Conditions Model

Information for existing conditions is typically obtained from a combination of topographic maps, aerial photographs, and field reconnaissance. Information for future land use conditions can be computed from municipal zoning maps, land use maps, and the McHenry County Comprehensive Land Use Plan.

Runoff calculations for all offsite tributary area shall be based on either anticipated future land use conditions or existing land use conditions. Anticipated future land use conditions will be based on future land use and existing offsite storage facilities. Existing land use conditions will be based on existing land use and existing offsite storage facilities.

In determining site drainage patterns, the tributary area, time of concentration, runoff curve number, discharge elevation and the amount of discharge should be provided for each subbasin. Information of existing detention facilities or depressional storage areas should include normal, high and base flood elevations and the amount of discharge for the various storm events under consideration. Peak runoff rates shall be based on critical storm duration analysis for drainage areas greater than or equal to 100 acres. For drainage areas less than 100 acres, peak runoff rates shall be based on either the critical storm duration analysis, or the 24-hour NRCS Type II rainfall distribution. A general rule is that the critical storm duration should occur approximately the same time as the time of concentration for the site. For sites that anticipate having an area that would remain undisturbed, the existing model should be divided and analyzed into subbasins. The undisturbed area should be included in a separate subbasin in order to analyze the flows under the proposed conditions.

2.3.1.6.2 Proposed Conditions Model

The proposed condition should maintain the runoff onto and through the site without causing negative impacts for the range of storm frequencies. Therefore, the drainage analysis should provide a comparison of the existing and proposed flows.

In order to allow the runoff to pass through the proposed site, on-stream detention provisions of the SMO must be addressed. In general, the runoff from off-site flows needs to be evaluated to ensure that the additional runoff is properly conveyed through the site and that adequate downstream capacity exists at the outlet.

2.3.2 Release Rates and Discharges

The SMO defines release rate requirements for intermediate and major and some public road developments. The release rate is effective in controlling the base floods, reducing negative impacts downstream and reducing overall flooding conditions for storm events less than and equal to the 100-year event. The 2-year release rate is effective in controlling the magnitude and frequency of bank full streamflow conditions downstream of the property. The 2-year release rate also provides water quality benefits by allowing time for suspended stormwater pollutants to settle out and be removed from the runoff.

The primary runoff management performance standards of the SMO are:

- Control the cumulative future land use conditions stage increase and the cumulative future land use conditions flow increase in the 100-year event.
- Control the cumulative future land use conditions stage increase and the cumulative future land use conditions flow increase in the 2-year event.

2.3.2.1 Allowable Release Rates

The flow draining from the site in the 100-year event is limited to a maximum rate of 0.15 cubic feet per second (cfs) per acre. In other words, the maximum outflow from the site in cubic feet per second is the total drainage area of the site multiplied by 0.15. Any flow above the maximum release must be stored on the site or the site must be designed with sufficient infiltration capacity such that the maximum allowable flow is never exceeded for up to and including the 100-year event. Similarly, the maximum allowable flow in the 2-year event is 0.04 cfs per acre. These release rates apply to the hydrologically disturbed area of the ownership parcel. Undeveloped and undisturbed areas of the site that are not tributary to the stormwater management system do not need to be included in the release rate or detention basin computations. The enforcement officer shall review all areas that are to be preserved and approve their removal from the detention computations. This ensures that there is no penalty for preserving open space areas.

The SMO regulates the release rates for a site as the primary means to manage the stormwater. The use of detention facilities is typically the most effective measure used to control the release rate. However, when taking a holistic approach to manage the stormwater, other important aspects should be considered. One factor that influences the overall release rate is on-site flows that are not tributary to the detention basin. These flows are considered unrestricted on-site flows. The proposed grading plans are useful for clearly indicating the direction of flow for the hydrologically disturbed areas. Any hydrologically disturbed areas discharging from the site undetained should be included in the proposed total release rate from the site. If there is no other alternative for detaining these flows, then the detention basin may be oversized such that the cumulative flow from the site meets the allowable release rate, or a developer may apply for fee-in-lieu of detention for the undetained areas. Over-detaining the detention basin typically is required to account for undetained flows from the site.

2.3.2.2 Watershed Specific Release Rates

If the MCSC adopts a Basin plan that includes more restrictive release rates than the rates indicated above, those release rates in the adopted Basin plan shall prevail.

At present, there are no watershed specific release rates to be considered.

2.3.2.3 Existing Conditions Release Rates

If the existing peak discharges from the site are at a rate less than 0.04 cfs/acre for the 2-year storm, or 0.15 cfs/acre for the 100-year storm, then the proposed release rate from the developed site may not exceed the existing conditions release rate.

2.3.2.4 Concentrated Stormwater Discharge

2.3.2.4.1 Downstream Stormwater Capacity

All concentrated stormwater discharges leaving a site must be conveyed into an existing channel, storm sewer, or overland flow path with adequate downstream stormwater capacity and will not result in increased erosion, flood damage or other drainage hazard.

All points where runoff exits the site must be identified, including point discharges as well as diffused overland flow. The discharge points must be assessed for their susceptibility to water damage. Downstream conveyance paths must be capable of safely passing the design flow without damaging adjacent property. In general, if existing drainage patterns have been retained, and discharge rates have not been increased, the flow from the site will probably not cause damage to the adjacent property. If these conditions are not met, then the developer should demonstrate that the proposed discharge will not affect adjacent properties adversely. Increased flow rate or velocity should be confined to a downstream drainage easement reaching from the development to a downstream existing drainageway. If concentrated flow is discharged to an existing overland flow path, energy dissipation and permanent erosion control features must be used to protect adjoining properties from erosion and sedimentation.

2.3.2.4.2 Discharge to Field Tile

Stormwater systems shall properly incorporate and be compatible with existing subsurface and surface drainage systems including agricultural systems. Existing subsurface drain tile systems shall only be used for the conveyance of low flow ground water and nuisance flow releases. Designs shall not cause damage to the existing drainage system(s) or the existing adjacent or tributary land including those with agricultural uses. Agricultural subsurface and surface drainage systems shall be evaluated with regard to their capacity and capability to properly convey low flow groundwater and nuisance flow release without damage to downstream drainage systems and land use on the adjacent property. If the outfall drain tile and surface drainage systems prove to be inadequate, it will be necessary to modify the existing systems or construct new systems, which will not conflict with the existing systems and will not impact the existing agricultural land use.

Concentrated stormwater discharge shall not be connected to an existing field or any other drainage tile system unless the applicant submits a maintenance agreement, recorded easement and a report that indicates the existing system from the connections to the discharge point in an open channel has adequate hydraulic capacity and structural integrity. The recorded easement and maintenance agreement must extend from the connection to the discharge point *in an open channel. The recorded easement and maintenance agreement must be approved by the MCSC chief engineer prior to issuance of a Watershed Development Permit.*

2.3.2.5 Inter-Basin Transfer

Inter-basin transfer is best avoided by ensuring that existing drainage patterns are not altered. Inter-basin transfer of water will not be allowed unless no reasonable alternative exists as determined by the Enforcement Officer. It may be considered in certain cases. For example, when localized flooding occurs adjacent to a proposed site, the development may be designed to provide relief to the existing drainage problem. If inter-basin transfer is proposed, it will be necessary to calculate flows and hydraulic grade lines on all affected waterways to demonstrate that there are no adverse impacts of the proposed modification.

2.3.2.6 Compensatory Storage for Depressional Area

Compensatory storage, that is required due to the proposed filling of a depressional storage area, shall be maintained on-site or added to the required on-site detention volume. This combined volume shall be released at a rate no greater than the release rates specified in the SMO.

Compensatory storage for depressional areas that are filled shall be at least equal to the storage volume replaced.

2.3.3 Detention Facility Design

Detention basins are the most conventional method used to reduce runoff volume and control the peak discharge from new developments. Detention basins temporarily store runoff from a site and release it at a controlled rate. In addition to reducing peak flow rates, detention basins are an economical means of mitigating problems associated with flooding, pollution, soil erosion and siltation.

Detention basins are constructed depressions with their discharge sufficiently restricted to store stormwater and gradually release it to the downstream drainage system. Detention basins can also provide water quality improvement. A detention facility that is designed, installed and maintained properly can function effectively to provide hydrologic and ecologic benefits. This section will discuss the various types of detention facilities, provide design guidelines for the numerous components and discuss special conditions for floodplain locations and on-stream detention

Detention will only be required for projects that involve the creation of more than 20,000 square feet of new impervious area.

2.3.3.1 Determining Detention Volumes

There are two methods that may be used when determining the volume for a detention facility. These are the unit area detention method, and the hydrograph method. The unit area detention method employs the use of a Detention Volume vs. Percent Impervious Chart developed by the Northeastern Illinois Planning

Commission (NIPC). The hydrograph method, which may be used for all watersheds, employs the use of a hydrograph-producing model (or method) as described earlier. The two methods are explained below.

2.3.3.1.1 Unit Area Detention Method

The unit area detention method involves the use of a chart, which relates detention volume to the percent impervious of the site, to determine the required detention volume. This chart, shown in Figure 2-10, was developed by the Northeastern Illinois Planning Commission in their publication, Investigation of Hydrologic Methods for Site Design in Northeastern Illinois (Dreher and Price, 1991). The following requirements must be met in order to use the unit area detention method:

(1) The drainage area tributary to the detention facility is less than 10 acres.

(2) All runoff from the drainage areas tributary to the proposed detention facility is required to be stored at the allowable 2-year and 100-year release rates of 0.04 cfs/acre and 0.15 cfs/acre, respectively.

(3) Adequate downstream capacity exists for the site with 2-year and 100-year release rates of 0.04 cfs/acre and 0.15 cfs/acre, respectively.

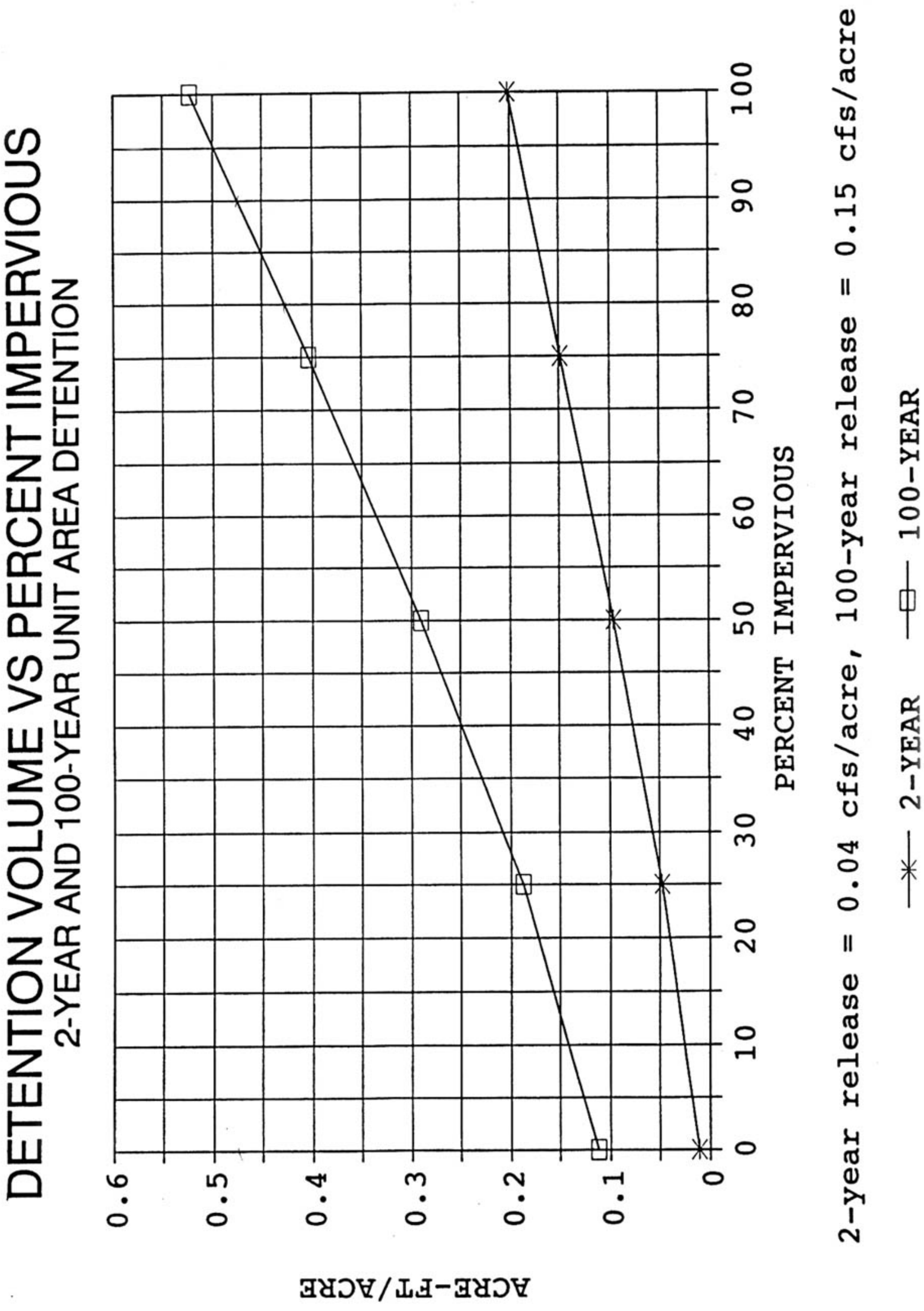
The following procedure should be followed when determining detention volumes based on the unit area detention method:

(1) The first step is to compute the design area of impervious cover for the hydrologically disturbed area of the proposed site or the area of the ultimate build out. For the purpose of these curves, the impervious surface area shall be defined as any hard-surfaced, man made area that does not readily absorb or retain water, including but not limited to building roofs, parking and driveway areas, graveled areas, sidewalks and paved recreational areas. Supporting calculations and a schematic should be provided with the submittal.

(2) Having the detention volumes and the impervious percentage computed in Step (1), the unit area detention volume can be obtained directly from the NIPC curves. Detention volumes for the 2-year and 100-year events are then computed by multiplying the design hydrologically disturbed drainage area by the unit detention volume.

(3) The detention basin outlet structure is then designed such that the basin is releasing 0.04 cfs/ac when the basin is at the elevation of the 2-year detention volume, and releasing 0.15 cfs/ac when it is at the elevation of the 100-year detention volume. The outlet structure can be designed using the appropriate weir, orifice or pipe flow equation.

Figure 2-10: Unit Area Detention Volume (NIPC, 1991)



In summary, the NIPC curve method should only be applied to simple hydrologic conditions of areas less than 10 acres as described above. On more complex sites, the hydrograph method should be used.

2.3.3.1.2 Hydrograph Method

For more complex sites, and for sites with a tributary area greater than 10 acres draining to the detention basin, the hydrograph method is used to determine the required storage volume. The hydrograph method generates an inflow hydrograph and then routes the hydrograph through the detention facility using a flood routing procedure. Several flood routing procedures are available in published texts and computer models. One method that is commonly used is called the Modified Puls Method. The data that is required to analyze a proposed detention facility include:

(1) An inflow hydrograph to the pond that represents the appropriate land use as recommended in this section.

(2) A stage-storage-discharge curve that represents the proposed outlet structure and pond configuration.

Using the above information, the inflow hydrograph can be routed through the proposed detention facility using a flood routing procedure to determine if the release rate requirements are being met for the 2-year and 100-year storms. A critical storm duration analysis will be required to determine the storm that produces the greatest need for storage to achieve the required release rates. Additional storms should be routed through the detention facility to obtain a full range of operation. The additional storms include durations of 1-, 3-, 6-, 12-, 48-, 72-, 120- and 240-hours. The output results confirm the maximum detention volume required to achieve release rates for the 2-year and 100-year events. This hydrologic model represents the regulatory run based on the hydrologically disturbed area.

A second hydrologic model reflects the actual proposed conditions. The second run models emergency spillway flows and elevations, top of berm elevations, proposed outlet restrictor sizes, established floodplain elevations and includes off-site flow conditions.

2.3.3.2 Design Guidelines for Detention Basins

Many detention basins in northeastern Illinois presently are not designed for water quality benefits, although some achieve pollutant removal unintentionally. For the purpose of controlling runoff rates, both wet detention basins and dry detention basins can be effective. However for reducing runoff pollutant loads, wet (or wetland) detention basins are considerably more effective than conventional dry detention basins.

Traditional dry detention basins are intended to completely drain and retain no water between storms. Wet detention basins are designed with a permanent pool of water over the bottom of the basin that is typically four to ten feet deep. Wetland detention basins may be dry over a portion of the bottom area, but typically include a shallow marsh near the outlet structure. Wetland detention basins, therefore, retain water and are vegetated with native wetland plants.

Detention basins may be multiple use facilities that provide pollutant removal and aesthetic amenities in a permanent pool or wetland area, active recreational space in predominantly dry areas, and flood control over the entire drainage basin.

A variety of combinations of these three detention basin types are possible. For example, rather than combining a wetland with a partially dry detention basin, the low area could be designed similar to a wet detention basin. Another option is to incorporate a stormwater wetland into a predominantly deeper wet basin. Although each detention basin design will vary slightly or, as mentioned above, will be a combination of several types, general design guidelines apply to the various types of basins. Some design issues relate to all of the various types of basins and are discussed below.

Wet Basin Depths – Wet detention basins have a permanent pool of water over all or most of the bottom of the basin. If the pond serves as a sediment basin, additional volume (live storage) is required to provide for sediment deposits during construction. If it is desirable to keep fish in the pond, the following considerations should be made:

1. A minimum of 25 percent of the pond area should be 10 feet deep to prevent winterkill.

2. The area of the pond that is much greater than 10 feet deep should be minimized to prevent thermal stratification and the development of an oxygen deficient zone.

Drainage for Combination Wet/Dry Basins– When combination wet/dry basins are proposed, the dry portion of the basin should be designed to be drained in 72 hours or less following the 100-year event. Plans shall distinguish the areas of the basin that are intended to be dry.

Inlet and Outlet Orientation - All detention basins should be configured to prevent short-circuiting directly from the inlet to the outlet. Recommendations to accomplish this include:

> **Length to Width Ratio** - Construct the outlet as far as possible from the inlet. Provide a flow path at least 3 times longer than the average basin width. This can be accomplished with a basin length to width ratio of 3:1, or using berms to direct inlet flows away from the outlet.
>
> Do not provide a low-flow channel system, including paved low-flow channels. To achieve pollutant removal objectives, it is critical that low flows

and the "first flush" of storm runoff pass through the basin with adequate opportunities for pollutant filtering and settling.

When an inlet and outlet are relatively close, an earthen berm should be installed to redirect the flows into the center of the basin and increase the overall flow path of the inflow.

Side Slopes - *The side slopes at the shoreline of wet and wetland detention basins (from at least 6 inches below to at least 6 inches above normal water level) shall be no steeper than 10:1 to prevent shoreline erosion due to wave action and fluctuating water levels.* To provide a more natural appearance and improve plant habitat for a wetland fringe, flatter (and variable) side slopes (i.e., 6:1 to 10:1 or flatter) may be used and extended to at least one foot below normal water level. *Above the shoreline areas, or in dry bottom portions, the maximum side slope shall be 4:1* or flatter to improve safety, allow maintenance access, facilitate establishment of bank vegetation, and prevent slumping during draSMOwn.

Safety Shelf - *A safety shelf with a minimum eight foot width shall be constructed no more than one foot below normal water level.* The safety shelf combined with the gentle shoreline slopes will create a broad littoral zone favorable to wetland and aquatic vegetation and provide a measure of safety by deterring small children from entering the deeper water of the basin. To emulate a natural wetland, the littoral zone should cover 30 percent to 35 percent of the pond's surface area. The slope within the pond beyond the safety ledge should not exceed 4H:1V.

Bank Erosion Protection - *The shoreline of wet detention basins shall be protected from erosion. The preferred method of shoreline stabilization is native wetland and wet prairie vegetation with deep root systems to stabilize the soils*. Shallow water entry angles, as discussed above under side slopes, will create a broad emergent vegetation zone that will absorb wave energy and minimize erosive forces.

Off-site Flow – *Off-site flow may be diverted around a proposed detention facility provided that the other applicable standards regarding Regulatory Special flood hazard area areas are met.* When diverting off-site flows, the bypass structure should be sized to safely convey the peak 100-year discharge.

Dam Permit – Whenever a development involves the construction, modification or removal of a dam as defined in 17 Ill. Adm. Code 3702 (Rules for Construction of Dams), the applicant shall obtain a Dam Safety Permit or a letter indicating that a permit is not required from the Illinois Department of Natural Resources/ Office of Water Resources. A dam is defined as all obstructions, wall embankments or barriers, together with their abutments and appurtenant works, if any, constructed for the purpose of storing or diverting water or creating a permanent pool. The requirement for a dam permit depends upon the total tributary drainage area, the height of the dam, and the impoundment capacity.

Floodplain/Flood Prone Construction– *Berms for stormwater infiltration, retention and detention facilities shall not be constructed in a Regulatory Floodplain or a flood prone area unless approved by the MCSC Chief Engineer in a non-certified community or the enforcement officer in a certified community.* All construction must meet the requirements of the Floodplain Management section of the SMO. Compensatory storage for regulatory floodplain impacts should not be provided in the detention facility unless approved by the MCSC. If compensatory storage must be provided in the detention facility, then the compensatory storage volume must be in addition to the required detention volume and be available at the appropriate storage interval.

Depressional Storage Volume - Depressional storage volume should be added to the 2-year detention storage volume. Existing depressional storage volume shall be no more than the volume at an elevation 0.5 feet above the overflow elevation or the volume during the critical duration storm event.

Low-Flow Bypass – Low flow bypass structures such as concrete channels or pipes shall not be used in detention basins. Underground drains such as tile systems are not considered low-flow bypass structures as long as they have no surface inlets and discharge to the detention control structure.

2.3.3.3 Detention Basin Outlet Design

The outlet structure in a detention facility serves to discharge the floodwaters at the design release rates. The size, type and configuration of the outlet structure are dependent on several factors such as storage configuration, stormwater inflows, environmental constraints, maintenance and release rates. Most outlets for runoff control are either v-notch weir or multiple orifices, but many are constructed weirs, grated box openings, or storm sewers. There are numerous outlet configurations that may be used to meet the performance standards of the SMO.

The SMO requires that when a single pipe outlet is to be used to discharge, it should have a minimum inside diameter of **12 inches**. Maintenance of outlets smaller than 12 inches is likely to be a problem. If design release rates call for outlets smaller than this, release structures such as perforated risers or flow control orifices should be used. A minimum diameter of **4 inches** should be used for flow control orifices.

Numerous types of outlet structures can be used to achieve the two-stage release discussed above. Outlet structure designs should consider clog protection, winter frost conditions and hydraulic control. Clog protection can be achieved through a variety of measures, including:

- Low maintenance orifice restrictors
- Submerged orifices in permanent pools
- Perforated risers with gravel filters

- Trash Racks

The main steps required for the design of a detention basin outlet are:

- Calculation of the proposed conditions flood hydrograph
- Design of storage and outlet for the 2-year storm
- Design of storage and outlet for the 100-year storm

The 2-year outlet should be designed first because it is used to convey a portion of the 100-year flow. Once the configuration for the 2-year storage and outlet structure is developed, the 100-year storage and outlet structure may be designed. Depending on the geometry of the outlet structure, discharge for various headwater depths can be controlled by the inlet crest (weir control), the riser or barrel opening (orifice control), or the outlet pipe (pipe control). Each of these flow controls shall be evaluated when determining the rating curve of the principal outlet. In general, outlet structures can be designed using weir, orifice, or pipe flow conditions. The general form of each equation follows:

2.3.3.3.1 Weir Design

Weir flow may be computed by the following equation:

$Q_w = C\ L\ H^{3/2}$
where:
Q_w = discharge, cfs
C = weir coefficient (typical range 2.5-3.0)
L = length of the weir, ft
H = the depth of flow over the weir crest, ft
The weir coefficients (C) for various weir configurations, and levels submergence can be found in most hydraulic handbooks. One source that can be used is the Handbook of Hydraulics by Brater and King (Brater and King, 1976).

2.3.3.3.2 Orifice Design

Orifice flow may be computed by the following equation:

$Q_o = C\ A\ (2\ g\ H)^{1/2}$
where:

Q_o = discharge, cfs
C = orifice coefficient (for circular orifices < 2ft. use 0.60)
A = cross-sectional area of the pipe, ft ^{2}
g = acceleration of gravity, 32.2 ft/sec ^{2}
H = head across the orifice, ft (from center line orifice)
D = orifice diameter, ft

The orifice coefficient (C) for various orifice sizes and shapes can be found in most hydraulic handbooks. One source that can be used for orifice coefficients is the Handbook of Hydraulics by Brater and King (Brater and King, 1976).

2.3.3.3.3 Pipe Design

There are several methods available for the computation of flow in a pipe. These procedures usually involve the computation of pipe friction and minor head losses over the length of the pipe. The following formula, which uses the Manning's equation for pipe friction losses, may be used to compute pipe flow:

$$Q = A[\ (2gH)/(k_b + k_{en} + k_{ex} + k_f)\ ]^{1/2}$$

where:
Q = discharge, cfs
A = cross-sectional area of the pipe, ft^2
g = acceleration of gravity, 32.2 ft/sec^2
H = the difference between headwater and tailwater, ft
k_b = bend loss coefficient
k_{en} = entrance loss coefficient
k_{ex} = exit loss coefficient
k_f = friction loss coefficient = $\frac{185\ n^2}{D^{4/3}}$
n = Manning roughness coefficient
D = diameter of pipe, ft
L = length of pipe, ft

The minor loss coefficients (k_b, k_{en}, and k_{ex}), and Manning roughness coefficients (n) can be found in most hydraulic handbooks. One source that can be used for these coefficients is the Handbook of Hydraulics by Brater and King (Brater and King, 1976).

2.3.3.3.4 Downstream Capacity

The release rate for a site may need to be reduced beyond the regulated release rate when the capacity of the downstream receiving channel is inadequate to accept the flows from the site. When the downstream receiving channel is able to convey stormwater runoff up to and including the 100-year storm event, then there is adequate downstream capacity. The impact to the downstream receiving channel shall not increase the risk or damage to adjacent property owners. The downstream capacity needs to be evaluated at the outflow structure and the downstream receiving system. The applicant should discuss the anticipated outlet location with the local agencies to verify the existing drainage capacity and identify any areas with sensitive drainage conditions.

The historic flood maps and FIRM maps may be a good indication of potential problems. The storm sewer information downstream of the site should be reviewed to determine the capacity of the existing system. If an existing sewer system were designed for the 5-year or 10-year storm, the system would be surcharged with a tailwater effect. For urban cross sections, the design capacity of the storm sewer system should also be determined. Area contour maps often indicate whether a safe overflow path exists downstream of the site. Once the various data is collected for a site, a field visit should be performed to confirm the accuracy of the data and identify any potential concerns or issues that may not be readily apparent.

2.3.3.4 Emergency Overflow

The SMO requires that *all stormwater infiltration, retention, and detention facilities shall have an emergency overflow structure or path that is capable of passing inflow from a 100-year storm without damages to structures or property.* The emergency overflow weir should be designed for a minimum depth of one foot or the depth required to pass the 100-year peak inflow, whichever is greater. The 100-year inflow rate used to design the emergency overflow structure should be based on the peak offsite and onsite flows that are tributary to the detention pond. When computing the 100- year peak inflow rates used to design the emergency overflow, the following guidelines should be followed:

- The hydrologic method and parameters used to compute the onsite and offsite flows tributary to the detention facility should be based on the performance standards in the SMO.

- The inflow rates at each detention facility where an emergency overflow spillway is being designed should be based on the outflow of any upstream onsite detention facility plus the offsite flow bypassed around the upstream detention facility, plus any other direct inflow into the detention facility in which the emergency spillway is being designed.

- If additional storage is to be provided above the design 100-year elevation in a detention facility, the emergency overflow structure can be sized by routing a second 100-year event through the pond. The routing will be based on the storage volumes above the 100-year elevation and should be performed for the critical duration storm event.

- The position, profile, and length of the spillway are influenced by geologic and topographic features of the site. The cross section dimensions are governed by hydraulic elements and are determined by acceptable reservoir routing of the design storm. Most emergency spillways for detention ponds may be designed as grass-lined open channels.

- Velocities through the spillway should be checked to assure that erosion will not occur. If the spillway velocities exceed the erosive velocity, additional protection should be provided. Outflow from the emergency spillway should be conveyed onsite without damages to property or structures. This can be conveyed in swales, storm sewers, streams and roadways. Outflow from an emergency spillway leaving the site should be directed to the main channel.

Protection of onsite properties and structures may be accomplished by implementing several possible erosion control measures, including, but not limited to, riprap, rolled erosion control products, and deep-rooted native vegetation.

2.3.3.5 On-line Detention Facilities

On-line detention shall not be permissible on perennial streams. This shall include all streams exhibiting year round flow and depicted as a solid blue line on the USGS 7.5 minute quadrangle maps. An on-line detention facility is any facility that has off-site tributary area draining through it. Individual sites may involve off-site tributary flow. In some cases there may be no other alternative than to accept off-site runoff into the detention facility. In other cases off-site runoff may be directed to the detention facility to provide watershed benefits. In order to allow the runoff to pass through the proposed site, on-line detention provisions of the SMO must be addressed. In general, the runoff from off-site flows needs to be evaluated to ensure that the additional runoff is properly conveyed through the site and that adequate downstream capacity exists at the outlet.

The off-site to on-site drainage area ratio must be less than 10:1 and the total drainage area must be less than 640 acres. Large off-site drainage areas in relation to the on-site area, or larger than one square mile require special consideration due to excessive inflows and will only be considered if the proposed facility will provide a watershed benefit.

The release rate shall be 0.04 cfs per acre of the total tributary area (on-site and off-site) at the elevation created by impoundment of the on-site 2-year storm volume and 0.15 cfs per acre at the elevation created by impoundment of the on-site 100-year storm volume. Modifications from these release rates will not be permitted unless approved by the MCSC due to site-specific conditions. The facility will provide at least the storage volumes (2 year and 100 year) calculated using the critical duration storm and the on-site drainage area, assuming no off-site flow as described in Section 2.3.3.1.2. The allowable release rate must also not exceed existing conditions release rates as required by Article V.F. of the SMO.

An emergency overflow structure capable of passing the 100-year, critical duration off-site flow rate shall be provided. The off-site flow rates shall be calculated assuming existing conditions or future conditions with detention required by Article V.F. of the SMO. The total flow off-site and on-site should be considered in the design of the overflow structure.

A permanent pool should be provided with an average depth of at least four feet and a volume of 2.0 inches over the tributary drainage area. The on-line facility should also meet all requirements for detention facilities such as wet basin depths, side slopes, safety shelf, bank erosion protection and dam permit.

2.3.3.6 Detention Requirement Examples

The TRM addresses three development situations with different approaches for meeting the storm water detention requirements in the SMO. Usually only one of the approaches will be applicable to a particular development. The three development examples are:

- Single Site Facility
- Single Site with Offsite Drainage
- Multi-Site Developments

2.3.3.6.1 Single Site Facility

A single site facility is a development or redevelopment in which all the drainage area is either contained on the site or there is offsite drainage area that the developer has chosen to include and manage using the release rate approach. In such a typical development, a detention basin (or basins) would be designed to provide sufficient storage to meet the 0.04 and 0.15 cfs/acre release rates for the 2- and 100-year events, respectively. Regardless of whether the development is a new development or a redevelopment, the maximum outflow from the site would be limited to the unit release rate multiplied by the drainage area. For redevelopments, the drainage area for peak runoff management could include only the newly developed area or it could also include the previously developed area, but the entire tributary drainage area must be limited to the outflow established by the 2-year and 100-year release rates

2.3.3.6.2 Single Site with Offsite Drainage

A single site with offsite drainage is a development site with offsite tributary flow where the offsite drainage is typically owned and controlled by others. The magnitude of the offsite drainage area is usually large enough so that it is not practical to control it with the development site's stormwater management facilities and still limit flows to the maximum allowable release rate outflow.

There are three options for meeting the SMO when a development property has significant tributary inflow from upstream offsite properties. The preferred option is to bypass the offsite flows around or through the development by providing appropriate conveyance facilities that do not increase flows downstream. This may be accomplished in existing natural drainage or through man-made conveyance facilities that can pass offsite flows for events up to and including the 100-year event. With this approach, the development site drainage area is managed similar to the single site, using the established unit release rates.

A second option is to capture the offsite flow in a single detention basin and maintain the single site release rate as in the single site facility above. In this option, the detention basin is designed using the single site approach and the established unit release rates. When offsite drainage area is captured, the storm water management plan must account for all offsite drainage and an acceptable future land use condition. Sites using this approach should seek MCSC approval on site assumptions and technical procedures early on in the project. Basins designed in this manner must meet all requirements of on-line detention facilities.

2.3.3.6.3 Multi-Site Developments

Multi-site developments may have runoff management facilities, typically detention basins or flood management facilities, which provide runoff management for multiple developments or sites. These facilities have often been referred to as "regional" detention facilities. Multi-site facilities are sized to manage the runoff from the entire tributary area upstream and typically include multiple developments, many of which may have had site limitations for construction of single site facilities.

Multi-site facilities are more cost efficient to construct and maintain compared to single, onsite facilities. They are often better able to take advantage of physical watershed characteristics and can often incorporate multi-use opportunities that would otherwise be impractical in a single site facility.

For multi-site facilities to be effective and appropriate, tributary developments must convey their increased runoff flows and volumes to the multi-site facility. Designs of the facility and the individual developments must ensure that runoff for up to and including the 100-year event can reach the multi-site facility without any adverse impacts. This often requires design and construction of overland flow paths, and may require upsizing of natural and manmade facilities between the developments and the multi-site detention facility.

Multi-site facilities require detailed analyses to incorporate ultimate development in the tributary watershed and must anticipate potential phasing of construction as development occurs.

2.3.3.7 Infiltration Basins

Infiltration basins are a type of detention basins with no primary outlet (an emergency overflow is still required). Infiltration basins drain only by infiltration through its bottom and sides.

Infiltration basins may be used as detention facilities subject to the following:

- *The basin must be designed to dewater within 72 hours following the end of the critical duration storm.*
- *The underlying soils must have an infiltration rate of at least 0.5 inches per hour as determined by a geotechnical engineer.*
- *Pretreatment facilities must be provided to prevent obstruction.*
- *The basins must be at least 100 feet away from any water supply wells.*

- *Runoff from the areas that have water quality concerns or subject to frequent winter deicing must not be routed to the infiltration facility.*
- *The bottom of the infiltration basin must be at least four (4) feet above the seasonal high groundwater elevation.*

Infiltration basins are most suitable for residential or campus type developments with upstream pretreatment facilities. For infiltration basins, the critical duration storm must be computed using the expected discharge rate of the infiltration basin. The storm which requires the greatest storage will be the critical duration. The infiltration basin cannot be sized to provide less total storage than that which would be required under the standard approach using the 100-year release rate of 0.15 cfs/acre.

The developer must prove that the infiltration basin volume is adequate for a range of stormwater events at the expected release rates, up to the 100-year event. An emergency overflow shall be provided for events that exceed the volume from the 100-year event. This emergency overflow must discharge to an overland flow path as specified in the SMO.

2.3.3.8 Maintenance Considerations for Stormwater Facilities

There are various maintenance provisions for stormwater facilities that should be taken into consideration including:

- Alternate outflows to drain the basin for cleaning and sediment removal;
- Use of pretreatment facilities, such as pre-sedimentation basins for sediment removal and heavy solids collection;
- Routine removal of visible debris and trash from the basin outlet structure;
- Periodic removal of sediments; and
- Mowing of landscaped areas of detention and drainage facilities.

For all Intermediate and Major Developments, a plan for the ongoing maintenance of all stormwater management system components including wetlands and buffer areas is required prior to plan approval. The plan should include:

- Maintenance tasks;
- The party responsible for performing the tasks;
- A Description of all permanent public or private access maintenance easements and overland flow paths, and compensatory storage areas; and
- A Description of dedicated sources of funding for the required maintenance.

2.3.4 Drainage into Wetlands

Management of water in wetlands in McHenry County has historically focused on drainage activities intended to de-water the wetland, allowing it to be converted to agricultural or urban purposes. However, the impacts of stormwater drainage into wetlands resulting from development within the watershed of wetlands also needs to be addressed as part of site development planning.

From an ecological standpoint, wetlands can suffer from "too much water" as well as from "not enough water". Variability of water quantity in wetlands is associated with the presence of habitats of different depths. These habitats are characterized by specific plant and aquatic communities. There is also an obvious connection between water quantity and the spatial extent of wetland habitat.

Invasive plant species are frequently favored by alterations to water regimes, or by sedimentation resulting from adjacent upland activities. Management of wetlands degraded by historic drainage or sedimentation impacts may benefit by planned increases in specific quantities of stormwater runoff, properly pre-treated by appropriate Best Management Practices before entering the wetland.

Approaches to determining the environmental water requirements of wetlands can be divided into hydrology-driven and ecology-driven methods. Hydrology-driven approaches involve first the calculation of, and then the maintenance of the pre-development water regime of the wetland. It is assumed that the existing biota is adapted to the pre-development water regime and that the restoration of this regime will result in a healthy ecosystem. Ecology-driven approaches involve the determination of the optimal water regime requirements of the preferred biota, and the provision of that regime. Ecology-driven approaches may lead to more defensible analyses than those determined by hydrology-driven approaches.

The pre-development water regime of wetlands may be determined through the use of historical data where this is available, or through modeling. Significant elements of the pre-development water regime include the quantity, timing, duration and frequency of inundation. This information may be gained from historical hydrological data or from modeling. While hydrology-driven methodologies for the determination of environmental flows often focus on the maintenance of minimum flows, the importance of maintaining natural variability is considered critical. Optimal management of wetland environmental water requirements may involve the replication of seasonal or ephemeral water regimes.

Any proposed stormwater discharge into a wetland should have a stage-duration analysis prepared which identifies the proposed hydrologic condition of the affected wetland(s). This analysis calculates how high the water will rise in the wetland during a given runoff event for how long a period. In general, a rise in the water surface of a wetland of two feet or more, for a period of longer than 24 hours during the 100-year storm event, can begin to adversely affect wetlands with any type of existing or proposed diverse plant community.

Any development activity that will result into discharge into an otherwise unmodified wetland will need to meet the water quality standards and release rates required by the SMO. Efforts should be made to maintain the pre-disturbance watershed drainage patterns and watershed area of each affected wetland

Any development activity that requires any alteration (dredging, filling, construction of outfall structures, etc.) shall have to adhere to the wetland delineation and permitting requirements of the SMO, as well as any other local, state or federal regulatory programs.

2.3.5 Fee in Lieu of On-Site Detention

The MCSC may require, or the applicant may request, the payment of a nondetention impact fee in lieu of on-site detention to fulfill all or part of on-site detention requirements for a development. The MCSC will request a nondetention impact fee in lieu of on-site detention or will reject its use within 21 days of receipt of a complete request including engineering studies and an estimated fee.

Criteria:

1. *The following requirements must be met before a nondetention impact fee in lieu of on-site detention will be utilized for a development that results in 20,000 square feet or greater of hydrologically disturbed area:*

    a. *The downstream stormwater management system has adequate downstream stormwater capacity; and*

    b. *The elimination of on-site detention facilities is consistent with an approved MCSC Master Plan or an adopted Basin Plan or the applicant's engineer and the MCSC Chief Engineer determine that such an exemption will not result in an increased erosion, flood or drainage hazard.*

For a project that results in greater than 20,000 square feet of hydrologically disturbed area (and new impervious area) and for which fee in lieu of detention is requested, the applicant must address the release rate and quantity of runoff to demonstrate that the development will not increase existing flood damages. The applicant should determine the existing capacity of the downstream drainageway, accounting for all upstream flow. The applicant should then demonstrate that the proposed development would have no adverse impacts on the drainageways to which it will discharge. In addition, a project requesting fee in lieu of detention must demonstrate a net benefit in water quality will need to be realized through the water quality treatment methods. Showing that the site plan for a redevelopment project has a net decrease in impervious area is also presumed to benefit water quality compared to the currently developed condition.

For a project that involves only mass grading, the developer has the option of requesting fee-in-lieu of detention for the project. The mass-grading project cannot contain any net increase in impervious surfaces and cannot re-construct a structure, if it is to be considered for fee-in-lieu of detention.

2.3.6 Storm Sewers And Swales

2.3.6.1 Storm Sewer System

A storm sewer system is a system of inlets, pipes, manholes, junctions, outlets and other structures designed to convey stormwater runoff to a discharge point. The stormwater storage and water quality benefits from storm sewers are minimal. Use of vegetated swales should be incorporated into the site design whenever possible. Open vegetated swales can be used to reduce the peak volume of runoff and improve the water quality from a site. For more information on the design of vegetated swales refer to Section 2.1. In general, the advantages of swales over conventional storm sewer systems include the following:

- the slowing of stormwater runoff velocities thereby lengthening time of concentration and reducing peak discharges;
- potential to increase infiltration, especially for dry swales;
- increased stormwater storage;
- removal of suspended pollutants;
- vegetation provides pretreatment by trapping, filtering, and infiltrating particulate and associated pollutants;
- accents natural landscape and are generally easy to maintain;
- swales are easily located and constructed;
- provide a reduction in cost from constructing storm sewers and is generally less expensive than curb-and-gutter systems.

Disadvantages to the use of swales include:

- potential increased maintenance costs;
- limited ability to control peak flows or reduce stormwater volumes;
- roadside swales are subject to damage from off-street parking and snow removal;

- potential for freezing and overflow during winter conditions.

2.3.6.2 Storm Sewer Design

The design of a storm sewer is generally divided into the following operations:

1. Determine the location and spacing of all inlets.

2. Prepare a plan and layout of the storm sewer system that establishes the following design data:

   - Location of storm sewers
   - Direction of flow
   - Location of manholes
   - Location of existing utilities such as water, gas, electric, or sanitary sewers

3. The design of the storm sewer is then accomplished by determining drainage areas, computing runoff by the rational method or other accepted hydrologic method, and computing the hydraulic capacity of the storm sewers.

Specific requirements for the design of storm sewers in McHenry County include:

- *The 10-year critical duration storm shall be used as a minimum for the design of storm sewers, minor swales, and appurtenances. Storm sewer design shall be based on full flow conditions; otherwise, hydraulic grade line calculations shall be performed that show that rims are not inundated at the design storm.*
- *Storm sewers and swales shall not connect to sanitary sewers.*
- *Design practices intended to minimize erosion shall be provided at the inlets and outlets for all pipes, transitions and channels.*
- *The minimum storm sewer size shall be 12 inches unless approved by the Enforcement Officer.*
- *The minimum design velocity for a storm sewer shall be 2.5 feet per second. The maximum design velocity for a storm sewer shall be 8.0 feet per second.*

When storm sewer systems are designed for full flow, the designer should establish the head losses caused by flow resistance in the conduit, interference at junctions and structures. This information should then be used to establish the design water surface elevation at each structure.

The IDOT Drainage Manual presents a detailed procedure for the hydrologic and hydraulic analysis and design of storm sewer systems.

2.3.6.3 Storm Sewer System Connection

Storm sewers and swales may connect to existing drain tiles or storm sewers only if the applicant submits a maintenance agreement, recorded easements and a report that indicates the existing system from the connection to the discharge point in an open channel has adequate hydraulic capacity and structures integrity. The recorded easement and maintenance agreement must extend from the connection to the discharge point in an open channel. The recorded easement and maintenance agreement must be approved by the MCSC Chief Engineer prior to issuance of a Watershed Development Permit.

Stormwater systems shall properly incorporate and be compatible with existing subsurface and surface drainage systems including agricultural systems. See Section 2.3.2.4.2 for guidance on connections with downstream existing field tile.

Field tile systems disturbed during development must be reconnected by those responsible for their disturbance unless the approved drainage plan includes provisions for the system. All abandoned field tiles shall be removed in their entirety.

Agricultural drainage systems shall be located and evaluated on-site in accordance with the SMO. All existing on-site agricultural drain tiles not serving a beneficial use shall be abandoned by trench removal prior to other development and recorded on record plans. If any existing drain tiles continue to upland watersheds, the developer must maintain tributary drainage service during construction until new sewers can be installed for a permanent connection.

Existing drainage systems shall be evaluated with regard to existing capabilities and reasonable future expansion capacities. All existing tributary drain tiles shall be incorporated into the new development drainage system and shall provide a free flow discharge and shall not allow surcharge conditions from new stormwater management systems. Junction structures with removable foundry lids shall be located at the property limits for observation and maintenance.

2.3.7 Overland Flow Paths

All areas of development must provide an overland flow path that will pass the 100-year flood flow (including offsite tributary flow) without damage to structures or property.

For drainage areas less than 20 acres, inlets and the storm sewer may be sized to safely pass the entire 100-year flow. Unless detention storage and the storm sewer system are sized to store and convey the entire 100-year flood event, an overland flow path must be provided through the site. Overland flow paths are small surface drainage systems, such as vegetated swales, which are designed to collect relatively minor sheet flow and allow it to pass through the site without interference. Roadways may also be used as overland flow paths. The design of an overland flow path must account for the lowest opening of adjacent structures.

Structures adjacent to an overland flow path shall have the following lowest opening elevation for the following tributary areas:

(1) 0.5 (one-half) foot above the overflow elevation for tributary areas of 20 acres or less.

(2) 1 (one) foot above the overflow elevation for tributary areas between 20 acres and 100 acres.

(3) At or above the BFE for tributary areas of 100 acres or greater.

Overland flow paths can be sized using the Manning's equation, unless there is evidence that suggests that backwater effects must be considered. The "overflow elevation" is the elevation of the highwater in the overflow as computed by the Manning's equation. The BFE is the elevation of the BFE plus two feet. The BFE will be defined for all areas with more than 100 acres of tributary drainage area. Overland flow paths shall be protected by a recorded covenant to prevent the construction of any obstructions that could impair its function.

2.4 Floodplain Management

Floodplains provide a variety of benefits related to water quality, storage, recreation and aesthetics. Floodplains allow floodwaters to spread out, reducing velocities and providing additional channel storage, which reduces stages. Floodplain vegetation filters out impurities and further slows floodwaters allowing sediment and other debris to settle out. Floodplains can be used for recreational purposes such as parks, bike paths and conservation areas and can be important habitat for wildlife and stopovers for migratory birds. Floodplain Management is required to preserve these natural benefits and minimize the impacts of necessary modifications to the floodplain. The SMO addresses all developments located in flood prone areas, depressional storage areas, Regulatory Floodplains and Regulatory Floodways.

2.4.1 Floodplains and Floodways

2.4.1.1 Base Flood Elevation (BFE)

The base flood is the standard baseline in inundation frequency adopted by the National Flood Insurance Program (NFIP) and the State of Illinois to be used for the purpose of flood insurance and regulating new development. The base flood has a one-percent chance of occurring in a given year and is commonly referred to as the one-percent probability flood event or the 100-year recurrence interval flood event. The BFE is the corresponding water surface elevation for the base flood.

The SMO requires the BFE to be obtained from the flood profiles in the FEMA Flood Insurance Studies (FIS). If flood profiles are not available, FEMA maps with delineated "AH Zones" or "AO Zones" shall be used according to the methods provided in the SMO. Note, BFEs that appear on FEMA Flood Insurance Rate Maps (FIRMs) are rounded to the nearest whole foot. Whenever possible, the FIS flood profile should be used to obtain elevations to the nearest 0.1 foot.

When BFE information in the FIS is not applicable or not available, an appropriate hydrologic and hydraulic (H&H) analysis is required to determine the BFE. The analysis must be submitted to MCSC for approval. If a channel has a tributary drainage area of 640 acres (one square mile) or more, the analysis will also need IDNR/OWR concurrence. Table 2-12 lists hydrologic models that are approved for use for BFE determination. Other methods require MCSC approval and IDNR approval if the drainage area exceeds 640 acres.

Table 2-12: Approved Hydrologic Models

Model	Supporting Agency	Drainage Area Restrictions
Rational Formula	--	<20 acres
TR-55	NRCS	<100 acres
TR-20	NRCS	None
HEC-1	USACE	None

Approved hydraulic models include HEC-2, HEC-RAS and WSP2. Other methods require MCSC approval and IDNR approval if the drainage area exceeds 640 acres.

2.4.1.2 Regulatory Floodplain

The Regulatory Floodplain or flood prone area limits are established by delineating the BFE onto the site topographic map. All areas with a ground elevation at or below the BFE are included in the Regulatory Floodplain or the flood prone area.

The accuracy of the Regulatory Floodplain boundary or flood prone area limit is only as good as the topographic map used for the site plan. If necessary, a topographic survey should be performed to verify elevations so the boundaries can be correctly delineated.

For non-riverine Regulatory Floodplains or flood prone areas, the historic flood of record plus two feet may be used for the BFE instead of performing a detailed hydrologic and hydraulic study.

2.4.1.3 Regulatory Floodway

The floodway is the stream channel and the portion of the floodplain adjacent to the channel that is required to pass the base flood. The location of the Regulatory Floodway shall be determined from the floodway boundary maps listed in Appendix B of the SMO. To locate the floodway boundary, the Regulatory Floodway limits should be scaled from the floodway boundary map and transferred to the project site plan using reference marks common to both maps. Typical reference marks are street intersections, corporate limits and section lines. It is important that the accurate floodway width be maintained during the data transfer process from the regulatory floodway maps to the applicant's site plan. The applicant should then check the floodway location in relation to the stream and the site topography. As with the regulatory floodplain maps, an accurate delineation of the floodway boundary is important to determine the applicable requirements of the SMO. If it appears that the floodway location is unreasonable, the applicant may wish to pursue a Letter of Map Amendment (LOMR) based on improved map quality. The LOMR request is made to FEMA through IDNR/OWR.

2.4.2 General Performance Standards

The General Performance Standards apply to all developments in the Regulatory Special flood hazard areas unless superseded by more stringent requirements in subsequent sections. The SMO states that *no development shall be allowed in the Regulatory Floodplain or flood prone areas that singularly or cumulatively creates a damaging or potentially damaging increase in flood heights or velocity or threat to public health, safety and welfare*.

To be consistent with these standards, all developments are subject to the following requirements:

- The conveyance capacity of the floodplain and floodway shall not be reduced, except for public flood control projects.

- Changes to the regulatory floodplain or BFE require a Letter of Map Revision (LOMR) from FEMA.
- Changes to the floodway require an LOMR and concurrence from IDNR/OWR.
- No building may be constructed in the floodplain until a Conditional Letter of Map Revision (CLOMR) is actually obtained from FEMA.
- Proposed changes to the floodplain, floodway or BFE must be submitted to MCSC.

Public flood control projects reduce flood damages to buildings or structure and are operated and maintained by a public agency. Projects meeting this definition have less stringent requirements when the floodplain, floodway, or BFE is being changed. Public flood control projects may not increase flood heights outside the project right of way or specific flood easements. This requirement applies to all floods up to the BFE.

2.4.3 Public Health Protection Standards

The Public Health Protection Standards are intended to prevent contamination of drinking water supplies and floodwaters, damage to wastewater treatment plant facilities, and inflow and infiltration to sewer systems. Manhole covers, doors, hatches and other above- ground openings shall be watertight (i.e. sealed to prevent impairment of the plant or contamination of the floodwaters) if located below the Flood Protection Elevation (FPE), which is the BFE plus two feet as described in 2.4.4.1. Construction of septic and other disposal systems is prohibited within the Regulatory Floodplain. Storage of hazardous or flammable materials below the BFE is also prohibited.

2.4.4 Building Protection Standards

The Building Protection Standards apply to all buildings located in the Regulatory Floodplain or in a flood prone area that has at least 100 acres of tributary area. Generally, construction of new or replacement buildings or substantial improvement of existing buildings is not appropriate in the Regulatory Floodplain.

2.4.4.1 Residential Buildings

The SMO stipulates that the lowest floor, including the basement, of new or substantially improved residential buildings; or manufactured homes, must be elevated up to at least the Flood Protection Elevation (FPE), which is two feet above the BFE. This exceeds the NFIP regulations, which require the lowest floor, to be only at or above the BFE. A safety factor of two feet above the BFE accounts for potential errors in determining the BFE and the impact of wave action during the base flood event. The requirement for a minimum elevation in new or substantially improved residential buildings reflects the fact that other floodproofing methods have a poor performance record and may become quite costly. Public safety and reducing property damage are the primary purposes of the SMO and the use of this stringent requirement helps to achieve these objectives. Dry floodproofing may not be considered in lieu of properly elevating residential buildings. An attached garage for a structure must be elevated to at least 0.5 feet above the BFE.

Substantial improvement is defined as any repair, reconstruction or improvement of a structure, where the cost of the repair, reconstruction or improvements equals or exceeds 50 percent of the market value of the structure either, a) before the improvements or repair is started, or b) if the structure has been damaged, and is being restored, before the damage occurred. For the purpose of this definition, "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure. The term does not, however, include either 1) any project for improvement of a structure to comply with existing state or local health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions or 2) any alteration of a structure listed on the National Register of Historic Places or a State Inventory of Historic Places.

For purposes of determining substantial improvement, market value pertains only to the structure in question. It does not pertain to the land, landscaping or detached accessory structures on the property. When determining substantial improvement, the value of the land must always be subtracted.

Acceptable estimates of market value can be obtained from the following sources:

- Independent appraisals by a certified professional appraiser.
- Detailed estimates of the structure's Actual Cash Value (used as a substitute for market value based on the preference of the community).
- Property appraisals used for tax assessment purposes (Adjusted Assessed Value: used as a screening tool).
- The value of buildings taken from NFIP claims data (used as a screening tool).
- "Qualified estimates" based on sound professional judgment made by staff of the local building department or local or State tax assessor's office.

As indicated above, some market value estimates should only be used as screening tools to identify those structures where the substantial improvement ratios are obviously less than or greater than 50 percent. (Deviations greater than ten percentage points are considered to be significant.) For structures that fall between the 40 percent and 60 percent range, more precise market value estimates should be used.

The use of assessed value has some limitations that, if not considered and accounted for, can produce erroneous estimates of market value. These limitations are:

- Appraisal Cycle: How often are the appraisals done and when was the date of the last appraisal? Market value estimates can be outdated if the cycle is long and the community happens to be in a stage of its cycle where the subject property has not been appraised for many years.

- Land Values: In most cases, land values and the value of improvements (structures) will be assessed separately and listed as such on the tax records. In cases where they are not distinguished, a determination of the value of the land must be made and subtracted from the total assessed value.

- Assessment Level: States and local taxing jurisdictions vary in assessment levels (an established statutory ratio between the assessor's estimate of value and the true fair market value).

In cases where the assessment level is unacceptably low or where the projected ratio of cost of repair to market value is close to 50 percent, adjustments for assessment level must be made. If the use of assessed value is questioned, an appeal is warranted, but the burden of proof can be placed on the permit applicant who can be required to submit an independent appraisal by a qualified appraiser.

If a structure is rebuilt in violation of the MCSC floodplain management regulations and not elevated to or above the FPE (or floodproofed if nonresidential), the flood insurance premiums will be significantly higher. For substantially damaged structures, which have their lowest floors, including basements, several feet or more below the BFE, the annual premium cost increases by thousands of dollars. The guidance provided here on substantial improvement was obtained from *Answers to Questions About Substantially Damaged Buildings* (Federal Emergency Management Agency, FEMA – 213, March 1991).

2.4.4.2 Elevation Using Fill

Fill placed to elevate a residential structure and attached garages must follow the requirements of Article V.G.4.a in the SMO. The fill shall also be adequately protected against erosion, scour and differential settlement. It is strongly recommended that fill placed be in accordance with the FEMA criteria for development. Section 65.6(a)(6) of the NFIP regulations reads as follows:

(i) Fill must be compacted to 95 percent of the maximum density obtainable with the Standard Proctor Test method used by the American Society for Testing and Materials (ASTM Standard D-698).

(ii) Fill slopes for granular material are not steeper than one vertical on one-and-one-half horizontal unless substantiating data justifying steeper slopes is submitted.

(iii) Adequate protection is provided for fill slopes exposed to flood waters with expected velocities during the occurrence of the base flood of five feet per second or less by covering them with grass, vines, weeds, or similar vegetation undergrowth.

(iv) Adequate protection is provided for fill slopes exposed to flood waters with velocities during the occurrence of the base flood of greater than five feet per second by armoring them with stone or rock slope protection."

The performance standards of the SMO (Article V.G.2) require that the flood carrying capacity of the regulatory floodplain must be maintained. Fill placed in the regulatory floodplain must be shown to not singularly or cumulatively create a damaging increase in flood heights or velocities, pose a threat to public health or safety or impair the natural hydrologic functions of the floodplain or channel. Therefore, for any development involving fill placement, whether for a building pad or other reasons, the applicant must evaluate the impacts of the fill upon the existing floodplain storage and provide compensatory storage as described in Section 2.4.5.

2.4.4.3 Elevation by Other Means

A building may be elevated by means other than fill by constructing it on piles or walls so that the lowest floor is above the FPE and the floodplain storage under the structure is left open. The supporting structures for buildings elevated by means other than fill must:

- be permanently open to the entry of flood waters,
- have permanent openings that are at most one foot above grade,
- provide one square inch of opening for each square foot of enclosed floodplain area,
- be designed to withstand the hydrostatic pressure of the base flood,
- be anchored and aligned to minimize hydrodynamic forces from the current, waves, ice and debris, and
- be constructed using flood resistant materials.

The open area below the structure cannot be used for temporary or permanent storage of any items as all such items and materials must be in a location at least 0.5 feet above the BFE. All residential electrical, heating, ventilating, plumbing, and air conditioning equipment must be located above the FPE.

2.4.4.4 Non-residential Buildings

The requirements for non-residential buildings are similar to residential buildings. However, as stated in the SMO: *The lowest floor, including the basement, of all new or substantially improved non-residential buildings shall be elevated at least to the FPE…or be structurally dry floodproofed to at least the FPE*. In addition, the building design shall take into account the hydrostatic and dynamic forces of the base flood.

2.4.4.5 Manufactured Homes and Recreational Vehicles

According to the Rules and Regulations for the Illinois Mobile Home Tie-Down Act, manufactured homes and recreational vehicles require protection from flood damage when they are to be installed on a site for more than 180 days. They shall be elevated to or above the FPE and shall be anchored to resist flotation, collapse, or lateral movement.

2.4.4.6 Accessory and Non-conforming Structures

Accessory structures may be constructed with the lowest floor below the FPE provided the criteria listed in the SMO (Article V.G.4.d) apply. Accessory structures that do not meet these criteria may be constructed if they are dry floodproofed or elevated at least 0.5 feet above the BFE.

As stated in the SMO, *Non-conforming structures damaged by flood, fire, wind or other disaster may be restored unless the damage meets or exceeds 50 percent of its market value before it was damaged, in which case it shall conform to the Floodplain Management Standards of this Ordinance.*

2.4.5 Compensatory Storage Volume Standards

Compensatory storage is the replacement of the existing floodplain and the floodway storage lost due to an allowable floodplain or floodway activity. Compensatory storage is required in both riverine and non-riverine floodplain systems. Compensatory storage is required when a portion of the floodplain is filled, occupied by a structure, or a change in the channel hydraulics reduces the existing available floodplain storage. An example is the placement of fill for the construction of a structure. It is important that the natural storage volume be preserved, since it functions like a flood control reservoir to reduce peak flood flows.

2.4.5.1 Requirements

Volume displaced by fill or buildings in a floodplain must be replaced by excavation of compensatory storage equal to 1.5 times the volume displaced. In riverine floodplains, fill that is placed below the 10-year elevation must be compensated for below the 10-year flood elevation and fill that is displaced between the 10-year flood elevation and the BFE must be compensated between the 10-year elevation and the BFE. The required 50 percent additional compensatory storage can be excavated at any elevation below the BFE.

Floodplains adjacent to lakes require compensatory storage of 1.5 times the displaced volume to be located at any elevation. Other non-riverine floodplains require compensatory storage that is 1.0 times the volume displaced.

Compensatory storage areas must also:

- be designed to drain freely to the channel,

- be reasonably close to the location of the fill, and
- be protected by a recorded covenant that ensures that the storage area will be preserved and maintained.

A fee, in-lieu of providing compensatory storage, may be requested by the applicant or required by the MCSC. The requirements for this option are provided in Article V.G.5.f of the SMO.

2.4.5.2 Compensatory Storage Procedures

Compensatory storage calculations typically are based on floodplain cross-sections and employ the average end area method. For each flood height of interest, the flood flow area of a cross-section is computed. The average area of adjacent cross-sections is multiplied by the distance between the sections to obtain an estimate of the floodplain storage volume. The computational cross-sections must cover the entire portion of the site where modifications to the channel, floodplain or BFE will occur. Additional requirements include the following:

- A sufficient number of cross-sections should be used to fully define the proposed floodplain modification. The cross-sections needed for a hydraulic model are rarely sufficient in number for the purpose of compensatory storage calculations.
- The cross-section should be parallel to one another and generally perpendicular to the flow.
- Where channel bends require cross-sections to be skewed, do not allow the sections to cross one another and use a weighted average to determine the floodplain length between them.
- Use the same cross-section locations to calculate existing and proposed conditions.

2.4.6 Floodway Standards

The SMO states that the only developments allowed in a Regulatory Floodway are *appropriate uses which will not cause an increase in flood heights for all flood events up to and including the base flood*. All standards applicable to the Regulatory Floodplain shall apply in addition to the Regulatory Floodway standards defined in the SMO.

The Regulatory Floodway boundaries are determined by hydraulic and hydrologic analyses. The analyses calculate that portion of the floodplain which must be preserved to store and discharge floodwaters without causing damaging or potentially damaging increases in flood stage and flood velocities. State regulations define this as the loss of flood storage, which would result singularly or cumulatively in more than a 0.1-foot increase in flood stage or a 10% increase in velocity.

2.4.6.1 Appropriate Uses

Most development is prohibited in floodways by State statutes and the SMO. A limited number of appropriate uses have been identified including public flood control improvements, water dependent uses, sewer outfalls, floodproofed utilities, open recreational space, bridges, culverts, and parking lots. In addition, structure floodproofing, repair, and minor improvement are also permitted.

2.4.6.2 Floodway Analysis Requirements

Construction of appropriate uses may be permitted if the project meets the mitigation requirements described in the SMO. The mitigation requirements are considered to be met by providing a written statement signed and sealed by an Illinois registered professional engineer along with supporting drawings and calculations. The analysis should be performed using an approved hydraulic model and include the following:

- Analysis based on the models, profiles, flows and data obtained from the sources specified in Section 2.4.1.
- Demonstration of no net loss of effective floodway conveyance at all model cross-section (does not apply to dams and culverts).
- Sufficient model cross-sections to portray the impact of the development.
- Identical Manning n values for both existing and proposed conditions.
- Horizontal expansion rates no greater than 1 to 4.
- Horizontal contraction rates no greater than 1 to 1.
- Vertical expansion or contraction rates no greater than 1 to 10.
- Cross-sections oriented perpendicular to the flow.
- Analysis of multiple flood events covering all frequencies up to the 100-year flood event.
- No increase in stage.
- No increase in velocity except limited local increases around hydraulic structures with appropriate erosion and scour protection.

In addition, the following special conditions might apply to the analysis:

- If the baseline data or models appear to contain errors or represent changed conditions, the base conditions shall have the concurrence and approval of IDNR/OWR and MCSC.
- If the area is affected by backwater from a downstream receiving stream, then an evaluation of the backwater impact is required. One acceptable approach is to conduct the analysis assuming the receiving stream is at its BFE.
- If the applicant is informed by IDNR/OWR of the planned removal of a restrictive structure within the next five years, the analysis shall be conducted for both existing conditions and with the structure removed.

Projects resulting in changes in the regulatory floodway boundary or BFE require CLOMR approval from FEMA and IDNR, public notice and public comment and submittal of the CLOMR information to MCSC.

2.4.6.3 Special Requirements for Structures Intended to Back up Water

- Increases in flood stages shall be contained within the channel banks or recorded easements.
- The structure shall have a permit or a letter indicating that a permit is not required issued by IDNR/OWR.
- Dams and impoundments shall have a dam safety permit from IDNR/OWR.
- Impoundments shall be in the public interest by providing a regional flood control or recreational benefit.
- Structures may not interfere with migration or reproduction of fish.
- Impoundment designs shall use appropriate slopes and bank stabilization methods.
- Impoundments should not contribute to degraded water quality.
- The project should include a plan to control the input of sediment, nutrients, oil, metals and other pollutants through nonpoint source controls in the tributary watershed.

2.4.6.4 Floodproofing

Floodproofing of residential and commercial structures is considered an appropriate use of the floodway. Compensation of lost conveyance and storage is required for any activity outside the 10-foot perimeter around the structure. The activity shall not increase flood damage to any other building.

2.4.7 Riverine Special Flood Hazard Area Standards

Within all regulatory riverine floodplains where the regulatory floodway has not been determined by the IDNR/OWR or FEMA, the applicant must provide a detailed hydrologic and hydraulic analysis that demonstrates a stormwater runoff conveyance path for the proposed development. The detailed analysis must conform to the hydrologic and hydraulic modeling requirements described in the Stormwater Management article of the manual and this section, respectively. For mapped regulatory floodplains with certified 100-year flood discharges, the applicant may request from the Enforcement Officer permission to use the existing 100-year flood discharge. However, if the study conditions have changed, the Enforcement Officer may require a new hydrologic analysis. By definition, the stormwater conveyance path determination is slightly less detailed than a floodway determination under IDNR/OWR regulations. The stormwater conveyance path is essentially a conveyance floodway only and will not require an analysis of the floodway storage component.

2.4.8 Bridge and Culvert Standards

2.4.8.1 Procedures for New Bridges and Culverts

Permits involving new stream crossings or any significant modifications to existing structures will require analysis using a hydraulic model if the stream has a regulatory floodway. Both the existing and with-project conditions analysis should utilize the same cross-section locations so that each case can be compared at all locations along the reach.

For modification or replacement of existing structures, a determination must be made whether or not the existing structure is a source of flood damage. This is done by comparing the profile of the natural channel (as if the structure did not exist) against the profile of the channel with the existing structure in place. By delineating the floodplains of each of the two profiles upstream of the restrictive structure, the applicant can determine the area that is impacted by backwater created by the restrictive structure. If a building is located in the floodplain when analyzing a restrictive structure, but not in the floodplain when the structure is removed, the structure may be a source of flood damage. The applicant must then evaluate the feasibility of redesigning the structure to reduce the existing backwater, taking into consideration the effects on flood stages on upstream and downstream properties.

All excavations for new construction or modifications to existing structures at crossings must be designed in accordance with the standards listed in the introduction to Section 2.4.6 for limitations on average channel or regulatory floodway velocities.

Lost floodway storage must be compensated for as required in the "General Performance Standards" of the SMO except that artificially created storage lost due to a reduction in head loss behind a bridge shall not be required to be replaced, provided no damage will be incurred downstream.

Application submittal material should be submitted to IDNR/OWR for stream crossings over public bodies of water so that IDNR/OWR may issue a public notice. Also, where hydraulic analyses are required for road crossings, the application submittal material should also be submitted to IDNR/OWR for concurrence that a conditional LOMR is not required.

The detailed hydraulic analysis of upstream flood stages must be based on the Enforcement Officer approved regulatory discharges and corresponding flood elevations for tailwater conditions. Culverts may be analyzed using the U.S. DOT, FHWA Hydraulic Chart for the Selection of Highway Culverts and bridges may be analyzed using the FHWA Hydraulics of Bridge Waterways calculation procedures. Bridge and culvert may also be analyzed using an approved hydraulic model.

2.4.8.2 Temporary Crossings

Temporary stream crossing may be provided for the use of construction vehicles. The following requirements apply.

- There is no adequate existing crossing.
- The approach roads shall be built on 0.5 foot of fill or less.
- The crossing passes stream flow without any backup of water above the channel banks.
- The top of the fill in the channel is two feet below the top of the bank.
- The channel fill is non-erosive.
- The crossing and access road will be removed within one year.

2.5 Wetlands

Wetlands are an essential feature of the Illinois landscape. Illinois supports a variety of wetland types, including wet prairie, marshes, floodplain forests, and swamps. Prior to European settlement, wetlands covered at least 23% of the surface area of Illinois, an estimated 3.3 million hectares (8.2 million acres). To accommodate the demands of human settlement over the past two hundred years, however, Illinois wetlands have been drained, cleared, filled, modified, or polluted. As a result, the extent of wetland acreage in Illinois has been drastically reduced. By the 1980's, only 371,414 hectares (917,765 acres) of the state's original wetlands (2.6% of the state's surface area) remained, a loss of 89% of the wetland acreage in Illinois. Many of the remaining wetlands have been degraded by agricultural or urban encroachment, sedimentation, and by receiving polluted stormwater runoff from urbanizing areas.

But wetlands have also been recognized as a valuable resource. The functions of wetlands are many, including storing and slowing flood flows, sediment stabilization, nutrient removal and storage, and biological diversity. While the long-term consequences of losing wetlands have not been thoroughly studied, awareness of the benefits wetlands provide has led to efforts to protect, restore, and replace the wetland resources of Illinois.

In areas undergoing urban development, isolated wetlands have special characteristics that make them particularly valuable. Many isolated wetlands are true depressions, or potholes, that are not drained by a surface outlet. Such wetlands can hold large quantities of water for extended periods during wet seasons. This water is slowly infiltrated into the ground, thereby recharging groundwater aquifers, or is evaporated. By slowly releasing runoff, isolated wetlands maintain the baseflow in downstream creeks and rivers and prevent erosion. Perhaps even more important to local government officials, isolated wetlands are absolutely essential in preventing increases in flood damage, which is estimated to exceed $39 million in an average year in northeastern Illinois.

Studies have shown that wetlands, even those relatively small in size, provide essential habitat for amphibians, birds, and migrating waterfowl. They also are important in processing damaging pollutants that run off the landscape, such as phosphorous and nitrogen, thereby protecting the water quality of downstream rivers and lakes. In addition, isolated wetlands can be valuable in re-charging the groundwater that communities need for drinking water supplies.

It is also worth noting that wetlands are increasingly valued as aesthetic amenities in suburban communities. Savvy homebuilders are discovering that preserving wetlands and other natural areas sells houses. This can be seen in the growing number of "conservation" developments in the region, where buyers pay a premium to live next to wetlands and other natural areas. The U.S. Army Corps of Engineers has prepared a document entitled "Living with Wetlands", which is available at:

http://www.lrc.usace.army.mil/co-r/lwwetlands.pdf

2.5.1 Wetland Jurisdiction

Any development activity proposed in McHenry County will need to address the potential presence of wetlands on or adjacent to the subject parcel. If any potential wetland areas are determined to be present by McHenry County staff or other resource agencies, the applicant shall provide adequate documentation establishing the presence, location and extent, jurisdictional status, and current and potential environmental quality of those areas.

Activities in wetlands for which permits may be required include, but are not limited to:

- Placement of fill material
- Ditching or dredging activities when the excavated material is sidecast
- Levee and dike construction
- Channel maintenance
- Streambank / shoreline stabilization
- Mechanized land clearing, excavation, or land leveling
- Most road construction, including driveway crossings of wetlands/streams
- Pond construction
- Dam construction

For regulatory purposes, wetlands in McHenry County are divided into two jurisdictional classes. These are Waters of the United States and Isolated Wetlands of McHenry County. As discussed later in this section, Waters of the United States (WOTUS) include those non-isolated wetlands that drain to, or are adjacent to another waterbody. Isolated Wetlands of McHenry County (IWMC) are those wetlands that have no defined connection to, or are not adjacent to another waterbody.

It is critical that a landowner realize that any given parcel of land may contain both WOTUS and IWMC wetlands, requiring coordination and permitting with different agencies. In addition, jurisdiction over WOTUS wetlands is further divided between two Federal agencies, based upon whether they are located within agricultural or non-agricultural areas.

In addition to McHenry County, there are essentially six government agencies with regulatory influence over wetlands in the County. These agencies work cooperatively with one another for the protection of these resources. These include the:

- U.S. Army Corps of Engineers (USACE),

- United States Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS)
- U.S. Environmental Protection Agency (USEPA)
- U.S. Fish and Wildlife Service (USFWS)
- Illinois Department of Natural Resources (IDNR) and
- Illinois Environmental Protection Agency (IEPA)

Although these agencies try to coordinate their actions, it cannot be assumed that because a regulatory permit (or regulatory clearance) has been received from any one agency, that no other approvals or clearances are required. It is also important to note that any municipality within McHenry County could, at their discretion, enact wetland regulations that are even more stringent than those contained within the McHenry County Stormwater Management Ordinance, or other regulatory agencies. Finally, at the time that this manual was prepared, the State of Illinois was considering enacting legislation to provide regulatory protection for isolated wetlands.

The following is a listing of agencies a landowner (or their agent) might have to contact regarding wetland issues.

Agency	**Waters of the United States (WOTUS)**	**Isolated Wetlands of McHenry County (IWMC)**
McHenry County	x	x
USACE	x	
USDA/NRCS	x	x
USEPA	x	
USFWS	x	x
IDNR	x	x
IEPA	x	

Most landowners dealing with WOTUS wetland issues will primarily deal with the USACE and the USDA/NRCS, depending on whether the subject property is non-agricultural or agricultural, respectively. The USEPA usually only becomes involved if a wetland violation occurs, and enforcement action is required. The USFWS and IDNR primarily provide input on the potential presence of, or potential impacts to, threatened and endangered species in the vicinity of the land proposed for development. The IEPA is primarily involved with regulating any pollutant potential associated with wetlands impacts.

Each federal or state agency is granted specific wetland regulatory authorities through separate federal or state legislative acts. The USEPA receives its authority from the 1972 federal Water Pollution Control Act, also known as the Clean Water Act

(CWA). Section 404 of the Clean Water Act requires that anyone interested in depositing dredged or fill material into "Waters of the United States, including wetlands," must receive authorization for such activities. The USACE receives its authority from Section 404 of the same act, and has been assigned responsibility for administering the Section 404 permitting process. The IEPA receives its authority from Section 401 of the CWA. The USDA/NRCS receives its authority from the National Food Security Act of 1985 (NFSA) and its subsequent amendments. The IDNR receives most of its authority from the Interagency Wetlands Policy Act of 1989 (IWPA) and peripheral authority through the state's Rivers, Lakes, and Streams Act (RLSA).

2.5.2 Waters of the United States

Under Section 404 of the Clean Water Act, Waters of the United States include the following:

a. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters, which are subject to the ebb and flow of the tide.

b. All interstate waters including interstate wetlands.

c. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:

   (1) which are or could be used by interstate or foreign travelers for recreational or other purposes; or

   (2) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

   (3) which are used or could be used for industrial purpose by industries in interstate commerce.

d. All impoundments of waters otherwise defined as waters of the United States under the definition.

e. Tributaries of waters identified in paragraphs 1-4 above.

f. The territorial seas.

g. Wetlands adjacent to waters (other than wetlands) identified in paragraphs 1-6 above.

h. EPA has clarified that waters of the United States also include the following waters:

(1) which are or would be used as habitat by birds protected by Migratory Bird Treaties; or

(2) which are or would be used as habitat by other migratory birds which cross state lines; or

(3) which are or would be used as habitat for endangered species; or

(4) used to irrigate crops sold in interstate commerce.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of the CWA (other than cooling ponds as defined in 40 CFR 123.11(m) which also meet the criteria of this definition) are not waters of the United States. It should be noted that we generally do not consider the following waters to be Waters of the United States. However, the Corps and EPA reserve the right on a case-by-case basis to determine that a particular waterbody within these categories of waters is a water of the United States.

a. Non-tidal drainage and irrigation ditches excavated on dry land.

b. Artificially irrigated areas which would revert to upland if the irrigation ceased.

c. Artificial lakes created by excavating and/or diking dry land to collect and retain water and which are used exclusively for such purposes as stock watering, irrigation, settling basins, or rice growing.

d. Artificial reflecting or swimming pools or other small ornamental bodies of water created by excavating and/or diking dry land to retain water for primarily aesthetic reasons.

e. Waterfilled depressions created in dry land incidental to construction activity and pits excavated in dry land for the purpose of obtaining fill, sand, or gravel unless and until the construction or excavation operation is abandoned and the resulting body of water meets the definition of waters of the United States. (33 CFR 328 and Supplementary Information)

The final determination of whether an area is subject to USACE regulations, and whether the proposed activity requires a permit under Section 404 must be made by the appropriate USACE District Office. For McHenry County, this is the Chicago District Office of the USACE, which is located in downtown Chicago.

For a general overview of the U.S. Army Corps of Engineers Regulatory Program:

www.lrc.usace.army.mil/co-r/index.htm

For a checklist of submittal requirements for a Section 404 permit:

http://www.lrc.usace.army.mil/co-r/checklis.htm

The Chicago District, U.S. Army Corps of Engineers (USACE) administers a permit program under Section 404 of the Clean Water Act, which regulates various activities in waters of the United States, including wetlands. As a condition of permit issuance, the USACE requires appropriate soil erosion and sediment control measures to be implemented and maintained until the construction site is re-vegetated and stabilized.

The USACE reviews the impacts of a proposed project with the supposition that soil erosion from the site will be negligible. However, the USACE has frequently observed that many permittees fail to implement and maintain appropriate erosion and sediment control measures. As a result, the impacts of the project become more than minimal. Construction site erosion has been identified as a significant source of pollution in Illinois lakes and streams. Sediment deposition from water erosion results in the loss of sensitive or threatened fish species and reduced food supplies, reduced channel capacity, reduced storm water conveyance and storage functions and creates safety and nuisance issues. Numerous studies show that it is more cost effective to develop measures to prevent pollutants in storm water during site development than to try to correct problems caused by the pollutants later.

As part of their regulatory permit program, the USACE has entered into an Interagency Coordination Agreements (ICA) with the McHenry County Soil & Water Conservation District (SWCD) to provide Soil Erosion and Sediment control (SESC) oversight on permitted wetland impacts. The intent of the ICA is to utilize the technical expertise of the NRCS and the SWCD. An applicant would be required to give the SWCD the information necessary to conduct an adequate technical review of the plans. The SWCD reviews and approves SESC plans submitted by the applicant, and determine if the plans meet technical standards.

The USACE will use the SWCD's opinion in part to ensure that the impacts of the project are not more than minimal. The SWCD will also attend a pre-construction meeting and periodically inspect the site during active construction. The SWCD performs inspections of the effectiveness of SESC practices during the construction phase.

If during the course of their site inspections, the SWCD observes inadequacies or failures of SESC practices, they will notify the USACE, who may consider the activity to be a breach of the permit activity.

Additional information on the SWCD program can be obtained from:

http://www.mchenryswcd.org/downloadable_forms.htm

2.5.3 Agricultural Wetlands

Because the federal government bases the jurisdictions of the wetland regulatory agencies upon whether wetlands are found on agricultural and non-agricultural land, a Memorandum of Agreement (MOA) between the USDA/NRCS, the USEPA, the Department of the Interior (of which the USF&WS is a division), and the Department of Defense (of which the USACE is a division) was adopted.

The MOA defines agricultural and non-agricultural lands and dictates which agency has the lead for wetland determinations and or delineations under specific circumstances. This MOA defines agricultural lands as those lands, "that are intensively used and managed for food or fiber production to the extent that the natural vegetation has been removed and cannot be used to determine whether the area meets applicable hydrophytic vegetation criteria in making a wetland delineation." All other lands are considered non-agricultural lands.

If individuals want to know if wetlands are present on their property; if an activity in which they are involved will potentially impact a wetland; or if an activity is exempt under the NFSA they should contact the Woodstock USDA/NRCS District Office even if the activity is not on agricultural land. An applicant wishing to request USDA/NRCS conduct this review should request the form NRCS-CPA-38 Request for Certified Wetland Determination/Delineation.

If the USDA/NRCS has jurisdiction, either through the NFSA or the MOA, they will perform the determination or delineation. If they do not have jurisdiction, they will refer the individual to McHenry County and/or the appropriate USACE District Office.

2.5.4 Isolated Wetlands

A January 2001 decision by the U.S. Supreme Court removed federal protection for numerous wetlands nationwide. Specifically, "isolated" wetlands are no longer subject to the permitting authority of the U.S. Army Corps of Engineers. A preliminary estimate indicates that anywhere from 30 to 60 percent of the Nation's wetlands could qualify as Isolated, and not be subject to federal protection as a result of the Supreme Court decision.

Generally speaking, isolated wetlands are depressional wetland pockets in the landscape that are internally drained, and do not contribute any surface flow to any other surface water bodies. Due to the glacial origin of the landscape of McHenry County, numerous isolated wetlands are found.

The Chicago District of the USACE has made an interpretation that a wetland is considered isolated, and therefore not subject to a federal jurisdiction, if there is no clear surface water connection to a stream or river, or it is not adjacent to a surface waterbody. While the true significance of this ruling may not be known for some time, it is known that the potential destruction of our isolated wetlands will have very harmful effects to our water resources and natural habitats.

Consequently, the McHenry County Stormwater Management Ordinance authorizes regulatory protection for isolated wetlands not subject to USACE authority. Proposed impacts to Isolated Wetlands of McHenry County require a development permit to be issued by the MCSMO Enforcement Officer prior to the impact occurring.

2.5.5 Advanced Identification (ADID) Wetlands

In an effort to better quantify the extent, location and relative quality of wetlands within McHenry County, an intensive survey of wetlands was conducted in 1998. This Advanced Identification (ADID) study resulted in a series of maps of McHenry County onto which the extent and quality of wetlands was superimposed. These maps classified wetlands under the following categories:

- High Quality Aquatic Resources (HQAR)
- High Quality Habitat Sites (HQHS)
- High Functional Value Wetlands (HFVW)
- Wetlands
- Farmed Wetlands
- Lakes

The ADID maps are available for review at the offices of the McHenry County Soil and Water Conservation District (SWCD). They are also available for viewing from the Chicago District USACE website at:

http://www.lrc.usace.army.mil/co-r/mchenry.htm

Wetlands that have received a HQAR, HQHS, and HFVW designation will face increased regulatory scrutiny from all agencies involved with wetlands. Proposed impacts to these types of wetlands, if even allowed, will require a higher level of wetland mitigation to be provided by the applicant.

The presence of these ADID designations on a waterbody will also have implications on the width of the buffer that will be required to be provided under the SMO, as discussed in the buffer article of the Ordinance and this document.

2.5.6 Wetland Mapping

In addition to the ADID maps, a number of additional mapping products available at the SWCD for review that can provide information on the potential presence, extent, and jurisdictional status of wetland areas. These include:

- National Wetland Inventory (NWI) Maps – Mapping from the 1980's generated from satellite imagery that identified larger wetland areas and provided a notation of the type of wetland. This information was superimposed onto on USGS topographic quadrangle maps.

- NRCS "Swampbuster" Wetland Maps – Mapping generated as part of the 1985 Food Security Act which superimposes the approximate extent of wetland areas on aerial photography, and includes a notation on the type / regulatory status of wetlands.
- Hydrologic Atlas Maps – Mapping from the 1960's and 1970's that show areas subject to flooding during "flood of records". A precursor to modern day FEMA floodplain maps, overlaid on USGS topographic quadrangle maps.
- Aerial Photography – The SWCD has aerial photography dating back to 1939 which can be used to determine the historic presence or extent of wetland areas, or to identify drainage patterns.

All of these resources are helpful in gaining a sense of where possible wetlands may exist; however, there is no mapping resource that is considered a definitive map of the presence, jurisdictional extent or regulatory status of a wetland area. That can only be accomplished by having a qualified wetland scientist perform a wetland determination in the field.

2.5.7 Wetland Determination

The US Army Corps of Engineers (USACE), the US Environmental Protection Agency, and the State of Illinois define wetlands as follows:

> *Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.*

Wetlands are areas that are covered by water or have waterlogged soils for long periods during the growing season. Plants growing in wetlands are capable of living in saturated soil conditions for at least part of the growing season. Wetlands such as swamps and marshes are often obvious, but some wetlands are not easily recognized, often because they are dry during part of the year or "they just don't look very wet" from the roadside.

The USACE uses three characteristics of wetlands when making wetland determinations: vegetation, soil, and hydrology. Unless an area has been altered or is a rare natural situation, wetland indicators of all three characteristics must be present during some portion of the growing season for an area to be a wetland. Each characteristic is discussed below.

However, there are some general situations in which an area has a strong probability of being a wetland. If any of the following situations occur, the applicant should ask the local Corps office to determine whether the area is a wetland:

- Area occurs in a floodplain or otherwise has low spots in which water stands at or above the soil surface during the growing season.
- Area has water dependent (hydrophytic) plant communities that commonly occur in areas having standing water for part of the growing season (e.g., cordgrass marshes, cattail marshes, bulrush marshes, and sphagnum bogs).
- Area has soils that are called peats or mucks.

The presence of many wetlands types can be readily identified by the general criteria listed above. For the boundary of these areas and numerous other wetlands, however, it is unclear whether these situations occur.

In such cases, it is necessary to carefully examine the area for wetland indicators of the three major characteristics of wetlands: vegetation, soil, and hydrology. Wetland indicators of these characteristics, which may indicate that the area is a wetland, are described on the following pages.

The Chicago District of the U.S. Army Corps of Engineers has prepared a brochure titled "Recognizing Wetlands" which helps provide further guidance. It is available at: http://www.lrc.usace.army.mil/co-r/recwet.pdf.

2.5.7.1 Vegetation Indicators

To many people, the only type of vegetation that is indicative of wetlands is cattails. However, nearly 5,000 plant types in the United States may occur in wetlands. These plants, known as hydrophytic vegetation, are listed in regional publications of the U.S. Fish and Wildlife Service. These publications can be obtained from http://wetlands.fws.gov/bha/.

Hydrophytic vegetation is defined as the sum total of macrophytic plant life that occurs in areas where frequency and duration of inundation or soil saturation are sufficient to exert a controlling influence on the plant species present. The primary indicator of hydrophytic vegetation is: more than 50% of the dominant species are OBL, FACW, FAC+, or FAC on lists of plant species that occur in wetlands. Other indicators of hydrophytic vegetation include, but are not limited to: visual observation of plant species growing in areas of prolonged inundation and/or soil saturation, morphological adaptations, technical literature, physiological adaptations, and reproductive adaptations.

However, one can usually determine if wetland vegetation is present by knowing the plant types that most commonly occur in the area. For example, cattails, bulrushes, prairie cordgrass, sphagnum moss, willows, sedges, arrowheads, and water plantains usually occur in wetlands.

Other indicators of plants growing in wetlands include trees having shallow root systems, swollen trunks (e.g., bald cypress), or roots found growing from the plant stem or trunk above the soil surface. Several USACE offices have published pictorial guides of representative wetland plant types in their regions.

If one cannot determine whether the plant types in your area are those that commonly occur in wetlands, ask the local USACE District Office or a local botanist for assistance.

2.5.7.2 Soil Indicators

In upland depressions and in low-lying areas of the County are soils that consistently or frequently exhibit very shallow depth to water table, and sometimes standing water. Having a seasonally high water table less than two feet below the surface of the ground, these soils are often termed "wet soils," or hydric soils, and are not generally suitable for development, threatening wet basement problems and unable to adequately absorb wastewater. Pollutants of any sort introduced upon these soils might easily enter the groundwater system, potentially contaminating water supplies or resurfacing elsewhere in surface waters.

These "wet soils" frequently harbor actual wetlands. In essence, no development activity may occur within a wetland area without a permit. The permitting process requires investigation of alternative development scenarios and may require mitigative action.

Based upon identified characteristics, these soils can be categorized as to their general suitability for development. Key soil characteristics, which determine suitability, are soil depth, slope, water content and drainage conditions.

A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Indicators of hydric soils include, but are not limited to: organic soils, histic epipedons, sulfidic material, aquic or peraquic moisture regime, reducing soil conditions, presence on hydric soil lists, iron and manganese concretions, and soil colors including gley colors and bright mottles and/or low matrix chroma.

There are approximately 2,000 named soils in the United States that may occur in wetlands. Such soils, called hydric soils, have characteristics that indicate they were developed in conditions where soil oxygen is limited by the presence of saturated soil for long periods during the growing season. If the soil in your area is listed as hydric by the Natural Resource Conservation Service (NRCS), the area might be a wetland. The McHenry County office of the NRCS has soil maps available, in both paper and digital formats, as well as lists of the hydric soils found in the County.

An examination of the soil can determine the presence of any hydric soil indicators, including:

- Soil consists predominantly of decomposed plant material (peats or mucks).
- Soil has a thick layer of decomposing plant material on the surface.
- Soil has a bluish gray or gray color below the surface, or the major color of the soil at this depth is dark (brownish black or black) and dull.
- Soil has the odor of rotten eggs.
- Soil is sandy and has a layer of decomposing plant material at the soil surface.
- Soil is sandy and has dark stains or dark streaks of organic material in the upper layer below the soil surface. These streaks are decomposed plant material attached to the soil particles. When soil from these streaks is rubbed between the fingers, a dark stain is left on the fingers.

2.5.7.3 Hydrology Indicators

Wetland hydrology refers to the presence of water at or above the soil surface for a sufficient period of the year to significantly influence the plant types and soils that occur in the area. However, it is important to note that most McHenry County wetlands lack both standing water and waterlogged soils during at least part of the growing season. The presence of extensive networks of agricultural drain tile systems in rural areas further complicates the determination of wetland hydrology, particularly if these tile systems, often decades old, begin to fall into disrepair.

Although the most reliable evidence of wetland hydrology may be provided by gauging station or groundwater well data, such information is limited for most areas and, when available, requires analysis by trained individuals. Thus, most hydrologic indicators are those that can be observed during field inspection. Most do not reveal either the frequency, timing, or duration of flooding or the soil saturation.

Wetland hydrology encompasses all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface at some time during the growing season. Areas with evident characteristics of wetland hydrology are those where the presence of water has an overriding influence on characteristics of vegetation and soils due to anaerobic and reducing conditions, respectively. Indicators of wetland hydrology include, but are not limited to: recorded gage data, field data, visual observation of inundation or saturation, watermarks, drift lines, sediment deposits, and wetland drainage patterns.

The following indicators may provide some evidence of the periodic presence of flooding or soil saturation:

- Standing or flowing water is observed on the area during the growing season.

- Soil is waterlogged during the growing season.

- Watermarks are present on trees or other erect object. Such marks indicate that water periodically covers the area to the depth shown on the objects.

- Drift lines, which are small piles of debris oriented in the direction of water movement through an area, are present. These often occur along contours and represent the approximate extent of flooding in an area.

- Debris is lodged in trees or piled against other object by water.

- Thin layers of sediments are deposited on leaves or other objects. Sometimes these become consolidated with small plant parts to form discernible crust on the soil surface.

One or more indicators of wetland vegetation, hydric soil, and wetland hydrology must be present for an area to be a wetland. If definite indicators of any of the three characteristics are observed, assistance should be sought from either the local USACE District Office or an environmental consultant qualified in making wetland determinations. The Chicago District of the USACE maintains a list on their website of environmental consultants available to perform these determinations.

In most situations, at a landowner's request, the USDA/NRCS may make wetland determinations and/or delineations on agricultural lands. The USACE and the USEPA usually only make determinations and/or delineations in situations when they are pursuing potential CWA violations. The USACE may also perform determinations and/or delineations on non-agricultural lands when special situations such as linear projects (i.e., utility lines, railroads, and highways) are involved.

All wetland delineations are made with either the National Food Securities Act Manual (NFSAM) or the 1987 USACE Wetlands Delineation Manual. There is very little variation between the two manuals. To eliminate any possible discrepancies, however, the MOA establishes that at no time will both manuals be used to evaluate the same piece of property. The NFSAM will be used for all agricultural lands. The 1987 USACE Wetlands Delineation Manual will be used for all non-agricultural lands.

All certified wetland delineations must be made with an on-site evaluation. For an on-site evaluation, the NRCS, USACE, or USEPA will visit the site in question and make an assessment based upon the manual most appropriate to the surrounding land use, circumstances, and property history. However, due to the lengthy time period involved to have the USACE or USEPA schedule a site visit, wetland delineations may also be performed on-site by private environmental consultants. In most situations, if the reviewing agency is satisfied with the training and professional experience of the environmental consultant, the findings of their reports are accepted.

The NRCS may make a wetland determination based upon an off-site review providing that review is accompanied with a visit to the site. An off-site review is performed by interpreting the best available base map according to a set of prescribed practices and procedures. There are a multitude of maps that may contain the appropriate wetlands data. It is possible that either National Wetland Inventory (NWI) maps, local wetland maps, soil survey maps, aerial photography, or NFSA slides could be used for a particular site. The chosen map must, however, be made from rectified photography; provide a clear, quality representation of the area; enable future digitization; and provide a basis for updating.

2.5.8 Wetland Impacts

Sometimes, there are unavoidable circumstances in which there is an adverse impact to a wetland, such as filling or draining in order to facilitate necessary development. Due to the valuable functions of wetlands in sediment and nutrient filtering, flood water storage, and habitat for endangered and threatened species it is important to replace these wetlands to ensure there is no loss of the benefits they provide. With passage of the Interagency Wetlands Policy Act in 1989, Illinois became only the second state in the nation to consider the functions and values of wetlands to be important enough to adopt a state goal of no net loss of wetlands or their functional values. In 1991, Federal Executive Order 11990 adopted this same standard as a national goal.

Under both Section 404 WOTUS and McHenry County IWMC permitting requirements, an applicant is required to document that for any proposed wetland impact, "no feasible alternative" exists.

For IWMC, an exemption is available for proposed impacts to isolated wetlands one-quarter (0.25) acre in size or less, provided the activity does not involve any other actions that would be subject to Regulated Development criteria. For example, many isolated wetlands provide depressional storage benefits that would have to be compensated for if the wetland were filled. The impact to a depressional storage area would trigger the need for a development permit.

Even if a wetland impact falls below the regulatory mitigation threshold of the USACE or McHenry County, impacts to WOTUS or IWMC, respectively, the proposed wetland impact cannot occur until written regulatory approval or clearance has been received from the applicable agency. Stated another way, any activity undertaken without having written authorization will be considered a regulatory violation, even if the impact area is below the regulatory mitigation threshold.

2.5.9 Wetland Mitigation

Wetland mitigation is required as a condition of USACE or IWMC permits. It is intended to compensate for the adverse impacts of permitted activity on wetland functions and values. Wetland mitigation generally involves the restoration of former wetland areas, the creation of new wetlands, or the enhancement of existing wetland areas. Mitigation goals usually are established through the permit review process. Wetland mitigation is only considered as an option after the USACE or McHenry County have determined that the applicant has avoided impacts to their respective jurisdictional areas to the extent practicable, and has minimized unavoidable impacts to such areas. Mitigation is usually required for wetland impacts to ensure that any lost wetland functions and values are adequately replaced. It is the policy of the USACE that whenever practicable, wetland mitigation be established onsite, or as close to the impact area as possible. Where the USACE determines that onsite mitigation is not feasible or appropriate, offsite mitigation will be accepted. Options for offsite USACE mitigation include mitigation banking, the Wetland Restoration Fund, or other acceptable mitigation sites identified by the applicant. The USACE retains final authority on what is considered acceptable mitigation alternatives for impacts to WOTUS wetlands.

Wetland mitigation banking is one tool that can be used to help reach the goal of no net loss. Mitigation banks provide for the compensation of unavoidable adverse wetland losses, by restoring chemical, physical, and biological functions of wetlands and/or other aquatic resources prior to an adverse impact. Wetland mitigation banks are typically large blocks of wetlands whose values and functions are summed and assigned a value that is translated into "credits". These credits are deposited, just as a deposit is made into a regular checking account. As approved wetland losses occur, these credits are withdrawn to compensate for the losses. Mitigation banks can be developed by private individuals, public agencies, or a combination of these entities and the credits sold in order to compensate for adverse wetland impacts.

Mitigation banking credits can be achieved through creation, restoration, enhancement, or in some rare circumstances preservation of wetland areas of high value. As with on-site mitigation, a bank site is to be managed and preserved in perpetuity.

The USACE maintains an exhibit of USACE approved wetland mitigation banks in the Chicago region. This information is available at:
http://www.lrc.usace.army.mil/co-r/mitbank.jpg

Four elements are integral to the successful establishment of wetland mitigation areas: design, implementation, management, and monitoring. Good mitigation design requires, among other factors, appropriate site selection, assurance of adequate wetland hydrology, and knowledge of plant ecology. Correct implementation of the design, including use of specialized construction practices, is essential to the successful establishment of native plant communities. The monitoring of mitigation sites is an essential part of the permit compliance determination, because it generates the field data used to gage the performance of the site against the predetermined performance standards. Management of the wetland facilitates the development of the wetland communities, and ensures that the goal of the mitigation plan, the replacement of aquatic functions and values, is achieved.

The USACE has developed mitigation guidelines to assist applicants and/or their consultants in the preparation of mitigation proposals. The Mitigation Guidelines and Requirements outline the information the Chicago District needs to evaluate the adequacy of a proposed mitigation plan. This information can be obtained from: http://www.lrc.usace.army.mil/co-r/mitgr.htm

The District, in cooperation with the United States Fish and Wildlife Service and the United States Environmental Protection Agency, has developed the Interagency Coordination Agreement on Wetland Mitigation Banking (ICA). The ICA outlines the criteria for establishing and operating wetland mitigation banks within the regulatory boundaries of the Chicago District. It also establishes the procedures for sales from the mitigation bank to those parties needing wetland mitigation as a condition of their Department of the Army permit. This local agreement is consistent with the November 1995 interagency Federal guidance on mitigation banking.

Interagency Coordination Agreement on Wetland Mitigation Banking (ICA)

http://www.lrc.usace.army.mil/co-r/ica_all.htm

1995 Interagency Federal Guidelines

http://www.usace.army.mil/inet/functions/cw/cecwo/reg/mitbankn.htm

2.5.10 Wetland Restoration and Creation

In general, wetland restoration means the re-establishment of a wetland in the landscape where a wetland existed historically. Wetland creation describes construction a wetland where none has occurred.

The permitting process requires that mitigation procedures be followed in order to avoid or minimize wetland impacts. When wetlands are destroyed, their loss must be compensated, primarily through restoration or creation.

The current emphasis in wetland restoration and creation is to attempt to replicate natural wetland structure and function according to selected ecological principles. Restoration continues to promise the greatest potential for success. The art and science of ecological wetland restoration and creation, however, is still relatively new and the technology incomplete. Many attempts to replicate natural function and form have not been successful. Even "successful" restored or created wetlands do not fully replace the functions or biological and chemical features that have evolved in natural wetlands throughout many years. It is extremely important to promote sound science to restore and create systems that function as and closely resemble natural wetlands.

Certain activities require a permit from a state or federal agency if they are going to occur in a wetland. Landowners may, therefore, find it very helpful to know if they have wetlands on their property, prior to participating in any practice that may result in land disturbance. Landowners may also wish to identify the location of any wetlands on their property if they plan to manage their land for wildlife benefits. Individuals concerned about the location of wetlands on their property should seek to have a formal wetland determination and/or delineation conducted. Wetland restoration and creation projects begin with planning to determine feasibility and design. Without proper planning, projects may lead to local drainage problems

2.5.10.1 Restoration Techniques

Typical projects restore water to a fully or partially drained wetland basin by removing underground drain tiles, plugging open ditches, or building small dikes. Projects are often one to three acres in size, and have an average water depth of about 18 inches. Many small-basin wetlands of this type that were drained for agriculture provide opportunities for restoration today. Generally, marshes or swamps, with seasonal or permanent water, are most often restored.

2.5.10.2 Ditch Plugs and Tile Breaks

The simplest restoration, a "tile break," involves removing a section of underground agricultural tile that is draining a wetland basin. Drain tile (or field tile as it is often called) is usually made of clay or perforated plastic and buried at a depth of two to six feet. Generally, a contractor with a backhoe is used to remove or crush a 25 to 50 ft section of tile downstream of the basin. The downstream end or outlet pipe is then plugged with a bag of redi-mix concrete or clean clay fill, and the trench is filled.

Sometimes, a portion of un-perforated tile, called a “riser”, is connected to the downstream end of the tile line and brought to the surface in order to control the water level. Water will fill the wetland basin until it reaches the mouth of this riser where it will then flow back through the tile line into the ditch. This may work well when the intent is to maintain downstream drainage.

A "ditch plug" restoration builds an earthen wall to impound water. This type of restoration uses equipment to fill a portion of a drainage ditch to natural ground level. Again, a riser may be used to let water flow through a tube once it reaches a certain level. A small dike or berm may also be used, which will impound the water that will begin to collect once the drain has been plugged. A dike prevents the drainage of water downstream and requires a spill way or other water-control structure to regulate the water level and prevent the dike from being washed away during periods of heavy runoff.

Typically, a berm or dike is constructed with a top width of eight to 10 feet and a maximum side slope of 3:1 (three feet of horizontal width to each foot of rise). A three-foot high dike would have a bottom width of 24 to 30 feet. When constructing a low-level dike, soil is often pushed up or excavated from within the former wetland site. This helps to form a deeper pool within the basin. Sod and topsoil are stripped from the construction site and stockpiled. The dike or berm is then constructed with subsoil, often with a good clay component. Topsoil from the basin, which is a good seed source for wetland plants, is then spread back into the basin and on the dike or berm. Disturbed upland areas, including areas of the ditch plug, dike, or berm, are seeded with grasses to minimize erosion and provide cover. Generally, nothing is planted in the wetland basin as wetland vegetation usually re-establishes itself quickly from seeds that have remained dormant in the soil.

Managing water, especially excess water, is important on restoration projects. A water-control structure can be used to manage water levels within a project. Examples include plastic or metal risers, and corrugated metal or plastic stop-log structures. These help to manage the normal flow of water. An emergency spillway, which is a wide trough-like opening in the side of the dike, should be designed into wetland restoration projects if excess water is expected during flood events. Emergency spillways are sized according to the watershed but typically are at least eight feet wide and one to two feet below the top of the ditch plug, dike, or berm. These spillways allow water to pass through without damaging the retention structures in high-water events. Since water management is critical, consult a professional for design specifications suitable for your wetland.

Most restoration projects involve open-area wetlands, but forest and shrub wetlands are also important and can be restored too. Restoration of wooded sites should be done cautiously, however, to avoid killing the trees and shrubs that normally grow in wetlands. Woody wetland plants can often withstand brief flooding during the growing season, but be aware that prolonged inundation may stress trees and kill them.

2.5.10.3 Maintenance of the Restored Site

Simple basin restorations should be relatively maintenance-free. However, some restored wetlands, particularly those with water-control or earthen structures, require some maintenance. Water-control structures should be checked periodically. Fallen leaves, twigs, or other debris may build up around the mouth of the structure. An accumulation of debris may partially obstruct the flow causing the water level to rise. Inspection of the site, particularly during and after a big storm, will allow removal of materials before problems develop.

Ditch plugs, dikes, and berms also require some care. Established seedings of grasses should be periodically mowed or burned to prevent woody vegetation from invading. Root growth from woody vegetation will allow water to penetrate the earthen structure, which will cause it to leak and may contribute to a future washout. Annual maintenance also means keeping muskrats, beaver, and woodchucks in check by filling their excavations, and removing some through trapping if necessary.

2.5.11 Wetland Glossary

AAP Agency Action Plan	An agreement between specific Illinois state agencies that describes how each agency will comply with the regulations established in the Interagency Wetland Policy Act of 1989.
Accretion	The gradual build-up of deposited sediments in a wetland.

Adventitious	Roots which grow in unusual places, such as wherever the stem of the plant comes in contact with the ground.
Aerenchyma	Spongy, specialized plant tissue made of large air-filled intercellular spaces that transport air from the leaves, and stems to the roots.
Anaerobic	The condition of oxygen being absent.
Artificial Wetlands (AW)	Artificial and Irrigation-induced Wetland. USDA/NRCS classification of wetlands with NFSA exemptions. Wetlands in an area that was formerly non-wetland, but now meets wetland criteria due to human activities, including wetlands created by an irrigation system on an area that was formerly non-wetland.
Buttressed	The state of a tree trunk being excessively swollen to the height of the usual high water mark.
CW Converted Wetland	USDA/NRCS classification of wetlands subject to FSA restrictions. Wetlands drained, dredged, filled, leveled, or otherwise manipulated for the purpose of, or to have the effect of, making possible the production of an agricultural commodity. These lands must have been W, FW, or FWP and not highly erodible prior to the conversion. They may have been converted by any activity, including the removal of woody vegetation, that impaired or reduced the flow, circulation, or reach of water; provided the conversion activity was such that agricultural production on the land would not have been possible without its application.
Delineation	The marking of a boundary on the ground that designates between wetland and non-wetland areas.
Deposition	The gradual accumulation of sediments over time.
Determination	The classification of a wetland type on a parcel of land.
Discharge Zone	An area through which an aquifer releases excess water.
Emergent	Plant species that establishes its roots below normal water level and projects its stems and leaves above normal water level.

Endangered	A classification for species in low enough populations that they are likely to become extinct from their natural range.
Extirpated	A classification for species that have become locally extinct.
Farmland Assessment Act	State legislation allowing farmland taken out of production to be eligible for tax relief.
FAC	Facultative Macrophytic plant species equally likely to occur in wetlands or non-wetlands (estimated probability 34-66 percent).
FACU	Facultative Upland. Macrophytic plant species that usually occur in non-wetlands (estimated probability 67-99 (percent) but are occasionally found in wetlands (estimated probability 1-33 percent).
FACW	Facultative Wetland. Macrophytic Plant species that usually occur in wetlands (estimated probability 67-99 percent) but are occasionally found in non-wetlands.
FW	Farmed Wetlands. USDA/NRCS classification of wetlands subject to NFSA restrictions. Wetlands that were drained, dredged, filled, leveled, or otherwise manipulated before December 23, 1985 for the purpose of, or to have the effect of, making the production of an agricultural commodity possible and continue to meet specific wetland hydrology criteria.
FWP	Farmed Wetland Pasture or Hayland. USDA/NRCS classification of wetlands subject to NFSA restrictions. Wetlands that were manipulated and used for pasture or hayland, including native pasture and hayland, prior to December 23, 1985, still meet specific wetland hydrology criteria, and are not abandoned; or are in agricultural use and met FWP criteria on December 23, 1985.
Gleyed	A soil characteristic that describes soils with a blue-grey or greyish appearance.

Hydric Soil	1). Wetland soils. 2). A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation.
IDNR	Illinois Department of Natural Resources. Illinois state agency given the responsibility of protecting and managing the natural resources of the state.
IEPA	Illinois Environmental Protection Agency. Illinois state agency given the responsibility of protecting the quality of the environment and human health.
Inundated	To be covered by water.
IWPA	Interagency Wetlands Policy Act of 1989. State legislation establishing IDNR's primary authority over wetlands.
Lacustrine	Wetland system associated with open water bodies such as lakes, reservoirs, and impounded rivers.
Limnetic	Lacustrine wetland subsystem consisting of the area from the shoreline to a depth of 2 meters below low-water, or to the extent of non-persistent emergents (if they grow at greater depths).
Littoral	Lacustrine subsystem consisting of all deepwater habitats.
Macrophyte	A plant capable of being viewed with the naked eye which has specialized vascular tissues.
Mottles	Blotches, streaks, and spots of different colors or shades.
MOA	Memorandum of Agreement. A legally binding agreement reached between government entities concerning activities surrounding a given issue.
Natural Wetlands	Wetlands that existed before human modification of their characteristics or of the surrounding environment.
NFSA	National Food Securities Act. Federal law passed in 1985 to help manage production on agricultural lands.

NFSAM	National Food Securities Act Manual. Guidance document used by the USDA/NRCS to delineate wetlands associated with agricultural land.
NRCS	Natural Resource Conservation Service. A division within the United States Department of Agriculture given the responsibility of protecting natural resources related to farmland.
NTCHS	National Technical Committee for Hydric Soils. Government entity responsible for maintaining a national list of hydric soils.
NW Non-Wetland	USDA/NRCS classification of wetlands with NFSA exemptions. Land that under natural conditions does not meet wetland criteria; includes wetlands which were converted to the extent that wetland criteria was not present prior to December 23, 1985 but were not cropped.
National Wetlands Inventory	USF&WS project to map all of the wetlands in the United States.
NWP	Nationwide Permit. A general permit intended to apply throughout the United States and its territories, which eliminates the need to issue an individual permit for very specific activities.
OBL Obligate	A macrophytic plant species, which occurs almost always (estimated probability >99 percent) under natural conditions in wetlands.
Palustrine	Wetland system associated with soggy highly vegetated non-tidal areas such as; marshes, bogs, swamps, bottomland forests, and small ponds.
PC	Prior Converted Cropland. USDA/NRCS classification of wetlands with NFSA exemptions. Converted wetlands where the conversion occurred prior to December 23, 1985; an agricultural commodity had been produced at least once before December 23, 1985; and as of December 23, 1985 the converted wetland met certain specific hydrologic criteria and did not support woody vegetation.
Peakflow	The maximum flow of a stream for average precipitation.
Recharge Zone	Permeable area of ground though which an unconfined aquifer may be refilled.

Riverine	Relating to, formed by, or resembling stream (including creeks and rivers).
RLSA	Rivers, Lakes, and Streams Act. State legislation that gives IDNR regulatory authority over construction activities in floodplains and public bodies of water.
Saturated	To be thoroughly soaked with the maximum amount of moisture that can be absorbed.
Succession	The natural dynamic process by which the existing biological community of an ecosystem is gradually replaced by another. This process often causes wetlands to change their classification or gradually fill-in and become upland areas.
Threatened	A classification for species in low enough populations that they are likely to become endangered.
UPL	Upland. Macrophytic plant species that occur almost always (estimated probability >99 percent) under natural conditions in non-wetlands.
USACE	United States Army Corps of Engineers. Branch of the United States Army given the responsibility of managing civil projects and administering Section 404 of the Clean Water Act.
USDA	United States Department of Agriculture. Federal agency given responsibility concerning agricultural issues. The parent agency of the Natural Resource Conservation Service.
USEPA	United States Environmental Protection Agency. Federal agency given the responsibility of protecting the environment and human health. Has jurisdiction over all sections of the Clean Water Act.
USF&WS	United States Fish and Wildlife Service. Agency in the U.S. Department of the Interior given the responsibility of managing and protecting the nation's wildlife resources.
W Wetlands	USDA/NRCS classification of wetlands subject to NFSA restrictions. Those areas that meet wetland criteria under natural conditions and have typically not beenmanipulated by altering hydrology and/or removing woody vegetation. Wetlands include areas that have been abandoned.

Wetland	A wetland is considered a subset of the definition of the Waters of the United States. Wetlands are land that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, under normal conditions, a prevalence of vegetation adapted for life in saturated soil conditions (known as hydrophytic vegetation). A wetland is identified based upon the three attributes: 1) hydrology, 2) soils and 3) vegetation as mandated by the current Federal wetland determination methodology.
Wetland Creation	The introduction of wetlands to an area where none existed historically.
Wetland Enhancement	The improvement in wetland functional value of an area currently meeting the technical definition of a wetland.
Wetland Impact	Isolated Waters of McHenry County or Waters of the U.S. that are hydrologically disturbed or otherwise adversely affected by flooding, filling, excavation, or drainage which results from implementation of a development activity, or any development activity within the boundary of a delineated wetland. For those areas regulated by the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers impacts are defined based on 33 CFR Part 230 – section 404(b)(1) and 33 CFR Parts 320 through 330 as amended.
Wetland Mitigation	Compensation for impacts to wetlands through the restoration, creation, enhancement, or preservation of wetlands.
Wetland Mitigation Banking	The process of purchasing "credits" from a financial institution established by a third party to compensate for permitted losses.
Wetland Preservation	The permanent preservation of an area currently meeting the technical definition of a wetland
Wetland Restoration	The re-introduction of wetlands to an area where wetlands existed historically, but not prior to the mitigation activity

Wetland Restoration Activities	Those restoration activities in Isolated Waters of McHenry County (IWMC) or adjacent buffer areas determined to be necessary and beneficial to the preservation, maintenance, or restoration of wetland plant communities, wildlife habitat and ecosystems native to McHenry County. All excavation and grading quantities under this category are limited to less than 500 square feet of disturbance or 40 cubic yards of material.
WRP	Wetland Reserve Program. A voluntary, incentive-based, federal program established in the Food Securities Act with the goal of protecting and restoring wetlands and their functions on agricultural lands.

2.6 Subsurface Drainage Requirements

Subsurface drainage investigation is required for intermediate, major and public roadway developments. Agricultural drainage systems shall be located and evaluated on-site in accordance with Article VI.B.15 of the SMO. This section provides guidance on the location and treatment of existing drain tiles at the project site. Specific limitations and requirements for the connection to downstream drain tiles are included in Articles V.F.3.e and V.F.3.h of the SMO.

2.6.1 Subsurface Drainage Investigation

The subsurface drainage investigation requires the following:

1. A subsurface drainage survey to locate existing farm and storm drainage tiles by means of slit trenching and other appropriate methods must be performed by an experienced subsurface drainage consultant.

2. All existing drain tile damaged during the investigation should be repaired and functional.

3. The applicant shall provide a topographical boundary map showing:

    a. Location of each slit trench and identified to correspond with the tile investigation report and field staked at no less than 50 foot intervals;
    b. Location of each drain tile with flow direction arrow, tile size and connection to adjoining properties;
    c. A summary of tile investigation report showing trench identification number, tile size, material and quality, percentage of tile filled with water, percentage of restrictions caused by sediment, depth of ground cover, system classification;
    d. Name, address and phone number of person/firm conducting investigation

4. Information collected during drainage investigation shall be used to design and develop long-term subsurface drainage system appropriate for the soils under the development and properly connect all upstream and/or downstream properties.

2.6.2 Abandoned Drain Tile

All existing on-site agricultural drain tiles not serving a beneficial use should be abandoned by trench removal prior to other development and recorded on record plans. If any existing drain tiles continue to upland watersheds, the developer must maintain tributary drainage service during construction until new sewers can be installed for a permanent connection.

2.6.3 Off-Site Tributary Drain Tiles

Existing drainage systems should be evaluated with regard to existing capabilities and reasonable future expansion capacities. All existing tributary drain tiles should be incorporated into the new development drainage system. A free flow discharge must be provided and surcharging of upstream tiles due to new stormwater management systems is not allowable. Junction structures with removable foundry lids should be located at the property limits for observation and maintenance.

New roadway construction shall preserve existing subsurface systems within the right of way. Inspection wells should be placed at the right of way prior to the start of the project. Tiles found not be flowing between inspection wells at the end of construction shall be replaced.

Section 3
Permit Submittal Checklists

Submittals Checklist

- Minor Development
- Intermediate Development
- Major Development
- Public Road Development
- Special Flood Hazard Area Development
- Wetlands

The following permit submittal checklists can be used as a guideline to determine if the appropriate application requirements for a Watershed Development Permit have been met. For clarification purposes, please consult the McHenry County Stormwater Management Ordinance. All application requirements will be submitted to the Enforcement Officer. If certain checklist items are not included in the permit, then an explanation must be provided as to why those items are not included.

For determination of which development checklist to utilize, follow the guidelines below which are also found in the McHenry County Stormwater Management Ordinance.

Minor Development

A minor development is defined as regulated development that:

1. Is not partially or completely located in a depressional storage area, flood prone area, a regulatory floodplain, a regulatory floodway or is not adjacent to a perennial water resource;

2. Consists of hydrologic disturbance of less than 20,000 square feet; and

3. Is not a Public Road Development.

Intermediate Development

An intermediate development is defined as a regulated development that:

1. Is not partially or completely located in a depressional storage area, flood prone area, a regulatory floodplain or a regulatory floodway

2. Consists of hydrologic disturbance of between 20,000 square feet and 5 (five) acres; and

3. Is not a Public Road Development.

Public Road Development

Public Road Development is defined as a regulated development that:

1. Takes place in a public right-of-way or part thereof;

2. Does not include the construction of a building; and

3. Consists of culverts, bridges, roadways, sidewalks, bike paths and related construction.

Major Development

A major development is defined as all other development that is not defined by the above criteria.

Special Flood Hazard Area Development

A development that is partially or completely located in a depressional storage area, floodplain or flood prone area.

Wetland Submittal

A wetland submittal is required for any development located in, near, or adjacent to a wetland. Any of the following items can trigger the requirement for a wetland submittal:

1. The presence or proximity of a hydric soil mapping unit as documented in the current *Soil Survey for McHenry County*, produced by the Natural Resource Conservation Service, or by any on-site soil investigation by a soil scientist.

2. The presence or proximity of any regulatory floodway or floodplain areas, as documented on current *Flood Insurance Rate Maps*, produced by the Federal Emergency Management Agency, or as the result of any other engineering studies.

3. The presence or proximity of any "flood of record" areas, as documented on *Hydrologic Atlas Maps*, produced by the Northeastern Illinois Planning Commission.

4. The presence or proximity of any potential wetland areas as documented on maps or aerial photographs maintained by the Natural Resource Conservation Service for use in determining compliance with United States Department of Agriculture programs.

5. The presence or proximity of any wetland areas, as documented on *National Wetland Inventory Maps*, produced by the U.S. Fish and Wildlife Service.

6. The presence or proximity of any wetland areas, as documented on *McHenry County Advanced Identification (ADID) Wetland Maps*, produced by the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency.

7. Any other mapping, anecdotal, or resource information that indicates the potential presence of wetlands.

3.1 Minor Development Submittal Checklist

The following items should be submitted for a minor development:

_______ Watershed Development Permit Application including:

- ❑ Name, legal address and telephone number of applicant
- ❑ Name, legal address and telephone number of the owner if different from the applicant
- ❑ Name, legal address and telephone number of applicant's agent (if used)
- ❑ Legal Description and/or PIN
- ❑ Common address of development
- ❑ Site location map of development
- ❑ Brief description of the proposed development
- ❑ Signature of applicant or applicant's agent

_______ General Description of the existing and proposed stormwater management system

_______ A grading plan showing proposed and existing contours (recommended minimum contour interval of 2 feet, elevations referenced to NGVD)

_______ A site drainage plan (same scale as grading plan) showing the following existing and proposed drainage features:

- ❑ Wetlands, lakes and ponds
- ❑ Overland flow paths
- ❑ Floodway and floodplain boundaries
- ❑ Flood prone areas
- ❑ Discharge points
- ❑ Storage facilities
- ❑ Easements and buffers
- ❑ Drainage divides

_______ An area drainage plan

_______ An erosion and sediment control plan including description and depiction of measures to be taken

3.2 Intermediate Development Submittal Checklist

The following items should be submitted for an intermediate development:

_______ Watershed Development Permit Application including:
- ❑ Name, legal address and telephone number of applicant
- ❑ Name, legal address and telephone number of the owner if different from the applicant
- ❑ Name, legal address and telephone number of applicant's agent (if used)
- ❑ Legal Description and/or PIN
- ❑ Common address of development
- ❑ Site location map of development
- ❑ Brief description of the proposed development
- ❑ Signature of applicant or applicant's agent

_______ A vicinity map with the Parcel Identification Numbers (PIN) of all parcels comprising the proposed development

_______ Anticipated dates of initiation and completion of activities

_______ Existing and proposed plans (grading, drainage, etc.) of the development including:
- ❑ Topography (minimum 2-foot contour interval, elevations referenced to NGVD)
- ❑ Location of all roads
- ❑ Overland Flow Paths
- ❑ Boundaries of predominate soil types
- ❑ Boundaries of predominate vegetation
- ❑ Drainage easements
- ❑ Location of detention and/or retention basins (including their inflow and outflow structures)
- ❑ Location, size and utilized flow capacities of all storm or combined sewers
- ❑ Location of all utilities and easements
- ❑ Specifications and dimensions of any proposed channel modifications, location and orientation of cross-sections
- ❑ Wetlands, lakes and ponds
- ❑ Floodplain and floodway boundaries
- ❑ Flood prone areas
- ❑ Easements and buffers

_______ Cross-section views for the stormwater management system including:
- ❑ Existing and proposed conditions
- ❑ Existing and proposed elevations
- ❑ Normal and base flood elevations
- ❑ Overland flow depths and paths

_______ Hydrologic and hydraulic report including:
- ❑ Names of the streams or bodies of water affected
- ❑ A statement of purpose of the proposed activity

- ❑ An analysis of the existing drainage system including the methodology and support calculations in computing runoff rates, runoff volumes, velocities, water surface elevations, and floodplain and depressional storage. This analysis will also include methodology and supporting calculations used to determine the effects from the upstream drainage areas.
- ❑ An analysis of the proposed drainage system including runoff rates, runoff volumes, velocities, water surface elevations, and floodplain and depressional storage. This analysis will also include the methodology and supporting calculations used to determine the effects from the upstream drainage areas.
- ❑ An analysis of the effects that the improvements will have on the receiving stream or body of water.
- ❑ All supporting design calculations and computer models
- ❑ How the proposed project meets all standards of the McHenry County Stormwater Management Ordinance

_______ A section in the hydrologic and hydraulic report for detention facilities (if required) including:

- ❑ Plots or tabulations of storage volumes and water surface areas with corresponding water surface elevations
- ❑ Stage-discharge or outlet rating curves
- ❑ Design hydrographs of inflow for the 2- and 100-year, critical duration (for storage) storm event under existing and proposed conditions
- ❑ Design hydrographs of outflow for the 2- and 100-year, critical duration (for storage) storm event under existing and proposed conditions
- ❑ All supporting design calculations

_______ A soil erosion and sedimentation control plan including:

- ❑ Name and telephone number of parties responsible for maintenance of erosion and sediment control practices
- ❑ The types of control to be used
- ❑ Site map (same scale as drainage plans) indicating the location of the control measures
- ❑ Detail drawings and specifications of the control measures
- ❑ All supporting design calculations
- ❑ Sequence of grading and soil disturbances
- ❑ Estimated installation schedule
- ❑ Regular maintenance schedule

_______ A maintenance plan including:

- ❑ Name, legal address and telephone numbers of parties responsible for performing maintenance tasks
- ❑ Description of annual maintenance tasks
- ❑ Description of all permanent public or private easements, overland flow paths and compensatory storage areas
- ❑ Description of dedicated sources of funding for maintenance

______ Subsurface Drainage (Tiles)

- ❑ Subsurface drainage survey
- ❑ Topographical boundary map locating each of the following: each slit trench; each drain tile with flow direction arrow, tile size and connection to adjoining properties; summary of tile investigation report showing trench identification number, tile size, material and quality, percentage of tile filled with water, percentage of restrictions caused by sediment, depth of ground cover, tile system classification; name, address and phone number of person/firm conducting investigation

______ A listing of all local, state and federal permits or approval letters that may be required including the application date

______ Submitting data required to MCSC, IDNR/OWR and FEMA for a LOMR (if applicable)

______ Submitting data required to MCSC, IDNR/OWR and FEMA for a LOMA (if applicable)

______ A copy of the Chicago District, U.S. Army Corps of Engineer's permit or a letter indicating that a permit is not required (For developments located in, near or adjacent to a wetland as shown on either the ADID, NWI or the NRCS)

______ IDNR/OWR Dam Safety permit or letter stating that it is not required if the development includes a dam prior to obtaining a watershed development permit.

______ Sealed statement from a registered professional engineer that the application meets the requirements of the McHenry County Stormwater Management Ordinance

3.3 Major Development Submittal Checklist

The following items should be submitted for a major development:

_______ Watershed Development Permit Application including:
- ❑ Name, legal address and telephone number of applicant
- ❑ Name, legal address and telephone number of the owner if different from the applicant
- ❑ Name, legal address and telephone number of applicant's agent (if used)
- ❑ Legal Description and/or PIN
- ❑ Common address of development
- ❑ Site location map of development
- ❑ Brief description of the proposed development
- ❑ Signature of applicant or applicant's agent

_______ A vicinity map with the Parcel Identification Numbers (PIN) of all parcels comprising the proposed development

_______ Anticipated dates of initiation and completion of activities

_______ Existing and proposed plans (grading, drainage, etc.) of the development including:
- ❑ Topography (minimum 2-foot contour interval, elevations referenced to NGVD)
- ❑ Location of all roads
- ❑ Overland Flow Paths
- ❑ Boundaries of predominate soil types
- ❑ Boundaries of predominate vegetation
- ❑ Drainage easements
- ❑ Location of detention and/or retention basins (including their inflow and outflow structures)
- ❑ Location, size and utilized flow capacities of all storm or combined sewers
- ❑ Location of all utilities and easements
- ❑ Specifications and dimensions of any proposed channel modifications, location and orientation of cross-sections
- ❑ Wetlands, lakes and ponds
- ❑ Floodplain and floodway boundaries
- ❑ Flood prone areas
- ❑ Easements and buffers

_______ Cross-section views for the stormwater management system including:
- ❑ Existing and proposed conditions
- ❑ Existing and proposed elevations
- ❑ Normal and base flood elevations
- ❑ Overland flow depths and paths

_______ Hydrologic and hydraulic report including:
- ❑ Names of the streams or bodies of water affected
- ❑ A statement of purpose of the proposed activity

- ❑ An analysis of the existing drainage system including the methodology and support calculations in computing runoff rates, runoff volumes, velocities, water surface elevations, and floodplain and depressional storage. This analysis will also include methodology and supporting calculations used to determine the effects from the upstream drainage areas.
- ❑ An analysis of the proposed drainage system including runoff rates, runoff volumes, velocities, water surface elevations, and floodplain and depressional storage. This analysis will also include the methodology and supporting calculations used to determine the effects from the upstream drainage areas.
- ❑ An analysis of the effects that the improvements will have on the receiving stream or body of water.
- ❑ All supporting design calculations and computer models
- ❑ How the proposed project meets all standards of the McHenry County Stormwater Management Ordinance

_______ A section in the hydrologic and hydraulic report for detention facilities (if required) including:

- ❑ Plots or tabulations of storage volumes and water surface areas with corresponding water surface elevations
- ❑ Stage-discharge or outlet rating curves
- ❑ Design hydrographs of inflow for the 2- and 100-year, critical duration (for storage) storm event under existing and proposed conditions
- ❑ Design hydrographs of outflow for the 2- and 100-year, critical duration (for storage) storm event under existing and proposed conditions
- ❑ All supporting design calculations

_______ A soil erosion and sedimentation control plan including:

- ❑ Name and telephone number of parties responsible for maintenance of erosion and sediment control practices
- ❑ The types of control to be used
- ❑ Site map (same scale as drainage plans) indicating the location of the control measures
- ❑ Detail drawings and specifications of the control measures
- ❑ All supporting design calculations
- ❑ Sequence of grading and soil disturbances
- ❑ Estimated installation schedule
- ❑ Regular maintenance schedule

_______ Subsurface Drainage (Tiles)

- ❑ Subsurface drainage survey
- ❑ Topographical boundary map locating each of the following: each slit trench; each drain tile with flow direction arrow, tile size and connection to adjoining properties; summary of tile investigation report showing trench identification number, tile size, material and quality, percentage of tile filled with water, percentage of restrictions caused by sediment, depth of ground

cover, tile system classification; name, address and phone number of person/firm conducting investigation

______ A maintenance plan including:

- ❑ Name, legal address and telephone numbers of parties responsible for performing maintenance tasks
- ❑ Description of annual maintenance tasks
- ❑ Description of all permanent public or private easements, overland flow paths and compensatory storage areas
- ❑ Description of dedicated sources of funding for maintenance

______ A listing of all local, state and federal permits or approval letters that may be required including the application date

______ Submitting data required to MCSC, IDNR/OWR and FEMA for a LOMR (if applicable)

______ Submitting data required to MCSC, IDNR/OWR and FEMA for a LOMA (if applicable)

______ A copy of the Chicago District, U.S. Army Corps of Engineer's permit or a letter indicating that a permit is not required (For developments located in, near or adjacent to a wetland as shown on either the ADID, NWI or the NRCS)

______ IDNR/OWR Dam Safety permit or letter stating that it is not required if the development includes a dam prior to obtaining a watershed development permit.

______ Sealed statement from a registered professional engineer that the application meets the requirements of the McHenry County Stormwater Management Ordinance

3.4 Special Flood Hazard Area Submittal Checklist

These additional items should be submitted for development in a regulatory floodplain or flood prone area:

______ Location map of the property, drawn to scale on the regulatory floodplain and floodway maps, and indicating what community it is in

______ Plans (grading, drainage, etc.) of the development including:

- ❑ Existing and proposed regulatory floodway limit, regulatory floodplain or flood prone area limit
- ❑ Existing water line for public bodies of water as defined by IDNR/OWR
- ❑ Cross-section views of the impacted reach showing existing and proposed conditions including principal dimensions with existing and proposed water surface elevations
- ❑ Normal elevations and 10- and 100-year frequency flood elevations
- ❑ Copy of the regulatory floodway map with project site delineated and marked to reflect any proposed changes in the regulatory floodway

______ A written hydrologic and hydraulic report including engineering calculation and supporting data showing that the proposed work will meet the performance standards of the Ordinance

______ Changes in grade resulting from any proposed excavation/filling

______ Location and dimension of all building and additions to buildings including the elevations for the lowest floor and lowest opening of all proposed buildings

______ For all buildings in the floodplain, elevation certificates of the lowest floor (including basements) or the elevation to which a non-residential building has been flood proofed

______ Structural and floodproofing certificates

- ❑ Elevation certificates of the lowest floor elevation for all residential structures
- ❑ Floodproofing certificates that show the elevation to which all non-residential buildings are floodproofed
- ❑ Certificates that show that all structures outside the Regulatory Floodplain or flood prone area have a lowest opening above the flood protection elevation (FPE)

3.5 Public Road Development Submittal Checklist

_______ Watershed Development Permit Application including:

- ❑ Name, legal address and telephone number of applicant
- ❑ Name, legal address and telephone number of the owner if different from the applicant
- ❑ Name, legal address and telephone number of applicant's agent (if used)
- ❑ Common address of development
- ❑ Site location map of development
- ❑ Brief description of the proposed development
- ❑ Signature of applicant or applicant's agent

_______ A listing of all local, state and federal permits or approval letters that may be required including the application date

_______ Report, supporting analyses, documentation and plans of the proposed drainage system including:

- ❑ Location and size of all existing and proposed drainage structures and improvements
- ❑ Plan, section and profile views of all existing and proposed drainage structures and improvements

_______ Hydrologic and hydraulic report including:

- ❑ Names of the streams or bodies of water affected
- ❑ A statement of purpose of the proposed activity
- ❑ Anticipated dates of initiation and completion
- ❑ Documentation and plans of any proposed floodway, floodplain or flood prone area modifications including construction or reconstruction of any existing and proposed development
- ❑ An analysis of the effects that the improvements will have on the receiving stream or body of water.
- ❑ All supporting design calculations and computer models
- ❑ How the proposed project meets all standards of the McHenry County Stormwater Management Ordinance

_______ A soil erosion and sedimentation control plan including:

- ❑ Name and telephone number of parties responsible for maintenance of erosion and sediment control practices
- ❑ The types of control to be used
- ❑ Site map (same scale as drainage plans) indicating the location of the control measures Detail drawings and specifications of the control measures
- ❑ All supporting design calculations
- ❑ Sequence of grading and soil disturbances
- ❑ Estimated installation schedule
- ❑ Regular maintenance schedule

3.6 Wetlands Submittal Checklist

For any development located in or adjacent to a wetland, it is necessary to determine the location, extent, and jurisdictional status of all potential wetland areas. A wetland determination report shall be prepared and submitted with any development permit application. If the area involves farmed wetlands subject to USDA-NRCS authority, a copy of that determination shall be submitted. If the applicant has requested a received a "Jurisdictional Determination" from the USACE for the subject area, that should also be submitted.

Any of the preceding wetland information submitted with a development permit application must be no more than two years old, to ensure that the information is still current.

The following items in the first grouping are typically contained in a wetland determination. The second, third and fourth groupings must be submitted if the proposed wetland impact proposes compensatory wetland mitigation.

______ Wetland Determination Report

- ❑ Aerial photograph showing wetlands and project boundaries
- ❑ Hydric soil map and verification
- ❑ Watershed boundaries
- ❑ Detailed wetland plant lists and representative color photographs
- ❑ A written description of the wetland(s) including a functional assessment of at least the hydrologic functions, water quality functions and special considerations

______ Wetland Mitigation Plan

- ❑ Names, addresses and telephone numbers of principals associated with implementation of the mitigation plan
- ❑ Statement of the concept, goals and objectives of the mitigation plan.
- ❑ Mapping of the development sites proposed conditions including wetland alterations, topography (recommended 1"=200' and 2' minimum contours), erosion and sediment control practices and construction storage and staging areas
- ❑ Documentation of hydrologic analysis that include normal and 100-year surface elevations and estimated seasonal water surface elevations
- ❑ A plan identifying how a site will be prepared for planting
- ❑ A planting plan which will notate the wetland community location, plant species, propagule type, commercial source of planting stock, planting density, planting method and planting schedule
- ❑ Statement of performance criteria for evaluating the success of the mitigation plan

______ Wetland Monitoring Plan

- ❑ Names, addresses and telephone numbers of principals responsible for management and monitoring
- ❑ Statement of expected management techniques and schedule
- ❑ Monitoring schedule, methods and reporting schedule

______ Long-Term Maintenance Plan

- ❑ Names, addresses and telephone numbers of principals responsible for long-term maintenance
- ❑ Documentation of all deed restrictions, covenants or conservation easements
- ❑ Documentation of a funding mechanism for the long-term maintenance of the wetlands

Section 4
Inspection Procedures

4.1 Introduction

Correct implementation and maintenance of Best Management Practices (BMPs) and other techniques are needed to protect McHenry County's water resources from the adverse effects of sedimentation and erosion. Inspections of construction sites and their control measures are necessary to ensure the protection of water resources and the compliance with the permitted plans.

Article V.E.4 of the McHenry County Stormwater Management Ordinance states, *the permittee shall make inspections and maintain on-site records of such inspection at the intervals specified below:*

> a. *Upon completion of installation of sediment and runoff control measures (including perimeter controls and diversions), prior to proceeding with any other earth disturbance or grading;*
>
> b. *After rough grading;*
>
> c. *After final grading; and*
>
> d. *Weekly and after each rainfall event of 0.5 inches of rain or more over a 24-hour period.*

Reports shall also be made after any necessary repairs to soil erosion and sediment control measures. A monthly inspection report, including copies of the on-site inspection records, is required to be submitted to the enforcement officer until such time as construction is completed. Construction plans approved by the Enforcement Officer shall be maintained at the site during the progress of the work.

In order to assist the Enforcement Officer's inspections to ensure compliance with the permitted erosion and sediment control plan, the grading permit, the building permit, and the SMO, the Enforcement Officer shall be notified within two (2) working days of the completion of the following construction stages (for intermediate and major developments):

> a. *Upon completion of installation of sediment and runoff controls, prior to proceeding with any other earth disturbance or grading,*
>
> b. *After stripping and clearing,*
>
> c. *After rough grading,*
>
> d. *After final grading,*
>
> e. *After seeding and landscaping deadlines, and*

f. After final stabilization and landscaping, prior to removal of sediment controls.

The Enforcement Officer may inspect site development at any stage in the construction process. All of the above requirements shall apply to intermediate and major developments. For minor developments, only a, c, and f of the above requirements shall apply.

This section contains an inspection form for use by the inspection officer during site inspections. Also included is information necessary for the applicant to comply with ongoing inspection and maintenance of the construction site.

4.2 Inspection Forms

4.2.1 Inspection Officer Form

The Inspection Officer may use this form for project site inspections. This form contains the basic guidelines for any site inspection, but more detailed inspection may be necessary depending on the site conditions and is left to the discretion of the Inspection and Enforcement Officers.

4.2.2 Project Inspection Forms

The McHenry County Stormwater Management Ordinance requires the permittee to make inspections and maintain records of inspections. Copies of the weekly inspection records are to be submitted to the enforcement officer in the form of a monthly inspection report.

It is necessary for the permittee to create a site-specific inspection report. The report shall identify all of the areas and measures that will be inspected. This may include, but is not limited to the following:

- All disturbed areas of the site,
- Areas for material storage,
- Locations where vehicles enter or exit the site, and
- All the erosion and sediment controls that are included in the permitted plans.

Inspections must determine if the erosion and sediment controls are in good working order. Inspections must be done while there is a portion of the site disturbed and construction activity is present. The inspection should primarily determine whether or not the control measure was installed or performed correctly, whether or not there has been damage to the control measure since it was installed or performed, and what should be done to correct any problems with the control measure.

SOIL EROSION AND SEDIMENT CONTROL
INSPECTION REPORT

Project Name: ________________________________ Permit #:______________________

Inspection Date:____/_____/_____ Time:_________ Inspected by:___________________

STAGE OF CONSTRUCTION

____ Pre-Construction Meeting
____ Clearing and Grubbing
____ Temporary Stabilization
____ Finish Grading
____ Initial Installation of SE/SC Measures
____ Rough Grading
____ Building Construction
____ Final Stabilization

YES	NO	N/A	INSPECTION CHECKLIST
__	__	__	1. Have all sediment-trapping measures been installed prior to site disturbance?
__	__	__	2. Have all soil erosion and sediment control devices indicated on the permitted plan set been installed?
__	__	__	3. Are all soil stockpiles adequately stabilized with the use of temporary seed and a sediment trapping device?
__	__	__	4. Are all perimeter sediment control devices properly installed and maintained?
__	__	__	5. Are all sediments basins and/or traps properly installed, stabilized and maintained in working condition?
__	__	__	6. Have all stormwater management systems been constructed, stabilized and are functioning?
__	__	__	7. Have all disturbed areas been stabilized with temporary or permanent measures within 14 days of the end of active hydrologic disturbance?
__	__	__	8. Are finished cut and fill slopes adequately stabilized?
__	__	__	9. Has all erosion control blanket, hydro-mulch, mulch or other erosion control devices been installed where required?
__	__	__	10. Are stormwater conveyance channels adequately stabilized with channel lining and outlet protection?
__	__	__	11. Do all operational storm sewer inlets have adequate inlet protection?
__	__	__	12. Do all construction ingress and egress points have a stabilized construction entrance installed?
__	__	__	13. Are soil and mud being kept off all adjacent public roadways?
__	__	__	14. Are measures being taken to control dust?
__	__	__	15. Are all utility trenches being properly backfilled, tamped and stabilized?
__	__	__	16. Are temporary stream crossings of non-erodible material installed where applicable?
__	__	__	17. Is necessary re-stabilization of in-stream construction complete?

YES NO N/A **INSPECTION CHECKLIST**

__ __ __ 18. Have all temporary control structures that are no longer needed been removed within 30-days of final stabilization?

__ __ __ 19. Is in-stream construction conducted using measures to minimize channel damage?

__ __ __ 20. Are properties and waterways downstream from development adequately protected from soil erosion and sediment deposition due to increases in peak stormwater runoff?

__ __ __ 21. Is there evidence of sediment leaving the site affecting downstream property?

Please explain: ____

____

WEATHER CONDITIONS: ____

SITE CONDITIONS: ____

COMMENTS: ____

____

____

REPORT BY:

____

Section 5
Applicable Local, State, and Federal Permits

Oftentimes, various permitting agencies are involved on a particular site due to the jurisdictional overlap that can occur. This section provides a comprehensive, yet not an exhaustive, list of permits that may be required for development in McHenry County. The applicant should be aware that a range of other permits from other agencies might be required for a development. Concurrent submittals to the Illinois Department of Natural Resources – Division of Water Resources Management (IDNR/OWR) (or its designee) and the Federal Emergency Management Agency (FEMA) may be required for activities within the Regulatory Floodway or Regulatory Floodplain. A Federal permit from the U.S. Army Corps of Engineers (Corps) may be required for development in a wetland, as well as Illinois Environmental Protection Agency (IEPA) water quality certification. Copies of the most frequently used permit applications are included in Appendix A.

5.1 Federal Programs

The Corps of Engineers and the EPA are the federal agencies that regulate water quality. Both agencies have authorities under Section 404 of the Clean Water Act (CWA), but the Corps alone has authority under Section 10 of the Rivers and Harbors Act. McHenry County is within the Great Lakes Center Chicago District jurisdiction, which is located at 111 N. Canal, Chicago, IL 60606 (http://www.lrc.usace.army.mil). Though not working within the regulatory framework, the U.S. Department of Agriculture Natural Resources Conservation Service (http://www.nrcs.usda.gov) and the Department of the Interior U.S. Fish and Wildlife Service (http://www.fws.gov/) work to provide educational and technical assistance to correct conditions and practices that threaten our water supply. The NRCS and Fish and Wildlife Service are working more closely than ever with other federal and state water agencies to improve water quality.

5.1.1 Section 10 – Rivers and Harbors Act of 1899 (RHA)

The mission of the U.S. Army Corps of Engineers is to develop, manage and protect our nation's waters and related land resources. Their jurisdiction includes waters that are, have been, or might be navigable for interstate commerce. This statute requires the Corps to regulate "all work or structures" placed in or affecting the navigable waters of the United States. Specifically, projects involving marinas, bulkheads, bank stabilization, shoreline protection, piers, pipelines, dredging, discharging or other work in dredging or discharging navigable waters of the U.S. requires a permit from the Corps. The Corps implements the Section 10 permit program, although the evaluation process includes review by other agencies as well as notification of the public.

5.1.2 Clean Water Act of 1977 (CWA)

Formerly known as the Federal Water Pollution Control Act (FWPCA), this statute was enacted principally to address the problem of water pollution, mainly by reducing discharges of pollutants, particularly from industrial sources, in U.S. lakes, rivers, and streams. The goals of the CWA established a system of water quality standards, discharge limitations, and permits. The CWA authorized EPA to require owners and operators of point source discharges to monitor, sample, and maintain effluent records. If a project results in the placement of material into waters of the United States, a Corps of Engineers Dredge and Fill Permit (Section 404 of CWA) may be required. It should be noted that the Section 404 permit also pertains to activities in wetlands and riparian wetland areas. Prior to the issuance of a Section 404 permit, the applicant must obtain a Section 401 certification. This declaration states that any discharge complies with all applicable effluent limitations and water quality standards. Certain Federal projects may be exempt from the requirements of Section 404 if the conditions set forth in Section 404(r) are met.

The full text of the Clean Water Act can be viewed on the following website: http://www4.law.cornell.edu/uscode/33/ch26.html

5.1.2.1 Section 401 - Clean Water Act

Under Section 401 of CWA, states have the authority to review any federal permit of license which may result in a discharge to waters of the United States, including Section 404 permit applications, to ensure that actions would be consistent with the State's water quality standards. A Section 401 review provides the State's water quality certification through the Illinois Environmental Protection Agency.

The full text of Section 401 can be viewed on the following website: http://www.usace.army.mil/inet/functions/cw/cecwo/reg/sec401.htm

5.1.2.2 Section 404 - Clean Water Act

This Section provides a special authority for the Corps, away from the general EPA permit authority, to issue permits for the discharge of two types of pollutants: dredged material and fill material. Under Section 404, a permit is required from the Corps before dredge or fill materials can be discharged into any waters of the U.S., including wetlands. Definition of "discharge" is broad and includes filling any U.S. waters for any type of development. Typical regulated activity includes mechanized land clearing, grading, leveling, ditching, redistribution of material and wetlands. This Section also encompasses more than just traditionally navigable waters as regulated by Section 10 of the Rivers and Harbors Act. In general, the Corps will not issue a Section 404 permit unless the proposed project complies with state laws, including state water-quality certification (Section 401) and state wetlands laws.

The full text of Section 404 can be viewed on the following website: http://www.usace.army.mil/inet/functions/cw/cecwo/reg/sec404.htm

On January 9, 2001, the Supreme Court ruled on a case that involved the Solid Waste Agency of Northern Cook County's (SWANCC) development of a disposal site that developed permanent and seasonal ponds in remnant excavation trenches. The Court ruled that CWA Section 404 does not apply to non-navigable, isolated and intrastate waters based solely on the use of such waters by migratory birds. The Corps will still exert control of navigable waters and adjacent wetlands; the term "adjacent" is defined as bordering, contiguous, or neighboring.

Both the Corps and EPA administer the Section 404 program, while the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) have advisory roles. The Corps has the primary responsibility for the permit program and is authorized to issue permits. The EPA reviews and comments on permit applications being evaluated by the Corps. The FWS consults and assists the Corp under the Fish and Wildlife Coordination Act (FWCA). The NMFS has review responsibilities similar to the FWS for certain Section 404 permit actions when they relate to marine resources.

404(a) - authorizes the Corps to issue permits for filling navigable waters, including wetlands. The CWA gave the Corps authority to issue permits, but no guidelines to evaluate them; so, the Corps relies heavily on its public interest review to evaluate permits.

404(b) - requires the Corps to issue permits in accordance with guidelines developed by EPA--the so-called "b-1 guidelines." These guidelines state that, among other things, "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem..." In addition, "no discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of the waters of the U.S."

404(c) - authorizes EPA to veto a decision by the Corps to issue a permit to fill in a wetland.

404(e) - authorizes the Corps to issue general permits on a state, regional, or nationwide basis for certain categories of activities in jurisdictional wetlands that are "similar in nature, [and] will cause only minimal adverse effect to the environment."

404(f) - exempts certain activities from the permit requirements, such as "normal farming, agriculture, and ranching activities, minor drainage, harvesting for the production of food, fiber and forest products, or upland soil and water conservation practices."

404(g) - authorizes States to assume the permit program from the Corps (except in the case of coastal waters), provided their program is approved by EPA.

5.1.3 NPDES Phase I and Phase II Stormwater Rules

The Environmental Protection Agency (EPA) published rules in the Federal Register on December 1988 and December 1999 for the regulation of stormwater discharges under the National Pollutant Discharge Elimination System (NPDES I & II) Program. Phase I rulings impacted Municipalities with separated sanitary and storm sewer systems with a population greater than 100,000. The Phase II ruling impacted smaller municipalities ranging in population from 10,000 to 100,000.

The rules place the burden of stormwater management upon the local community. The agency responsible for the construction, maintenance and operation of the stormwater treatment system will also be responsible for the quality of stormwater discharged. The NPDES rulings outline six minimum control measures required to be implemented by the effected communities by March 2003. The control measures include the following:

- Public Education and Public Outreach regarding stormwater impacts
- Public Involvement in stormwater related issues
- Detection and elimination of illicit discharge from storm sewer systems
- Stormwater runoff control from construction sites
- Post-construction stormwater management for developments
- Good house keeping procedures and practices.

Additional information on the NPDES program can be found on the EPA website: http://cfpub1.epa.gov/npdes/index.cfm

5.1.4 Endangered Species Act (ESA)

The federal ESA imposes compliance duties on federal agencies, licensees and permitees that require the subordination of state water rights to federal flow release schedules. ESA contains three major protection mechanisms: (1) listing, (2) agency consultation and protection duties, and (3) the prohibition against takings that is independent of any federal agency action.

Section 7 of the ESA involves consultation and protection duties by requiring a federal agency or that is funding, authorizing or carrying out an action to consult with the Secretary of the Interior (through Fish and Wildlife Service) before undertaking action which may adversely effect an endangered or threatened species. Section 9 of the ESA makes it unlawful to "take" an endangered animal species within the United States or territorial area of the United States. Theoretically, each time an endangered animal species is killed by a project, a Section 9 violation occurs.

The full text of the Endangered Species Act can be viewed on the following website: http://endangered.fws.gov/esa.html

5.1.5 National Flood Insurance Program

There are three different procedures that FEMA can use to remove a structure or parcel of property from the floodplain: Letter of Map Amendment (LOMA), Letter of Map Revision based on fill (LOMR-F) and Letter of Map Revision (LOMR). For applicants, state and community officials, the result is the same for each procedure - the removal of a structure or property from the floodplain to eliminate the NFIP regulations pertaining to construction in a designated floodplain and the mandatory Federal requirement for the purchase of flood insurance. However, FEMA views these as three distinct procedures that are enforced under three separate sections within the NFIP regulations. Therefore, it is in the best interest of the applicants that the procedures and their separate data requirements are understood. A good understanding will ensure that FEMA submittals are clear and complete, thus reducing the turnaround time for determination letters and avoiding misunderstandings of FEMA procedures.

Applicant's Note: The Ordinance is more restrictive than the NFIP regulations for new or substantially improved buildings. Under the Ordinance, the elevation of the lowest floor, including basement, must be above the BFE, which is two (2) feet above the BFE. Applicants must be cognizant of this additional requirement when coordinating a request for the removal of property or a structure from the floodplain with FEMA, the community, or when appropriate, IDNR/OWR.

The MT-EZ form and the FEMA Elevation Certificate are included in Appendix A.

Additional information can be viewed on the FEMA website: http://www.fema.gov/nfip

5.1.5.1 Letter of Map Amendment (LOMA)

For parcels of property or structures based on naturally high ground (i.e. involving no fill), FEMA will evaluate a request for removal from the Special Flood Hazard Area (SFHA) under Part 70 of the NFIP regulations. Parcels and structures which are inadvertently included within the SFHA on the current NFIP map may be removed from the SFHA by a LOMA issued by FEMA. An "inadvertent inclusion" refers to a parcel or structure, that due to mapping accuracy resulting from limitations in the NFIP map scale, has been incorrectly shown within the SFHA.

A LOMA will only be issued if the certified lowest lot elevation for an undeveloped parcel or the elevation of the lowest adjacent grade (LAG) for a structure is at or above the BFE and the ground surrounding the structure has not been altered by fill placed since the initial identification. The term "undeveloped" refers to property without a structure. The elevation of the top of foundation, first floor, finished floor, lowest opening, or lowest corner of the structure is not sufficient for this data requirement. FEMA is looking for the certified, absolute lowest grade around the outside of the structure where the soil meets the foundation. The LAG used in the LOMA determination considers the lowest grade for window wells, basement walkouts, patios, decks and porches, including any support posts or piers. As far as FEMA is concerned, any fill placed to establish the LAG at or above the BFE would prohibit the structure from being removed from the floodplain by the LOMA process. Once a parcel or structure is removed from the floodplain, the mandatory Federal requirement for the purchase of flood insurance is also removed.

Applicant's Note: Over the years, FEMA has changed the format and contents of the NFIP Elevation Certificate.

The current version is identified as FEMA Form 81-31, January 2003. Other versions, including superseded forms, remain in circulation among communities and insurance agents. Some of the older forms request an "average adjacent grade" instead of the lowest adjacent grade. For purposes of removing a structure from the SFHA, the certified lowest adjacent grade (LAG) will always be required, regardless of what a community official, insurance agent or lender requests. Therefore, it is important that this elevation be obtained during the field survey. This data is entered in Section C(f) of the current FEMA Elevation Certificate.

Revisions based upon physical changes to the floodplain (such as fill placement or the effects of flood control structures) or revised methodology which results in changes to BFEs, hydrology or hydraulics cannot be processed as a LOMA. Properties and/or structures located in the FEMA regulatory floodway on the NFIP map, but involving natural high ground, must be processed under FEMA's LOMR criteria for their removal from the floodway.

Because a LOMA involves a map amendment due to an inadvertent inclusion and not a map revision, the community can utilize the best available topographic data to determine whether high ground, which does not involve fill, is out of the floodplain. In this manner, the community can still administer a sound floodplain management program without requesting an official modification to the NFIP map by FEMA.

The LOMA application can be found at the following website:
http://www.fema.gov/library/mt-1.pdf (multi-lot) and
http://www.fema.gov/library/mt-ez.pdf (single lot).

5.1.5.2 Letter of Map Revision (LOMR)

(1) LOMR Based on Fill (LOMR-F)

LOMRs based on fill (LOMR-F) can be issued for requests which involve floodplain boundary changes, but do not involve BFE changes. This includes individual lots and structures or subdivisions. Fill placed in the FEMA regulatory floodway will require a detailed analysis to demonstrate that no increase (0.00 feet) in the BFE will result from the encroachment. If an encroachment in the floodway results in a BFE increase, the requestor must then process a floodway revision which requires a detailed hydraulic analysis, community acknowledgement, and approval of the revision by IDNR/OWR prior to the submittal to FEMA. The procedures to be followed for a floodway revision are listed in Section 65.7 of the NFIP regulations Removal of Property Based On Fill: Undeveloped parcels of property may be removed from the floodplain under Section 65.5 of the NFIP regulations by a LOMR-F provided that the entire parcel has been filled to an elevation at or above the BFE. The LOMR-F will be issued if the certified, lowest elevation on the lot is at or above the BFE, fill placed has been properly compacted to the specifications of the NFIP regulations (Section 65.5 (a)(6)) and community acknowledgement of the revision request is received by FEMA. Once a parcel of property has been removed from the floodplain by a LOMR-F, the NFIP regulations pertaining to the development of that property no longer apply unless the community adopts a more restrictive floodplain ordinance and decides to exert authority over development on property removed from the floodplain by FEMA.

Structures built on fill must have the LAG at or above the BFE and lowest floor, including basement or garage, at or above the BFE (2 feet above BFE in McHenry County) for the structure to be removed from the floodplain by FEMA and remain compliant with the Ordinance. FEMA will not accept the elevation of the top of foundation, lowest finished floor or lowest habitable floor in support of a request for a LOMR based on fill. Even though the entire lot may be filled, the elevation of the lowest floor, including basement and garage, must still be at or above the BFE. Under this situation, a lot may be partially inundated by the floodplain and still have a structure removed by a LOMR-F based on the LAG being at or above the BFE and lowest floor being above the BFE. This is permissible under the NFIP regulations since flood insurance pertains only to structures and contents and does not cover property or landscaping. A LOMR-F may be requested from FEMA for a lot once the fill has been placed and properly compacted, the community signs the required acknowledgement form and the certified as-built LAG and lowest floor elevations are available.

(2) LOMR Involving BFE or Floodway Changes (LOMR)
This type of LOMR is based on revised hydrology or hydraulics which reflect physical changes in the floodplain (i.e. a dam or channelization project) or revised input parameters for the technical analysis (i.e. updated data or methodologies).

For revisions to BFEs or the floodway, the supporting data for FEMA should include detailed hydrologic and hydraulic analyses, topographic mapping, community acknowledgement and IDNR/OWR approval (or statement of no interest). Revisions involving approximate Zone A areas will need an estimate of the BFE and appropriate changes to the floodplain boundaries. Revisions to detailed study areas (Zone AE or numbered Zone A areas on the NFIP map) require the same level of detail as the FIS. An FIS model will need to be provided for the entire stream for the same flood frequencies which are contained in the FIS. If only a floodway revision is requested, the 100-year baseline model may need to be revised to include any new cross-sections used in the floodway model to demonstrate that there are no impacts to the BFE or the floodplain boundary. The procedures and criteria for revisions to BFEs and floodways are covered under Sections 65.6 and 65.7, respectively, of the NFIP regulations.

The LOMR application can be found at the following website:
http://www.fema.gov/fhm/dl_mt-2.shtm

5.1.5.3 Conditional Letter of Map Revision (CLOMR)

A conditional letter of map revision (CLOMR) is issued by FEMA for proposed modifications in floodplains and floodways and is discussed in Section 65.12 and Part 72 of the NFIP regulations. In essence, CLOMRs are only a comment by FEMA for a proposed revision and do not actually revise the NFIP map. A final evaluation of the revision request cannot be completed until certified as-built plans and a final technical analysis are provided to FEMA. CLOMRs are optional for most types of modifications, although IDNR/OWR and some communities require a CLOMR from FEMA as part of their permit process. A conditional LOMR is only required by FEMA for proposed encroachment into a FEMA regulatory floodway that would cause any increase in the BFE.

The CLOMR application can be found at the following website:
http://www.fema.gov/fhm/dl_mt-2.shtm

5.1.5.4 Procedures for Submitting Map Revisions

The necessary supporting documentation involves the data required by the IDNR/OWR as well as that required by the FEMA. Further guidance for fulfilling these requirements is contained in *Appeals, Revisions, and Amendments to Flood Insurance Maps, A Guide for Community Officials* (Federal Emergency Management Agency, January 1990).

When the floodplain will be modified by development, the sequence regarding map revisions is as follows:

(1) Arrange a pre-application meeting with the Enforcement Officer to discuss the project concept, calculation techniques, and requirements for a CLOMR (optional, but advised).

(2) Submit a copy of the application letter for a CLOMR with supporting documentation, to the Enforcement Officer and the MCSC.

(3) Obtain community and MCSC concurrence for the CLOMR request.

(4) Forward the CLOMR application and community concurrence by the Enforcement Officer to FEMA if the development affects only a floodplain with less than 640 acres of tributary area or to IDNR/OWR and then to FEMA

if it affects the floodplain and floodway with more than 640 acres of tributary area.

(5) After receipt of the CLOMR, begin filling, grading, dredging, or excavation related to floodplain modification, but not general construction related to other structures or buildings in the floodplain, in accordance with plans set forth in the application.

(6) Submit a copy of the application letter for a LOMR with supporting documentation including certified as-built plans to the Enforcement Officer.

(7) Forward the LOMR application, as-built plans and community concurrence by the Enforcement Officer to FEMA, and IDNR/OWR as applicable.

(8) After receipt of the LOMR, the Enforcement Officer may issue development permits.

5.2 State Permits

5.2.1 Illinois Department of Natural Resources Office of Water Resources (IDNR/OWR)

The INDR/OWR administers the Rivers, Lakes and Streams Act (615 ILCS 5). The IDNR/OWR regulates all public water construction activities and all construction activities in the floodways of streams draining 1 square mile or more in urban areas and 10 square miles or more in rural areas.

For developments in northeastern Illinois including McHenry County, all developments within designated floodways are subject to the Floodway Construction Rules (17 Illinois Administrative Code, Part 3708). Dams are subject to the Rules for Construction and Maintenance of Dams (17 Illinois Administrative Code, Part 3702).

All developments in public waters are subject to the Regulation of Public Waters Rules (17 Illinois Administrative Code, Part 3704). All floodway construction projects are subject to the Construction in Floodways of Rivers, Lakes and Streams rules (18 Illinois Administrative Code, Part 3700).

Information on the IDNR/OWR permit program is available at:
http://dnr.state.il.us/owr/owr_programs.htm

The purposes of these regulations are to protect public interests and uses in the state's various public bodies of water and to prevent increased flood damage. The IDNR/OWR does not have the authority to ensure that the building protection standards and other requirements of the National Flood Insurance Program or the McHenry County SMO are met.

Application for the IDNR/OWR floodway permit is made on the Joint Permit Application, which includes the combined interests of IDNR, IEPA and the Corps. This form is required of:

> *"Anyone proposing to construct, operate or maintain any dam, dock, pier, wharf, sluice, levee, dike, building, utility crossing, piling, wall, fence or other structure in, or dredge, fill or otherwise alter the bed or banks of any stream, lake, wetlands, floodplain or floodway subject to State or Federal regulatory jurisdiction…"*

A copy of the Joint Application Form and instructions are included in Appendix A. The Joint Application Form and additional information are available online at: http://dnr.state.il.us/owr/owr_programs.htm

5.2.2 Illinois Department of Transportation (IDOT)

McHenry County is located within the IDOT Regional area of District 1 located at 201 W. Center Court, Schaumburg, Illinois. Developments generally requiring an IDOT permit are located along a marked or unmarked state route, an interstate frontage road or properties owned by the Department. Improvements such as a proposed entrance or any other construction activity within the state right-of-way require a permit. Additionally, stormwater discharge onto state right-of-way requires a permit.

Additional information is available on the IDOT website at: http://dot.state.il.us

5.2.3 Illinois Environmental Protection Agency (IEPA)

The IEPA oversees a wide range of environmental concerns. For developments in McHenry County, generally three permits are required. Water permits are issued for public water supply and distribution facilities. Sanitary sewer permits are issued for public wastewater collection and treatment. Permits are issued for construction sites over 5-acres through the National Pollutant Discharge Elimination System (NPDES) program.

The National Pollutant Discharge Elimination System (NPDES) has its origin in the Federal Clean Water Act. This program requires permits for the discharge of treated municipal effluent, treated industrial effluent and stormwater. The NPDES permits establish the conditions under which the discharge may occur and establish monitoring and reporting requirements. This program was delegated to Illinois from the federal program on October 23, 1977.

The statewide general NPDES permit for stormwater discharge associated with construction sites is included in Appendix A. Forms for applicants under the general NPDES permit for stormwater discharge associated with construction such as the Notice of Intent (NOI), Notice of Termination (NOT), and the Incidence of Non-Compliance (ION) are also included in Appendix A.

Additional information is available on the IEPA website at:
http://www.epa.state.il.us/water/index-wpc.html

5.2.4 Illinois Department of Natural Resources (IDNR)

The Department of Natural Resources has jurisdiction to protect the wildlife and native plant resources of the state. The IDNR has established the Endangered and Threatened Species Program. A development in McHenry County requires an IDNR Endangered or Threatened Species Consultation Program Agency Action Report if it is answers any of the following questions:

1. Is the development funded, performed, or authorized by a State agency or local government, regardless of whether it is carried out by private or public entities?

2. May the development result, directly or indirectly, in alteration of existing environmental conditions?

3. Does the development have the potential to adversely impact, directly or indirectly, a listed species or Natural Area?

Additional information is available on the IDNR website at:
http://dnr.state.il.us/espb/index.htm

5.2.5 Illinois Historical Preservation Agency (IHPA)

The IHPA is authorized through the IDNR for the archaeological and paleontological protection of Illinois public lands. The IHPA also serves as an advisory review agency for sites throughout Illinois.

Additional information is available on the IHPA website at:
http://www.state.il.us/hpa/ps/resourcesprotection.htm.

5.3 County/Local Permits

5.3.1 McHenry County Soil & Water Conservation District (SWCD)

The McHenry County SWCD was formed in 1947 under the "Soil and Water Conservation Districts Act" of 1937. This act specifically states that it is "in the public interest to provide (a) for the conservation of soil, soil resources, water and water resources in the State, (b) for the control and prevention of soil erosion, (c) for the prevention of air and water pollution, and (d) for the prevention of erosion, floodwater and sediment damages, and thereby to conserve natural resources, control floods, prevent impairment of dams and reservoirs, assist in maintaining the navigability of rivers and harbors, conserve wildlife and forests…" It is the SWCD's charge through this Act to assist in conservation and protection of the land, water, air and other resources of the State and McHenry County.

Additional information is available on the SWCD website at:
http://www.mchenryswcd.org/

5.3.2 McHenry County Highway Department (MCHD)

The McHenry County Highway Department's goal is to "provide transportation and planning to address the demands of maintaining the ever increasing lane miles in McHenry County in a safe and efficient manner, and to implement improved access management policies."

The MCHD has established the Access Management Ordinance (http://www.co.mchenry.il.us/CountyDpt/highway/HwyAMOrd.asp), which details the requirements for access permits onto County highways. The MCHD also issues various permits including a Highway Permit Application and a Utility Consent Permit. More information is available on the MCHD website at:
http://www.co.mchenry.il.us/CountyDpt/highway/default.asp

5.3.3 McHenry County Planning and Development

The McHenry County Planning and Development department consists of four divisions including the Permitting, Inspection, Enforcement (P.I.E.) Division, the Planning Division, the Mapping/Graphic Division, and the Community Development Division.

The P.I.E. Division issues building and construction permits and the various permits and checklists can be found on their website at:
http://www.co.mchenry.il.us/CountyDpt/plandev/PIEDiv.asp.

Additional information is available on the McHenry County Planning and Development website at:
http://www.co.mchenry.il.us/CountyDpt/plandev/default.asp

Section 6
References

General References/Section 1

McHenry County Stormwater Committee. 2001. *McHenry County Watershed Development Ordinance*.

McHenry County Stormwater Committee. 1996. *McHenry County Comprehensive Stormwater Management Plan.*

Lake County Stormwater Management Commission. June 1992. *Technical Reference Manual*.

DuPage County Stormwater Management Committee. April 1992. *Technical Guidance for the DuPage Countywide Stormwater and Floodplain Ordinance*.

Kane County Stormwater Management Committee. October 2001. *Technical Guidance Manual*.

Center for Watershed Protection, Inc. 2000. *Stormwater Manager's Resource Center (SMRC)* Website www.stormwatercenter.net Location: Ellicott City, MD

Section 2 Performance Standards

Section 2-1 Water Quality Protection

Center for Watershed Protection, Inc. 2000. *Stormwater Manager's Resource Center (SMRC)* Website www.stormwatercenter.net Location: Ellicott City, MD

Center for Watershed Protection, Inc. *Stormwater Practices in Cold Climates*. No longer available in print, available at www.cwp.org

Dreher, D. and T. Price. 1992. *Best Management Practice Guidebook for Urban Development*. Northeastern Illinois Planning Commission.

Illinois Environmental Protection Agency. 1987. *Standards and Specifications for Soil Erosion and Sediment Control*.

Illinois Environmental Protection Agency Bureau of Water. 2000. *Conditions of Illinois Water Resources 2000*.

Natural Resources Conservation Service. 1995. *Illinois Urban Manual*. (1999/2000 updates available online at www.il.nrcs.usda.gov/technical/engineer/urban)

Schueler, T.R. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's*. Metropolitan Washington Council of Governments, Washington, D.C.

United States Environmental Protection Agency. 1993. *Urban Runoff Pollution Prevention and Control Planning Handbook.*

United States Environmental Protection Agency Office of Water. *Post Construction Stormwater Management BMP Fact Sheets Website***.**

The Urban Committee of the Association of Illinois Soil and Water Conservation Districts. July 1998. *Procedures and Standards for Urban Soil Erosion and Sedimentation Control in Illinois* (the Green Book).

Washington State Department of Ecology Water Quality Program. August 2001. "Infiltration and Bio-Infiltration Treatment Facilities." *Stormwater Management Manual for Western Washington,* Volume 4.

Section 2-2 Soil Erosion and Sediment Control

Dreher, D. and T. Price. 1992. *Best Management Practice Guidebook for Urban Development*. Northeastern Illinois Planning Commission, Chicago.

Illinois Department of Transportation. 2000. *Bureau of Design and Environmental Manual*.

Illinois Environmental Protection Agency. 1987. *Standards and Specifications for Soil Erosion and Sediment Control*.

The Urban Committee of the Association of Illinois Soil and Water Conservation Districts. July 1998. *Procedures and Standards for Urban Soil Erosion and Sedimentation Control in Illinois* (the Green Book).

Natural Resources Conservation Service. 1995. *Illinois Urban Manual.* (1999/2000 updates available online at www.il.nrcs.usda.gov/technical/engineer/urban)

Section 2-3 Stormwater Management

Arendt, Randall G, 1996. *Conservation Design for Subdivisions, A Practical Guide to Creating Open Space*

Center for Watershed Protection. 2000. *Better Site Design and Stormwater Management Techniques for Phase II Communities*.

Chow, Ven Te. 1959. *Open Channel Hydraulics.* McGraw-Hill Book Company, Inc., New York, NY.

Delaware Department of Natural Resources and Environmental Control and The Environmental Management Center. 1997. *Conservation Design for Stormwater Management, A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use.* Brandywine Conservancy.

Department of Environmental Resources, Prince's George County, Maryland. 1997. *Low-Impact Development Design Manual*

Dreher, D. and T. Price. 1991. *Investigation of Hydrologic Methods for Site Design in Northeastern Illinois*. Northeastern Illinois Planning Commission, Chicago.

Dreher, D. and T. Price. 1997. *Reducing the Impacts of Urban Runoff: The Advantages of Alternative Site Design Approaches.* Northeastern Illinois Planning Commission, Chicago.

Huff, F.A and J.R. Angel. 1989. *Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois.* Illinois State Water Survey, Bulletin 70.

Illinois Department of Transportation. 2000. *Bureau of Design and Environmental Manual*.

Illinois Department of Transportation. *Drainage Manual*.

Norman, J.M; R.J. Houghtalen; and W.J. Johnston. September 1985. *Hydraulic Design Highway Culverts*, Hydraulic Design Series No. 5. Federal Highway Administration Office of Implementation.

Natural Resources Conservation Service. June 1986. *Urban Hydrology for Small Watersheds: TR-55*.

Natural Resources Conservation Service. 1971. N*ational Engineering Handbook, Section 4 Hydrology.*

Section 2-4 Floodplain Management

Federal Emergency Management Agency. 1991. *Answers to Questions About Substantially Damaged Buildings.*

Federal Emergency Management Agency. 2001. *Federal Emergency Management Agency: National Flood Insurance Program (NFIP) Home Page* Website www.fema.gov/nfip/.

Illinois Association for Floodplain and Stormwater Management. March 2000. *Floodplain Management Home Study Course*.

Illinois Department of Natural Resources. 2001. *Illinois Department of Natural Resources, Office of Water Resources (IDNR-OWR)* Website http://dnr.state.il.us/owr/owr_programs.htm