appendix F - watershed best management practice toolbox

This is an expanded and more detailed version of the watershed best management toolbox contained in Chapter 4.

1 INTRODUCTION

The best management practice tools and techniques described in this chapter, when applied to the watershed, can be used to help achieve the watershed goals and objectives identified in the watershed plan. The watershed techniques presented are broadly organized into the following categories: policy and planning, water quality, flooding, and natural resources. Many watershed protection tools can be categorized as *preventive* or *remedial*, and many others can be categorized as both preventive *and* remedial, and are classified as such. Some practices also can be used to *retrofit* previously constructed landscape elements.

Preventive measures reduce the likelihood that new watershed problems such as flooding or water quality degradation will arise, or that existing problems will worsen. Preventive techniques generally target new development in the watershed and are geared toward protecting and preventing degradation of existing resources. Planning, regulatory and administrative programs, alternative site designs, and construction practices are examples of preventive measures. Prevention also includes measures that protect the natural drainage system through land acquisition and conservation management.

Remedial measures are used to solve known watershed problems or to improve current watershed conditions. Remedial measures include retrofitting drainage system infrastructure such as detention basins and stormsewer outfalls to improve water quality, adjust release rates, or reduce erosion. Both water quality and water quantity problems can be addressed by installing measures that improve infiltration and reduce runoff. Examples include disconnecting downspouts from stormsewers, installing biofilters, and retrofitting landscaping with deep-rooted native vegetation. Other remedial techniques range from stabilizing eroded streambanks and restoring wetlands to floodproofing and additional runoff storage for flood mitigation.

The USEPA document *National Management Measures to Control Nonpoint Source Pollution from Urban Areas* (2005) contains additional details and additional tools and practices for watershed improvement and urban nonpoint source pollution control.

2 WATERSHED PLANNING AND POLICY

2.1 POLICY AND REGULATION

Policies and regulations establish and enforce minimum standards for protecting watershed resources, particularly water quality. Regulations are most useful when incorporated into state and federal statutes and administrative rules, or in local ordinances. Watershed issues and problems can be most effectively addressed at the local level since local units of government are responsible for land use planning and development decisions. In addition to local controls, state and federal regulations, such as the federal Clean Water Act, include requirements directed at water resource protection. Water quality and quantity impacts are considered in stormwater permits for large municipalities, wetland permitting (Section 404) and with soil erosion and sediment control requirements for new developments (Rule 5).

2.1.1 Zoning Ordinances

Preventive

Zoning ordinances regulate development by dividing a community into zones or districts and then setting development criteria for each district. Zoning can be used to control where new development or redevelopment occurs, so that new flood problems are not created and existing flood problems are not worsened. Two zoning approaches can be used to prevent inappropriate development in floodprone areas. They involve establishing separate zoning districts or using overlay zoning. Separate districts designate floodplain as a special zoning district that only allows development that is not susceptible to flood damage, such as recreational uses, conservation or agriculture. Overlay zoning adds special development limitations to the underlying zoning (i.e. residential, commercial, industrial etc.) in areas subject to flooding.

2.1.2 Lake County Watershed Development Ordinance

Preventive

In addition to zoning ordinances, regulations that restrict construction in floodplains are usually found in one or more of the following documents: subdivision ordinances, building codes, and/or separate, stand-alone stormwater ordinances such as the Watershed Development Ordinance in Lake County. If the zoning for a site allows a structure to be built, then the applicable subdivision and building regulations will impose construction standards to protect buildings from flood damage, and will require compensatory storage to prevent the development from aggravating an existing flooding problem. Subdivision ordinances specifically govern how land will be subdivided into lots, and set standards for infrastructure provided by the developer including roads, sidewalks, utilities, stormwater detention, stormsewers and drainage ways. Building codes should establish flood protection standards for all structures.

Lake County's Watershed Development Ordinance was enacted as a preventive measure and requires that consistent stormwater management practices be applied countywide. In concept, the WDO should be a fairly effective measure for coordinating at the watershed level to prevent both water quantity and quality problems. While LCSMC has over-all administrative responsibility for the WDO in the county, many communities, upon request, have been delegated the authority to administer and enforce the ordinance through a certification process. All Illinois communities in the watershed (Winthrop Harbor, Beach Park, Zion, and Waukegan) are certified to enforce the WDO.

Because of limited staff and varied priorities, WDO enforcement by certified communities is not always as effective as it should be. Strategies to improve WDO enforcement that were incorporated into the 1999 amendment of the ordinance include providing more training opportunities for enforcement officers, making participation in specific training workshops a requirement for community re-certification (rather than optional), and holding certified communities more accountable for lax enforcement within their jurisdictions during re-certification. In particular, the water quality requirements in the WDO are not consistently applied and enforced throughout the watershed. WDO amendments adopted in 1999 have improved the ordinance language and more clearly specify WDO requirements so they are less subject to loose interpretation and application.

The WDO contains three primary requirements that address water quality. One requirement is to use landscaping best management practices (BMPs) to treat at least 0.01 inch of runoff for every one percent of impervious surface in a development, with a minimum volume equal to 0.2 inches of runoff (e.g. 20% or less impervious area requires 0.2 inches to be treated; 50% impervious area requires 0.5 inches to be treated; 90% impervious area requires 0.9 inches to be treated) before releasing it to the drainage system. The ordinance does not dictate how water quality treatment should be done, it only requires that these runoff quantities be treated. The WDO generally references the Lake County Stormwater Management Commission's Technical Reference Manual for design guidance on water quality treatment BMPs.

The second WDO requirement for water quality protection is the installation of soil erosion and sediment control measures on building sites for the purpose of preventing erosion, or at minimum, preventing sediment from leaving the site. Soil erosion & sediment control requirements include the use of filter barriers, sediment traps, settling basins, side slope stabilization, filters on stormsewer inlets, and temporary and permanent vegetative stabilization. Filter barriers (such as silt fence) are required for disturbed areas that drain less than 1 acre. Sediment traps are required for disturbed areas that drain from 1-5 acres, and sediment basins are required for disturbed areas greater than 5 acres.

The third WDO water quality requirement is to provide buffers for waterbodies to filter sheet flow runoff before it drains into the water body. This requirement applies to streams, rivers, wetlands and lakes. See section below and Article IV Section B.1.i. of the WDO for more detailed information on buffer requirements.

The WDO does not include performance standards for the required BMPs. Therefore, while the effectiveness of various BMPs has been documented, variability in the approval, application, maintenance, and monitoring of the BMPs leads to variable results for preventing water quality impacts from development. The 1999 WDO amendments clarified the level of water quality treatment required by the WDO and improved enforcement procedures. One key amendment to the soil erosion & sediment control provisions is the requirement for on-site pre-construction meetings prior to the commencement of earthmoving. The 1999 water quality amendments have resulted in more consistent implementation of BMP requirements for water quality protection by all of the watershed communities.

The Illinois Department of Natural Resources (IDNR) regulates development in the floodplain through a statewide permit program. IDNR has delegated floodplain permitting authority to the LCSMC subject to concurrence by the IDNR. All development in floodplains requires a WDO permit. The WDO restricts development in mapped floodways and limits development in the 100-year floodplain. Lowest floor elevations (including basements) must be a minimum of 2 feet above the base flood elevation (BFE) for residential structures constructed in the floodplain. Non-residential structures must also meet these lowest floor elevation requirements, or be dry-floodproofed to 2 feet above the BFE. In addition to elevating the structures, compensatory storage must be provided for water storage lost due to floodplain fill at a ratio of 1.2:1 for riverine floodplain and 1:1 for depressional floodplain.

All Lake County communities must adhere to the standards required in the WDO as minimum development requirements for their community. Depending on flood risk, individual communities can adopt floodplain regulations that are more restrictive than the minimum requirements of the WDO.

Some of the development in the watershed was developed before the WDO became effective; therefore WDO requirements for detention and water quality treatment did not apply to these areas. However, the WDO applies to both new developments and redevelopment projects, and the WDO flood prevention and water quality provisions have the potential to improve conditions in redeveloped areas or areas where homeowners desire significant improvements to their structures.

Tailoring the Lake County WDO to the specific conditions that exist in the watershed would be an effective tool to prevent further flood damage (and water quality degradation). The main provisions of the WDO that affect runoff are the maximum allowable release rates and the runoff volume reduction hierarchy (RVRH; Table 6).

The release rate requirement applies to the maximum runoff rate that can occur from a parcel after it has been developed. Currently, the maximum release rate is 0.04 cubic feet per second per acre (cfs/ac) for the 2-year 24-hour storm event and 0.15 cfs/ac for the 100 year, 24 hour storm event. An effective way to lower or maintain peak flows and to prevent new flooding problems is to establish more stringent release rates specific to the watershed.

The runoff volume reduction hierarchy specifies that sites should choose a strategy that minimizes the increase in runoff volumes and rates from development. However, there is some debate on whether some or all of the runoff reduction techniques in the WDO should be implemented on a voluntary basis, or be required as a part of a stormwater management regulatory program. Currently, the WDO does not provide explicit incentives for developers to use the hierarchy and it is not consistently enforced. Experience has shown that permit reviewers from certified communities have interpreted the requirements of the hierarchy in different ways, therefore the hierarchy has not been consistently applied throughout the county. The runoff volume reduction hierarchy language in the WDO was amended in 1999 to provide more clarity. Individual communities have the greatest authority to improve the use and effectiveness of the hierarchy by attaching density or other incentives to its use. The Kellogg Creek watershed along with all other watersheds in Lake County would benefit from stronger and more consistent enforcement of the runoff volume reduction hierarchy, which includes:

1. Preservation of natural resource features of the development site (e.g. floodplains, wetlands, isolated Waters of Lake County, prairies and woodlands).
2. Preservation of the existing natural streams, channels, and drainageways.
3. Minimizing impervious surfaces created at the site (e.g. narrowing road width, minimizing driveway length and width, clustering homes, and shared driveways).
4. The use of open vegetated channels to convey stormwater runoff.
5. Preservation of the natural infiltration and storage characteristics of the site (e.g. disconnection of impervious cover and on-lot bioretention facilities).
6. Structural measures that provide water quality and quantity control.
7. Structural measures that provide only quantity control and conveyance.

The WDO emphasizes the use of detention as the primary stormwater management control measure for Lake County. Detention is used to prevent an increase in the rate of runoff from a site after it is developed, and is the designated measure to achieve the post-development release rates required by the WDO. The release rate requirements apply to all development where the total land area in an ownership parcel results in:

1. More than one acre of impervious surface; or
2. Has more that 3 acres of hydrologically-disturbed area (unless the new impervious surface is less than one-half acre); or
3. Has an impervious surface area ratio of 50% or greater (unless the new impervious surface is less than one-half acre).

The additional volume of runoff generated by new impervious surface is not directly addressed in WDO requirements, although the runoff volume reduction hierarchy is designed to mitigate the effects of increased runoff.

2.1.3 Wetland Regulation

Preventive

Another preventive measure that can benefit the watershed is the wetlands regulatory program. Since the 1970s, wetlands have been regulated through a permit program administered by the US Army Corps of Engineers (USACE) under the authority of the Clean Water Act. In 1997, the USACE, the Natural Resources Conservation Service (NRCS), Lake County Soil & Water Conservation District (LCSWCD) and the LCSMC entered into a cooperative agreement to more stringently review and enforce soil erosion and sediment control on development sites that include wetlands. While coordination among the permitting staff of these agencies has improved dramatically, the watershed would also benefit from better coordination regarding wetland mitigation and restoration.

Because of the existing flooding and water quality problems in the watershed, it is important that the watershed not lose any more wetland acreage through the USACE permit program. On August 14, 2001, the Lake County Board unanimously approved amendments to the Watershed Development Ordinance (WDO) to protect isolated wetlands that were no longer under regulation by the federal Clean Water Act administered by the U. S. Army Corps of Engineers (Corps). The amendments require the applicant to first submit a jurisdictional determination (JD) request to the U.S. Army Corps of Engineers. The Corps decides whether the wetland in question is jurisdictional under the Clean Water Act, or isolated by nature of the SWANCC Supreme Court Decision. LCSMC wetland staff are now authorized by the Corps to perform preliminary JDs under an Interagency Coordination Agreement (ICA). In this case, LCSMC sends JD information to the Corps for concurrence.

Another measure to prevent wetland losses centers on where wetland mitigation and restoration occur. Historically, wetlands lost in the watershed could have been mitigated in any watershed throughout the six-county Chicago metropolitan region. Recent WDO amendments require that all wetland losses in Lake County be mitigated in Lake County in order to receive a Watershed Development Permit. As an alternative, a cooperative agreement could be developed between the permit agencies (LCSMC, USACE) and the US Fish & Wildlife Service and the Natural Resources Conservation Service that stipulates that any wetland mitigation required for unavoidable losses should be located within the same watershed where the loss or impact occurs. This agreement could also spell out the permitting agencies' roles and responsibilities in promoting, coordinating and funding wetland restoration projects within the watershed.

2.2 LAND USE AND DEVELOPMENT PLANNING

2.2.1 Watershed Planning

Preventive and Remedial

Watershed planning is a broad land use management tool used to understand existing conditions, predict future land use impacts on water resources, develop water resource protection goals, identify tools needed to protect water resources, and anticipate costs for implementing watershed protection tools (Center for Watershed Protection 1998). Watershed planning typically addresses land use management strategies, such as policy changes, land use planning such as alternative site designs, open space protection, stormwater management measures, and land restoration.

2.2.2 Site Planning

Preventive and Remedial Retrofit

Site planning that incorporates open space protection and stormwater and landscaping BMPs is an effective tool for protecting and improving watershed resources. Alternative site designs and conservation developments are planning and design processes that reduce impervious cover, incorporate runoff reduction strategies, and protect open space for infiltration and recreational opportunities.

Natural Drainage Measures
A series of features that can be used in new development sites (and larger redevelopment sites) throughout the watershed are 'natural' drainage measures. Natural drainage measures use vegetated swales, filter strips and other techniques that absorb, filter and convey runoff. Natural drainage measures can significantly reduce runoff volumes by allowing infiltration of stormwater, while conventional drainage systems (e.g. stormsewers, concrete-lined channels, or curbs and gutters) accelerate the delivery of runoff to the receiving water. In addition to infiltration benefits, natural drainage measures can remove pollutants from runoff by using vegetation to filter and absorb pollutants. Natural drainage measures often cost less to build than conventional drainage systems, and the use of native vegetation with natural drainage practices requires less maintenance and provides wildlife habitat. A number of these measures are described in detail in section 3.2 Stormwater & Landscaping Best Management Practices.

Impervious Area Reduction
Impervious surface area, water quality, and runoff volumes are directly correlated. The Chicago Metropolitan Agency for Planning (formerly NIPC) estimates that, on an annual basis, stormwater runoff volumes from impervious surfaces such as parking lots are four times as great as the volume off of lawns (Dreher and Price 1997). Along with the increased amounts of runoff, there are also greater amounts of nonpoint source (NPS) pollutants carried in the runoff. Studies indicate that there is a direct relationship between the amount of impervious surface in a watershed and the quality of the receiving stream, as in the table below.

Table F.1. Relationship between Impervious Cover and Stream Quality.

Impervious Cover	Stream quality
0 -10%	good (stressed)
11 - 25%	fair (impacted)
>25%	low (degraded)

Source: Schueler and Claytor (1997)

There are several ways to reduce imperviousness through the use of alternative site designs that will result in smaller increases in runoff following development. After reducing impervious area as much as possible using the practices below, connectivity of the remaining impervious areas can be reduced to provide additional benefits. A few rather simple ways to do this include directing downspouts to vegetated, bioretention, or infiltration areas; directing flows from driveways to vegetated areas; breaking up flow directions from expansive paved areas; encouraging sheet flow through vegetated areas; and carefully locating impervious areas so that they drain as naturally as possible and runoff from the site is minimized.

Alternative Site Designs and Streetscapes
Alternative site design techniques can be used for new developments and redeveloped sites. Alternative site designs use a series of best management practices to:

- Reduce the amount of impervious surface area on the development site thereby reducing the amount of stormwater runoff and the risk of new flooding.
- Preserve the natural infiltration and storage characteristics of a site.
- Improve the water quality of runoff from a site by using the landscape to filter and infiltrate runoff.

Alternative site designs incorporate runoff reduction strategies, water quality enhancements, and protect more open space for infiltration and recreational opportunities. Alternative site designs use the following techniques: maintain the natural drainage system; use vegetated swales rather than traditional curb, gutter and stormsewer; reduce the percent of impervious surface; and cluster buildings (Dreher and Price 1997; Price, Dreher and Schaal 1994; Terrene Institute 1994; Schueler 1995; Arendt 1996).

After building rooftops, the major contributors to high impervious surface areas are roadways, driveways, parking areas, and sidewalks. Minimizing and disconnecting these areas helps reduce total impervious area and runoff. Residential streets should be designed for the minimum required pavement width needed to support travel lanes, parking, emergency and service vehicles, and should be based on the average expected volume of traffic rather than maximum traffic volume. Excessive pavement widths make streets the largest single component of impervious cover in a subdivision, and narrowing streets can significantly reduce the amount of impervious surface. For example, reducing low density residential street widths from 32 to 20 feet will result in an approximate 18% reduction in impervious surface for a typical ¼ acre lot subdivision, and a 6% reduction in impervious area over an entire watershed (Table 8). Examples of narrow residential street widths range from 16-20 feet with no parking, to 26-28 feet with parking. "Several national engineering organizations have recommended that residential streets can be as narrow as 22 feet in width (AASHTO, 1994; ASCE, 1990) if they serve neighborhoods that produce low traffic volumes (less than 500 daily trips, or 50 homes)" (Center for Watershed Protection 1998). Narrower streets also tend to discourage cut-through traffic and speeding.

Alternatives to the conventional grid road layout can potentially reduce imperviousness 26 percent, but may reduce the connectivity of road networks and impede effective and efficient traffic flow. Fragmented grids, warped parallel, and loop / cul-de-sac layouts all require fewer total feet of pavement than the grid pattern. In turn, cul-de-sac design can be altered to reduce pavement area. A few alternatives include reducing the radius of the cul-de-sac, adding a vegetated island to the middle of the cul-de-sac to serve as both an aesthetic street feature as well as a bioretention area, or using a "T" or "hammerhead" terminus rather than a cul-de-sac. Additionally, road segments can be strategically placed within the layout to fit the existing topography (such as locating roads on ridgelines). Reductions in the width of paved roads will reduce total imperviousness as well as clearing and grading impacts.

Curb and gutter features are part of many stormwater conveyance systems, collecting sheet flow from impervious areas and channeling it into a collection system or a receiving water body. For low impact developments, curb and gutter systems can be eliminated or modified to reduce runoff, increase lag time and provide water quality treatment. Eliminating curb and gutter and utilizing vegetated roadside swales may reduce paved width by 30 percent or more. If curbs cannot be eliminated completely, the number of curb cuts should be increased, preferably discharging to some sort of pretreatment or bioretention facility.

Likewise, if it is feasible to remove on-street parking from one or both sides of the street, doing so has the potential to reduce imperviousness 25 to 30 percent. The effect of driveways, while difficult to completely eliminate, can be reduced in a number of ways. Shared driveways may be an alternative in some instances, driveway width and length can be reduced (a width of 9 feet is suggested) and alternative driveway materials such as porous pavement or gravel should be considered (these also delay runoff longer than asphalt or concrete).

Another significant reduction in impervious area can be achieved by reducing building setbacks. Reduced setbacks result in shorter driveways and less impervious surface. For example a 30-foot setback decreased to 20 feet still allows sufficient length for parking in the driveway. However, it eliminates 10 feet of wasted driveway space (and impervious surface) that was too short for another car length. This design practice adds the benefit of more back yard, which tends to be utilized for "living space" more than front yard areas.

Sidewalk area can also be decreased to reduce imperviousness without losing functionality. For example, sidewalks can be narrowed from 5 feet to 4 feet in residential areas, and/or only installed on one side of the street, though this is not the best approach from an urban design perspective. Another option for reducing paved area is to design pervious paths located away from the streetscape as an alternative to traditional sidewalks. Overall, combining the above reductions in impervious area from narrower streets, smaller turnarounds, shorter setbacks and narrower sidewalks will result in a significant reduction in imperviousness within a development (Dreher and Price 1997).

Alternative Parking Lot Designs

Alternative parking lot designs that reduce impervious surface can be used in most types of non-residential developments and some multi-family developments. These

Table F.2. Innovative site planning techniques and their effect on impervious cover.

Strategy	Impervious Reduction (%)
Reduce residential sidewalks 50% by installing on only 1 side of the street	1.3
Reduce residential sidewalks from 5 feet to 4 feet width	0.5
Reduce local access street widths from 32 feet to 27 feet Reduce local access street widths from 32 feet to 25 feet Reduce local access street widths from 32 feet to 20 feet	2.5 3.5 6.0
Reduce commercial parking by 5 percent Reduce commercial parking by 10 percent Reduce commercial parking by 20 percent	2.7 5.3 10.7
Reduce multifamily parking by 5 percent Reduce multifamily parking by 10 percent Reduce multifamily parking by 20 percent	0.7 1.5 3.0
Reduce commercial, industrial and multifamily roof areas by 10 percent Reduce commercial, industrial and multifamily roof areas by 20 percent	4.3 8.5

“green” parking lots use techniques to reduce parking lot runoff by either reducing the size of the paved parking lot, or designing the parking lot to catch and infiltrate runoff. Several techniques used to reduce the size of parking lots include:

- reviewing and updating peak parking demand assumptions to make sure that allocated parking is actually needed and being used;
- banking parking for new developments rather than constructing a parking lot that will initially be oversized;
- reducing the size of some of the parking stalls for smaller vehicles;
- sharing parking lots between users.

Parking lot designs that increase infiltration usually incorporate excavated islands or swales between rows of cars where runoff is directed through curb cuts. The vegetated swales infiltrate and filter the runoff, thereby reducing the volume of stormwater directed to stormsewers. Alternative parking lot designs frequently cost less to build and maintain than traditional lots. For example, bio-swales used in a parking lot at the Oregon Museum of Science and Industry resulted in a $78,000 savings compared to a conventional lot design (USDA Natural Resources Conservation Service 1997).

When the techniques described in this section are used together on a development site to reduce runoff, this is referred to as a runoff volume reduction hierarchy. The goal of this hierarchy is to maintain runoff volumes and rates from the developed site as close as possible to pre-development conditions. When these techniques are combined with an integrated on-site system to also improve water quality, this system is called a treatment train. The goal of the treatment train is to reduce pollutants in urban stormwater runoff to the maximum extent possible through the use of multiple stormwater management techniques.

2.2.3 Conservation Design Development/ Low Impact Development

Preventive

The goal of conservation development is to protect open space and natural resources for people and wildlife while at the same time allowing development. Conservation design developments designate half or more of the buildable land area as undivided permanent open space. They are density neutral, allowing the same density as in conventional developments. Density is realized on smaller areas of land by clustering buildings and infrastructure. In addition to clustering, conservation design developments incorporate natural riparian and natural area buffers and setbacks for streams, wetlands, other water bodies and adjacent agricultural land (Dreher and Price 1997; Terrene Institute 1994; Schueler 1995; Arendt 1996).

The first and most important step in designing a conservation development is to identify the most essential lands to preserve in conservation areas. Natural features including streams, wetlands, lakes, steep slopes, mature woodlands, native prairie and meadow (as well as significant historical and cultural features) are included in conservation areas. Clustering is a method for preserving these areas. Clustered developments allow for increased densities on less sensitive portions of a site, while preserving the remainder of the site in open space for conservation and recreational uses (such as trails, soccer or ball fields).

Clustering is often used in planned unit developments (PUDs) or planned residential developments (PRDs). PUDs contain a mix of zoning classifications that may include commercial, residential and light industrial uses, all of which are blended together. As with clustering, the purpose of a PUD is to maintain density while preserving open space. Well-designed PUDs usually locate residences and offices within walking distance of each other to reduce traffic. Planned residential developments (PRDs) apply similar concepts to residential developments. A good example of a clustered development and permanent open space protection is Prairie Crossing a 677-acre planned development with approximately 70% open space, more than 10 miles of trails, an organic farm, school, and a large lake with a beach and boat dock.

2.2.4 Green Infrastructure Planning

Preventive

Green infrastructure encompasses a number of landscape elements, including natural areas, conservation and recreation areas, trail networks and working lands such as forests, farms, and pastures. Ideally, these elements form a network functioning to support native species, maintain natural ecological processes, sustain air and water resources and contribute to health and quality of life.

Green infrastructure features form a system of “hubs” and “links.” Hubs are anchors or nodes within the network that provide an origin or destination for wildlife and ecological processes. Hubs may include such landscape elements as reserves, managed forests, working lands, parks, and natural areas. Links are the connections that tie the system together, enabling the network to function. Links may include greenbelts, conservation corridors, greenways, natural drainage or stream corridors, and buffers.

As described in the Fish Lake Drain Watershed Management Plan (LCSMC and CDF 2004), a Green Infrastructure Plan is a blueprint for water resources protection. Its purpose is to identify appropriate locations for the preservation of open space, that when preserved, will:

1. Protect and enhance the natural hydrologic functions of the watershed.
2. Allow flow of runoff through the watershed in a manner that supports and enhances aquatic life.
3. Provide natural conveyance, floodwater storage, and water quality benefits.

Before preparing a Green Infrastructure Plan, watershed communities should adopt policies that establish the identification, protection, and management of a green infrastructure network as community priority in comprehensive plans and other community documents. This establishes the foundation and framework for enacting protective zoning, subdivision, and other local ordinances, programs, and plans. It also establishes the community’s commitment to using local resources to enact the plan, laying the groundwork for including green infrastructure priorities in annual capital funding budgets and plans. In essence, a Green Infrastructure Plan is a plan for open space and natural areas protection that also improves water quality and prevents flood damage. The first step in preparing a Green Infrastructure Plan is to identify water resources, natural features, and open space that are either already connected or that could be developed into a network natural corridors. Examples include floodplains, lakes, wetlands, wetland buffers, hydric soils, drain tiles, regionally significant depressional areas, parks, greenways and trails, and forest preserves. The next step is to outline the network by connecting isolated water features to each other. Hydric soils are a useful connector for isolated natural resources because they provide opportunities for wetland restoration. The final step is to remove developed areas from the boundary of the plan and refine the network to work around or through existing developments.

Green Infrastructure Plans often require regulatory changes to zoning and development codes and can be difficult to implement quickly if unprotected open space must first be acquired and permanently protected. However, if incorporated into local government land use plans, Green Infrastructure Plans can be a very strong tool for protecting natural resources, improving water quality, and preventing flood damage.

2.2.5 Greenways and Trails

Preventive and Remedial Retrofit

Greenways and trails can provide a large number of functions and benefits to nature and the public. For plants and animals, greenways provide habitat, a buffer from development and a corridor for migration. Greenways located along streams include riparian buffers that protect water quality by filtering sediments and nutrients from surface runoff and stabilizing streambanks. By buffering the stream from adjacent developed land use, riparian greenways offset some of the impacts associated with increased impervious surface in a watershed. Maintaining a good riparian buffer can mitigate the negative impacts of approximately 5% additional impervious surface in the watershed (Schueler 1995).

Greenways also provide long, linear corridors with options for recreational trails. Trails along the river provide watershed residents with an opportunity to exercise and enjoy the outdoors. Even more important, trails allow users to see and access the stream, thereby connecting people to their river and watershed. Trails can also be used to connect natural areas, cultural and historic sites and communities, and serve as a safe transportation corridor between work, school and shopping destinations (Northeastern Illinois Planning Commission and Openlands Project 1997a, 1997b; Labaree 1992).

Techniques for establishing greenways and trails involve several steps. The first step involves the development of a plan that proposes general locations for greenways and trails. In the case of trails, the plan also identifies who the users will be and provides direction on trail standards. Plans can be developed at the community and/or county level as well as regionally, statewide, and in a few cases, at the national level. Public and stakeholder input are crucial for developing successful greenway and trail plans.

Several techniques can be used for establishing greenways and trails. Greenways can remain in private ownership, they can be purchased, or easements can be acquired for public use. If the lands remain in private ownership, greenway standards can be developed, adopted and implemented at the local level through land use planning and regulation. Development rights for the greenway can be purchased from private landowners where regulations are unpopular or not feasible.

If the greenways will include trails for public use, the land for trails is usually purchased and held by a public agency such as a forest preserve district or local park system. In some cases, easements will be purchased rather than purchasing the land itself. Usually longer trail systems are built in segments, and completing connections between communities depends heavily on the level of public interest in those communities.

In developing areas, the local planning authority can require trails. Either the developer or the community can build the trails. In some cases, the developer will voluntarily plan and build a trail connection through the development and use this as a marketing tool to future homebuyers. In other cases, the local planning authority may require the developer to donate an easement for the trail.

To install trails through already developed areas, land can be purchased by a community agency with a combination of local, state and federal funds. Impediments to land purchase can significantly slow up trail connections in already established areas.

2.3 POLICY AND PLANNING COORDINATION

2.3.1 Lake County – Lake Michigan Watershed Management Board

The Lake Michigan Watershed Management Board (WMB) was established in 1990 as an advisory board to the Lake County Stormwater Management Commission (LCSMC). The WMB, formed under the direction of the Lake County Comprehensive Stormwater Management Plan, is made up of the chief elected official from every municipality, township, drainage district and county board district in the Lake Michigan watershed in Lake County. The WMB makes recommendations to LCSMC on financial, institutional and programmatic aspects of the drainage system and stormwater management services within the Lake Michigan watershed. The board's primary role is to serve as a forum for the coordination and allocation of resources, to contribute to basin planning and implementation projects and to resolve inter-jurisdictional watershed issues. Prior to 1998, the WMB met 3-4 times per year. Because of low meeting attendance, the number of meetings was reduced to one per year beginning in 1998.WMB cost-share funding for local projects in the Lake Michigan watershed has been approximately $25,000 per year.

2.3.2 Lake Michigan Ecosystem Partnership

The Lake Michigan Watershed Ecosystem Partnership (LMEP) was formed in 2005. Portions of Lake and Cook Counties form the Illinois portion of the Lake Michigan watershed. The Partnership is a diverse group, made up of landowners, businesses, non-profit organizations, agencies and governments within the Lake Michigan watershed region. All partners in the watershed are eligible to apply for Conservation 2000 funds through the Illinois Department of Natural Resources. C2000 funding applications are evaluated once per year with an application deadline during February.

3. WATERSHED TOOLS TO PROTECT AND IMPROVE WATER QUALITY

The watershed inventory and assessment for the watershed suggests that the most significant potential impairments of water quality are hydrologic / flow alteration and associated symptoms, suspended solids and sedimentation, streamside alterations, and low dissolved oxygen. The primary sources of impairment are probably urban runoff / storm sewers, loss of riparian habitat, land development, and streambank modification. In general, the diverse and diffuse nature of nonpoint pollutant sources presents a challenge for improving water quality. Therefore, to effectively address the scattered and cumulative impacts of nonpoint source pollution, various techniques including those described below, can be applied at numerous sites throughout the watershed.

Preventive measures will address how land needs to be developed and maintained to reduce future increases in nonpoint source pollutant loads. History has demonstrated that as land is developed in a watershed through conventional development practices, water quality declines. If land continues to be developed in a conventional manner in the watershed, it is anticipated that water quality will continue to degrade. Improvements will need to be made in development designs and in land management practices in order to protect water quality. Development design features are addressed in the water quality measures described below and in the following flood reduction section. Maintaining streams and riparian buffers can also help prevent water pollution. Individual property owners play a significant role in implementing these measures, and in reducing the use of products and practices that contribute to water pollution.

Water quality can be improved using a number of retrofitting techniques. Retrofitting refers to modification of existing stormwater control structures such as detention basins and conveyance systems such as ditches and stormsewers. These structures were originally designed to improve drainage and reduce flood risk, but they can also be retrofitted to improve water quality. This section will focus on properly maintaining septic tanks and fields to improve water quality, retrofitting existing detention basins, stormwater outfalls, and other stormwater infrastructure, and stabilizing streambanks.

3.1 CONSTRUCTION PRACTICES

3.1.1 Site Clearing and Grading

Preventive

Strategic clearing and grading of development sites can reduce the amount of land and vegetation disturbed and the amount of soil compaction, helping to reduce the volume and rate of runoff generated during both construction and build-out. Strategic clearing and grading refers to a combination of two general practices: reducing the area extent of disturbance and strategically locating cleared areas away from soils with high permeability, vegetated areas, and other zones that offer high stormwater management benefits.

Fingerprinting refers to the process of restricting ground disturbance by identifying the smallest possible area and clearly delineating it on the site.This may include minimizing the size of construction easements, materials and storage areas, and soil stockpiles within the development envelope. Home layout, clearing and grading should strive to avoid the removal of existing trees. Well-drained soils should be preserved wherever possible since covering these areas with impervious surfaces causes the greatest possible change in pre- and post-development conditions and watershed impacts. Site plans should also maintain existing topography to the greatest extent possible in order to preserve natural drainage patterns and encourage dispersed flow paths.

During development, contractors should install fencing or other barriers around areas to remain undisturbed. Site grading and construction can be phased so that only portions of the site are disturbed at a given time, while already developed areas are being stabilized with vegetation and other measures. Lot benching is a development technique used on hilly or rolling topography that establishes drainage patterns on individual lots and directs runoff to a stable outlet rather than to another lot. This practice reduces the length and slope of the disturbed area and its erosion potential. This practice also preserves some of the natural topography, soil structure, and drainage patterns.

3.1.2 Soil Erosion and Sediment Control

Preventive

Soil erosion and sediment control practices, as outlined in the Lake County Watershed Development Ordinance and detailed in the Illinois Urban Manual (2002, NRCS and IEPA), are required and enforced in Lake County. These practices include mulching, blankets, and mats, vegetative stabilization, structural methods, silt fence and other filter barriers, inlet protection, sedimentation basins and traps, and check dams.

Mulches, Blankets and Mats
These practices involve the installation of organic materials, typically as a pre-made blanket or applied loose as a mulch, to form a temporary, protective soil cover. Next to vegetative stabilization, these are the most effective and practical means of controlling runoff and erosion on disturbed land, and blankets are particularly effective on steep slopes and in swales and channels.

Organic mulches include wood fiber, straw, and hydro mulch, a processed material mixed with water and applied in a stream from a hose or other applicator. Erosion control blankets or fabrics are biodegradable, open-weave blankets with netting on one or two sides used for establishing and reinforcing vegetation on slopes, ditch bottoms and shorelines. Blankets need to be secured in place with staples or stakes. Turf-Reinforced Mats (TRM) are synthetic, non-degradable mats that are typically buried to add stability to soils that are prone to erosion, such as on slopes and in channels. TRMs are often filled with soil and vegetation or seed after installation, and covered with an erosion-control blanket or mulch for added protection.

Vegetative Methods
Vegetation, whether left undisturbed on the site or established after disturbance, is very good at preventing erosion. Vegetation should be established as soon after disturbance as possible on exposed soils. Native species, though slower to establish, require less maintenance, fertilizers, and irrigation than nonnative species, and because of their deep root systems are desirable for soil stabilization. A temporary cover crop of annual grasses like oats or rye are quickly established and provide good protection, and thus may be desirable to be mixed into native species seed mixes. Deep rooted native species and wildflowers also can be installed and provide habitat, water infiltration, and aesthetic values.

Structural Methods
Three structural erosion control measures include inlet and outlet riprap, permanent diversion of water, and temporary diversion of water using dikes and water bars. Riprap is heavy stone placed around inlets and outlets of pipes or channels to prevent erosion where concentrated water flow, turbulence, or wave energy are present. A stilling basin or impact basin may be installed along with riprap to help reduce the velocity and energy of water flow before being discharged to an outlet channel. Because riprap provides stabilization without water quality or habitat benefits, it should be considered as a secondary treatment method if vegetative and bioengineering methods are not feasible.

A permanent or temporary slope diversion structure is a channel and dike constructed across steep or long slopes, a ridge of compacted soil, or a flexible conduit or pipe designed to intercept runoff and divert it to stabilized outlets at a low velocity. The temporary slope diversion structure can sometimes be used instead of a silt fence. Dike and channel diversions can be used to prevent stormwater from entering, if built upslope, or leaving, if built downslope, the work area. A water bar is a ridge and channel constructed across a sloping road, right-of-way, or path that is subject to erosion. These bars capture and divert runoff from the path into side channels or swales.

Silt Fence
This temporary geotextile fabric barrier is staked and

trenched into the ground and designed to retard runoff and retain sediment on the construction site while allowing some water to pass. They are not appropriate for channels or other areas of concentrated flow, but good for perimeter uses and for side slopes if applied along the contour. Shallow ponding of water will occur with silt fence and should be released via outlet channels. A few different types and weights of silt fence can be specified for different applications.

Inlet Protection

Inlet protection methods prevent sediment from entering storm drainage systems before disturbed areas can be permanently stabilized. This may include a sediment filter, sedimentation basin, or geotextiles barrier installed around a storm drain inlet. These methods detain water causing ponding and settling of sediment before entering the storm drain. Sand bags and geotextiles are typically used together in this application.

Sedimentation Basins and Traps

A sedimentation basin is a controlled stormwater release structure formed by constructing an embankment of compacted soil across a drainageway with an outlet structure and pipe. Water is detained long enough for most sediment to settle out in the basin. Sediment traps are settling ponds with simple spillways stabilized with geotextiles and riprap without an outlet structure or pipe. Both of these 'settling pond' practices located at the downstream end of the site are the principal preferred sediment-control practices for construction sites.

Check Dams

Check dams are used with erosion control blankets in areas of concentrated flow, such as ditches and swales, to slow flow velocities, pond water, and filter and settle sediment. Rocks, silt dikes, wattles and excelsior logs can be used to form check dams, but silt fence and hay bales are NOT considered to be effective for building check dams.

3.1.3 Construction Sequencing

Preventive

Construction sequencing is the practice of scheduling development so that land-disturbing activities are coordinated with the installation of erosion and sediment control practices. Construction sequencing generally follows the schedule outlined in Table F.3. (from *Minnesota Urban Small Sites BMP Manual, Metropolitan Planning Council*, 2001).

Table F.3: Typical construction sequencing

	Construction Activity	Schedule Consideration
1	Identify and label protection areas (e.g., buffer zones, filter strips, trees).	Site delineation should be completed before construction begins.
2	Construction access. Construction entrance, construction routes, equipment parking areas, and cutting of vegetation.	First land-disturbing activity. Establish protected areas and designated resources for protection. Stabilize bare areas immediately with gravel and temporary vegetation as construction occurs.
3	Sediment traps and barriers. Basin traps, sediment fences, and outlet protection.	Install principal basins after construction site is accessed. Install additional traps and barriers as needed during grading.
4	Runoff control. Diversions, silt fence, perimeter dikes, water bars, and outlet protection.	Install key practices after principal sediment traps and before land grading. Install additional runoff control measures during grading.
5	Runoff conveyance system. Stabilize stream banks, storm drains, channels, inlet and outlet protection, and slope drains.	Where necessary, stabilize stream banks as early as possible. Install principal runoff conveyance system with runoff-control measures. Install remainder of system after grading.
6	Grubbing and grading. Site preparation: cutting, filling and grading, sediment traps, barriers, diversions, drains, surface roughening.	Begin major grubbing and grading after principal sediment and key runoff control measures are installed. Clear borrow and disposal areas only as needed. Install additional control measures as grading progresses.
7	Surface stabilization: temporary and permanent seeding, mulching, sodding and installing riprap.	Apply temporary or permanent stabilization measures immediately on all disturbed areas where work is delayed or complete.
8	Building construction: buildings, utilities, paving.	Install necessary erosion and sedimentation control practices as work takes place.
9	Landscaping and final stabilization: topsoiling, planting trees and shrubs, permanent seeding, mulching, sodding, installing riprap.	Last construction phase. Stabilize all open areas, including borrow and spoil areas. Remove and stabilize all temporary control measures.
10	Maintenance	Maintenance inspections should be performed weekly, and maintenance repairs should be made immediately after periods of rainfall.

Following site development, cleared and graded areas should be revegetated as soon as possible to decrease the post-development imperviousness and runoff as much as possible. Minimal disturbance techniques may be impractical, particularly when developing a group of lots. Therefore, revegetation can mitigate some of the negative impacts of site development.

3.2 STORMWATER & LANDSCAPING BEST MANAGEMENT PRACTICES

A number of best management practices (BMPs) can be implemented to reduce water quality impacts of developed areas by filtering and infiltrating runoff. Some of these and other BMPs can also be incorporated into farming practices.

3.2.1 Site Landscape Preparation

Preventive and Remedial Retrofit

It is essential that prior to establishing the final landscaping on a site, the ground and soil be adequately prepared. First, the subsoil (the existing soil following grading and construction) should be either tilled to a depth of a few inches or the surface roughed up to a depth of two inches. Topsoil should then be spread to a minimum depth of six inches and tilled or otherwise mixed into the top couple of inches of the subsoil. This 'zipping' together of the topsoil and subsoil significantly helps water infiltrate into the ground and prevents it from running off quickly. This may be codified in a municipality's development regulations as well as be included in site plans and specifications.

3.2.2 Filter Strips and Level Spreaders

Preventive and Remedial Retrofit

Filter strips are linear sections of the landscape covered with dense, preferably native, deep-rooted vegetation installed between pollutant source areas and a downstream receiving water body. The vegetation slows, absorbs, and filters stormwater runoff before it reaches an adjacent water body. When used in conjunction with level spreaders, filter strips effectively protect the water quality of adjacent wetlands and streams. Filter strips can be used on slopes less than 15% and should be between 20 and 150 feet wide.

Level spreaders are wide, shallow trenches filled with rock, crushed stone, or gravel with an overflow structure at the top. The trench is installed along the slope contour to slow and redistribute runoff across a vegetated slope to prevent erosion, increase infiltration, and to discharge it to treatment devices such as filter strips or bioretention areas. Because the effectiveness of the level spreader will be compromised if high amounts of sediment enter the system, level spreaders require some sort of pretreatment for sediment unless the tributary area contributes little or no sediment to the system. Level spreaders are best utilized in combination with an upstream or downstream treatment mechanism to achieve maximum water quality benefits.

Filter strips and level spreaders can be used alone but are better utilized as one component of a stormwater management system that combines a few different BMPs.

3.2.3 Riparian Buffers

Preventive and Remedial Retrofit

While the term *buffer* is commonly associated with riparian protection, buffers can be employed just about anywhere as a stormwater BMP. Vegetated buffers are strips of natural or planted vegetation around sensitive areas such as water bodies, wetlands, woodlands, or highly erodable soils. In addition to protecting sensitive areas, vegetated buffers help to reduce stormwater runoff impacts by trapping sediment and pollutants, providing infiltration, intercepting rainfall and slowing and dispersing stormwater flows over a wide area. Maintaining buffers along stream and river channels and lakeshores can reduce some of the water quality and habitat degradation effects associated with increased imperviousness (and runoff) in the watershed. Buffers provide hydrologic, wildlife habitat, recreational and aesthetic benefits as well as water quality functions.

Sediment, phosphorus and nitrogen are at least partly removed from water passing through a naturally vegetated buffer (see Table F.4). The percentage of pollutants removed depends on the pollutant load, the type of vegetation, the amount of runoff and the character of the buffer area. The most effective buffer width can vary along the length of a channel depending on adjacent land uses, topography, runoff velocity and soil and vegetation types. Where regulatory requirements for buffer width are absent, 50 to 100 feet is considered a minimum buffer width for typical surface water requirements. Wider buffers are recommended for more sensitive areas such as high quality streams and wetlands (Mitchell 1996).

Table F.4. Potential Pollutant Removal capability of Urban Stream Buffers

Pollutant	Potential Removal Rate*
Sediment	75%
Total nitrogen	40%
Total phosphorus	50%
Trace metals	60-70%
Hydrocarbons	75%

Source: Schueler (1995).
*Potential removal rate based on combined 25-foot grass strip in outer zone and 75 foot forested buffer in middle and streamside zone.

The Watershed Development Ordinance requires the designation of buffers along all stream channels, lakes and wetlands. When the channel has a watershed greater than 20 acres but less than one square mile, the required buffer width is 50 feet on each side of the channel. When the channel has a watershed greater than one square mile, a 30-foot buffer is required. High quality streams (with an Index of Biotic Integrity or IBI) rating greater than 40 require a 100-foot buffer. For all non-linear water bodies or wetlands with a total surface area of less than one (1) acre, a minimum buffer width of thirty (30) feet is required. For lakes and wetlands with a total surface area greater than one (1) acre but less than two and one half (2 ½) acres, a forty foot buffer is required, and for all water bodies or wetlands with a total surface area greater than two and one half (2½) acres, a minimum buffer width of fifty (50) feet must be maintained. Non-linear high quality aquatic resources shall have a minimum buffer width of one hundred (100) feet. LCSMC's buffer requirements are considered to be the minimum standard for the county. Individual communities have the option of adopting wider buffer requirements.

Another buffer system designates three zones. The streamside zone (25 feet) is densely vegetated to help maintain the physical integrity of the stream, and provides shade, litter, debris, and erosion protection.The middle zone (50 feet) is grassed or forested and its width depends on the size of the stream and its floodplain and the location of protected areas such as wetlands or steep slopes. The upland zone (25 feet wide) is an additional setback from the buffer and usually consists of turf grass lawn or other landscaping. Allowable land uses in the three zones vary. The streamside zone is limited to footpaths, runoff channels, and utility or roadway crossings. The middle zone may be used for recreation and runoff control practices. The upland zone may be used for many purposes, with the exception of septic systems, permanent structures, or impervious covers. A depression incorporated into the design of the upland zone can detain runoff during storms. This runoff is released slowly to the middle zone as sheet flow, which is then transferred to the dense streamside zone, designed to have minimal to no discharge of surface water to the stream.

Several state and federal programs exist to provide incentives for maintaining riparian buffers. The Wetlands Reserve Program makes funding available for the purchase and restoration of wetlands and riparian buffer connections between wetlands. The Illinois Buffer Partnership promotes and supports the voluntary efforts of farmers and landowners in the planting, maintenance and enhancement of streamside buffers. Property tax incentives for conservation also include reduced assessments for land dedicated to open space, conservation easements on natural areas and common areas in developments through the Real Property Conservation Rights Act and the Natural Areas Preservation Act.

3.2.4 Bioretention (Bioswales and Rain Gardens)

Preventive and Remedial Retrofit

A subset of stormwater and landscaping BMPs can be categorized as *bioretention* practices, which use a conditioned planting soil bed and vegetation to filter and infiltrate runoff stored within a shallow (6 to 18 inch deep) depression. Deep-rooted vegetation is vital to these systems to take up a portion of the runoff, transpire it back to the atmosphere, and to create flow pathways for infiltration of runoff into the ground, primarily via root systems. A bioretention system can include a pre-treatment filter strip or grass swale (channel) inlet, a shallow surface water ponding area, a bioretention planting area, a soil zone, an underdrain system, and an overflow outlet structure connected to the municipal stormwater system.

Bioswales are often constructed with an infiltration trench below a vegetated swale to encourage infiltration and provide temporary stormwater storage, particularly in areas with low soil permeability. Infiltration trenches are shallow excavations (3-12 feet) lined with filter fabric and backfilled with washed gravel, creating an underground reservoir for runoff that percolates into subsoils over several days.

Rain gardens are typically used to accept stormwater runoff from small areas such as residential lots, and from rooftops or downspouts. Both practices are helpful for preventing on-site or on-lot flooding, and can be incorporated into new or existing development in front and back yards, along roadside parkways and shoulders, within parking lot islands, and below roof downspouts. Bioretention systems are most effective when accompanied by some sort of pretreatment, such as swales or vegetated filter strips.

The bioretention facility should have a permeable soil planting bed at least 2-4 feet in depth with 6-12 inches of ponding area at the surface. Accumulation or ponding areas should collect water to depths not to exceed 12 inches and should be designed to drain / infiltrate ponded water within two days. Bioretention areas should occupy an area between 5 and 10 percent of the size of the tributary area, not including pretreatment areas such as filter strips, which are particularly important when receiving runoff from impervious surfaces. If the system is designed to filter to an underdrain, it should be constructed beneath the soil bed with perforated piping encased in gravel and separated from the permeable soil bed by filter fabric. The bottom of rain gardens and bioswales should be a minimum of 3 feet above the seasonally high water table to avoid the possibility of groundwater contamination.

3.2.5 Vegetated Swales

Preventive and Remedial Retrofit

Vegetated swales are stormwater conveyance, filtration, and infiltration features similar to bioswales except that they are not typically constructed with infiltration trenches. They are commonly located along roadways and rights of way, between lots or buildings, and in parking areas, and can accept runoff from one or a few development parcels. Swales may be either "wet" or "dry," depending upon the proximity of the channel bottom to the water table and the intended function of the system. Swales should provide a shallow ponding depth up to 18 inches and a bottom width of 2 to 8 feet, wider if the swale has check-dams, interior berms, and/or wetland sections, and maximum side slopes of 3:1.

Wet swales are broad, vegetated, open channels constructed near or intersecting the water table. Water quality treatment occurs through settling suspended solids, adsorption, and microbial breakdown of pollutants. Secondary benefits may include reduced runoff flow velocity and increased infiltration. Check-dams that trap sediment and slow runoff velocities during storm events can also be used with wet swales. Due to the likelihood of near-constant saturation or inundation, wet swales are typically planted with water-tolerant vegetation.

Dry swales store and convey runoff following storm events, but are dry much of the time. Dry swales may be an extension of a mown lawn or may be planted with native vegetation. In order to slow runoff, dry swales are typically equipped with a check-dam between the inlet and the main body of the swale. Unless the existing soils are highly permeable, dry swales must be constructed with an underlying filtering bed of permeable soil and an underdrain system, a perforated pipe encased in a layer of gravel separated from the permeable soil layer above by filter fabric. The bottom of the excavated area should be at least 3 feet above the seasonally high water table to prevent saturation of the soil or the potential for groundwater contamination.

3.2.6 Green Roofs

Preventive and Remedial Retrofit

Green roofs are roof-top gardens designed to absorb, temporarily store, and filter rainwater before it is released into downspouts or released by the vegetation to the atmosphere. Green roofs can be elaborate landscape features with aesthetic and recreational benefits, or be simple systems designed specifically for stormwater benefits. Green roof systems involve high quality water proofing and root-repellant, a drainage system, filter cloth, a lightweight growing medium, and plants of varying rooting depths and species, depending on the type of green roof used. These elements may be modular or each component may be installed separately.

3.2.7 Naturalized Detention Basins

Preventive and Remedial Retrofit

Detention basins are used to temporarily store stormwater and release it at a rate specified by local ordinances. Naturalized detention basins may include both wet and dry basins (though wet are preferred) that are planted with deep-rooted, native vegetation, designed to approximate a natural element of the landscape, and provide greater water quality and habitat benefits relative to standard detention basin designs. Constructed "wetland" detention basins, or wet-bottom basins, are either shallow marsh systems planted with native emergent vegetation or open water ponds with a fringe of wet prairie vegetation and a natural buffer of 25 to 50 feet. Wetland basins store the first flush of runoff from impervious surfaces and allow sufficient time for sediment and other solids to settle out to the bottom of the basin. Native plants aid in the water cleansing process by absorbing pollutants. The settling and filtering process results in cleaner water being discharged from the basin than the water entering the basin. Naturalized detention can be used to replace standard basins in virtually all applications. Pretreatment measures, such as a settling forebay immediately upstream of the basin, should be employed to reduce sediment loads and water level fluctuations and to make sediment removal easier and less costly.

Wet and wetland basins contain a permanent pool of water where sediment and other pollutants settle out, are absorbed by deep rooted vegetation along the basin edges, and broken down by microbial action. In general, relatively large tributary areas, approximately 10 to 640 acres, are required to maintain and not overload pool elevations. Building these basins on medium to fine textured soils is optimal to help establish vegetation, retain surface, permit groundwater discharge/recharge, and capture pollutants. More permeable soils that do not remain permanently saturated may require an impermeable liner, such as geotextile fabric or clay.

Littoral shelves 6 to 18 inches below normal pool elevation are recommended for safety and to promote aquatic and emergent vegetation growth. The Watershed Development Ordinance requires a minimum 8-foot wide safety shelf a maximum of three feet below normal pool elevation in all detention facilities. A length to width ratio of 3:1 is recommended to maximize the time water takes to get from the inlet to the outlet, which should be located at opposite ends of the basin. Average pool depth of 3 to 6 feet is optimal, unless fish are desired, which require deeper water. Side slopes above the shelf line should be no steeper than 3:1 and no steeper than 2:1 below the shelf.

3.2.8 Detention Basin Retrofits

Remedial Retrofit

The goal of detention basin retrofitting is to enhance a basins' water quality values. This is accomplished by changing the basin's functional design so it collects and filters sediment and other pollutants from stormwater while it is being stored. Existing detention basins can be retrofitted in several ways to improve water quality. Water flows can be adjusted by reducing release rates for more frequent rain events to provide more time for settling. For even better results, the outlets on dry bottom detention basins can be altered to create wet bottom (or wetland) basins that significantly improve water quality. Wet detention basins hold some level of water all of the time. Wet basins can store the first flush of runoff from impervious surfaces and allow sufficient time for sediment and other solids to settle out to the bottom of the basin. This settling process results in cleaner water being discharged from the basin than the inflow stormwater. Wetland plants in the basin aid in the water cleaning process by trapping, absorbing and transforming nutrients, solids and metals from the inflow stormwater. Therefore, the primary detention basin retrofit goals are to increase the residence time for stormwater in the basin so that pollutants can settle out; and using deep-rooted native plants around the basin to filter, absorb and transform pollutants and reduce erosion.

Redesigned detention basins also offer opportunities for improving the aesthetics of the basin, discouraging nuisance geese and providing habitat for other wildlife. Turf grass on the side slopes can be replaced with deep-rooted native vegetation to stabilize slopes and discourage nuisance geese and related pollution. For the best results, all of these techniques can be combined along with excavation of micro-pools and establishment of wetland vegetation in the basin to provide multiple benefits. Constructed wetland detention basins (detention wetlands) use features found in natural wetlands and lakes. They are designed with shallow shoreline slopes, emergent wetland vegetation and open water areas. Detention wetland designs allow for water quality improvement through filtration of runoff by vegetation and by allowing water to pool so sediment can settle out. Detention wetlands also provide more habitat for plants and animals, and are often more aesthetically pleasing. Detention wetlands generally require less maintenance than traditional designs, and are also less attractive to nuisance geese (Price and Dreher 1995, 1997; Price, Dreher and Schaal 1994; Terrene Institute 1994)

The watershed includes numerous detention basins constructed to temporarily store excess stormwater runoff to reduce flood peaks. When properly designed, constructed and maintained, detention basins control stormwater release rates from developed sites. Although many were originally constructed as single purpose facilities for flood reduction, many of these basins can be retrofitted to significantly reduce water pollution from lawns, streets, sidewalks, parking lots and rooftops before it is discharged into the creek.

LCSMC conducted a detention basin inventory in the watershed in 2004 to document existing conditions in the basins, and to identify opportunities for detention basin retrofits. During the inventory, detention basins were physically located, photographed and identified as one of three design types: dry bottom, wet bottom, and wetland. In addition to identifying basin type, location and pollutant removal effectiveness, maintenance and design problems such as shoreline erosion, clogged inlets/outlets and short-circuiting (water rushing straight through the basin rather than being stored for a period of time), and potential retrofit and restoration opportunities were recorded. Section XXXX Design Drainage System contains a detailed summary of detention basins in the watershed.

Appendix XX contains a table that includes a description for each detention basin that was inventoried in the watershed. In general, provided there are no design problems such as short circuiting, wet bottom and wetland detention basins are considered to have positive water quality benefits (or 'good' pollutant removal effectiveness). All dry bottom detention basins are assumed to have poor pollutant removal effectiveness, unless specifically designed with water quality features (such as sand filters).

Several key design and maintenance problems were identified for watershed detention basins:

- Shoreline and side slope structure and condition: Steep side slopes are more likely to contribute to erosion and can present potential safety hazards. Another problem seen was side slopes overgrown with herbaceous weeds (i.e. reed canary grass or purple loosestrife) and excess woody vegetation.
- Turf grass: Turf grass is a poor choice for use in wet detention basins. It is relatively intolerant of frequent wetting and drying, conditions common to detention basins. Turf grass also attracts nuisance geese.
- Insufficient buffer: buffers around detention basins provide habitat and filtration benefits.
- Inlet or outlet problems: Most of the problems identified include litter and clogging in outlets.
- Turbidity: Turbidity problems are most likely due to shoreline erosion or erosion upstream of the basin.
- Excess algae: Problems are likely due to nutrient loading from upstream and surrounding land uses.
- Excess sediment accumulation: Sediment accumulation reduces the available volume for water storage.
- Concrete channels: These channels immediately pass runoff (with pollutants) downstream rather than allowing it to be filtered by vegetation. Concrete

channels also preclude low flow runoff from infiltrating into the ground.

- Debris, garbage and woody vegetation: These can clog inlet and outlet pipes, reduce aesthetic quality, and introduce toxic or other harmful material to the water column.

Several different types of retrofit opportunities were identified during the detention basin inventory and subsequent analysis by the planning team:

- Create wet or wetland basin: Dry basins can be converted to wetland basins by excavating portions of the basin bottom to create wetland pockets and/or redesigning the outlet to allow for some water retention and planting wetland vegetation. Settling (or stilling) basins could be installed at the inlets and the basins planted in native vegetation. The increase in pollutant removal effectiveness will be a function of the volume of stormwater stored as the first flush size and the length of time it is stored. The excavated wetland pocket(s) as well as the extent to which native vegetation is used in the basin and buffer areas will also be determinants in pollutant removal effectiveness.
- Plant side slopes with native vegetation: Turf grass is relatively intolerant of water level fluctuations and is maintenance intensive. In addition, it is not as effective as native vegetation for filtering, absorbing and transforming pollutants in runoff. For these reasons, strong consideration should be given to replacing turf grass with native vegetation in detention basins throughout the watershed. Basin edges constructed of riprap or other armoring practice can also be retrofitted and replaced with native vegetation, but may also require regrading.
- Improve / expand buffers: Native vegetation buffers should be established around the perimeter of all basins where possible to stabilize shorelines, encourage native wildlife and discourage nuisance geese (and their pollution contribution) and filter pollutants. In many cases, buffers can be expanded to provide improved filtering functions and greater wildlife habitat.
- Clean or replace inlets and outlets: Clogged inlet and outlet structures collect trash and fill up with sediment that can back up water upstream. Trash racks could be installed to limit trash collecting in pipes. Inlets and outlets should be routinely monitored for obstructions. Failed pipes should be replaced.
- Stabilize / regrade shorelines: Shorelines of wet basins with erosion problems could be stabilized by regrading to 3:1 slope or flatter and planting native vegetation. Eroding shorelines within the basin can contribute to the amount of sediment, nutrients and other pollutants eventually draining downstream.
- Remove algae: Excessive algal growth decreases water clarity (increased turbidity) and prevents light from penetrating deeper waters to promote healthy aquatic plant growth. Algae can be removed over a short period of time using copper sulfate algicide treatments, or over a longer period of time using a combination of ecologically sensitive methods such as alum treatments, aquatic plant vegetation, and nutrient control. These longer term methods are recommended over quick fixes and will typically cost less over time than repeated copper sulfate treatments.
- Address turbidity / sedimentation: sediment accumulation can reduce the storage volume, clog inlet and outlet pipes, and reduce the water quality of detention basins. Checking for and removing sediment periodically can help alleviate these problems.
- Remove concrete channels: Concrete channels could be removed and converted to vegetated swales or filled in to allow water to spread out throughout the basin. After the concrete is removed, the newly created swale should be planted in native vegetation to improve infiltration and pollutant removal rates.
- Reduce woody vegetation cover, debris, and garbage: Woody vegetation can shade suppress and reduce cover of understory herbaceous plants, which have deep fibrous root systems to hold soil in place. Exotic woody plants such as buckthorn and honeysuckle spread quickly and should be controlled, if not eliminated. Other debris and garbage should be removed regularly to preserve aesthetics and reduce the potential for leaching of toxic materials.

3.2.9 Permeable Paving

Preventive and Remedial Retrofit

Porous or permeable pavement is the term given to a family of materials, structures, and pavement designs that allow runoff to infiltrate through the pavement and into the subsurface. In general, these pavements are not used for high-volume or high-speed roadways, but may be appropriate for off- and on-street parking areas, emergency drives, overflow or seasonal parking lots, alleys, driveways, and pedestrian areas. Permeable paving blocks are interlocking paver systems containing openings that are filled with gravel and placed on a gravel setting bed. These blocks present a more traditional or formal look than porous asphalt and concrete, which use large size aggregate material that allows precipitation to infiltrate through the paving material and into the ground or gravel setting bed. These may be more appropriate than paving blocks in pedestrian use areas, and otherwise can be used in many applications. Porous pavement uses large size aggregate material so that precipitation can rapidly infiltrate into the ground. Gravel grass is a mixture of gravel and a growing medium that allows grass to grow within the paved area but provides a strong and stable surface. It has been used in parking lot applications. Using permeable paving blocks and porous pavement can reduce runoff volumes and pollutant loadings (Dreher and Price 1997).

3.2.10 Rainwater Harvesting and Dry Wells

Preventive and Remedial Retrofit

Rain barrels and cisterns are temporary storage facilities that capture rainwater from rooftops and hold that water for other uses such as landscape irrigation. A general rule for rainwater harvesting is that 1 inch of rain falling on a 1,000 square foot roof yields approximately 600 gallons of water, a much greater volume than the typical residential rain barrel size of 50 to 80 gallons. Rain barrels should be constructed with a screen or filter for mosquito protection, a lid to prevent algae growth, a spigot to allow for use of harvested water, and an emergency overflow that discharges away from structures and preferably to another BMP. Water harvested in rain barrels can be used for a number of applications, including watering gardens and washing cars, but should not be used as a source of potable water.

Cisterns are larger storage tanks for rainwater and can be located above or below ground. They generally have much larger storage capacities than rain barrels and can collect water from several homes or buildings. Cisterns should be constructed of non-reactive materials such as reinforced concrete, galvanized steel, or plastic. Cisterns should be placed in areas that are sloped to drain surface water away from the structure. Underground cisterns should not be located near sewer lines or other potential sources of contamination and should not be located near trees because the roots can crack cistern walls. Because of their larger size, cisterns may have to be periodically treated and/or cleaned. Like rain barrels, water harvested in cisterns can be used to wash cars or water plants, but because it may pick up dust, soot, microorganisms or animal droppings, it is not suitable for human consumption.

Dry wells or "soakaway pits" are subsurface structures that receive and temporarily store runoff from roofs and slowly discharge into the surrounding soils. Dry wells can be a structural chamber inserted into an excavated pit or an excavated pit filled with aggregate located downslope or adequate distance from basements and foundations. Because dry wells discharge directly to the ground, the structures are not appropriate in areas with potential for groundwater contamination. Dry wells should drain runoff within 72 hours and therefore must be sized with consideration of both drainage area (1 acre maximum) and soil type (NRCS hydrologic soil groups A and B). Additionally, the bottom of the well should be at least 2 feet above the seasonal high water table.

3.2.11 Native Landscape Systems

Preventive and Remedial Retrofit

Native landscape systems utilizes deep-rooted vegetation such as grasses, wildflowers and wetland plants rather than turf grass in both new and existing developments to help filter and infiltrate rainwater. Native or natural landscaping promotes biodiversity and open space protection by providing habitat for endemic wildlife, can be applied at large and small scales, and require less irrigation, mowing, pesticide, and fertilization than turf grass or ornamental landscaping approaches. Native landscape designs should be appropriate to site characteristics including topography, soils, drainage, and solar exposure. Plant diversity and health is maximized by annual burning, but in some smaller applications and in more urban settings mowing may be the best alternative to burning. Native plants are components of many of the landscaping and stormwater best management practices described in this toolbox.

Larger sites where native vegetation could be used include: institutional sites such as schools, churches and hospitals; office and industrial parks; housing developments; community parks; and golf courses. In addition to larger sites, native vegetation also is an appropriate replacement for traditional lawns and gardens on individual residential and commercial lots and can be very effective at infiltrating runoff from rooftops, decks, driveways and parking lots. Local landscaping and weed ordinances may need to be revised to allow for - and promote - the use of native vegetation. (Northeastern Illinois Planning Commission 1997; USDA Natural Resources Conservation Service, 1997; Buslaff 1997; Highland Park Environmental Commission 1998).

3.2.12 Infiltration Devices

Preventive and Remedial Retrofit

Infiltration trenches and basins are two similar runoff reduction devices. Infiltration trenches and basins are excavated depressional areas where stormwater runoff is directed. Infiltration areas are planted with appropriate vegetation (also referred to as bio-infiltration or bioretention practices) or covered with decorative rock. Both infiltration trenches and basins reduce runoff and recharge groundwater, thereby decreasing the need for stormwater storage. Bioretention/ infiltration practices not only provide water quantity control benefits, but also improve water quality. These types of practices are especially appropriate as designed “rain gardens” that have the added advantage of being aesthetically pleasing. Individual yards and business sites can be designed or retrofitted to include bioretention practices.

Infiltration devices can be used in the watershed with a few limitations. First, they may freeze up in winter making them temporarily ineffective. Designs should include a backup system for this circumstance. They may also require a sediment trap to reduce the frequency of clogging. More importantly though, infiltration trenches and basins require permeable soils (hydrologic soil groups A and B), which are found primarily within the middle and eastern half of the watershed. When properly installed on sites with permeable soils, infiltration devices can be an effective tool for reducing runoff rate, volume and pollutant loads (Dreher and Price 1997, Department of Environmental Resources Prince George’s County, 1997).

3.2.13 Surface and Underground Filters

Preventive and Remedial Retrofit

Also known as filtration basins, filter systems, or media filtration facilities, surface sand filters consist of a pretreatment basin, a water storage reservoir, a flow spreader, sand, and underdrain piping. The pretreatment basin reduces the amount of sediment reaching the filter and helps ensure that stormwater reaches the filter as sheet flow rather than concentrated flow. A filter liner may also be necessary if infiltration into the underlying groundwater is undesirable. Underground filters are similar to surface filters except that the sand is installed below grade in a vault. The filter traps sediments and pollutants and provides a media for microbial removal of bacteria, but is not effective at reducing runoff volumes. These filters are typically used in constrained sites with high imperviousness and little area available for stormwater management facilities. They are appropriate for drainage areas up to 10 acres and should drain within 24 hours. Filters are appropriate for new and existing development area but should not be used in areas with high sediment loading or unstabilized development sites.

3.3 LANDSCAPE AND STREET MAINTENANCE

3.3.1 Landscape Maintenance

Preventive

Landowners should use sustainable lawn care practices whenever possible. Inappropriate application of fertilizers, pesticides, and irrigation can cause environmental degradation, and should be addressed by each land owner or manager. Selecting plant species and planting location appropriate to local conditions can reduce the need for irrigation, fertilizers, and pesticides. Where lawn chemicals are absolutely necessary, land owners and managers should strictly follow the application instructions. Applying more than the recommended amounts will not produce better lawn and garden results and will have a greater negative impact on water quality. Slow-release fertilizers (organic or synthetic) can reduce the loss of excess nitrogen into groundwater or surface water. Favor small, frequent applications rather than large occasional applications. Create areas around your yard or garden where runoff can infiltrate into the ground so that excess fertilizers and pesticides can be absorbed and filtered by the soil. Raingardens installed in yard depressions can serve this function.

Yard wastes such as grass clippings, prunings, and leaves should be properly disposed in compost piles, chopped up and used as mulch, or disposed of in yard waste collection facilities or programs that utilize large scale composting facilities. Throwing yard waste into the garbage merely accelerates the filling of our landfills with material that can be utilized on our yards and gardens as a valuable resource. Decaying organic matter thrown into a stream or streambank can compete with marine animals for the limited oxygen supply and smother vegetation that helps hold streambanks in place. For this reason mulch and compost piles should be located at a distance from water bodies.

The goals of environmentally sound irrigation are to maximize water infiltration and minimize runoff. Reduce the potential for runoff by reducing the need for supplemental irrigation, either through appropriate plant selection (i.e., plants adapted to the local climate), reducing the area needing irrigation, or irrigation with harvested rainwater (see rain barrels and cisterns above). Overwatering, which occurs when water is applied faster than the ground can absorb it, can wash away soil, pesticides, and nutrients, which eventually find their way into surface water or groundwater. Hand watering, either with a hose or a watering can, is generally appropriate for containers or small beds only. Soaker hoses reduce runoff and evaporative losses because they apply water slowly. Trickle or drip irrigation is also efficient, reducing water use by 50% to 80% compared with overhead irrigation. Landowners should water when the plants need it, not according to the calendar, and apply mulches to conserve soil moisture. If drought conditions occur, understand that a brown lawn is just dormant, not dead, and consider tolerating a brown lawn during the hottest, driest months rather than squandering precious water supplies in an effort to maintain a pristine green lawn.

Attempts to maintain a pest-free garden often result in heavy use of pesticides, which in turn increase the potential for water contamination. Try to keep pest populations below the level at which they cause unacceptable damage. Allowing low levels of pests to survive will help maintain a population of their natural enemies. Pest-resistant plant species and varieties may be available in your area. Rotate vegetables and annual flowers so that the same plant or plant family does not occupy the same space every year; rotation can reduce insect infestations and the buildup of soil-borne diseases. Remember that most such problems are cultural or environmental and will not respond to pesticide applications. If it is a pest problem, proper identification is also important in selecting the safest and most effective pest control strategy. Determine if a plant problem really justifies treatment; many pest problems are not life threatening to the plant and may cause only cosmetic damage.

Try the least toxic control strategies first. Hand picking weeds or insects may be adequate for small infestations. If you are going to use pesticides, choose those that pose the least threat to water quality; examples include pyrethrins, insecticide soaps, horticultural oils, and Bacillus thuringiensis (BT). If using insecticides, spot treat only those plants or plant parts affected. Compared to cover sprays, spot treatments can drastically reduce insecticide use (by over 90% in some cases) and still achieve good pest control. If pesticides are to be used, carefully read the label for directions, usage restrictions, and health and environmental precautions.

3.3.2 Street Maintenance

Preventive

Pollutants that are carried from roads and streets into our water resources can be reduced through proper maintenance such as regular street sweeping and reduced use of road salt in winter. Regular street sweeping in high traffic areas, particularly commercial districts, can substantially reduce runoff pollutants and debris such as leaves and other organic matter. Street sweeper debris should be stored greater than 100 feet than or at a higher elevation than the nearest ditch, storm drain inlet or surface water, and should be disposed of at a landfill.

Street and road construction projects also can contribute significant pollutants to our streams. During bridge repair work, such as sandblasting or painting, nets and drop cloths should be used to catch falling debris and materials. Waste and debris from bridge and other highway maintenance work should be swept and vacuumed after project completion. During maintenance work within 25 feet of storm drain, inlets should be protected with sediment capture and control methods. Chip sealing, striping, marking, and painting should be terminated during rainstorms to prevent potentially toxic materials from running off. Spill prevention and cleanup plans and techniques, such as drip pans, absorbents, and standard operating procedures, should be in place to immediately address these occurrences.

Reducing the use of road salt (sodium chloride) or substituting with less damaging chemicals, such as calcium chloride, can reduce winter runoff impacts on sensitive wetlands, streams, native prairies and woodlands. Some plants and animals, including roadside vegetation, are impacted at very low chloride concentrations. Salt storage facilities can have a greater potential for causing water pollution than roadway application. Rock salt and sand/salt mixes (if used) should be stored only on paved, bermed areas or in areas lined with impervious materials or under cover. Adequate drainage controls also should be used to prevent runoff water from contacting the salt pile.

Salt is the most commonly used highway de-icer due to its effectiveness and low cost. The second most commonly used de-icing chemical, calcium chloride, is effective in much lower temperatures than salt but is more expensive and equally as toxic and corrosive as salt. Sand is sometimes considered an alternative to salt, providing traction rather than deicing, but it is more difficult to clean up after the winter season and may exacerbate sedimentation issues in water bodies. Calcium magnesium acetate (CMA) much less toxic and corrosive than salt but nearly 15 times as expensive.

Salt application procedures can also be modified to reduce its impact. Salt application rates and frequency should be based on traffic volume, road grade and curvature, intersections, and weather conditions. Sensitive areas, such as streams, should be identified and made known to salt applicators so that they can reduce the application or use de-icing alternatives in these areas. Ground-speed controllers should be used for all spreaders to avoid over-application at stop signs or slow areas. For lesser traveled roads, consider applying salt in a four to eight foot strip along the centerline of a two lane road. Less salt is wasted with this pattern and quickly gives vehicles clear pavement under at least two wheels. Traffic will soon move some salt off the centerline and the salt brine will move toward both shoulders for added melting across the entire road width.

3.4 AGRICULTURAL PRACTICES

Agricultural practices can significantly impact water quality in the watershed. The Natural Resource Conservation Service (NRCS) publishes guidelines for farmers to prevent soil erosion and to improve or protect water quality and water resources. Some of the following information was taken from the NRCS Field Office Technical Guide (FOTG) and other Department of Agriculture resources and websites. Several of the practices described below are similar to

BMPs for riparian sites (such as filter strips and buffers), but specific suggestions are given for agricultural sites.

3.4.1 Residue Management, No till / Strip till

Preventive

This practice manages the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops planted in narrow slots, or tilled, residue-free strips previously untilled by full-width inversion implements.The purpose of this conservation practice is to reduce sheet and rill erosion thereby promoting improved water quality. Additional benefits of this practice are to reduce wind erosion, to maintain or improve soil organic matter content and tilth (tillage), to conserve soil moisture, to manage snow, to increase plant available moisture or reduce plant damage from freezing or desiccation, and to provide food and escape cover for wildlife. This technique includes tillage and planting methods commonly referred to as no till, zero till, slot plant, row till, direct seeding, or strip till.

Residue management maintains loose residues on the field and uniformly distributes them on the soil surface to minimize variability in planting depth, seed germination, and emergence of subsequently planted crops. When combines or similar machines are used for harvesting, they are equipped with spreaders capable of distributing residue over at least 80% of the working width. No till or strip till may be practiced continuously throughout the crop sequence, or may be managed as part of a system which includes other tillage and planting methods such as mulch till (see below). Production of adequate amounts of crop residues is necessary for the proper functioning of this conservation practice and can be enhanced by selection of high residue producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacing.

Maintaining a continuous no till system will maximize the improvement of soil organic matter content. Also, when no till is practiced continuously, soil reconsolidation provides additional resistance to sheet and rill erosion.

The effectiveness of stubble to trap snow or reduce plant damage from freezing or desiccation increases with stubble height. Variable height stubble patterns may be created to further increase snow storage.

3.4.2 Residue Management, Mulch till

Preventive

Mulch tillage (also known as chiseling or disking) manages the amount, orientation and distribution of crop and other plant residue on the soil surface year-round, while growing crops where the entire field surface is tilled prior to planting. The purpose of this conservation practice is to reduce sheet and rill erosion, which leads to improved water quality. Additional benefits are the same as no till practices. It applies to stubble mulching on summer-fallowed land, to tillage for annually planted crops, and to tillage for planting perennial crops.

Mulch till may be practiced continuously throughout the crop sequence, or may be used as part of a residue management system that includes other tillage methods such as no till. Like no till, mulch till requires production of adequate amounts of crop residue to function properly.

3.4.3 Nutrient Management

Preventive

Nutrient management is the management of the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments to minimize the transport of applied nutrients into surface water or ground water. Nutrient management seeks to supply adequate nutrients for optimum crop yield and quantity while also helping to sustain the physical, biological and chemical properties of the soil.

Nutrient management plans are developed with assistance from the Natural Resources Conservation Service (NRCS). A nutrient budget for nitrogen, phosphorus and potassium is developed considering all potential sources of nutrients including, but not limited to animal manure, commercial fertilizer, crop residue and legume credits. Realistic yields are based on soil productivity information, potential yield or historical yield data based on a 5-year average. A procedure for calculating 5-year average yields is found in the *Illinois Agronomy Handbook*. Nutrient management plans specify the form, source, amount, timing and method of application of nutrients on each field in order to achieve realistic production levels while minimizing transport of nutrients to surface and/or groundwater.

3.4.4 Pesticide Management

Preventive

Insecticides, herbicides and fungicides used to kill agricultural pests (any plant or animal judged to be undesirable to the production of crops or animals) can contaminate ground and surface water through direct application, runoff, and atmospheric deposition. They can poison fish and wildlife, disrupt reproduction, contaminate food sources, destroy habitat, and pose a health risk to humans. Pesticides also contribute to pesticide-resistant pest populations, which may lead to the development of more toxic control chemicals.

Integrated Pest Management (IPM) is an approach to pest control that combines biological, natural, cultural and other alternatives to chemical control with the judicious use of pesticides. The objective of IPM is to maintain pest levels below economically damaging levels while minimizing harmful effects of pest control on human health and environmental resources. IPM depends on a detailed understanding of pest growth and development, and in particular, what causes outbreaks and determines survival. IPM depends first on maximum use of naturally occurring control forces in the pest's environment, including weather, pest diseases, predators, and parasites. The second level of management focuses first on non-chemical measures that help prevent problems from developing, rather than relying on chemicals to kill infestations after they've occurred. Finally, IPM relies on chemical pesticides only if close inspection shows they are needed to prevent severe damage. If pesticides are to be used, they should be matched with field site features so that the risk of contaminating water is minimized.

Cultural methods of pest control used in IPM programs are those "good farming" (or "good horticultural") practices that break the infestation cycle by making the living and non-living environment less suitable for pest survival. Examples include crop rotation, tillage of infested plant material, altering planting and harvesting dates, and cover crops. Biological controls use living organisms to suppress populations of other pests, such as natural predators and parasites.

3.4.5 Animal Management

Preventive

Approximately 500 million tons of manure are produced on the thousands of animal feeding operations nationwide, contributing pathogens such as bacteria and viruses, nutrients, and oxygen-demanding organics and solids that cause water quality problems. Appropriate waste and waste water management systems can help address this issue.

High livestock concentrations in some areas have also led to applications of manure as a source of nutrients, primarily nitrogen and phosphorous, which may contribute to excessive levels of phosphorous being applied to crops and an increased risk of water contamination. Farmers should determine the nitrogen and the phosphorous content of manure to calculate appropriate application rates and consider fall rather than spring applications. Manure should not be applied to frozen or wet soils. Risk factors need to be explored as well including proximity to streams and water bodies and the presence of wells and field tile inlets. Manure can be injected into the soil to reduce the runoff risk.

In pastures, land managers can use shallow tillage tools to increase the infiltration and reduce the runoff of manure or fertilizer. Rotational grazing from one field to another reduces compaction, overgrazing and nutrient runoff. Livestock should be excluded from streams and other water bodies, except for those specifically constructed for watering.

One focus of grazing management measures is the protection of riparian areas and the control of erosion from other grazing lands above the riparian zone. These measures can reduce the physical disturbance to sensitive areas and reduce the discharge of sediment, animal waste, nutrients, pathogens, and chemicals to surface waters. The loss of stream bank stability, riparian vegetation, stream habitat, and modification of the hydrologic regime due to poor grazing practices can have a devastating effect on stream life.

Appropriate grazing management systems adjust grazing intensity and duration, maintain enough live vegetation and litter cover to protect the soil from erosion, and protect riparian and stream health objectives. Practices that accomplish this include: planting and cultivating appropriate forage plant species; managing the frequency, intensity, and season of grazing to optimally use and not abuse pasture resources; maintenance of a cover of living vegetative cover to reduce erosion potential; and exclusion of animals from sensitive areas such as stream corridors and wetlands.

Providing water and salt supplement facilities away from streams will help keep livestock away from streambanks and riparian zones. In some locations, artificial shade areas may be constructed to encourage use of upland sites for shading and loafing. For grazing areas with erosion problems, it may be necessary to improve or reestablish the vegetative cover on range or pastures or on streambanks. Streambank restoration efforts, exclusion fencing, stream buffer establishment, and pasture and range planting programs can significantly reduce erosion impacts due to grazing livestock.

The water quality problems associated with animal feeding operations (AFOs) result from accumulated animal wastes, facility wastewater (from watering, cleaning, or cooling animals), and storm runoff, all of which may be controlled with proper management techniques. Nutrients, suspended solids, pathogens, oxygen-demanding materials, and heavy metals all have the potential to migrate to water resources. The goal is to minimize the discharge of contaminants in facility wastewater, runoff, and seepage to ground and surface water resources.

The diversion of clean runoff water from upslope areas and roof runoff away from the animal lot and waste storage structure (e.g. installing roof gutters on facility buildings) can reduce waste volume and storage requirements. Management activities like scraping manure from pavement areas or proper storage of feeds and bedding can significantly reduce the availability of pollutants for transport. Structures such as detention basins can affect pollutant transport by regulating runoff movement and increasing settling within the facility. Vegetated filter strips, riparian buffers, or other vegetated areas located around animal facilities can reduce delivery of pollutants to surface waters by infiltrating, settling, trapping, or transforming nutrients, sediment, and pathogens in runoff leaving the facility. For new facilities and expansions to existing facilities, serious consideration should be given to siting the facility away from surface waters, critical or sensitive areas, residential areas, and areas with high leaching potential.

In addition to properly siting these practices, other measures can be utilized to successfully minimize impacts. These include diverting clean water away from the facility, proper waste storage and impoundment practices, proper waste management, and practices for dealing with animal mortality.

3.4.6 Filter Strip

Preventive

A filter strip is an area of permanent herbaceous vegetation situated between environmentally sensitive areas and cropland, grazing land, or otherwise disturbed land. Filter strips improve water quality by reducing sediment, particulate organic matter, sediment adsorbed contaminants and dissolved contaminants in runoff. Filter strips also help restore or maintain sheet flow from a concentrated flow and restore, create, and enhance herbaceous habitat for wildlife. This practice is most effective when used in conjunction with other conservation practices as part of a conservation management system.

The filter strip flow length is determined based on the field slope percent and length, filter strip slope percent, erosion rate, amount and particle size distribution of sediment delivered to the filter strip, density and height of filter strip vegetation, and runoff volume associated with erosion producing events.

Filter strips should be permanently designated plantings to treat runoff and should not be part of the adjacent cropland's rotation. Ideally overland flow entering the filter strip should be sheet flow, though the strip can help to disperse and distribute concentrated flow. Filter strips cannot be installed on unstable channel banks that are eroding due to undercutting of the toe bank. Permanent herbaceous vegetation should consist of a single species or a mixture of grasses, legumes and/or other forbs (a herbaceous plant other than a grass) adapted to the soil, climate and farm chemicals used in adjacent cropland. Filter strips must be maintained to function properly.

Filter strips should be located to reduce runoff and increase infiltration and ground water recharge throughout the watershed. Filter strips should also be strategically placed to intercept contaminants, thereby enhancing the water quality in the watershed. To avoid damage to the filter strip, consider using plant species that are tolerant to herbicides used in the upslope crop rotation. Filter strip sizes should be adjusted to accommodate planting, harvesting, and maintenance equipment. Filter strip widths greater than that needed to achieve a 30 minute flow-through time at ½-inch depth will not likely improve the effectiveness of the strip in addressing water quality concerns created by sediment, particulate organics, and sediment adsorbed contaminants.

3.4.7 Contour Buffer Strip

Preventive

Contour buffer strips are narrow strips of permanent, herbaceous vegetative cover established across the slope between parallel rows of crops. Contour buffer strips reduce sheet and rill erosion, reduce transport of sediment and other water-borne contaminants, and enhance wildlife habitat. This practice applies to cropland and is most suitable on uniform slopes ranging from 4 to 8 percent with slopes less than the Critical Slope Length (the length of slope above which contouring loses its effectiveness). The buffer strips are generally of equal width, unless a varying width buffer strip is needed to maintain crop widths or grades. Width of buffer strips at their narrowest point shall be no less than 15 feet for grasses or grass legume mixtures and no less than 30 feet when legumes are used alone.

To enhance wildlife habit, a native, warm season, grass species mixture, recommended for wildlife purposes, can be used. Mowing the buffer strips should be delayed to every other year or every third year depending on geographical location. Mow only after the desired species of ground nesting birds have hatched and allow for re-growth before the growing season ends. To enhance wildlife cover, the width of buffer strips should be increased to 30 feet or wider as determined based on the requirements for nesting and escape cover of the target wildlife species. The maximum width between buffer strips should not exceed 300 feet.

3.4.8 Contour Farming

Preventive

Contour farming is the tillage, planting, and other farming operations performed along the contour of the field slope. The purpose is to reduce sheet and rill erosion and to reduce the transport of sediment and other water-borne contaminants. Contour farming is most effective on slopes between 2 and 10 percent, is less effective on slopes exceeding 10 percent and is ineffective on slopes exceeding 25 percent. Contour farming requires that all tillage and planting operations be parallel to contour baselines or terraces, diversions, or contour buffer strip boundaries where these practices are used. All runoff from contouring should be delivered to stable outlets, such as grassed waterways, field borders, water and sediment control basins, or underground outlets for terraces and diversions.

3.4.9 Selecting Appropriate BMPs

To choose an appropriate BMP, it is essential to first determine the objectives, cost, and relative effectiveness of alternative BMPs. Once a BMPhas been selected, expertise is needed to insure that the BMP is properly installed, monitored and maintained over time. BMPs and their potential effectiveness in meeting water quality objectives are found in Table F.5.

Table F.5. BMP effectiveness toward meeting BMP objectives.

BEST MANAGEMENT PRACTICE	BMP OBJECTIVE						
	Runoff Rate Control	Runoff Volume Control	Physical Habitat Preservation	Sediment Pollution Control	Nutrient Control	BOD Control	Other* Pollutant Control
Impervious Area Reduction	2	2	2	2	2	2	2
Impervious Area Disconnection	2	2	1	2	2	2	2
Filter Strips	2	2	2	2	2	2	2
Swales	2	2	1	2	2	2	2
Inf ltration Devices	2	3	1	3	3	3	3
Porous Pavement	2	2	1	3	3	3	3
Wet Detention	3	1	2	3	2	3	2
Wetland Detention	3	1	2	3	2	3	2
Dry Detention	2	1	1	2	1	1	1
Settling Basins	2	1	1	2	2	2	2
Water Quality Inlets	1	1	1	2	1	1	1
Sand Filters	1	1	1	3	2	2	2
Rock Outlet Protection	1	1	2	2	1	1	1
Storage Area Cover	1	1	1	2	2	1	2-3
Street Sweeping	1	1	1	1-2	1	1-2	1-2
Source Controls	1	1	1	1	2	2	2
Stream Protection/ Restoration	2	1	3	2	2	2	1
Wetland Protection/ Restoration	2-3	2-3	3	2-3	2	2-3	2

Effectiveness Key:
3 = Fully achieves objective
2 = Partially achieves objective
1 = Does not achieve objective

* Other pollutants include toxic compounds such as heavy metals and pesticides, fecal bacteria, petroleum based hydrocarbons and deicing materials such as salt. A “2” in this column indicates that the BMP controls some of these pollutants but not others.
Source: Dreher (1994)

Tables F.6 and F.7 depict pollutant removal rates for different BMPs from data collected and reported by the Center for Watershed Protection (CWP) in June 1997. These removal efficiencies are based on 123 performance-monitoring studies that the CWP compiled into a database. Because performance can be extremely variable within a group of BMPs, estimates of BMP performance should be considered as a long-run average, not as a fixed or constant value. (Schueler 1995, Claytor & Schueler 1996, Schueler 1997, Center for Watershed Protection 1998, Price & Dreher 2000).

Table F.6. Comparison of median Pollutant Removal Efficiencies among selected BMP groups: Conventional pollutants.

Median Stormwater Pollutant Removal Rate (%)							
Best Management Practice	**No. of Studies[1]**	**Total Suspended Solids**	**Total P[2]**	**Soluble P[3]**	**Total N[4]**	**Nitrate**	**Carbon[5]**
Detention pond	2	7	10	2	5	3	(-1)
Dry ED* pond	6	61	19	(-9)	31	92	25
Wet pond	30	77	47	51	30	4	45
Wet ED* pond	6	60	58	58	35	42	27
PONDS [A]	36	67	48	52	31	24	41
Shallow marsh	14	84	38	37	24	78	21
ED* wetland	5	63	24	32	36	29	ND
Pond/wetland	11	72	54	39	13	15	4
WETLANDS	35	78	51	39	21	67	28
Surface sand filters	6	83	60	-37	32	(-9)	67
FILTERS [B]	11	87	51	-31	44	(-13)	66
CHANNELS	9	0	(-14)	(-15)	0	2	18
SWALES [C]	9	81	29	34	ND	38	67

Table F.7. Median Pollutant Removal reported for selected BMP groups: Fecal coliform, hydrocarbons and selected trace metals.

Median Stormwater Pollutant Removal Rate (%)						
Best Management Practice	**Bacteria [E]**	**Hydro-Carbons [F]**	**Cadmium**	**Copper**	**Lead**	**Zinc**
Detention and Dry ED* Ponds	ND	ND	54	26	43	26
Ponds [A]	65	83	24	57	73	51
Wetlands	77	90	69	39	63	54
Filters [B]	55	81	--	34	71	80
Channels	0	ND	55	14	30	29
Swales [C]	(-50)	62	42	51	67	71

* ED = extended detention

[A] Excludes conventional and dry ED ponds.

[B] Excludes vertical sand filters and vegetated filter strips

[C] Includes biofilters, wet swales and dry swales

[D] The number of studies is less than 5 for some BMP groups for bacteria, TPH, Cd and medians should be considered provisional.

[E] Bacteria values represent mean removal rates.

[F] Hydrocarbons measured as total petroleum hydrocarbons or oil/grease.

3.5 STREAM MAINTENANCE AND STABILIZATION

Stream maintenance is most effective when part of an ongoing program to repair eroded streambanks and remove blockages caused by accumulated sediment, debris, fallen trees and overgrown weedy, non-native vegetation. *Debris* refers to a wide range of materials that may include tree limbs and branches that accumulate naturally, discarded tires, appliances, and other litter, and lawn waste accidentally or intentionally dumped into channels or drainage swales. Routine clearing of debris from streams is a cost effective way to reduce the potential for flooding. In addition to sediment and debris removal, stream maintenance can also involve using best management practices (BMPs) to stabilize eroding streambanks. However, stream maintenance activities normally do not alter the shape of the channel (Dreher and Heringa 1998; Stowe and DuPage County 1991; Wildlife Society 1983; Illinois Department of Natural Resources 1983). In Lake County, parks, public works or highway departments, the Forest Preserve District and/or drainage districts (where rights-of-way are established or easements have been granted) generally are responsible for channel maintenance.

The Lake County Stormwater Management Commission (LCSMC) has developed "Riparian Area Management: A Citizen's Guide" to educate landowners about debris removal and riparian landscaping. There are currently no coordinated programs or maintenance standards established at the county-level for on going stream maintenance. Maintenance is typically done as needed in response to problems or complaints about blockages or erosion.

LCSMC anticipates adopting environmentally friendly stream maintenance standards in the future to provide guidance and consistency for projects throughout Lake County. In the interim, LCSMC recommends that the guidelines adopted by DuPage County (1995) or the American Fisheries Society (1983) be used. In addition, the following list of potential maintenance standards and other recommendations related to stream and buffer maintenance were compiled as part of other watershed planning efforts.

1. Identify, map and prioritize all stream reaches that municipalities and townships should include in annual maintenance plans.
2. Develop guidelines for bridges and culvert construction that will minimize habitat destruction and impediments to fish migration and require highway departments and municipalities to follow the guidelines.
3. Develop and enforce an anti-dumping ordinance.
4. Continue to enforce buffer requirements outlined in the Lake County Stormwater Ordinance and work with developers to restore stream reaches and implement maintenance programs.
5. Work with landowners to remove and replace failing hard armoring along streams with bioengineering alternatives.
6. Develop and implement ordinances prohibiting new dams and on-line detention for stormwater and flood control. Remove all unnecessary dams.
7. Retrofit as many storm sewer structures as possible to reduce runoff velocity and scouring.
8. Develop a stream clean-up program to encourage local citizens and organizations to participate in periodic clean up days.
9. Restore native understory vegetation and remove as many non-native weedy trees and shrubs as possible for at least 10-20 feet along stream corridors.
10. Avoid fertilizing along streambanks.
11. Avoid any channel modification unless the modification is included in an approved stream restoration plan.
12. Remove debris jams when they cause unacceptable flow problems or are causing at least moderate sediment accumulation.
13. Enforce erosion control measures on all new development.
14. Maintain all created and natural riffles, pools, and other high quality in-stream habitat at least twice a year to ensure they are functioning properly.
15. Eliminate livestock access to streams to reduce bank erosion and degraded water quality conditions downstream.

3.5.1 Streambank Stabilization

Remedial

Streambank erosion is a moderate problem for streams in the watershed and has the potential to become more severe. Streambank erosion results in a number of problems including poor water quality (because of high sediment loads), loss of terrestrial habitat (due to land loss) and degradation of aquatic habitat (loss of aquatic vegetation and clean substrate when deposited sediment buries the streambed). Erosion occurs not only along the streambanks but also at stormwater discharge pipes and channels, sometimes severe enough to cause failure of outlet pipes, headwalls, and other infrastructure.

Streambank erosion can be reduced using a number of techniques that range from soft, natural solutions such as native vegetation to hard solutions like rock riprap and concrete armoring. The preferred technique for streambank stabilization is soil and vegetation bioengineering. Soil bioengineering utilizes living plant materials as the primary component of a structural system. The end result is a mechanically stable native plant community that is capable of self-repair over time. Bioengineering solutions start weak and get stronger and more stable over time, while hardscaping solutions are strongest after installation and get weaker over time.

With soil bioengineering, native vegetation can be used alone or in combination with harder structures such as A-jacks or lunkers. The use of native vegetation alone is a relatively low-cost method for stabilizing streambanks that is most effective in lower velocity portions of the river. Combining native vegetation with structural measures such as coconut rolls, A-jacks and lunkers can stabilize streambanks where volumes and velocities are higher. These measures are specifically used to stabilize the toe of the slope, providing a stable rooting area and habitat benefits (Dreher and Heringa 1998; Stowe and DuPage County 1991; Wildlife Society 1983; Illinois Department of Natural Resources 1983; Price, Dreher and Schaal 1994).

In cases where the volume and energy of the stormwater flow is extreme, a bioengineering solution may not be effective. In this case, rock outlet protection or riprap may be the most effective technique. Rock outlet protection refers to the use of riprap or stone underlain with filter fabric to prevent erosion or scour where a stormsewer or other outfall drains into the river.

At stormwater discharge points and channels, the erosive force of stormwater must be reduced. Using runoff volume and rate reduction techniques throughout the watershed can significantly reduce the discharge and the erosional effects at these points. However, assuming that all rate and volume reductions will not be handled upstream, practices at the outfall points will be needed. Those practices described above are needed to stabilize the streambanks surrounding the discharge points so that they are not so easily eroded. Additional practices include reducing the fall distance from outlet pipes and creating splash pads that disperse erosional energy. Additional practices are suggested in Outfall Retrofits above.

Stream channel stabilization is also necessary in some locations where downcutting and headcutting are destabilizing the bottom of the stream. Landowners have attempted to line the stream bottom with rock or poured concrete, though this may cause more problems than it solves and reduces the health of stream habitat. More appropriate measures include the establishment of pools and riffles through the strategic placement of boulders and gravels, and the use of check dams and naturalized low head weirs.

3.5.2 Outfall Retrofits

Remedial Retrofit

Creating Wetland Meanders
Outfalls, especially stormsewer pipes, can be retrofitted to add water quality benefits. One technique for retrofitting outfalls is to daylight stormsewers so they flow through created pocket wetlands or wetland meanders before the stormwater is discharged to the stream. The created wetlands filter pollutants from the runoff and dissipate

energy before the water reaches the stream. The Village of Barrington has successfully used this technique on Flint Creek. For more information on the design of created wetland meanders, contact John Heinz, Public Works Director for the Village of Barrington at 847-381-7903.

End-of-Pipe Retrofits

End-of-pipe retrofits can also be used to filter runoff before discharging it to the stream. Sand filters are underground vaults that have a number of chambers with different media that remove pollutants from stormwater runoff. For this reason they are also known as a multi-chamber treatment train (MCTT). In a sand filter, the first chamber is usually empty or filled with water and is used to capture heavier solids. The second chamber contains sand or other filter media that removes smaller solids and dissolved and organic materials. Sand filters are moderately to highly effective for pollutant removal and can last for an extended period of time although they can require significant maintenance. MCTT filters have also been designed to use other filter media such as compost or peat.

Several proprietary retrofit products (such as Stormceptors and others) use cyclonic action to remove pollutants from stormwater runoff. These retrofits are used primarily on small, highly impervious sites, such as parking lots. A typical unit incorporates a circular holding tank that receives runoff from a flow diversion structure and allows solids to settle out. The normal flows are treated and high peak flows by-pass the unit to the downstream drainage network. The unit can trap sand, oil and grease reasonably if the tank is regularly cleaned and maintained (Claytor 1999).

An oil and grit separator is an underground structure with multiple chambers to remove pollutants from stormwater runoff at very small sites. The typical separator contains three chambers, one dry and two wets. The first chamber has a permanent pool of water and a trash rack designed to trap grit, coarse sediments, trash and debris. Two 6" orifices open out from behind the trash rack to pass water to the second chamber. Water can also pass over the chamber wall from the first to the second chamber. An inverted elbow pipe drains the second chamber to the third chamber. It is expected that the oil and grease will initially float on the surface in the second chamber and then adhere to suspended particles, which eventually settle to the bottom of the chamber. The contents of both chambers should be removed on a quarterly basis as part of normal maintenance. Recent study has suggested that pollutant removal performance of oil/grit separators is extremely limited (Shepp 1995).

3.6 Nonpoint Source Pollution Prevention Program

Preventive

Pollution prevention and source reduction programs reduce the generation and migration of pollutants that collect on streets, parking lots and other surfaces into streams, rivers and lakes. Because nonpoint source pollution is generated in relatively small amounts from numerous sites (including homeowner's lawns and driveways, schools, construction sites and businesses), the most effective source reduction strategies are community programs that include a combination of regulation, guidance and education.

Source controls prevent pollutants from entering the stormwater stream from the point where the rainwater falls. In most cases, source controls are more cost effective than structural water quality BMPs to reduce pollutant loading. However, a combination of source reduction and structural BMPs are usually the most effective method to control pollution from runoff.

Source reduction typically includes changing everyday practices to reduce the quantity of pollutants that end up on the land and in the water. In addition to reducing pollutant inputs, pollution prevention programs also recommend using environmentally friendly products and changing the timing of some activities to minimize the amount of materials that wash off the land. Opportunities to reduce pollutant loads are numerous and range from recycling and reducing applications of lawn chemicals to driving less and minimizing road salt usage. Some common source reduction opportunities are listed in Table F.8.

Table F.8. Source Reduction Activities.

Source Reduction Activity	Who's Responsible
1. Collect and recycle crankcase oil	homeowners, business, government
2. Reduce pesticide and fertilizer applications to lawns	homeowners, business, government
3. Don't litter	everyone
4. Clean up and properly dispose of pet wastes	homeowners, businesses (kennels)
5. Properly store and dispose of household chemicals	homeowners
6. Remove illegal and improper connections to storm drains	homeowners, business, government
7. Landscape yards and business grounds to reduce runoff	homeowners, business, government
8. Maintain septic tank properly	homeowners
9. Direct downspouts from paved surfaces	homeowners, business, government
10. Install rain barrels	homeowners
11. Sweep up rather than hose off to clean	homeowners, business, government
12. Sweep street gutters and keep stormsewer inlets clean of leaves and trash	homeowners, business, government
13. Prevent erosion	homeowners, business, government
14. Minimize quantity of road salt used	businesses, government

4. WATERSHED PROTECTION TOOLS TO MINIMIZE AND REDUCE FLOOD DAMAGE

Flood prevention and reduction techniques seek to prevent flooding problems before they occur and minimize damage where they do occur. Flood prevention techniques take the form of land use controls that include programmatic/regulatory controls and implementation of infiltration techniques in existing and new developments. Regulatory controls such as zoning, floodplain, and stormwater ordinances seek to prevent flood damages by limiting development in areas where flooding is most likely to occur, and by standardizing stormwater runoff requirements for new developments. Infiltration techniques, whether applied to old or new developments, decrease runoff that can lead to flooding. Flooding and other water quantity problems can be reduced by both structural and non-structural means. Structural flood control measures require the building of structures such as reservoirs, levees and floodwalls to control the flow of floodwaters and to reduce flood damages. Non-structural measures include practices such as acquisition or relocation of floodprone buildings, floodproofing and use of runoff reduction techniques such as native landscaping.

Programmatic/Regulatory Controls are covered within Watershed Protection Policy and Planning Tools above. Infiltration Techniques for Existing Developments are covered within Stormwater and Landscaping Best Management Practices above. Infiltration Techniques for New Development are covered within Watershed Protection Policy and Planning Tools above.

4.1 STRUCTURAL FLOOD CONTROL

Structural measures control or contain water and are generally designed to prevent floodwaters from reaching buildings. Structural alternatives generally include reservoirs, levees and floodwalls, diversions, stream channel conveyance improvements and drainage and stormsewer improvements. Because of their size and cost, structural projects are often implemented with help from state or federal flood control agencies such as the Illinois Department of Natural Resources - Office of Water Resources, the US Army Corps of Engineers (USACE) and the USDA Natural Resources Conservation Service.

Since structural flood control is generally the most expensive type of mitigation measure in terms of installation time and costs, maintenance requirements and environmental impacts, a thorough assessment of alternatives should be conducted before choosing a structural flood control measure. The advantages and disadvantages of structural flood control techniques are discussed in Table F.9. (Association of State Floodplain Managers 1996)

Table F.9. Benefits and Drawbacks to Structural Flood Control Measures.

Advantages	Shortcomings
• May provide the greatest amount of protection for land area used. • Because of land limitations, may be the only practical solution in some circumstances. • Can incorporate other benefits into structural project design such as water supply and recreational uses. • Regional detention may be more cost-efficient and effective than requiring numerous small detention basins.	• They disturb the land and disrupt natural water flows, often destroying wildlife habitat. • They require regular maintenance, which if neglected, can have disastrous consequences. • They are built to a certain flood protection level that can be exceeded by larger floods, causing extensive damage. • They can create a false sense of security, as people protected by a project often believe that no flood can ever reach them. • Although it may be unintended, in many circumstances they promote more intensive land use and development in the floodplain. • They can create new flooding problems if improperly designed or built. • Levees and reservoirs can significantly degrade riparian and aquatic habitat and water quality.

4.1.1 Reservoirs/ Regional Detention

Preventive and Remedial Retrofit

Reservoirs and regional detention are large structures that control flooding by holding high flows behind dams or in storage basins. After a flood peaks, water is released or pumped out slowly at a rate that is equal to or less than the capacity of the downstream channel. Reservoirs that maintain a normal water level may be used for water supply and/or to provide water-based recreational benefits. In addition, wet or dry detention basins can serve multiple uses by doubling as parks or providing other open space uses.

The amount of land needed, coupled with the expense of construction, management and maintenance limit the use of reservoirs. Additionally, reservoirs may fail to prevent floods that exceed their design levels; may eliminate the natural and beneficial functions of the floodplain; and may negatively impact water quality and aquatic habitat. Impoundments are also known to affect temperature, pH, dissolved oxygen and nutrient transport. In addition, reservoirs frequently act as giant sediment basins accumulating sediment over a period of years that reduces stormwater storage capacity.

4.1.2 Detention Basins

Preventive and Remedial Retrofit

Enlarging or adjusting flows through existing detention basins, or constructing new basins, can remedy some localized flooding problems. Detention basins are considered to be effective at flood reduction in watersheds of up to 30 square miles. While regional detention is generally more cost-effective than constructing numerous small detention facilities, in some cases there may not be sufficient land available for regional detention. Also, for very localized flood problems, a smaller detention basin may be the most economical solution. In addition, slowing release rates from new and existing detention basins can reduce the downstream flood risk and some of the impacts of flashy hydrology on the stream channel.

The known flood problem areas in the watershed suffer flood damage primarily caused by poor local drainage or a depressional location rather than flood damage from the river overbank flooding. Older developments in the watershed built prior to adoption of the WDO, as well as more open landscapes such as parks and open space, may lack adequate detention. Undeveloped areas are also without detention. Retrofitting older detention basins with restrictors that regulate the 2-year event, expanding detention basin capacity where feasible and installing new detention in localized flood problems areas are three types of retrofit opportunities available to mitigate flood damage at some flood problem sites.

4.1.3 Levees and Floodwalls

Preventive and Remedial Retrofit

Earthen levees or concrete floodwalls are erected between rivers or lakes and the properties to be protected. Levees and floodwalls confine water to the stream channel by artificially raising the banks. Levees must be well designed to account for large floods, underground seepage, pumping of internal drainage and erosion and scour. A serious concern with levees is that they frequently offer a false sense of security. In some cases land use behind a levee can change to high intensity, high-value occupation under the false assumption that all future floods will be controlled by the levee, when in reality, large floods may overtop or breach the levee creating more flood damage than would have occurred. Problems also arise when the present runoff volume in the channel exceeds the design capacity of older levees that were constructed for lower flow conditions.

Levees and floodwalls have other limitations. Placed along the lake, river or stream edge, they degrade riparian and aquatic habitat. Levees are expensive to construct, require considerable land and maintenance and are more likely to push floodwater onto other properties upstream or downstream. In some cases, it may be necessary to include expensive and noisy pumping operations for internal drainage. Levees also act as barriers to river access, block views and disrupt local drainage patterns.

4.1.4 Barriers

Preventive and Remedial Retrof t

Constructing barriers such as low f oodwalls and berms around an individual property can keep f oodwaters from reaching the building. Berms are commonly used in areas subject to shallow f ooding. Not considered engineered structures, berms are made by re-grading or f lling an area. Low f oodwalls may be built around stairwells to protect the basement and lower f oor of a split-level home. By keeping water away from the building walls, the problems of seepage and hydrostatic pressure are reduced.

As with levees, the use of f oodwalls and berms must also include a plan to install drainpipes and/or sump pumps to handle leaks and water seepage through or under the barrier, and to get rid of water that may collect inside. Care must be taken in the design, location and installation of berms or f oodwalls to insure that f oodwaters are not inadvertently pushed onto adjacent properties.

4.1.5 Improved Channel Conveyance

Preventive and Remedial Retrof t

Channel conveyance improvements alter the channel so that more water is carried away at a faster rate. Improvements generally include making the channel wider, deeper, smoother and/or straighter. Some channels in urban areas have also been lined with concrete or put in underground pipes.

Straightening, deepening and/or widening a stream or river channel, commonly referred to as 'channelization', has traditionally been the common remedy for local drainage or f ooding problems. Channelized rivers and streams drain water faster from areas adjacent to and upstream of the channel, but can create or worsen f ooding problems downstream as larger volumes of water are transported at a faster rate. Channelized waterways tend to be unstable and experience more streambank erosion. Therefore, the need for periodic reconstruction, streambank stabilization and silt removal becomes cyclic in these circumstances making stream and channel maintenance very expensive.

Dredging is another type of conveyance improvement. It is frequently cost prohibitive due to the expense of disposing of the dredged material. In addition, unless instream and/or upstream tributary erosion are corrected, the dredged areas usually f ll back in within a few years, and the process and expense have to be repeated. Channel conveyance improvements such as channelization and dredging are considered to be environmentally destructive because pool/riff e and riparian habitat are lost, negatively impacting both aquatic and terrestrial plants and animals. Increased water temperature and higher turbidity are two common water quality impacts associated with improved channel conveyance.

4.1.6 Drainage Improvements

Preventive and Remedial Retrof t

Drainage improvements can be in the form of open ditches, swales or stormsewers. Man-made ditches and stormsewers help drain areas where the surface drainage system is inadequate, or where underground drainageways may be safer or more practical. Particularly appropriate for depressions and low spots that will not drain naturally, drainage and stormsewer improvements usually are designed to carry the runoff from smaller, more frequent storms. Stormsewer improvements include installing new sewers, modif cations of sewer inlets, installing larger pipes and using measures such as f ap gates to prevent back f ows.

Because drainage ditches and stormsewers convey water faster to other locations, improvements are only recommended for small local problems where the receiving stream or river has suf f cient capacity to handle the additional volume and f ow of water. To reduce the cumulative downstream f ood impacts of numerous small drainage projects, additional detention and/or runoff reduction practices should be undertaken in conjunction with drainage system improvements.

In some areas, streets, parking lots or athletic fields can be modified to store water from larger, less frequent storms to relieve and reduce overloading of the local drainage system. Although street modifications for stormwater storage are not appropriate in all areas, in many circumstances, they can be more effective and less expensive than increasing the size of receiving stormsewer systems.

4.2 NON-STRUCTURAL FLOOD CONTROL

In addition to structural controls for flood remediation, flooding problems can also be addressed using non-structural means. Some of the non-structural flood control techniques include floodproofing, acquisition of floodplain buildings, building elevation and building relocation. More communities and countywide agencies could get involved in non-structural programs such as acquisition by helping to identify repetitively flooded properties. In addition to being used for prevention, runoff reduction techniques may also be used by individual homeowners or neighborhood associations in retrofit projects to lessen existing flooding problems.

4.2.1 Building Relocation

Preventive and Remedial

Moving a building to higher ground is an extremely effective way to protect it from flooding. While almost any building can be moved, the cost goes up for heavier structures, such as those made of brick, and for large or irregularly shaped buildings. Building relocation is generally cost-effective where flooding is relatively severe and/or frequent. Buildings that have suffered structural damage or contamination from frequent or long duration flooding should not be considered for relocation.
While relocation is typically the responsibility of the building owner, government-sponsored loans or grants may be available for cost-share. Communities and county-wide agencies could play a greater role in building relocation by improving public and local official awareness of this option, and by identifying buildings or properties well-suited for relocation and seeking potential cost-share funds to assist individual property owners.

4.2.2 Buyouts/ Acquisition

Preventive and Remedial

Like relocation, acquisition ensures that buildings in a floodprone area will cease to be subject to damage. The major difference is that acquisition is undertaken by a government agency, so the cost is not borne by the property owner. With acquisition, the flooded structure is removed and the land is converted to an appropriate public use such as a park. Acquiring and clearing buildings from the floodplain is not only the best long-term flood protection measure; it also is a way to convert a problem area into a community asset that can provide environmental and recreational benefits.

More communities and countywide agencies could get involved in acquisition by:

1. improving public awareness of this option;
2. budgeting the 25% matching funds necessary for state and federal funding;
3. establishing guidelines for determining when acquisition is preferable to flood control or flood proofing; and
4. prioritizing properties for purchase.

To achieve maximum benefits from this type of public investment, acquisition and land reuse should be a component of a community's redevelopment plan, and be incorporated as a strategy in park, greenways and capital improvement plans.

4.2.3 Floodplain Acquisition

Preventive

Floodplain acquisition can be an effective tool for reducing future flooding because it prevents developments in the floodplain. In addition to eliminating floodplain development and the resulting flood damages, floodplain acquisition can provide multiple benefits with the addition of amenities such as greenways, recreational trails, river access points and wildlife habitat corridors.

4.2.4 Building Elevation

Preventive and Remedial

Raising a house above the flood level is the best way to protect a structure that cannot be removed from the floodplain. The structure is elevated on a foundation or piers so that the lowest floor is above the base flood elevation. When flooding occurs, water levels stay below the main floor, causing no damage to the structure or its contents. Raising a building above the flood level is cheaper than moving it, and can be less disruptive to a neighborhood. Commonly practiced in floodprone areas nationwide, this protection technique is required by law for new and substantially damaged residences located in a 100-year floodplain.

Although flood damages can be reduced significantly or eliminated through building elevation, there are some limitations to remaining in a flood prone location. While the building itself is sufficiently elevated to be protected from flood damage, flooding may isolate the building and make it inaccessible. Flood waters surrounding the building can also result in a loss of utility service or septic use, making the building uninhabitable. Additionally, pollutant contamination in floodwaters may present health and safety concerns.

4.2.5 Floodproofing

Preventive and Remedial

Floodproofing measures can provide either wet floodproofing or dry floodproofing. In areas where there is shallow flooding, dry floodproofing measures can be used to prevent water from entering some buildings. A wet floodproofing strategy allows water to enter the building, but moves damageable belongings, appliances and utilities out of harm's way. Wet floodproofing includes some of the least expensive and easiest mitigation practices to install. Although floodwaters are not controlled, with wet floodproofing damage can be greatly reduced.

Dry floodproofing is a combination of practices that are used to seal a building against floodwaters. The building must be waterproofed; that is, walls, floors and all openings must be sealed and made watertight. Buildings with crawlspaces generally cannot be dry floodproofed because water can seep under walls into the crawlspace. However, buildings on slabs and buildings with basements can benefit from dry floodproofing.

Because of the need to address hydrostatic pressure, a structural engineer should be consulted when designing the dry floodproofing measures. If a dry floodproofed structure is not sufficiently reinforced, basement walls and floors can become cracked, buckled or broken by the pressure of floodwater.

Wet floodproofing protects from damage when floodwaters cannot be kept out of a building. It is a relatively simple means of making sure that nothing gets damaged or ruined when floodwaters get in. Wet floodproofing techniques range from moving a few valuable items to a higher floor, to totally rebuilding the area that floods. At the very least, several low-cost steps can be taken to wet floodproof a structure. Simply moving furniture and electrical appliances out of the floodprone portions of the building can prevent thousands of dollars in damages. One strong advantage is that no matter how little is done, flood damage will be reduced.

Wet floodproofing measures work in cases where there is a level above the flood zone to which items can be relocated. It generally does not work for one-story houses where living areas get flooded. An advantage of using wet floodproofing vs. dry floodproofing is that by allowing water in the structure, the danger of wall collapsing due to uneven pressure is alleviated.

4.2.6 Runoff Reduction

Preventive and Remedial

Examples of runoff reduction techniques that can be installed as retrofits in developed areas include the use of natural landscaping, permeable pavement, infiltration trenches, basins or swales, and disconnection of downspouts from impervious areas, which are described elsewhere in this toolbox. Disconnecting downspouts is also relatively simple and inexpensive. In these cases, runof f from rooftops is collected in rain barrels or diverted directly to lawns or rain gardens (bioretention areas) for inf ltration.

Implementing these runof f reduction retro f ts is generally the responsibility of individual property owners. While these techniques may not have a signi f cant impact when applied individually on a single site, the cumulative efect when used at numerous sites throughout the watershed can result in signif cant f ood reduction bene f ts. For example, a 1989 engineering report by Baxter & W oodman for the City of Highland indicates an average-sized home in Highland Park can contribute 3,000 gallons to sewers during a one-hour duration, 2-year frequency storm (1.45 inches; Baxter & Woodman 1989). Since public participation is necessary for watershed ef fectiveness, an aggressive public information and outreach ef fort should be used for implementation of these techniques.

4.2.7 Insurance

Preventive

Insurance does not prevent f ooding or f ood damage; it helps owners protect their property investments by paying for repairs and replacement of items damaged in a f ood. While a typical homeowner 's insurance policy does not cover f ood damages to property, f ood insurance coverage is available through the National Flood Insurance Program (NFIP), as is additional basement backup insurance.

Federal law demands that all federally insured lending institutions require that buildings located in the 100-year f oodplain have f ood insurance. Flood insurance is available to anyone located within a community that participates in the NFIP regardless of their location respective to the mapped f oodplain. Many communities in the Kellogg Creek watershed participate in the NFIP. Some communities may also participate in the Community Rating System (CRS), which is a program that credits a community for exceeding the minimum requirements of the NFIP . Residents of CRS communities pay reduced f ood insurance rates as a result of their community' s f ood mitigation activities. LCSMC provides technical and planning assistance to municipalities regarding NFIP compliance and to a limited extent for the CRS program.

5. WATERSHED TOOLS TO PROTECT, RESTORE AND ENHANCE NATURAL RESOURCES

Natural resources in the watershed can be protected and enhanced by the following techniques, many of which are described elsewhere in the toolbox, and others which are described below:

- Developing and changing zoning ordinances,
- Acquiring and protecting open space with conservation easements,
- Promoting conservation developments,
- Developing greenways and trails,
- Protecting threatened and endangered species and their habitat,
- Preserving and restoring wetlands,
- Developing and implementing green infrastructure plans, and
- Restoring streams and riparian buffers.

Several techniques can be used for protecting natural areas and open space in both public and private ownership. The first step in the process is to identify and prioritize properties for protection. All remaining undeveloped land in the watershed has been identified and prioritized as part of the watershed planning process. The highest priority natural areas should be acquired by public agencies or donated to public agencies dedicated to land conservation through a conservation easement. Other open space can be protected using conservation design development techniques, and be managed by private landowners or homeowner's associations. Protection of land by donation, deed restriction, conservation easement, etc. is a type of land use control that prevents future development or modification of natural or open space.

Stream maintenance, such as outfall remediation and streambank stabilization, are covered within Stormwater and Landscaping Best Management Practices above.

5.1 THREATENED AND ENDANGERED (T&E) SPECIES

Preventive and Remedial

Threatened and endangered species are those plant and animal species whose survival is in peril. Both the federal government and the State of Illinois maintain lists of species that meet threatened or endangered criteria within their respective jurisdictions. Federally endangered species are those that are in danger of extinction throughout all or a significant portion of their range. A state-endangered species is any species that is in danger of extinction as a breeding species in Illinois. Threatened species are those that are likely to become endangered in the foreseeable future.

Considerations in protecting endangered species include:

- Making sure there is sufficient habitat available - food, water and "living sites". For animals this means areas for making nests and dens and evading predators while for plants, it refers to availability of preferred substrate and other desirable growing conditions.
- Providing corridors for those species that need to move between sites.
- Protecting them from impacts due to changes in hydrology or increased pollutant loadings.

Several techniques can be used to protect T&E species. One technique is to acquire sites where T&E species occur. Purchase and protection of the site where the species is located (with adequate surrounding buffer) may be sufficient to protect that population. But, in some instances it just isn't feasible or possible to buy the needed land. Where the site and buffer area isn't available for purchase, where an animal moves in a large area (or migrates between sites), or where changes in hydrology or pollution from outside the site affect the species, other techniques must be used to protect the T&E species. Developing a resource conservation or management plan for the species and habitat of concern is the next step. Resource plans consider the need for buffer areas and habitat corridors, and consider watershed impacts from hydrology changes or pollutant loadings.

The conservation plan will include recommendations for management specific to the species and its habitat, whether located on private or public lands. The conservation plan will guide both the property owner, and the local unit of government that plans and permits adjacent land uses, in how to manage habitat to sustain the species.

5.2 WETLAND AND STREAM PROTECTION

Wetlands provide a multitude of benefits and functions. Wetlands improve water quality by removing suspended sediment and dissolved nutrients from runoff. They control the rate of runoff discharged from the watershed and reduce flooding by storing rainfall during storm events. Wetlands also provide habitat for plants and animals including many of those that are threatened and endangered.

Wetland protection techniques that can be employed in the watershed include:

- adopt a watershed regulation requiring no-net-loss of wetlands with a corresponding policy recommending gains in wetland acreages;
- develop management plans for the high quality (ADID) wetlands;
- prioritize and acquire high quality wetlands outright or purchase easements;
- develop regulatory requirements for wider wetland buffers;
- mitigate all wetland losses within the same watershed;
- provide local incentives for voluntary wetland protection and restoration; and
- solicit cost-share funding from established regional, state and federal funding programs for wetland acquisition and restoration.

Stream and wetland restoration practices maintain and restore natural water quality protection features of these landscape elements. It includes activities such as repairing eroded streambanks, naturalizing detention basins, and enhancing wetlands with native plants, practices described in greater detail elsewhere in this toolbox.

5.2.1 No-Net-Loss/Wetland Mitigation

Preventive and Remedial

Since the 1970s, wetlands have been regulated through a permit program administered by the US Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act. Even with the regulatory program, wetlands continued to be converted, albeit at a slower rate.

In the 1990s the Federal government adopted a policy of no-net-loss of wetlands to stem the tide of continued wetland losses. The no-net-loss policy has generated requirements for wetland mitigation so that permitted losses due to filling and other alterations can be replaced. Wetland mitigation for some projects involves the purchase of credits in established wetland mitigation banks.

In order to address the specific circumstances and conditions in individual jurisdictions, and to protect local interests, state and local units of government have adopted more stringent laws than the Federal requirements to protect wetlands. Frequently these laws and ordinances add support to the no-net-loss wetland policy. Adoption of a watershed-wide no-net-loss policy for wetlands within the watershed plan could include a recommendation to the USACE that all wetland losses in the Kellogg Creek watershed be mitigated or replaced in the same watershed.

5.2.2 Management Plans for ADID Wetlands

Preventive and Remedial

A number of wetlands in the Kellogg Creek watershed, most significantly those within Illinois Beach State Park, are classified as high quality (ADID) wetlands by the 1992 Lake County Wetland Inventory. Management plans, developed cooperatively between the wetland owners and local, state and federal agencies, are a measure that could prevent degradation of these high quality wetlands. The management plans would provide guidance to owners, whether private or public, on how to manage the ADID wetlands to sustain their values as high quality wetlands. Management plan recommendations could also be incorporated into appropriate park and forest preserve district plans, local land use and transportation plans, and the watershed plan.

5.2.3 Acquisition of High Priority Wetlands

Preventive

Acquisition as a protection technique is covered under Protected Ownership in Protecting Open Space and Natural Areas. The location of T&E species, ADID wetlands and high quality natural areas are several criteria, among others, that could be used to prioritize wetlands for acquisition.

5.2.4 Protected Ownership/ Conservation Easements

Preventive

There are several options for land transfer ranging from donation to fee simple purchase. Donations can be solicited and encouraged through incentive programs. Unfortunately , while preferred by money-strapped conservation programs, land donations are often not adequate to protect high priority sites. A second option is outright purchase (or fee-simple land purchase). Outright purchase is frequently the least complicated and most permanent protection technique, but is also the most costly. The conservation easement is a less expensive technique than outright purchase that does not require the transfer of land ownership but rather a transfer of use rights. Conservation easements might be attractive to property owners who do not want to sell their land at the present time, but would support perpetual protection from further development. Conservation easements can be donated or purchased.

5.2.5 Wetland Enhancement and Restoration

Preventive and Remedial

Because agriculture and urbanization have degraded many of the remaining wetlands in the Kellogg Creek watershed, wetland enhancement projects are necessary to improve the diversity and function of degraded wetlands. The term enhancement refers to improving the functions and values of an existing wetland. Converted wetland sites (or sites that were formerly wetlands but have now been converted to other uses) can also be restored to provide many of their former wetland benef ts. Wetland restoration is the process of establishing a wetland on a site that is not currently wetland, but was in the past prior to conversion.

Wetland functional values vary substantially from wetland to wetland; they receive special consideration because of the many roles that they play Because of the wetland protection laws currently in place, the greatest impact on wetlands from future development in the Kellogg Creek watershed will likely be a shift in the types of wetlands. Often in mitigation projects, various types of marshes, wet prairies and other wetlands are f lled and replaced elsewhere, usually with open water wetlands. This replacement may lead to a shift in the values served by the wetland communities due to a lack of diversity of wetland types. The wetland restorations that are proposed in the Kellogg Creek watershed should include a variety of dif ferent wetland types to increase the diversity of wetlands in the watershed. The restoration of wetlands will provide new stormwater storage areas, will improve water quality by treating stormwater runoff and will create new and better plant and animal habitat. In addition to these values, wetlands can be part of regional greenways or trail networks, they can be constructed with trails to allow the public to explore them more easily and they can be used to educate the public through signs, organized tours and other techniques. W etland restorations are an exceptional way to meet multiple objectives within a single project.

5.2.6 Riparian and Wetland Buffers

Preventive and Remedial

Wetland buf fers protect a wetland from water quality and hydrologic impacts resulting from adjacent land uses. In addition, if vegetated and managed properly , buf fers can provide considerable wildlife habitat. Buf fers should be comprised of native, unmowed vegetation that is periodically managed for non-native and invasive species.

The Lake County WDO currently requires that buffers be maintained around all areas defined as Waters of the United States or Isolated Waters of Lake County, exceptional functional value wetlands (including ADID wetlands), other wetlands, lakes and ponds. The Illinois Native Plant Guide (USDA-NRCS 2003, the updated 1997 *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois*) is the minimum standard for re-vegetation of disturbed buffer areas. Buffers are divided into two types in the WDO, linear buffers and water body buffers.

Linear buffer requirements (designated along both sides of the channel):

- For channels with a watershed >20 acres but < one square mile, a minimum buffer of 50 feet on each side of the channel is required.
- For channels with a watershed > one square mile, a minimum buffer of 30 feet on each side of the channel is required.
- For linear exceptional functional value wetlands and streams with an Index of Biotic Integrity greater than 40, a minimum buffer width of 100 feet is required

Water body buffer requirements:

- For water bodies or wetlands > 1/3 acre < 1 acre, a minimum 30-foot buffer is required.
- For water bodies or wetlands > 1 acre < 2 ½ acres, a minimum 40-foot buffer is required.
- For water bodies or wetlands > 2 ½ acres, a minimum 50-foot buffer is required.
- For all exceptional functional value wetlands and other water bodies (including ADID wetlands), a minimum 100-foot buffer is required.

These buffer requirements are considered to be the minimum standard for the county. Individual communities have the option of adopting more stringent buffer requirements. Adjacent land use, topography, runoff velocity and soil and vegetation types are all factors in determining the optimum buffer width for wetlands. Where a standard width is needed for regulatory purposes, 100 feet is considered a minimum buffer width for typical surface water requirements. Wider buffers are recommended for sensitive areas (Mitchell 1996). Required setbacks from the wetland should be calculated from the outer edge of the buffer rather than from the wetland itself.

5.2.7 Stream Restoration

Remedial

Stream restoration techniques are used to improve stream conditions so they more closely mimic natural conditions. For urban stream reaches, restoration to natural conditions may not be possible or feasible. For instance, physical constraints due to adjacent development may limit the ability to re-meander a stream. In addition, the natural stream conditions may not be able to accommodate the increased volume of flow from the developed watershed.

Even in cases where restoring the stream to its natural condition isn't possible, the stream can still be naturalized and improved by reestablishing riparian buffers, removing nuisance plants from the stream banks and buffer area, performing stream channel maintenance and debris removal, stabilizing streambanks using bioengineering techniques, and, where appropriate, by removing manmade dams and installing pool/riffle complexes. Stream restoration projects may be one component of floodplain restoration projects, and can be supplemented with trails and interpretive signs, providing recreational and educational benefits to the community. Additional details are provided in Stream Maintenance Program above.

Establishing pool/riffle complexes in the streambed is another method for restoring stream conditions. Pools and riffles naturally occur in streambeds in a sequence that follows the meander of the stream. However, pool/riffle sequences are usually lost when streams are channelized.

Riffle restoration is usually done with rock weirs placed in sequences at spacing intervals determined by the bankfull width of the stream. The cobble and boulder weirs are spaced so a distance of approximately six bankfull widths separates them. Pools develop between the riffles. The pool/riffle sequences benefit fish and macroinvertebrates by aerating the water during low flow conditions, and by providing more diverse substrate and deeper water for habitat.

The placement of the stone for the riffles can also reduce streambank erosion immediately downstream as stream flow is funneled through the center of the stream channel and away from the banks. Pool/riffle complexes are often installed in conjunction with the other streambank stabilization techniques described above for even better stream restoration results (Illinois State Water Survey 1998).

5.2.8 Wetland Incentives and Cost-Share Opportunities

Preventive and Remedial

There are a number of incentive programs to implement wetland projects. Funding sources for wetland protection and restoration, as well as technical assistance, are available from programs at the local, regional, state and federal levels of government.

US Army Corps of Engineers (USACE) Continuing Authorities Program
At the Federal level, the USACE Continuing Authorities Program (CAP) from Section 206 of the 1996 Water Resources Development Act targets wetland restoration. This section, also known as the “Aquatic Ecosystem Restoration” program gives the USACE the authority to carry out aquatic ecosystem restoration and protection if the projects will improve the quality of the environment, are in the public interest and are cost effective. The objective of section 206 is to restore degraded ecosystem structure, function and dynamic processes to a less degraded and more natural condition. The local sponsors of aquatic ecosystem restoration projects are required to contribute 35% towards the total project cost.

US Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS) Programs
The USDA - NRCS has four incentive programs that may have applicability in the Kellogg Creek watershed: the Environmental Quality Incentives Program (EQIP), the Wetland Reserve Program (WRP), the Conservation Reserve Program (CRP), and the Wildlife Habitat Incentive Program (WHIP). The goal of WRP is to restore and protect degraded wetlands such as farmed wetlands. WRP has three options available: permanent easements, 30-year easements and restoration agreements. NRCS will reimburse the landowners for easements on the property plus a portion of the restoration costs based on the type of easement agreed to by the landowner. The EQIP program is accommodating to grass-roots conservation. Typically EQIP monies will fund 75% of land improvements and installation of conservation practices such as grade stabilization structures, grassed waterways, and filter strips adjacent to water resources (including wetlands). Funding for the EQIP program is possible if the planning committee successfully nominates the Kellogg Creek watershed as a natural resource “priority area”. EQIP and WRP are only applicable to agricultural lands.

The goal of the CRP program (and CREP - Conservation Reserve Enhancement Program) is to give incentives to landowners who take frequently flooded and environmentally sensitive land out of crop production and plant specific types of vegetation. Participants earn annual rental payments and sign-up incentives.This program offers up to 90% cost share. Rental payments are boosted by 20% for projects such as installation of riparian buffers and filter strips. Windbreaks, contour buffer strips, and shallow water areas are additional funded practices. The WHIP program is available for private landowners to make improvements for wildlife on their property. This program offers up to 75% cost share. This grant program is competitive and funding depends on the project’s ranking compared to others in the state. Contact David Misek at the local USDA-NRCS office for details at (847) 223-1056.

US Fish and Wildlife Service (USFWS) Partners for Wildlife
Up to 100% cost-share funding is available for private landowners with restorable wetlands through the Partners for Wildlife program of the USFWS and the Illinois Department of Natural Resources – Division of Wildlife Resources. The landowner must agree to maintain the restored wetland for a minimum of 10 years. The restored wetlands should fulfill multiple objectives including providing habitat for waterfowl,

improving water quality, providing flood protection and recharging groundwater.

Illinois Department of Natural Resources (IDNR) Conservation 2000

Because Kellogg Creek is within the area of the Lake Michigan Watershed Ecosystem Partnership, funding is available on a competitive basis from the State of Illinois' Conservation 2000 Ecosystems Program (C2000). The C2000 program, administered by the Illinois Department of Natural Resources (IDNR) Office of Realty and Environmental Planning seeks to "to maintain and enhance the ecological and economic conditions in resource-rich landscapes by supporting Ecosystem Partnerships of local and regional interests." C2000 funds are available both for wetland/habitat acquisition and restoration.

Illinois Environmental Protection Agency (IEPA) Section 319

Funding for wetland related projects is provided by the IEPA through the Nonpoint Source Management Program (Section 319 of the Clean Water Act). Wetland-related projects funded with 319 funds, be they bufers, wetland restorations or other projects, must help "…to control nonpoint source pollution (NPS), improve Illinois water resources, and promote the public's knowledge and awareness of NPS pollution."

Northeastern Illinois Wetlands Conservation Account

Wetland restoration funds are also available through grants from the Northeastern Illinois Wetlands Conservation Account. This funding source is available to the 6 county Chicago region and is jointly administered by The Conservation Fund and the US Fish & Wildlife Service.

Wetlands Restoration Fund

Wetland restoration money is available through this fund formed to accept fee-in-lieu of wetland mitigation monies generated by the wetlands permitting program. Corlands administers this fund for the six-county Chicago region.

Lake County Soil and Water Conservation District (LCSWCD) Technical Assistance

At the local level, technical assistance is available from the LCSWCD. The LCSWCD, along with NRCS staff, offers free assistance to develop conservation plans, assist with technical design of conservation practices and provide and interpret natural resources information. LCSWCD assistance would be especially useful in development of management plans for high quality (ADID) wetlands.

Tax Assessment Reduction

At the local level, incentives are available to preserve land in open space through the County Assessor's office. Land that remains in open space for at least three years is eligible for a dual assessment. This means that as long as the land is used as open space, taxes are paid on a lower use value (rather than market value) based on the value of the poorest open space land in the county (according to court decisions). In order to be eligible for assessment as open space, the property must be at least 10 acres and meet a number of other criteria.

Sources: National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Office of Water, 2005.

Table F.10. Community Best Management Practices

Community Best Management Practice	Lead Partner	Relative Cost (High, Medium, Low)	Ease of Implementation (Diff cult, Moderate, Easy)	Implementation Obstacles	Implementation Time Frame / Schedule (Short, Medium, Long)	Maintenance (Routine, Quarterly / Annual, Infrequent)	Technical Assistance Required? From Whom?	Financial Assistance Required or Available?
Streambank stabilization	SMC, municipality, township, drainage district	Medium - High	Moderate - Diff cult	Easements, access, equipment, funding, permitting	Medium	Quarterly - Annual	SMC, LCSWC, municipality, consultant, FPD	Yes
Stream and wetland restoration	FPD, drainage district, park district, state	Low - High	Moderate - Diff cult	Easements, access, equipment, funding, permitting	Short	Quarterly - Annual	SMC, LCSWC, municipality, consultant, FPD	Yes
Stormwater outfall retrof ts (e.g., stabilizing/ extending pipe outfalls, outfall daylight f lters)	Municipality, LCDOT, IDOT, drainage district	Medium - High	Moderate - Diff cult	Easements, access, equipment, funding, permitting	Medium	Quarterly - Annual	SMC, LCSWC, municipality, consultant	Yes
Detention basin retrof ts	Homeowners association, municipality, landowner	Medium	Moderate	Education, maintenance	Short - Medium	Quarterly - Annual	SMC, LCSWC, municipality, consultant, LCHD	Yes
Naturalized detention basins	Homeowners association, municipality, landowner	Medium	Easy	Education, maintenance	Short - Medium	Quarterly - Annual	SMC, LCSWC, municipality, consultant, LCHD	May be available
Low impact development practices	Municipality, county, developer	Low	Moderate	Education	Short	Quarterly - Annual	Consultant, SMC, municipality	No
Construction practices – soil erosion/ sediment control	Municipality, county, developer	Low	Easy	Acceptance, site management	Short	Routine	Municipality, SMC, SWCD	No
Filter strips and level spreaders	Municipality, county, developer	Low	Easy	Education	Short	Quarterly - Annual	Municipality, SMC, SWCD, consultant	No
Surface and underground f lters	Municipality, county, developer	Medium	Moderate	Education	Short	Quarterly - Annual	Municipality, SMC, SWCD	May be available
Street cleaning	Municipality	High (start-up), Moderate (operation)	Easy	Education / training	Short	Routine	No	No

Table F.10. Community Best Management Practices (Continued)

Community Best Management Practice	Lead Partner	Relative Cost (High, Medium, Low)	Ease of Implementation (Diff cult, Moderate, Easy)	Implementation Obstacles	Implementation Time Frame / Schedule (Short, Medium, Long)	Maintenance (Routine, Quarterly / Annual, Infrequent)	Technical Assistance Required? From Whom?	Financial Assistance Required or Available?
Stormwater system maintenance	Homeowners association, municipality, drainage district	Low - High	Diff cult (homeowners association), Moderate (municipality, drainage district)	Landowner resistance, education / training, funding	Short	Routine	Municipality, SMC, consultant	No
Eliminate stormwater/ sanitary cross connections	Municipality	High	Diff cult	funding, landowner resistance, locating problems and solutions	Long	Infrequent	Legal, consultant	Yes (SRLF, CDBG)
Drainage improvements	Municipality, county, LCDOT, township, drainage district	Medium - High	Easy - Diff cult	Landowner resistance	Short - Long	Quarterly - Annual	Legal, consultant	Yes (CDBG, MFT, WMB)
Regional detention	SMC, IDNR, COE	High	Diff cult	Landowner resistance, funding, locating facilities	Long	Quarterly - Annual	Consultant, SMC, IDNR, COE	Yes
Stream maintenance	Landowner, drainage district, municipality, SMC	Medium	Moderate	Public support, education	Short	Routine	Legal, consultant, SMC, municipality, drainage district	Available (WMB)
Riparian/ wetland buffer enhancement program	SMC, municipality, drainage district	Medium	Moderate	Landowner resistance	Medium	Infrequent	SMC, consultant	Yes
Green infrastructure acquisition/ protection	Park district / department, municipality, FPD, land trust	High	Diff cult	Funding, landowner resistance	Long	NA	Legal, consultant, land trust	Yes
Nonpoint source pollution prevention	Municipality, LCDOT, IDOT, township, drainage district	Low - High	Easy - Diff cult	Education / training	Short	Routine	Consultant, SMC	No

Table F.11. Landowner Best Management Practices

Landowner Best Management Practice	Relative Cost (High, Medium, Low)	Ease of Implementation (Diff cult, Moderate, Easy)	Implementation Obstacles	Implementation Time Frame / Schedule (Short, Medium, Long)	Maintenance (Routine, Quarterly / Annual, Infrequent)	Technical Assistance Required? From Whom?	Financial Assistance Required or Available?
Disconnect downspouts	Low	Easy	Legal, basement f ooding, destination for water	Short	Infrequent	No	No
Bioretention – rain gardens	Medium	Moderate	Site topography, soils	Medium	Routine	Contractor, landscaper	No
Vegetated swales	Low (existing), Medium - High (new)	Easy (existing) - Moderate - Diff cult (new)	Legal, engineering / design	Short - Medium	Routine	Local government, contractor	No
Rainwater harvesting – rain barrels and cisterns	Low (rain barrels) - Medium (cisterns)	Easy (rain barrels) - Moderate - Diff cult (cisterns)	Maintenance	Short (rain barrels) - Medium (cisterns)	Routine	No (rain barrels), Yes (cisterns), design	May be available
Native landscape system	Low - Medium	Moderate	Local ordinance, maintenance	Medium	Routine	Landscape architect, FPD	No
Green roofs	High	Moderate - Diff cult	Education, engineering / design, funding	Short	Quarterly / Annual	Consultant	Yes (Section 319)
Permeable paving	High	Moderate - Diff cult	Maintenance, funding, education	Short	Quarterly / Annual	Consultant	May be available
Landscape maintenance	Low	Easy	Education, local landscape ordinances, acceptance	Short	Routine	Consultant, SMC, SWCD / extension	No
Landowner outfall stabilization BMPs	Low - Medium	Easy - Moderate	Education	Short	Quarterly / Annual	Consultant, municipality, SMC, SWCD / extension	No
Impervious surface maintenance (e.g., parking lots)	Low	Easy	Education	Short	Routine	LCHD	No
Riparian/wetland buffer	Low - Medium	Easy - Moderate	Education, invasive species, aesthetics	Short	Quarterly / Annual	SWCD, extension, SMC, consultant	Yes
Conservation easements	Low - High	Moderate	Legal, party to hold easement	Short	Quarterly / Annual	Legal, land trust	May be available
Flood insurance	Low - Medium	Easy	None	Short	Quarterly / Annual	No	No
Floodproof ng	Low - High	Easy - Diff cult	Funding, knowledge, technical assistance	Medium	Quarterly / Annual	Consultant, SMC	May be available