

# **Managing and Restoring Stream Greenways: A Landowners Handbook**

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## Chapter 1 Introduction

### Background

Streams and rivers are familiar features in the landscape of northeastern Illinois. They perform many important functions, some obvious and some not so apparent.

Drainage is their most obvious function. Streams convey runoff from the landscape, most noticeably during occasional floods when even the least conspicuous drainage way can become a raging torrent. Streams also convey the treated and untreated wastes of our urban and agricultural landscapes. In fact, virtually the entire flow in some of our more urban streams consists of treated wastewater during the drier times of the year.

Streams also are valued as recreational amenities because of their potential to support fishing, swimming, wildlife observation, and boating activities. Healthy stream environments provide habitat for diverse communities of fish, amphibians, insects, and aquatic plants. Stream and river corridors also are viewed as aesthetic amenities for residential development and public open space and provide travel corridors for wildlife.

Historically, however, conflicts have arisen between the various uses and functions of streams. In particular, increased reliance on streams as conduits for stormwater and wastewater has greatly diminished their ability to provide recreational, habitat, water quality, and aesthetic benefits.

There are two principal causes for use conflicts involving streams. The first is the alteration or destruction of the stream channel and its adjacent corridor, or *riparian* zone. Activities such as stream channelization or straightening destroy critical habitat features and upset the natural balance between a stream and its floodplain that has evolved over thousands of years.

The second cause of stream use conflicts is the alteration of the watershed that contributes flow to a stream. A common example is the conversion of farmland to subdivisions and shopping centers and the corresponding increase in impervious land surface. This can result in adverse changes to both the quantity and quality of streamflow. These changes can consequently upset the natural equilibrium of a stream, often resulting in channel erosion, lost habitat, degraded water quality, and frequent flooding.

### Purpose

To address these use conflicts, this handbook presents an approach for managing stream corridors, which preserves and enhances their natural functions. Improved stream corridor management, in conjunction with better controls on watershed development, can substantially reduce the potential for stream degradation, loss of beneficial uses, and costly damages to property. Improved stream management techniques also can be used to reclaim degraded streams, restoring aesthetics, water quality, and aquatic life.

The recommended stream management approach uses low-cost, ecologically-sensitive techniques that are targeted to streamside landowners. This handbook addresses a range of common management concerns, including streamside landscaping, channel maintenance, and

streambank stabilization. It provides a framework for improved stream corridor management but is not intended to be a definitive design manual.

## Overview of Recommended Approach

The stream management approach recommended in this handbook embodies several inter-related principles.

1. Effective management must address the stream and its riparian corridor as an integrated whole. The resultant stream *greenway*, a linear corridor of open land, can provide multiple, mutually-supportive functions, including habitat protection, water quality enhancement, flood storage and conveyance, and recreation.
2. Techniques used for stream and river management systems must be *multi-objective*. Techniques designed for a single purpose, without full consideration of their effects on other functions, are destined to cause or aggravate stream use conflicts.
3. Techniques used for stream protection or mitigation should be *sustainable*; that is, they should address identified problems without the need for excessive or costly future maintenance, and with minimal adverse effects on the surrounding environment.
4. Stream corridor management should rely on *natural* techniques, wherever feasible. Natural techniques are derived from systems and materials that have evolved in nature over thousands of years. The techniques recommended in this handbook, such as soil bio-engineering methods for channel stabilization or landscaping with native vegetation, often deviate substantially from conventional landscaping and engineering strategies.
5. Recommended stream management techniques must be *cost-effective*. Considering the large network of stream channels in northeastern Illinois, the region generally can not afford expensive solutions. Low-cost techniques are more likely to be implemented by a higher percentage of streamside landowners.

In summary, the handbook provides alternatives to streamside property owners that will enable them to evaluate common stream management problems and opportunities from an ecologically sensitive perspective. In some cases, the landowners will be able to address their problems themselves using simple, low-cost techniques. In other, more complicated circumstances the handbook encourages landowners to seek professional assistance from resource agencies or private consultants.

The handbook is particularly applicable to the many ongoing efforts to establish and restore stream-based greenways. The *Northeastern Illinois Regional Greenways Plan*, developed by NIPC and the Openlands Project, identifies over 1000 miles of stream greenways in the region. Stream greenways provide critical linkages to existing open space and natural areas, thereby enhancing biodiversity.

## A Comprehensive Planning Strategy for Stream Naturalization

It is clear that after decades of being ignored and abused, the rivers and streams of the region are being seen as potential amenities. Stream corridors also are now recognized as critical

linkages in restoring the integrity and biodiversity of the landscape and, ultimately, in enhancing the quality of life in the region.

Importantly, streams and other waterbodies are being viewed in the context of their watersheds. It is no coincidence that there is a growing network of watershed-based citizen stream protection and restoration initiatives in the region. These range from grass-roots groups, such as the Friends of the Chicago River, Friends of Tyler Creek, and DuPage River Coalition, to multi-jurisdictional initiatives such as the Ecosystem Partnerships for the Des Plaines, Fox, and Kishwaukee rivers, and other local government-based initiatives such as the Butterfield Creek Steering Committee.

A consistent element of all these initiatives is the awareness that local governments, developers, and landowners must treat the landscape with greater respect. In particular, there is a recognition that changes to the landscape are inter-related and that streams and rivers are reflections of the landscapes within their watersheds.

A sound planning approach that incorporates citizen and landowner interests is critical in accomplishing watershed and stream protection goals. Streamside landowners are encouraged to join forces with new or ongoing watershed and community-based initiatives in their area. Landowners, in addition to protecting and restoring their own section of stream corridor, can assist watershed initiatives in any of the following tasks.

1. Participate as a stakeholder on a watershed committee.
2. Support goals and objectives that embody progressive stream and watershed protection.
3. Volunteer for stream inventory tasks, such as identifying areas of bank erosion or suspicious pollution sources.
4. Support recommendations for more effective local government controls on new development to reduce stormwater runoff and limit infringement in stream corridors and wetlands.
5. Help to implement the watershed action plan by joining in stream-cleaning projects and educating neighbors.
6. Volunteer as a citizen stream monitor to track changes in water quality and aquatic life.

## **Handbook Overview**

Stream ecosystem dynamics: The handbook describes some of the important natural functions of stream corridor ecosystems. Included are descriptions of watershed relationships, stream morphology, aquatic habitat, and riparian buffer systems.

Traditional management approaches and their consequences: The handbook briefly describes traditional single-purpose, "engineered" approaches to stream management and some of the adverse consequences to natural habitats and stream functions.

Natural management concepts: The rationale for the use of native vegetation and natural materials is described to serve as the basis for discussions of specific management techniques.

Recommended management techniques: Appropriate, ecologically-sensitive management techniques for addressing stream problems and for restoring natural functions are presented. These techniques include:

1. streamside landscape buffers;

2. stream channel maintenance;
3. bank stabilization;
4. instream habitat restoration; and
5. accommodating trail access.

For each management technique, appropriate implementation and management considerations are addressed. Information on suggested plant lists, materials, relevant cost factors, and maintenance is provided, where available.

## **Chapter 2 Stream Management Principles**

This chapter lays the groundwork for specific management techniques that follow in Chapter 3. It is important, particularly when considering innovative or uncommon approaches, to understand why they may be preferred over conventional methods. This chapter addresses this need by providing information on stream characteristics and ecosystem dynamics, traditional stream management approaches and their consequences, and the philosophy behind natural management concepts.

### **Stream Characteristics and Ecosystem Dynamics**

When assessing a particular stream or stream segment, and particularly when considering how to manage that stream, it is important to understand certain basic stream characteristics. It also is important to recognize that a stream is a dynamic system which reflects its surrounding landscape.

This section provides a brief overview of several fundamental aspects of stream function, including:

1. watershed relationships,
2. flow characteristics, or *hydrology*,
3. channel structure, or *morphology*,
4. water chemistry,
5. aquatic habitat, and
6. the floodplain/*riparian* zone.

Watershed relationships: First and foremost, a stream is a reflection of its watershed. A watershed is the land area that contributes flow to a stream. Watershed characteristics that are most important include size, topography, land use, and soils.

As described below, watershed relationships affect virtually every aspect of a stream. First, the watershed affects the amount and variability of flow that reaches a stream. This, correspondingly, affects the shape and size of the stream channel. The watershed also affects the quality, temperature, and chemistry, of runoff water reaching a stream.

Hydrology: Hydrology reflects the flow characteristics of a stream, particularly how flow quantity varies over time. Hydrology is principally determined by the watershed. Larger watersheds contribute greater flows. The land use within a watershed also is important. Undeveloped

watersheds consisting of natural woodlands, prairies and wetlands tend to absorb rainfall and produce relatively little surface runoff. The runoff that does occur reaches the stream at a fairly steady rate. Fish and other organisms, both plants and animals, historically found in Midwestern streams have adapted to such stable conditions.

In contrast, a developed watershed that absorbs less rain water, particularly an urban watershed, tends to produce large quantities of flow that reach the stream in erratic pulses. A stream channel responds to greater flows by attempting to deepen and enlarge its channel. The unfortunate consequences of urbanization include channel erosion and increased flooding.

Soils also are an important determinant of stream hydrology. If permeable soils, particularly sands and silts, are predominant in a watershed, then water can move freely through the soils and enter streams as subsurface flow, or baseflow. This condition tends to produce steady, stable flows. However, if watershed soils are predominantly tighter clay soils, less water can move horizontally through the soil and more must run overland or pond on the surface.

Climate is another determinant of stream flows in northeastern Illinois. While there is relatively little climatic variability within this region, our Midwestern climate clearly distinguishes local streams from those in the arid west or more humid south. This climate tends to produce relatively higher runoff and streamflow in spring and early summer, in comparison to fall and winter. This climate also is characterized by intense thunderstorms and occasionally severe snowmelt events, which produce large flow pulses in streams. This climate also produces occasional droughts which diminish stream flows, which is especially noticeable in intermittent headwater streams.

Channel structure - Morphology: Stream channel shape, size, and slope (or *gradient*) are all elements of channel morphology. Stream morphology is reflective of watershed characteristics, topography, and soil conditions.

Channel size is related to watershed size. Larger watersheds contribute greater flows, which consequently result in larger stream and river channels. Channel slope also tends to be related to watershed size. In general, northeastern Illinois streams and rivers with large watersheds tend to have relatively flat gradients. For example, a large river (like the Des Plaines) whose watershed area is several hundred square miles, typically drops only 2-3 feet over every mile of length. In contrast, many headwaters and tributaries that drain smaller areas tend to be steeper, typically dropping from 5 to 20 feet per mile, on average.

Channel slope, which also is related to topography, correspondingly influences channel shape. In general, the channels of flat-gradient streams tend to curve, or *meander*, more than channels of steeply-sloped streams. In either case, meandering is a natural phenomenon resulting from a stream's tendency to dissipate the energy of flowing water.

Surface soils and underlying deposits also are a determinant of stream morphology, as well as channel stability. Soils found adjacent to stream channels reflect the evolution of drainage patterns going back to the time of glacial activity thousands of years ago. While the predominant underlying soils in northeastern Illinois are clays, stream channel soils can be highly variable. Commonly, finer soils, such as silts, are likely to be found at the top of the streambank and coarser materials, such as gravels, are more likely on the stream bottom. Streams in some parts of the region are underlain by bedrock outcrops. Stream channel soils

also are related to channel steepness. Streams with steeply-sloped channels tend to flow through coarse materials such as gravel and cobbles. This may reflect the fact that the channel has cut down over time through surface soils into underlying glacial materials. In contrast, flatter, slow-moving streams tend to flow through finer soils, including silts and organic wetland soils.

Morphology also establishes certain critical relationships between the occurrence of features such as pools and riffles, meanders, and channel width. In general, pools, the deepest zones in a stream channel, tend to occur at the outside bend of meanders. Riffles, the shallow, more turbulent zones in a channel, tend to occur in the straight portion of a channel, or "run," between meanders. It also has been determined in studies of numerous natural stream channels that the distance between meanders is directly related to average channel width.

Water chemistry: Another important stream characteristic is water chemistry. In a natural system, water chemistry indicators, such as pH, nutrient and organic content, and dissolved solids, are determined largely by watershed characteristics, principally soils. While there is not a great deal of natural variability in northeastern Illinois, it appears that some streams inherently carry higher concentrations of solids, nutrients, and organic matter than others. This may be related to watershed soil conditions. In a developed watershed, certain land uses, such as commercial and industrial areas, can significantly alter natural stream chemistry by generating high concentrations of nutrients, organic matter, and solids in stormwater runoff. This is called *nonpoint source pollution*. Water chemistry also is altered by the discharges of wastewater treatment plants that contribute *point source pollution*.

One of the most critical water chemistry factors is dissolved oxygen. In general, steep-gradient streams are likely to maintain higher dissolved oxygen levels than slow-moving, low gradient streams, due to the natural aeration provided by turbulence. Temperature is another important element of water chemistry. Stream temperature is most strongly affected by climate. Northeastern Illinois streams generally are classified, with few exceptions, as warm-water systems. This means that they can support fish such as bass but typically cannot support cold-water species such as trout. Water temperature also is affected by factors such as shading, flow depth, groundwater contribution, and watershed land use. For example, an urbanized watershed tends to produce higher summer stream temperatures due to surface runoff from sun-warmed parking lots and roads.

Aquatic habitat: Aquatic habitat includes all of those physical and chemical factors that determine the suitability of a stream channel for habitation by aquatic organisms, both animal and plant. Some of the most important physical habitat features are pools, riffles, bottom substrates, and cover. These features are important for various life-cycle functions of aquatic animals, particularly reproduction and feeding.

In general, a healthy stream ecosystem provides a diversity of habitats, including pools and riffles, submerged logs, channel vegetation, and a range of bottom substrates. Some organisms, for example, require water moving over coarse substrates such as gravels and cobbles. Other organisms generally prefer slower, deeper water moving over fine, organic substrates. These habitat needs also may vary over the various stages in an organism's life cycle. For example, fish fry will have different needs from adults.

Clean water and sediments also are prerequisites of healthy ecosystems. The presence of toxic

compounds and/or very high turbidity levels will eliminate all but the most tolerant species of plants and animals. Similarly, excessive levels of sediment covering natural substrates will preclude many organisms.

In summary, a healthy aquatic habitat will support a diverse assemblage of fish, bottom dwelling (or *benthic*) organisms, and aquatic plants. Beyond their dependency on habitat, aquatic organisms also exhibit an interdependency on each other.

Riparian zone: The riparian zone is the land area immediately adjacent to a stream. While there is no specific determinant of the outer edge of the riparian zone, it generally includes areas which are normally dry but prone to occasional inundations by floods. Conditions within a riparian zone can vary widely. Commonly, natural riparian zones in northeastern Illinois will contain relatively moist soils at an elevation close to the stage of the river or stream. These areas are commonly classified as riverine wetlands. For some streams, however, particularly those with relatively steep gradients, the riparian zone may include upland areas that are relatively dry.

In a natural stream setting, the riparian zone exists in a state of dynamic equilibrium with the stream; that is, the riparian zone shifts in response to natural erosive forces and the tendency of a stream channel to slowly meander. From a stream management perspective, this is an important concept to recognize so that actions are not taken which will lock a stream into a set channel location.

From a management perspective, the most critical element in the riparian zone is vegetation. In a natural system, vegetation is determined largely by the factors described previously, principally soils, climate, and hydrology. Assessments of vegetation conditions prior to settlement of this region by Europeans indicate that most streams were bordered by herbaceous vegetation, principally prairie and wetland plants. This was due, in part, to the influence of fires which swept across the flat prairie landscape. Woody vegetation was found in some riparian environments, principally along the larger rivers and along the eastern edges of rivers and streams that were less susceptible to the effects of fire. Woody vegetation also was found along many of the steeper, ravine-like channels which predominate in some parts of the region.

Riparian vegetation varies directly with soil moisture and inundation frequency. In the zone which contains the stream channel and the lower edges of streambanks, only water-tolerant vegetation -- such as rushes, emergent wetland plants, and moisture-loving grasses -- is likely to exist. In larger rivers which produce very extended durations of inundation, the banks and channel edges may be dominated by bare slopes and exposed gravel or sand bars. Higher up the stream bank and into the floodplain, where inundation is less frequent, other grasses, sedges, and woody vegetation is likely to be found.

Summary: All of the preceding factors combine to determine the conditions found in a given stream or stream segment. While healthy stream systems are relatively stable over time, their various components are dynamic, exhibiting variability in flow, temperature, and water chemistry. Even the physical characteristics of stream channels are dynamic, as channel shape and dimensions slowly evolve in response to long-term changes in watershed characteristics.

While streams are dynamic, their characteristics within a natural, relatively undisturbed watershed reflect a stable, predictable state of equilibrium with their surroundings.

Correspondingly, stream biota -- including fish, bottom-dwelling organisms, and aquatic vegetation -- have evolved and adapted over thousands of years to this state of equilibrium. Unless the characteristics described above are substantially altered, streams will continue to function as stable, diverse and productive ecosystems.

## **Historical Stream Management Approaches and Their Consequences**

Since the arrival and dispersal of immigrants began 150 years ago across the northeastern Illinois landscape, many of the natural characteristics of stream ecosystems have been radically altered. These changes are the result of two principal activities: 1) development of upstream watersheds; and 2) direct, physical alteration of streams, floodplains, and riparian wetlands. While it may be difficult to determine which of these activities has had the most significant effects, there can be little disagreement that the cumulative impacts have been dramatic. The general consequence of these activities has been a reduction in stream stability and health. For example, it has been observed that virtually all of the region's streams in urban and suburban watersheds are moderately to severely degraded with respect to aquatic life. Other observed impacts include increased flooding, more rapid fluctuations in water levels, accelerated streambank erosion, and degraded aesthetics.

Watershed development impacts: Watershed development impacts have predominantly affected the quantity and quality of flow reaching streams. Because this handbook is directed principally to the management of the stream channel and riparian zone, watershed concerns will not be discussed at length. However, it is important in evaluating stream management techniques to have a good general understanding of watershed-related factors.

Probably the most important watershed consideration is how development activities, particularly urbanization, have substantially changed the hydrology of receiving streams. Flow arrives in higher volumes and in much more erratic rates than under natural circumstances. Consequently, urban streamflows are commonly described as "flashy." As a result, most stream channels have widened due to erosion to expand their capacity. Subsequent effects include shallower flows and elevated water temperatures. Fortunately, stream management techniques can address some of the hydrologic consequences of watershed modification, and thereby improve the stability and function of degraded stream channels. However, it must also be recognized that stream channel management may be only partially successful if the upstream watershed is continuing to be modified.

Similarly, watershed development has substantially impacted water quality in many streams. Some of the most common effects include lowered dissolved oxygen levels due to increased concentrations of organic matter; excessive growth of algae and nuisance aquatic plants (called *eutrophication*) due to elevated concentrations of nutrients; reduced water clarity; and sedimentation of stream bottoms. To varying degrees, the utilization of holistic stream corridor management and restoration techniques can reduce the consequences of these watershed-induced changes.

Physical alteration of stream channels and floodplains: Streams and floodplains have been altered historically for a number of reasons: to improve the utility or economic use of riparian lands and floodplains; to reduce adjacent and upstream drainage or flooding problems; and to change the aesthetic character of the riparian zone. The purposes of modifications, and the

stream management techniques that evolved to accomplish them, often were justifiable within their historical context. However, it also is apparent that the adverse consequences of many historical modifications typically were either not understood or were considered to be of lesser importance than their intended economic objectives.

Several common types of channel and floodplain modifications are discussed in this handbook:

1. channelization;
2. channel armoring;
3. elimination of native vegetation;
4. impoundments; and
5. floodplain filling.

**Channelization** involves the straightening, deepening, and/or widening of a stream channel, generally for the purposes of increasing channel conveyance and/or draining adjacent land. One of the most extensive applications of channelization was performed by farmers and drainage districts to "improve" wet areas adjacent to streams for farming. Streams, particularly headwaters, were routinely straightened and deepened to increase drainage of both surface (via lateral ditches) and subsurface (via field tiles) water. Often, stream banks also were built up with berms or levees to keep routine floods out of farm fields. While such activities provided tremendous benefits to farmers and consumers, they also increased the quantity of runoff, lowered water tables, destroyed wetlands, and eliminated stream habitat features such as pools, riffles, and meanders.

The stream modification activities initiated by farmers have been expanded and magnified in urban areas. Channelization in urban areas has been performed to enable development of floodplains and riparian wetlands, and to reduce local flooding problems. In total, well over 40 percent of the stream miles in northeastern Illinois have been channelized. The unintended consequences of channelization include the destruction of aquatic habitat and increased downstream flooding, channel instability, and streambank erosion.

**Channel armoring** often accompanies channelization, particularly in urban settings. Armoring is accomplished with materials such as riprap, gabions, steel pilings, or concrete. Armoring is done to attain two principal purposes: to stabilize exposed streambanks, and/or to speed the flow of water by smoothing the surface of the channel.

The adverse effects of channel armoring are similar to those of channelization. An additional repercussion is the replacement of a vegetated streambank with a hard edge. As a consequence, the benefits of streambank vegetation, particularly its habitat for aquatic insects and amphibians and its shading effect, may be lost. The severity of the effect of armoring depends on whether the entire channel is lined (e.g., as in a small stream application) or armor is applied only in scattered locations (e.g., as in a larger river). The degree of impact also depends on the specific armoring technique used. Concrete lining, which produces an unnaturally smooth surface, eliminates nearly all desirable aquatic habitat features. Use of riprap, particularly in combination with native vegetation, can partially reduce the adverse ecologic effects by providing for some of the habitat needs of fish and benthic macroinvertebrates.

Other adverse ecologic consequences of some armoring installations are caused by the resultant increase in stream velocity. Excessive velocities can flush out bottom-dwelling

organisms and lead to increases in channel erosion downstream of the armor installation.

**Elimination of native vegetation** from streambanks has occurred both directly and indirectly. Substantial vegetation losses have occurred due to the planting of non-native turf grass on streambanks for landscaping purposes, and as a result of stream maintenance activities (see below). Native vegetation also has been lost more gradually as aggressive non-native species, such as reed canary grass or common buckthorn, have invaded areas disturbed by channelization projects. The elimination of natural fires also has favored the spread of non-native plants. The consequences of these activities include streambank instability due to the loss of stabilizing vegetation and root systems; increased temperatures due to a combination of reduced shading and wider channels; and reduced habitat for aquatic insects, amphibians, and fish.

**Channel maintenance** activities generally are performed to enhance and maintain the ability of a stream channel to convey floodwaters in urban settings or to maintain surface and subsurface drainage capacity in adjacent agricultural fields. Maintenance commonly involves the removal of small trees and brush, larger stumps, and instream debris. If limited principally to excessive instream debris, stream maintenance should have little adverse effect on stream ecology. However, if maintenance includes the extensive removal of native streambank vegetation, ecologic consequences can be severe, as described above. An additional adverse consequence is the elimination of natural instream debris which is important as fish cover.

**Onstream impoundments** are constructed for purposes of stormwater detention, flood control, and recreation/aesthetics. The significance of their impacts depends on whether a permanent pool is created or the impounding structure stores water only during flood events. Permanent pools can have substantial adverse habitat and water quality impacts, particularly if the impounded stream is enriched with nutrients and organic matter (e.g., from urban runoff). Permanent pools encourage the accumulation of sediment, the growth of excessive populations of aquatic plants and algae, the elevation of water temperatures, and the occasional reduction of dissolved oxygen levels.

Dams also can seriously constrain the migration of fish and other aquatic organisms, thereby limiting access to headwaters for spawning and limiting the repopulation of areas that have been chemically or hydrologically disturbed. Instream impoundments also alter fish habitat, changing a stream segment from a riverine to a *lacustrine*, or lake-like, environment.

**Floodplain filling** generally has been done to accommodate new development, including roads, buildings, and parking lots. If filling occurs in the riparian zone close to the stream channel, it is likely to have significant adverse effects on the stream. Alteration of natural riparian environments can degrade aquatic habitat and reduce the pollutant-filtering effect of the riparian buffer, leading to degraded water quality. Further, filling or construction in riparian areas can increase nearby flooding and limit the opportunity for the stream to meander naturally over time.

In summary, it is known that much of the stream network in northeastern Illinois has been modified by channelization, bank armoring, vegetation removal, and impoundment. It also is known that many traditional stream and floodplain management approaches have caused serious collateral stream degradation, either locally or downstream.

## Natural Stream Management Philosophy

The preceding observations lay the groundwork for alternative approaches to managing streams and their riparian corridors. At their core, the recommended approaches incorporate a "design with nature" philosophy, relying extensively on the use of native vegetation and natural materials. The recommended management approaches also are based on four previously stated principles:

1. Stream channels and riparian corridors should be managed as an integrated whole, or *greenway*;
2. Stream management techniques should not be designed for a single purpose but, instead, should be *multi-objective*;
3. Management measures should be *sustainable*, with minimal environmental effects and minimal requirements for excessive or costly maintenance;
4. Recommended techniques should be *cost-effective* to maximize their implementability on a broad regional scale, particularly by individual landowners.

This philosophy can be accomplished by considering the following guidance.

Emulate natural stream systems: As previously described, stream dynamics are based on relatively well-understood principles. When considering techniques for stream management, whether for protection of existing high quality streams or restoration of degraded or unstable systems, much can be learned by observing what "works" in nature. It is recommended that project designs reflect the conditions of similar streams in the same region as the project site which are stable and functioning well.

Take advantage of the benefits of native vegetation: One of the most important observations of stable, relatively undisturbed streams is the type of native vegetation found on streambanks and riparian areas. Because native vegetation is adapted to the soils and hydrologic conditions found in stable stream corridors, it is likely to adapt well in restoration applications. Equally important, native vegetation provides critical functions such as aquatic habitat and pollutant filtering. Native vegetation also is typically deep-rooted, thereby providing better streambank stabilization than introduced species like Kentucky bluegrass.

Be realistic in designing projects and setting objectives: While the ultimate goal of any stream protection or restoration project would be to replicate the characteristics of an undisturbed, exceptional-quality stream, this will rarely be possible in northeastern Illinois. Virtually every stream system has been altered to some degree by previous channel and/or watershed modifications. Therefore, the recommended objective of management and restoration efforts should be to maximize the beneficial *functions* of the stream system within the constraints of historical and ongoing disturbances. For example, rather than selecting a broad array of native plants, including rare and sensitive species, for an urban streambank stabilization project, begin with a shorter list of hardy native species which are tolerant of unstable hydrologic and water quality conditions.

Be patient in evaluating results: Natural methods may take longer to become fully effective than some conventional stream management techniques. This is particularly true for many native wetland and prairie plants which spend most of their energy during their early stages of development establishing a supportive root structure rather than above-ground growth. In contrast, shallow-rooted non-natives put most of their energy into above-ground growth. The investment in extensive root systems makes native plants more stable and tolerant of stressful

conditions than most non-native species in the long run.

Design to accommodate potential "competing" uses: Streams, by definition, have multiple uses. Some of these uses, particularly in urban watersheds, may sometimes conflict. For example, stream maintenance to enhance conveyance has traditionally relied on the extensive removal of riparian vegetation. Destruction of riparian vegetation, though, can impair aquatic habitat and destabilize streambanks. Therefore, stream managers must identify long-term solutions, such as the use of low-resistance native grasses and sedges, that will minimize such conflicts.

### **Suggested References**

*A Citizen's Streambank Restoration Handbook*, Karen Firehock and Jacqueline Doherty, Isaac Walton League of America, January 1995.

*Restoring Streams in Cities: A Guide for Planners, Policymakers, and Citizens*, Ann Riley, Island Press, 1998.

*Stream and Wetland Protection: A Natural Resource Management Priority in Northeastern Illinois*, D.W. Dreher, R.D. Mariner, and C. Hunt, Northeastern Illinois Planning Commission, 1988.

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## **Chapter 3    Recommended Management Techniques**

This chapter presents ecologically-sensitive management techniques for protecting, managing, and restoring stream greenways. These techniques address:

1. Streamside landscape buffers
2. Stream channel maintenance
3. Streambank stabilization
4. Instream habitat restoration
5. Accommodating trail access

For each technique, a range of implementation considerations will be addressed, including design and installation techniques, maintenance needs, and costs factors. Case studies also will be presented, where appropriate.

### **Implementation Considerations**

While this handbook attempts to provide the rationale and guidance for alternative approaches to improved stream corridor management, it is not intended to be an exhaustive reference or a definitive design manual. Readers are urged to consult the references included in each section for more in-depth guidance. Readers also are encouraged to contact the resource agencies listed at the end of this handbook for more information and design guidance.

In many cases -- particularly for large or complicated projects -- resource agencies will refer interested landowners to consultants and contractors who have practical experience in designing and installing the recommended stream management techniques. Landowners are encouraged to seek out consultants with multi-disciplinary capabilities -- including engineering, landscape architecture, and ecology -- who have demonstrated experience with the types of non-traditional management approaches recommended in this handbook. Because many of the recommended methods are relatively new, some consultants in a given field may not yet have adequate experience in successful project design and installation.

Qualified consultants also will be familiar with permitting requirements, an important consideration in some stream restoration activities. For any activity involving the physical modification of a stream channel or floodplain (e.g., grading or excavation), it is likely that a permit will be needed from the U.S. Army Corps of Engineers, the Illinois Department of Natural Resources/Office of Water Resources, and/or the local municipality or county.

### **3.1 Streamside Landscape Buffers**

## **The Buffer Concept**

The concept of a buffer is fairly simple. A buffer is a continuous vegetated strip of land comprised of the types of native plants which naturally exist in an undisturbed riparian setting. In contrast, a turf grass lawn down to the water's edge is not a buffer strip.

Buffers require little maintenance. In particular, the use of fertilizers is unnecessary, and pesticides should not be needed once the buffer is well-established. Buffer strip characteristics can vary depending on the stream or river setting. A buffer may be forest, prairie, or wetland. It may be 25 feet wide along a small headwater stream or hundreds of feet wide along a larger river. Most intrusions into the buffer are discouraged, but flexibility should be provided to allow appropriate user access.

## **Rationale and Benefits of Natural Buffer Strips**

Ecologists, water quality specialists, land planners, and stream managers all agree that a naturally vegetated buffer strip along the periphery of a stream or river is critical to the health and quality of the waterbody. A stable buffer is the last line of defense for forces that may seriously threaten a healthy, stable stream system.

Channel stabilization: Perhaps most importantly, a naturally vegetated riparian buffer lends stability to streambanks, warding off the erosive effects of high flow velocities and fluctuating water levels. This is accomplished by the soil-binding effect of a healthy root system and the deflection of erosive flows by lush above-ground growth.

Fish and wildlife habitat: Riparian buffers are essential to maintaining natural biodiversity in a stream corridor. Most importantly, a stream edge buffer provides critical habitat for fish and various aquatic insects, helping to maintain a balance in sensitive aquatic ecosystems. Riparian buffers also provide a transition zone between terrestrial and aquatic habitats, which is necessary for the survival of a number of birds, mammals, and amphibians. If sufficiently wide, riparian buffers also provide a connecting corridor for the migration of animals between larger open spaces.

Runoff filtering: A vegetated buffer filters runoff generated by surrounding land uses, removing or mitigating the effects of harmful chemicals, nutrients, and sediments before they can reach the stream.

Shading: Depending on the width of the stream and the type of vegetation used, buffers can provide substantial shading. Shading is important to keep stream water temperatures cool in the summertime and may help to limit nuisance growths of algae.

Noise screening: Buffers can enhance the quality of stream and river recreational uses by filtering out the noise associated with certain types of adjacent land uses. Forested buffers, where appropriate, can effectively intercept noise from adjacent highways and industrial operations.

Preservation of aesthetic values: Streamside property owners have varying senses of what is

appropriate streamside landscaping. However, most will agree that "natural" is better than "artificial." Even a narrow buffer can enhance the view across a stream or river. More substantial buffers can effectively screen the clutter of surrounding urban developments.

## **Buffer Design**

Buffer characteristics can vary widely depending on local circumstances. However, there are several basic components of any buffer.

Width: Any width of native vegetation along the edge of a stream will provide some benefits. However, it is recommended that a buffer extend a minimum distance of 25 feet from the edge of the water, or what is commonly called the "ordinary high water mark." Wider buffers -- 50 to 100 feet, or more -- should be protected for larger and more ecologically-sensitive streams and rivers. The U.S. Department of Agriculture recommends "filter strips" of 66 to 99 feet for water quality protection. A recent national survey of local and state guidance for stream buffers observed a median width of 100 feet, with a range between 20 and 200 feet.

Intrusions: While a continuous, uninterrupted buffer is preferable for protection of water quality and habitat, some flexibility is desirable to provide access to the stream for recreational uses, particularly in parks and other public lands. Access typically would be provided via a mown footpath. Less intrusive pedestrian access could be provided via a stepping stone trail. Paving through a buffer is strongly discouraged, although limited intrusions may be acceptable to accommodate trail access.

Vegetation: It is recommended that buffers be planted with native species which are indigenous to a particular locale. The Federal Land Survey, conducted in the mid-1800s, provides a good general indication of the vegetation communities that existed prior to European settlement. It distinguishes between wetland, prairie, and woodland communities and provides a good indication of the type of vegetation which is naturally acclimated to the soils, hydrology, and climate of an area. It may surprise many landowners to know that most of the smaller stream and river corridors in the region were historically vegetated with wetland and prairie grasses and flowers, not trees.

In selecting plants for a buffer it should be noted that it is not necessary, or even feasible under most circumstances, to return the buffer zone to a pre-settlement condition. Rather, information on native riparian vegetation should be used as a guide to restore important *functions* such as bank stability and wildlife habitat.

Buffer vegetation should begin at or below the normal water elevation with wetland species, and should proceed up the bank with water tolerant and upland species. Buffer vegetation also should reflect local needs and conditions. For example, a forested buffer may be appropriate if noise screening is desired but may not be appropriate if local residents desire an unobstructed view. Similarly, some property owners will prefer a greater mix of showy wildflowers, which may be less "functional" than other prairie plants but will enhance the beauty of the stream corridor.

A listing of suggested plant species which adapt well in urban and suburban stream buffers is provided at the end of this section. This list distinguishes between lower bank and upper bank zones. It also highlights several aggressive, invasive species which are undesirable in a

riparian buffer. Species are considered undesirable if they crowd out more desirable species and they: 1) have limited soil-holding ability because of shallow root structure (like Reed Canary Grass), 2) provide little or no habitat value (like Purple Loosestrife), and/or 3) shade out understory vegetation (like Common Buckthorn). These undesirable species should never be intentionally planted in a riparian zone and steps should be taken to eliminate them if they already exist.

A much more thorough discussion of appropriate buffer species is provided in the *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois* (NRCS, 1997). This reference provides detailed information on individual plant characteristics as well as plant suitability under various hydrologic and water quality regimes.

Another suggested reference that should be useful to landowners considering the conversion of buffers to native plant communities is *The Tallgrass Restoration Handbook*. While it applies predominantly to upland environments and its advice is intended principally for "serious" restoration efforts, *The Tallgrass Restoration Handbook* nonetheless provides a wealth of current advice from practitioners who have successfully converted and restored natural landscapes in this region.

Finally, it also should be noted that the buffer recommendations contained in this handbook are intended for relatively basic streamside landscaping applications. Where there is a desire to implement a more complete restoration of a high quality riparian ecosystem, and hydrologic and water quality conditions are suitable, additional assistance should be sought from a trained ecologist.

## **Buffer Installation**

There are two equally-important steps in establishing or restoring a buffer: site preparation and planting. However, the specific approach taken on a given site will vary depending on the size of the site and the conditions in the riparian zone.

Site preparation: Site preparation is critical to ensure that native vegetation has good growing conditions and is not overwhelmed by invasive species. One of several typical conditions may exist on a site prior to buffer installation: 1) the existing buffer is not regularly maintained and is overgrown with undesirable vegetation; 2) the buffer zone is vegetated principally with turf grass; or 3) the buffer is in a transitional state (e.g., from agricultural to residential) where bare soil may be predominant. Recommendations for each of these conditions follow.

If the buffer is **overgrown with undesirable species**, buffer installation should begin with the removal of the unsuitable vegetation. Some of the most objectionable species are listed in the table at the end of this section. Possible techniques include cutting, mowing, burning, hand pulling, and herbicide application.

Cutting generally will be necessary for undesirable trees and shrubs. Sometimes it will be necessary to treat the stumps with a herbicide to prevent resprouting, particularly for species such as Common Buckthorn. Landowners should be aware that use of such herbicides (e.g., Garlon 4a) generally requires a licensed applicator.

Undesirable herbaceous species should be treated via some combination of mowing, burning,

hand pulling, and herbicide application. The appropriate techniques for a particular site will depend on local conditions. Because native landscape restoration is an evolving field, even experts may disagree on the best approach for a given site. In general, if infestations are limited, hand pulling may be effective. Where infestations are severe, some combination of herbiciding and burning may be necessary. While this handbook recommends the use of herbicide as a possible alternative for several vegetation management situations, landowners should be very cautious and judicious in its use. In particular, in riparian environments care should be taken avoid to herbicide spraying in the stream channel.

If the buffer zone is **vegetated principally with turf grass**, site preparation needs may be minimal. Some experts recommend herbicide application or removal of the sod layer to reduce competition with newly-planted native species. In some cases, shallow tilling may be appropriate. Tilling is discouraged, however, in riparian areas that are subject to frequent inundation or erosive water flow velocities. Also, it is important that exposed soil be quickly stabilized using temporary seeding, straw mulch, and/or other appropriate techniques.

If the buffer is **in a transitional state and bare soil is predominant**, herbicide application still may be appropriate to reduce competition from emerging weeds.

**Planting:** Planting should be done immediately after site preparation is completed. Planting can be done with live plants and/or seeds.

Where project budgets allow, use of live plants, in combination with seeding, is preferable because it results in rapid establishment of vegetative cover. Live plants are particularly desirable on streambanks which are susceptible to frequent inundation. It generally is desirable to install most live plants in the spring or early summer to allow for effective root establishment before the following winter, although some species are best planted in the fall. Most trees and shrubs also can be planted in a dormant state in the fall.

Because most project budgets will allow for only limited use of live plants, seeding typically is used over the majority of the buffer zone. Where seeding is done, it is important to use a cover crop (see suggestions at the end of this section) to quickly establish a stable vegetative cover. Depending on the season, planting native vegetation seeds may be deferred until moisture and temperature conditions are appropriate. In general, most native plants should be seeded in the spring. As an alternative, dormant seeding may be done in the late fall or winter. The *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois* should be consulted for information on appropriate seeding techniques and conditions.

To prevent seeds and soil from washing away, several techniques should be considered. Where stabilizing root structures of herbaceous plants are already present, use of a no-till drill is recommended. Where bare soil is present, the seed should be raked into the ground and erosion blanket should be installed to maintain soil moisture and minimize erosion. In riparian areas where inundation is unlikely, mulch is a less-expensive alternative to erosion blanket.

If unusually dry conditions persist after planting or seeding, short-term irrigation may be necessary to prevent desiccation. Irrigation generally will not be necessary, however, if planting is done in the recommended seasons.

## **Buffer Maintenance**

The most critical time for buffer maintenance is shortly after planting. During this period, herbaceous plant species are putting most of their energy into the establishment of root system, and relatively little growth may occur above ground. It is particularly important, therefore, to limit competition from aggressive, non-native plants. During this period, mowing and/or selected use of approved herbicides may be necessary to control weed species. When mowing to suppress weeds, practitioners generally recommend mowing high (e.g., 9 to 12 inches). If weed problems are particularly severe, it may be advisable to contact a professional landscape contractor familiar with native vegetation for advice.

Once the buffer is well established (typically within 1-3 years), maintenance will involve occasional mowing or prescribed burns to suppress weeds and maintain native plant diversity. Where site conditions permit, burning generally is the preferred maintenance approach because it is a natural process that rejuvenates native plant communities, particularly prairies and wetlands, and can effectively suppress weeds. However, burning requires an Illinois Environmental Protection Agency permit and should be conducted only by trained individuals. If certain noxious weeds need additional control, limited use of approved herbicides may be appropriate in localized areas. Use of fertilizer is not necessary and should be avoided in the buffer strip.

## **Local Examples**

The Chicago Botanic Garden in Glencoe recently created a twelve-acre buffer along a nearly one mile stretch of the Skokie River. The created buffer averages about 50 feet in width on both sides of the channel and consists of several "oxbow" wetlands and an evolving prairie community. The former landscape was dominated by Kentucky bluegrass and invasive weeds.

Site preparation involved a prescribed burn in the spring to remove thatch followed by the application of herbicide (glyphosate) to kill emerging non-native vegetation. Initial prairie planting was done using a no-till drill technique to reduce soil disturbance and avoid activating the weed seed bank. A low-cost mix of annual rye and eight species of prairie grasses and forbs was seeded at a rate of 16 pounds per acre. This was supplemented by hand seeding an expanded array of native species in subsequent years. Wetland zones were planted by volunteers with live plants. While the buffer is still a work in progress, it has clearly transformed the landscape of the river corridor and greatly enhanced wildlife and water quality functions. This site is easily viewed from trails and roadways along the west side of the Garden property.

Contact: Joan O'Shaughnessy  
Chicago Botanic Garden  
1000 Lake Cook Road  
Glencoe, Illinois 60022  
847/835-8312

Citizens for Conservation (CFC), a non-profit citizens group based in the Barrington area, owns and manages several parcels of land. In 1996, it began restoration of a 1000-foot buffer along Flint Creek upstream of Route 22 in Lake Barrington on a site called the Flint Creek Savanna. The riparian zone was almost entirely dominated by Reed Canary Grass, a species that has become a troublesome invader of riparian zones throughout the area. Two techniques were used to eliminate Reed Canary Grass. Parts of the riparian zone were mechanically scraped, physically removing existing vegetation and the top six inches of soil that contained most of the

root zone. Dormant seeding was applied to these areas in the fall. Remaining riparian areas were treated by successive applications of burn management and herbicide. Treated areas were planted by volunteers with plant plugs. Subsequent applications of a selective herbicide that does not harm sedges and forbs were made to eliminate Reed Canary Grass sprouts. Supplemental seeding and planting were done by volunteers early the following summer. Planted vegetation spread effectively, and by the end of the 1997 growing season the buffer was very well-vegetated with a diverse mix of native species, and there was almost no evidence of Reed Canary Grass. While long-term conclusions can not yet be drawn, the short-term restoration results are highly encouraging and visually striking. The rehabilitated riparian buffer is now an integral habitat component of the Flint Creek Savanna, blending with adjacent prairie, wetland, and oak savanna communities.

Contact: Tom Vanderpoel  
Citizens for Conservation  
P.O. Box 435  
Barrington, Illinois 60011  
847/462-0358 (at Savanna Landscaping Co.)

### **Suggested Plant Species Mixes**

These lists are derived principally from the *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois*. The suggested plant species mixes are intended to provide landowners with an idea of species that could be used together in riparian and streambank zones. Selection of species for a given site should factor in local environmental conditions, such as soils, hydrology, and pre-settlement vegetation, as well as aesthetic considerations. Generally, it may be desirable to overlap planting of different species mixes given the varying, and sometimes uncertain, hydrologic regime in a given zone. It should be noted that the recommended species lists represent a very limited diversity of plants, emphasizing those species that should be relatively easy to establish in modified riparian zones. For prairie or wetland restorations, planting mixes should go beyond the species listed here.

#### **Streambank Stabilization**

Water Plantain *Alisma subcordatum*  
Fox sedge *Carex vulpinoidea*  
Hackberry *Celtis occidentalis*  
Common Buttonbush *Cephalanthus occidentalis*  
Gray Dogwood *Cornus racemosa*  
Red-Osier Dogwood *Cornus stolonifera*  
Blunt Spike Rush *Eleocharis obtusa*  
Creeping Spike Rush *Eleocharis acicularis*  
Nodding Wild Rye *Elymus canadensis*  
Virginia Wild Rye *Elymus virginicus*  
Green ash *Fraxinus pennsylvanica*  
Fowl Manna Grass *Glyceria striata*

Common Sneezeweed *Helenium autumnale*  
Rice Cut Grass *Leersia oryzoides*  
Switch Grass *Panicum virgatum*  
Peachleaf Willow *Salix amygdaloides*  
Black Willow *Salix nigra*  
Chairmaker's Rush *Scirpus americanus*  
Late Goldenrod *Solidago gigantea*  
Prairie Cord Grass *Spartina pectinata*  
Blue Vervain *Verbena hastata*  
Nannyberry *Viburnum lentago*

In severe erosion situations where the dormant stake method is appropriate, sandbar willow (*Salix interior*) may be recommended due to its aggressive behavior.

### **Upper Bank and Riparian Zone**

Big Bluestem *Andropogon gerardi*  
Smooth Blue Aster *Aster laevis*  
Panicked Aster *Aster lanceolatus*  
New England Aster *Aster novae-angliae*  
Common Beggar's Ticks *Bidens frondosa*  
Side-oats Gramma *Bouteloua curtipendula*  
Hackberry *Celtis occidentalis*  
Tall Coreopsis *Coreopsis tripteris*  
Gray Dogwood *Cornus racemosa*  
Red-Osier Dogwood *Cornus stolonifera*  
Nodding Wild Rye *Elymus canadensis*  
Virginia Wild Rye *Elymus virginicus*  
Green ash *Fraxinus pennsylvanica*  
Wild Bergamot *Monarda fistulosa*  
Switch Grass *Panicum virgatum*  
Purple Prairie Clover *Petalostemum purpureum*  
Common Mountain Mint *Pycnanthemum virginianum*  
Swamp White Oak *Quercus bicolor*  
Bur Oak *Quercus macrocarpa*  
Pin Oak *Quercus palustris*  
Yellow Coneflower *Ratibida pinnata*  
Black-eyed Susan *Rudbeckia hirta*  
Little Bluestem *Schizachyrium scoparium*  
Compass Plant *Silphium laciniatum*  
Prairie Dock *Silphium terebinthinaceum*  
Stiff Goldenrod *Solidago rigida*  
Indian Grass *Sorghastrum nutans*  
Prairie Cord Grass *Spartina pectinata*  
Spiderwort *Tradescantia ohioensis*  
Common Iron Weed *Veronia fasciculata*  
Arrow-Wood Viburnum *Viburnum dentatum lucidum*  
Nannyberry *Viburnum lentago*

## Cover Crops

Annual Ryegrass *Lolium multiflorum*  
Smartweed *Polygonum punctatum*  
Yellow Coneflower *Ratibida pinnata*  
Black-eyed Susan *Rudbeckia hirta*

## Undesirable Species

Box Elder *Acer negundo*  
Garlic Mustard *Alliaria officinalis*  
Tartarian Honeysuckle *Lonicera tatarica*  
Purple Loosestrife *Lythrum salicaria*  
Reed Canary Grass *Phalaris arundinacea*  
Common Buckthorn *Rhamnus cathartica*  
Glossy Buckthorn *Rhamnus frangula*  
Multiflora Rose *Rosa multiflora*

## Suggested References

*Landscaping Techniques and Materials for Urban Illinois Stream Corridors and Wetland Edges*, R.D. Mariner and L. Mertz-Erwin, Northeastern Illinois Planning Commission, for the Illinois Department of Energy and Natural Resources, 1991.

*Model Stream and Wetland Protection Ordinance*, Northeastern Illinois Planning Commission, 1988.

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