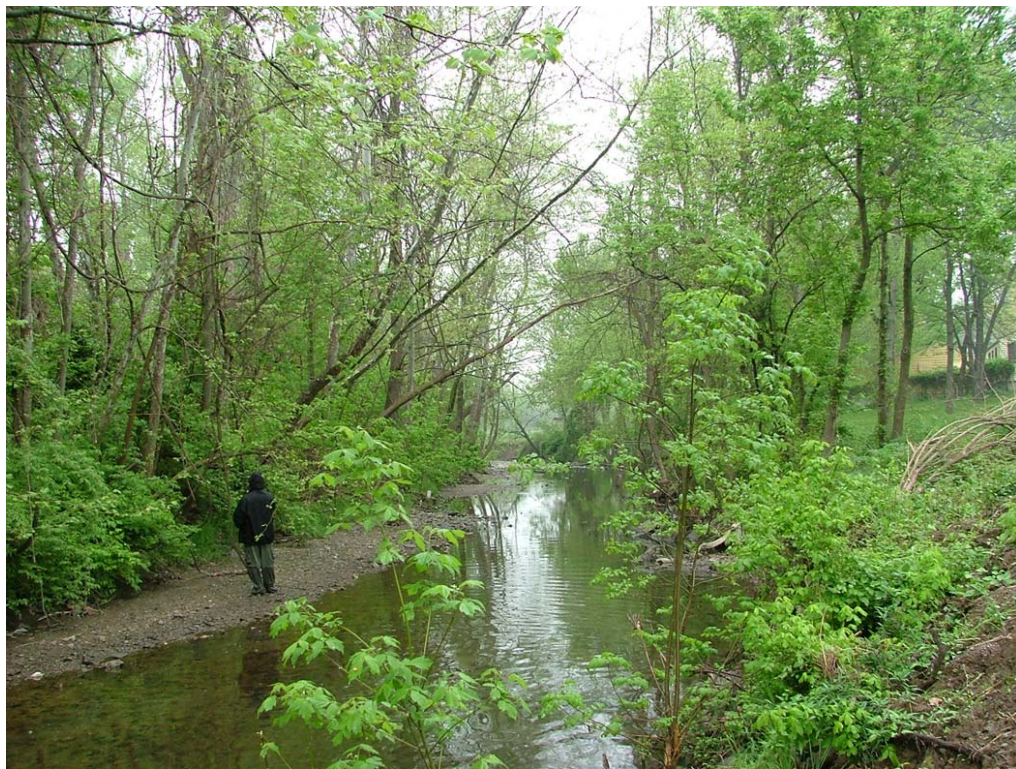


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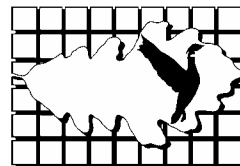
# ***Stream Corridor Protection and Adaptive Management Manual***

***Prepared for the City of Independence, Missouri***



*Rock Creek – Independence, Missouri*

***By Patti Banks Associates and Applied Ecological Services, Inc.***



***January 24, 2006***

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## **I. Introduction**

The City of Independence, Missouri (City) is committed to the twin goals of protecting the health and safety of the community and preserving its natural resources. One critical means of honoring this commitment is comprehensive flood and stormwater management that serves multiple community needs. The City has created a stream corridor protection program to lessen the severity of flooding during large storm events, protect stream corridors from the impacts of future development, and safeguard the City's natural resources and beauty. This stream buffer program is intended to reduce property damage and loss of life, protect the City's valuable infrastructure, prevent the degradation of streams and water quality, and provide recreational opportunities. The purpose of this *Stream Corridor Protection Restoration and Adaptive Management Manual* is to help City staff and citizens understand the importance of stream corridors and how they function, and to guide maintenance and management in all types of settings, regardless of buffer ownership.

The City's goal is that all streams be protected and managed to ensure proper function and to maximize their unique value. Through partnership between the City of Independence and our citizens we can protect our resources and enhance our quality of life. The City and private landowners share a responsibility to manage and maintain stream corridors.

The program's main tool is to preserve or "buffer" all stream corridors—the vegetated zone or riparian corridor that includes trees, shrubs, and herbaceous vegetation. The American Public Works Association (APWA) and Mid-America Regional Council in the Section 5600 *Stormwater Design Criteria* (APWA Section 5600) and the *Manual of Best Management Practices for Stormwater Quality* (BMP Manual) recommend that cities adopt comprehensive stream preservation and specify minimum buffer criteria. Independence's vision goes beyond APWA Section 5600 to meet the City's goals.

The benefits of restoring, protecting, and enhancing stream corridors are many. Stream buffers help:

- Reduce flood damages by limiting streamside construction
- Reduce the impact of stormwater runoff by trapping sediment and sediment-bound pollutants;
- Encourage infiltration and recharge of groundwater;
- Slow and disperse stormwater flows over a wide area, helping to protect City infrastructure, human health, and property from potential damage.
- Preserve stream bank stability by reinforcing the soil with root systems.

- Create recreation opportunities with walking and running trails, and protect habitat and wildlife corridors.

The remainder of this manual expands on the benefits of stream corridor protection and provides general and specific tools for their management.

### **A. How to Use This Manual**

This *Stream Corridor Protection and Adaptive Management Manual* provides information and guidance for City staff, developers, and private property owners to preserve and maintain stream corridors throughout the City. This manual presents general maintenance practices, restoration measures, and vegetation management, with an eye toward future buffer restoration and recreation. The management guidance is organized by general land use (urban, transition, agriculture, and undisturbed lands), because land use greatly influences streams and available management opportunities. Within each land use discussion are recommendations for short-, medium- and long-range management. Stream corridor managers should follow these general steps:

- Learn how stream corridors function and why they are important (**Section IC through IE**).
- Determine the type of stream corridor(s) to be managed (**Section IIA through IID**).
- Identify general stream protection strategies (**Section IIE and IIF**).
- Select and implement short- and medium-term protection and management practices for:
  - Urban Streams (**Section III**)
  - Transitional Streams (**Section IV**)
  - Agricultural Streams (**Section V**)
  - Non-Developable Streams (**Section VI**)
- Assess staff training needs and create a stream buffer monitoring and reporting program to track management needs and measure progress (**Section VII**).
- Plan to enhance and restore buffers as conditions improve and as experience and resources permit (**Sections VIII through X**).
- **Adapt** to changes in stream conditions, land use, experience and resources (**all sections**).

### **B. Floodplains—What Purpose Do They Serve and Why is It Important to Protect Them?**

Floodplains are the part of a stream or river where the excess water flows during flood events. Historically, when streams and floodplains were undeveloped and in their natural state, streams and rivers which flooded more readily dropped sediment, nutrients, and other materials onto the flat,

broad floodplain. These floodplains also promoted water absorption and storage as well as groundwater recharge. With shallow stream channels and low banks, the floodplain also helped regulate stream flow, dispersing increased volume over a wider, shallower area. In addition, the floodplain provided a rich and diverse habitat for fish, mammal, and plant life.

We have altered land use and drainage basins in ways that change natural stream flow. Increasing impervious surfaces (rooftops and parking lots) reduces stormwater infiltration (absorption into soils and groundwater) and speeds runoff. Construction of levees attempts to stop flooding by restricting the floodplain, reducing frequent flooding but speeding stream flow. Building and farming to the edge of streams eliminates vegetative buffers that slow runoff and flood waters and stabilize banks. Continued reduction in the breadth of the floodplain reduces the area where floodwaters can spread out. As a result, the dynamics of streams and their floodplains have dramatically changed. The consequences include property damage, degraded streams, wetland loss, poor water quality, and the decrease of the diversity and abundance of the flora and fauna. Flooding frequency and volume have *increased*, and damage to property and city infrastructure has increased with it.

These changes are profound, and this is why it is more important to protect our floodplains in any way that is possible. To achieve these ends, an important step is to protect and restore the stream corridors.

### **C. Stream Corridors —Why Are They Important?**

Stream corridors provide many environmental and resource management benefits including:

- Restoring and maintaining the chemical, physical, and biological integrity of water resources
- Removing pollutants from stormwater runoff
- Reducing erosion and sediment entering the stream
- Reducing future flood hazards
- Stabilizing stream banks
- Providing infiltration of stormwater runoff
- Maintaining the base flow of streams
- Contributing the organic matter that is a source of food and energy for the aquatic ecosystem
- Providing tree canopy to shade streams and promote desirable aquatic organisms
- Providing riparian wildlife habitat

- Creating community and neighborhood amenities by furnishing scenic value and recreational opportunity

With such a long and varied list of benefits, the City considers the establishment, protection, and maintenance of stream buffers to be an integral part of its Storm Water Management Program. To achieve these ends, the City has established a goal to protect stream corridors as part of all projects where development or redevelopment will occur on property that includes or is adjacent to a stream in the City of Independence. An important part of the process is to incorporate stream and riparian corridor preservation into the development review process.

***D. Management of Stream Corridors Through Preservation, Enhancement, and Re-creation***

The City wants to protect and maintain the native vegetation in riparian and wetland areas. Implementation of such a desire or vision can be conducted through three restoration approaches—

- Preservation
- Enhancement
- Re-creation

The term management can be misleading as it has many meanings, and is applied differently in varying situations by agencies, professionals, and lay persons. For the purposes of this manual, management is the maintenance, improvement, or re-establishment of the functions and characteristics of a stream corridor, and may include preservation, enhancement, and re-creation. Preservation is the protection of an important stream corridor or component (e.g., woodland, wetland, or prairie) in perpetuity. Enhancement is the improvement of functions and characteristics of an existing intact stream corridor or component (e.g., woodland, wetland, or prairie). Re-creation is the re-establishment of the characteristics and functions of a stream corridor or component (e.g., woodland, wetland, or prairie) that no longer exists or exists in a considerably degraded state.

The type of management required at a site will depend on the existing conditions of the riparian corridor. The level of effort necessary in a stream corridor will increase as the level of degradation increases. Management efforts begin with a limited effort in the short-term, and build to a higher level of effort over the long-term as experience and resources permit. The three management approaches are characterized below.

- **Preservation (Short-Term):** The first and most basic management approach is to preserve the existing riparian corridor, especially where it is intact and consists of relatively high to moderate quality habitat that requires minimal restoration effort. A buffer of this type could include diverse second or third growth forest or quality (predominantly native) grassland.

Management would focus on the maintenance of the current conditions with activities to preserve existing, desirable vegetation, remove fences, and construct and maintain trails.

- **Enhancement (Medium Term):** The riparian corridor is intact, but is of lower quality than noted above. The corridor may have immature woods, a wetland with weedy infestation, or grasslands that are overgrazed or contain many non-native species. Thus, activities are targeted to improve the functioning and overall quality of the site. Activities that enhance the stream corridor include the thinning of tree and shrub species from the mid-story, removal of an invasive species (e.g., reed canary grass) from a wetland, installing live willow stakes into rip rap bordering a stream, or overseeding of native grass and restricting grazing in woodland and grassland habitat.
- **Re-creation (Long-Term):** The riparian corridor is very degraded or is mowed or farmed to the creek banks. Consequently, the stream corridor has to be extensively restored to perform the numerous functions listed in Section III above. Stream buffers requiring re-creation include cropland and lawns.

Preservation, enhancement, and re-creation of stream corridors in Independence can be successful using a process of *adaptive management*. Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Typically, adaptive management can be viewed as a process involving six fundamental steps:

1. Assess the problem or current condition
2. Design a solution to the problem or program to manage the condition
3. Implement the design
4. Monitor the solution or program
5. Evaluate the results or outcomes
6. Adjust the design to account for new conditions

## **II. Stream Corridor Condition and Protection**

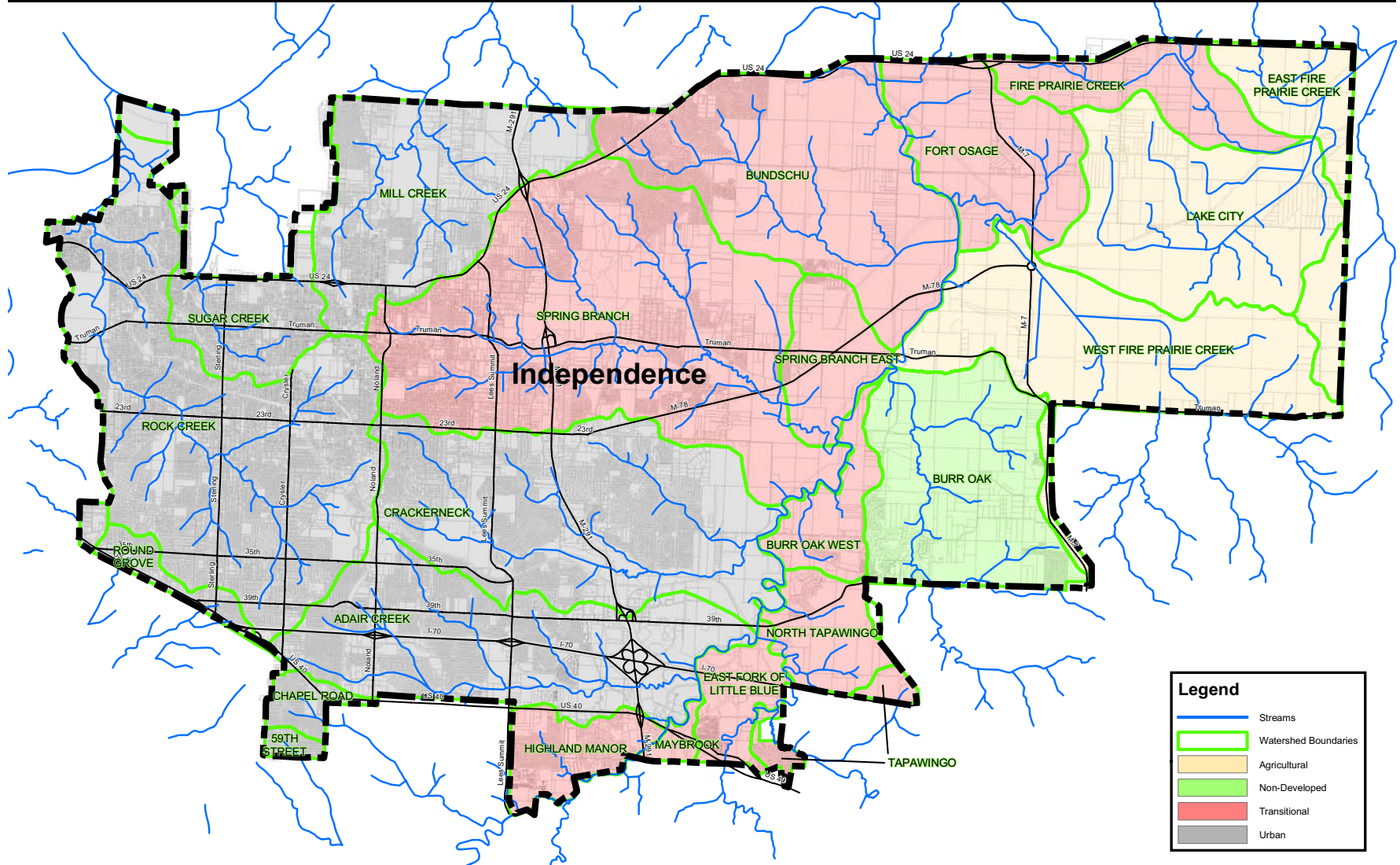
Streams within the City of Independence drain across a variety of landscapes, from urban, fully developed areas within the City, to rural, undisturbed areas or land used agricultural production. Land use and the amount of impervious cover in the watershed greatly influence stream conditions. Changing land uses alter stream conditions and determine the needed and available stream corridor management strategies.

The first part of this section summarizes the general conditions of the riparian corridors within the City limits of Independence. The second part of this section gives an overview of buffers and other stream protection strategies. The following sections provided detailed recommendations for each stream type.

### **A. Stream Condition and Type**

For the purpose of this manual the riparian corridors are grouped into four types based on the dominant land use within the contributing drainage area: **urban**, **transitional**, **agricultural**, and **undisturbed**. These types refer to the stream's actual, physical condition as described in the following sections; changes in adjacent land use or development within the contributing drainage may alter stream type at any time. Figure 1 shows the *general* locations of these stream types within Independence, based on random inspections, general knowledge of the City's watersheds and development, and experience in stream behavior and ecology. The figure provides the reader with a *general* idea of where different stream types may be found in the City of Independence *at the time of this writing* (Fall 2005), based on the predominant conditions in the contributing sub-watershed.

Stream conditions within a watershed will change with surrounding development patterns. Streams such as Rock Creek and Adair Creek and their tributaries, flow from largely developed areas with extensive impervious surfaces, to more suburban and rural areas. The Little Blue River, in contrast, flows through developed and undeveloped floodplain. Stream types may also change over time as impervious cover increases from development or decreases from stream buffering. For this reason the manual describes how stream types are identified. Stream corridor managers should evaluate and type specific stream reaches based on the general conditions within their drainage area, and reevaluate stream conditions as watersheds develop and change.



# City of Independence, Missouri

Figure 1: General Stream Types - November, 2005



**Urban Streams**

**Urban riparian corridors are located in extensively developed watersheds where impervious surfaces dominate the watershed. Buildings, parking lots, and maintained yards encroach on the riparian corridor, and roads and utilities cross the streams. However, active development is no longer occurring and land uses are stable.**

Urban stream corridors are located in fully developed watersheds with a high percentage of impervious surfaces – typically in western Independence. With less resistance and opportunity to infiltrate into the soil, runoff often reaches the stream with increased volumes and velocities causing incised channels, steep banks, and toe erosion (erosion at the base of the bank). The results generally are increased sedimentation, pollution, degraded water quality, and decreased stream stability. To correct stream degradation problems, past



*Figure 2: Degradation of stream banks is often a result in developed urban areas.*

approaches have included rip rap installation, stream channelization with channels of concrete or banks with walls. These measures themselves degrade rapidly as the increased volume and velocity of flow can further erode stream banks at the edges of the hard surfaces, causing them to break apart and fail over time. The opportunities to buffer streams in such an altered environment is variable, since buildings, parking lots, and other urban improvements encroach on the corridors.

The urban area also includes less densely built suburban environments, such as older neighborhoods with lawns and mature woodlands or park settings. The Crackerneck Creek watershed is a mix of urban and suburban development. Urban streams are also affected by the highly armored stabilization measures such as rip rap, stone or concrete walls, or gabion baskets in place in the upstream urban areas. Down cutting in the stream channel, head cutting at bridges and other infrastructure and erosion are often observed in many areas along the stream bank. The stream corridor in this type of environment is typically highly variable, and may include a mix of conditions such as mature woods on one side of the bank, and mowed lawn to the stream on the

other side of the bank. Depending on the vegetation condition, the stream corridor may or may not provide adequate protection from increased flows to the adjoining properties.

### **Transitional Streams**

**Transitional areas are located on the urban edge where suburban areas transition to rural land. Transitional watersheds include a mix of (1) recent suburban neighborhoods, (2) current development, and (3) agricultural or undeveloped land. Bridges and infrastructure crossings have been recently installed or are under construction.**

As a result of these recent changes and current development pressures, the transitional riparian corridor is probably in the most flux of the four types of riparian corridors. Examples of this type of corridor may be found along many of the tributaries of the Little Blue River in the eastern portions of the City, particularly where new or existing neighborhoods occur along the existing floodplain, or in some of the rural areas near Burr Oak or Highland Manor.

Generally, transitional corridors may vary from closely-cut residential lawns with a narrow fringe of trees, to stream banks protected by hard armoring (such as rip rap), to cropland extending to the edge of the stream. It is important to recognize the varying conditions of the land-use surrounding the stream corridor to account for changes that will likely occur, resulting in changes in the amounts and quality of stormwater runoff entering the stream. Management of stream corridors in these areas is affected by decisions of adjacent land-owners as well as the City for needs of streets, sewers, and open park areas.



*Figure 3: Streams can rapidly degrade in transitional areas due to rapid increases in stormwater runoff*

In transitional corridors, stream stabilization measures such as rip rap along channels or detention basins scattered through the neighborhood may be recently installed and may need additional maintenance to assure that the stream banks are stabilized. In areas of newer development, erosion control measures may sometimes fail or be inadequate depending on the severity of weather and level of monitoring. These conditions can substantially affect stream conditions and water quality, and maintenance and monitoring of the buffer in the transitional riparian corridor is important to protect adjacent properties as well as City infrastructure (sewers, streets, etc.) that could be damaged from excess erosion. Transitional stream

corridors and their buffers may be the most difficult to manage because of recent and pending changes in land use and population pressures.

### **Agricultural Streams**

**Agricultural streams are located in watersheds that are predominantly used for cropland and livestock grazing. Agricultural areas may include some rural residential neighborhoods but active development is not occurring. Portions of the watershed may be undeveloped due to terrain and soils.**

Agricultural streams are generally found in eastern Independence. The agricultural riparian corridor is often substantially affected because of tillage and grazing practices that extend to the stream bank, with no vegetative buffer. The regular tillage of soil due to cropping production coupled with high erosion rates on unprotected lands can result in poor water quality and eroded surfaces. Livestock may overgraze pastures and damage vegetation close to streams (and may enter the streams themselves), resulting in bank erosion and degraded water quality. In some areas, inadequate stream buffers have been maintained, and runoff from adjacent fields creates increased



*Figure 4: Agricultural stream corridors may lack vegetative buffers and allow livestock access*

flow volumes and velocities in the streams, resulting in bank destabilization not unlike that found on the urban fringe. In these areas, streams can be highly incised, often with steep, unstable banks experiencing erosion problems. Sediment and pollutant loading can be heavy and water quality is often poor. The corridor in the agricultural setting is often cropland or pasture up to the creek banks but may include a hedgerow or small tract of woods bordering the stream itself.

In areas where the cropland has been abandoned, the land-use may transition back to a variety of vegetative types, usually predominantly invasive species that may not provide desirable stream bank protection qualities. Management of these corridors in future development will require detailed planning to address the needs for proper buffer widths and restoration.

### Undisturbed Streams

Undisturbed riparian corridors are located in watersheds with little or no development. Development may be prevented by steep topography or soils that preclude structures and agriculture, or the watersheds may be situated in a state or municipal park (e.g., Burr Oak Woods) that do not allow development.

The northern portion of the Burr Oak watershed is the only predominantly undisturbed area in Independence, although smaller undisturbed drainages may exist within other watersheds. Conditions of the streams and adjacent corridors are quite variable in undisturbed areas. They are influenced by such factors as in-stream conditions upstream, soils, slope, aspect, and adjacent land use. Buffer type will also highly vary depending on the factors listed above.



*Figure 5: Stream corridor in undisturbed areas retain great natural features worth conserving.*

Generally, stream corridors in undisturbed land should be stable. If they are not, due to upstream influences, it may be necessary to stabilize stream banks to minimize damages to adjacent properties or land features. These corridors may need monitoring to make sure that stream conditions can be stabilized or that they are maintained without further degradation.

### **B. Stream Protection Strategies**

#### **Stream Buffers**

Stream protection begins with preserving the stream corridor. Independence's overall goal is to buffer all of the City's streams. A buffer typically consists of a strip of land along both sides of a stream, preferably including the floodplain, wetlands, and slopes greater than 15 percent. Stream buffers often are divided into three distinct zones on each side of the stream, each of which has a distinct purpose:

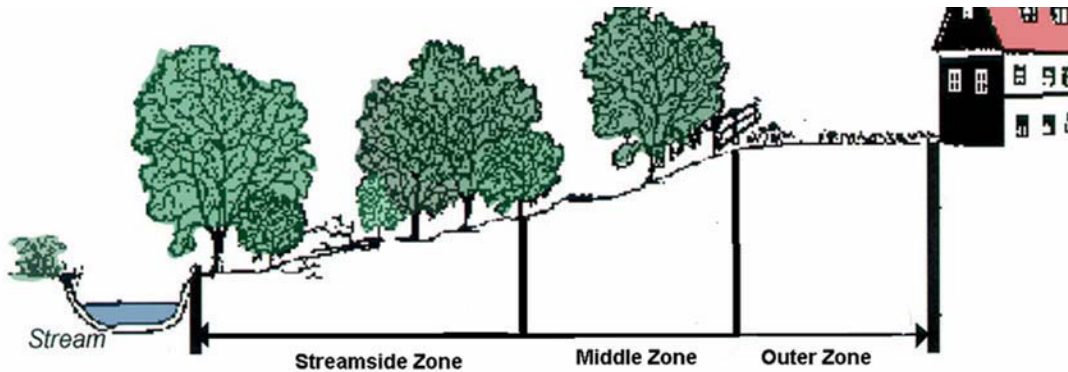
1. Streamside Zone – Closest to the stream, protecting the physical and ecological integrity of the stream.
2. Middle Zone – Protects key components of the stream with mature vegetation adapted to the region, providing distance between upland development and the streamside zone.

The middle zone may vary to include the entire floodplain and contiguous slopes greater than 15 percent.

3. Outer Zone – A transition between the buffer and development that prevents encroachment into the stream buffer and filters runoff from residential and commercial development.

Figure 5 illustrates the configuration of these three zones (referred to as “cores”).

*Figure 6: Stream Buffer Zones. Modified From: Center for Watershed Protection*



### **Stream Protection and Management Strategies**

There are a number of specific strategies for protecting stream corridors. The strategies range from setting aside buffers and avoiding activities that will damage the stream corridor, to general maintenance practices, and finally restoration and creation of vegetation and corridor function.

Many practices are common to all streams; some vary by general stream type and land use, which will dictate need and constraints. Some strategies should be implemented immediately while others build on initial efforts or become practical as managers gain experience or obtain more resources.

Table 1 gives a general overview of strategies as an initial screening tool for stream managers. The strategies are organized by stream type and by short-, medium-, or long-term applicability. Consult the following sections for more detailed recommendations by stream type and time frame.

Table 1. Stream Protection Strategies

Time Frame	Protection Strategy	Stream Type			
		Urban	Transitional	Agricultural	Undisturbed
Short-Term	Set aside stream buffer	●	●	●	●
	Prohibit structures and encroachment	●	●	●	
	Prohibit clearing or grading	●	●	●	
	Prohibit ditching and drainage	●	●	●	
	Prohibit dumping	●	●	●	●
	Avoid mowing	●	●	●	●
	No storage or use of pesticides or heavy equipment*	●	●	●	●
	Inspect condition (bank stability, erosion, vegetative cover)	●	●	●	●
	Remove trash **	●	●	●	●
	Identify erosion damage	●	●	●	●
	Prevent livestock access		●	●	
Medium-Term	Properly align and design road and infrastructure crossings***		●	●	●
	Remove dams and drainage tiles	●	●	●	
	Repair unstable banks***	●	●	●	
	Remove exotic or invasive vegetation	●	●	●	●
	Remove other undesirable vegetation	●	●	●	●
	Remove debris and fill**	●	●	●	
	Remove hard armoring (if feasible)	●	●	●	
	Restore native vegetation	●	●	●	●
Long-Term	Establish vegetative buffers	●	●	●	
	Stabilize hydrology and streambed***	●	●	●	●

Notes:

- \* Excluding spot removal of exotic and undesirable vegetation or streambank stabilization and repair.
- \*\* Leave vegetative detritus and debris unless it threatens to cause infrastructure damage or flooding.
- \*\*\* Based on site-specific analysis and design by trained and experienced staff or professionals.

### **III. Management of Urban Streams**

This section discusses the rationale and approach for managing urban streams, and provides specific, detailed management and restoration strategies.

#### **A. Adaptive Management—Rationale and Approach**

The basic philosophy of this manual is a process of adaptive management that responds to actual stream conditions. The first step in managing urban corridors is to examine the stream corridor for bank stability, vegetative cover and quality, and water quality – the physical and ecological factors that affect the stream now and in the future. In addition, the stream must be examined to determine if it contributes to downstream degradation, and if changes can be made to minimize flow volume and velocity to protect property adjacent to the stream or at downstream locations. Finally, stream corridors in urban areas must be examined to determine an adaptive management strategy or process that can be used to address these conditions.

#### **Rationale**

Management and maintenance of stream corridors in urban areas is based on a well-defined restoration and management program in which degraded – or even absent - natural stream systems can be restored to sustain a higher level of riparian health. The objective and success of the urban stream program includes routine assessment of stream conditions, identifying problem areas, and prioritizing adjacent stream corridor areas that can provide a required buffer width and be restored, to the extent possible, to natural stream characteristics and vegetation. The program depends on careful and efficient implementation of the tasks, close monitoring and accounting of critical performance milestones, community education, and a concerted, ongoing effort by land managers and other stakeholders.

#### **Approach**

Responses to urban stream management and restoration treatments can be quite dynamic and unpredictable, following the combined effects of varied bank stabilization strategies (hard armoring or vegetated banks) and changes in stormwater runoff into the stream. For this reason, management strategies for urban stream segments in Independence need to be flexible to respond to varied corridor conditions (such as amount of built area and impervious surfaces, corridor width, and/or rapid changes in stream morphology). Adaptive management of urban streams begins with evaluation of stream conditions to identify high-quality corridors and problem areas, and to assess the feasibility of changing the stream to an adaptive, natural community that improves flow volume and velocity. Assessment allows the corridor manager to prioritize and adjust the timing and application of specific treatments to better improve the overall performance of the corridor. As

each stream is evaluated, the management plan should be specific to that particular area and refined as necessary to account for changes in the stream and its performance.

### **B. Urban Stream Corridor Management and Restoration**

A phased approach is recommended for implementing the strategies: short-term practices should be implemented first, followed by medium-term and long-term strategies as conditions, resources, and experience permit. Additional information on long-term management is provided in **Sections VIII through X**.

#### **Short-Term Strategies**

The first and most basic urban stream management approach is to preserve the existing riparian corridor—set aside a stream buffer that includes trees, shrubs, and herbaceous vegetation, and excludes permanent structures or impervious surfaces. This basic step will go along way to stabilizing stream banks and filtering runoff entering the stream.

The next step is to avoid damaging the stream buffer. The stream buffer should be managed to protect its integrity and to enhance and maximize the unique value of urban streams. To maintain the buffer's integrity, avoid the following activities:

1. Soil disturbance by grading, stripping, or other practices
2. Filling or dumping (including but not limited to soil, trash, and yard waste)
3. Drainage by ditching, underdrains, or other systems
4. Use, storage, or application of pesticides, except for spot spraying of noxious weeds or non-native species consistent with recommendations of the City
5. Mowing: the streamside and middle zones are exempt from the City Code provisions requiring mowing.

Finally, the urban stream manager should physically inspect stream and bank conditions and address basic maintenance needs. The following tasks should be completed as basic maintenance for urban stream corridors and buffers.

1. Stream sections with hard armoring and/or rip rap:
  - i. Evaluate stream bank conditions annually to inspect for bank erosion, scouring, degradation and/or failure of armoring, and down cutting of the channel.
  - ii. Encourage emerging vegetation, leaving it in place.
  - iii. Inspect for dumping of refuse, and remove all trash. Woody or vegetative detritus, such as logs or other large, natural objects in the stream will be left in place unless they threaten structures or infrastructure or cause blockages.

- iv. Examine the stream section for opportunities to plant native vegetation in the buffer zone.
2. Streams with natural banks and vegetation:
    - i. Inspect the stream for bank erosion and degradation, scouring, and changes since the last inspection. Keep good records of all inspections, including photographs.
    - ii. Inspect vegetation presence and condition. Percent cover and species type may be recorded. Clearing of existing vegetation, unless approved by the City, is prohibited.
    - iii. Inspect for dumping of refuse, and remove all trash. No clearing of vegetation or storage of materials should be allowed in the buffer zones. Woody or vegetative detritus, such as logs or other large, natural objects in the stream will be left in place unless they threaten structures or infrastructure or cause blockages.
    - iv. Inspect urban stream buffers to assure that no un-permitted uses of buffer areas are occurring. Storage and operation of machinery are not permitted in the buffer zone except for buffer maintenance and in case of emergency.
    - v. Assess and record surrounding land use to make sure that no encroachment of the stream buffer by private landowners is occurring, and to determine if changes to the surrounding land use may result in increased flow volume and/or decreased water quality.

In addition to the routine inspections, stream flow conditions will be inspected and recorded during specified storm events. Annual inspections will also include an evaluation of the need or feasibility of restoring the stream to natural conditions. Beyond the initial evaluation and planning stages, the implementation of an effective restoration and management program is typically carried out in two phases: a medium-term, remedial phase and a long-term phase, the strategies for which are detailed in the next section.

### **Medium-Term Strategies**

The medium-term is when major efforts are undertaken to restore the stream corridor to a natural condition with native or stabilizing vegetation and biological diversity. This phase begins the process of restoring or re-invigorating natural biological and physical functions of the stream that will stabilize the stream corridor while stemming high flow volumes and velocity. Urban stream segments should be evaluated individually for determining the need and prioritization for the remedial phase.

Tasks undertaken during this phase for urban stream corridors include:

- repairing unstable bank walls (eroded cutbanks and steep slopes) and stabilizing with biotechnical engineering practices,
- removal of exotic invasive species,

- reduction of other undesirable trees and brush, and
- mechanical removal of hard armoring where feasible.

This phase may also include the removal of dams or breaking of drainage tiles, removal of debris, spoils, and fill, treatment of erosion and contamination problems, and manual or mechanical installation of native seeds and plants, including larger shrubs and trees. Consequently, the remedial phase requires the greatest short-term financial commitment and level of human effort. The period of time required to conduct the remedial restoration phase depends on the level of effort required, the condition of the ecological systems, and physical opportunities and constraints (i.e., access, weather, and biological response), and the level of funding available for the program.

This phase requires site-specific assessment and detailed planning to address stream conditions and the level of effort for restoring the stream corridor. Site assessment and restoration should be conducted by trained staff or experienced professionals (see **Section VII** for training recommendations). APWA Section 5605.5 provides detailed stream assessment guidance, while Sections 5605.10 and 5605.13 cover grade control and bank stabilization, respectively. The remedial phase could take up to five years in any selected urban stream segment identified by the City (See **Section X – Proposed Schedule**).

### Long-Term Strategies

Once the initial stream corridor and buffer objectives, including ecological and biological objectives, are achieved, the restoration program enters a long-term management phase, guided by both regular management techniques and by strategies that are implemented on a rotational basis through identified management units. Tasks may include:

- hydrology and grade control (see APWA Section 5605.15),
- occasional use of chemical herbicides as well as mechanical/physical removal of invasive- or non-desirable vegetative species,
- potential re-seeding and planting to assure vegetative establishment for appropriate species, and
- monitoring to assure that established vegetation is performing as planned.

Although this phase of the program can be viewed as a routine maintenance program conducted annually at strategic times to achieve and maintain specific the stream corridor objectives, management decisions must remain responsive to concepts of *adaptive management*, that is, to manage the stream corridor and buffer with flexibility to adapt to the inevitable changes in the

stream and its vegetation, and understand the dynamic natural system associated with it. For urban stream segments, the long-term management phase will require an ongoing effort designed to achieve a desirable and sustainable ecological system within the context of available funding, volunteer resources, and the commitment of all stakeholders. The goals of the urban stream corridor, by nature of physical limitations of the surrounding land use, will be different from the goals of less impacted and constrained stream segments and their buffers.

**Sections VIII and IX** provide more detailed guidance for long-term restoration and management.

## **IV. Management of Transitional Streams**

This section discusses the rationale and approach for managing transitional streams, and provides specific, detailed management and restoration strategies.

### **A. Adaptive Management—Rationale and Approach**

Transitional streams in the city, as described earlier in this document, are streams encountering the greatest amounts of change in the stream structure and performance and in surrounding land use. Because of this, close monitoring of stream conditions and consideration for remedial measures to correct damaging conditions, and to restore adequate stream buffer floodplain, must be completed in order to achieve the City's goal for protecting human health and property from flood damage, and to protect stream and water quality.

#### ***Rationale***

Because streams in transitional areas may still retain characteristics of natural function and vegetation, management and maintenance of transitional stream corridors focuses on sustainable natural stream systems that can be restored to an equivalent or higher level of riparian health. The objective and success of transitional stream adaptive management includes routine assessment of stream and buffer conditions for function and ecological value, identifying problem areas, and the prioritization of areas that can provide a required buffer width and be restored, to the extent possible, to natural stream and floodplain morphology and vegetative structure. Opportunities exist in the transitional stream network to retain the functional and ecological value of stream buffers and their protective floodplains that will provide benefits to the City as well as the health of the stream. As with the urban stream management approach, the transitional stream program depends on careful and efficient implementation of the tasks, close monitoring and accounting of critical performance milestones, community education, and a concerted, ongoing effort by land managers and other stakeholders.

#### ***Approach***

Management and restoration treatments in the transitional stream rely extensively on surrounding land use and how that land is managed, including changes that may be occurring. Changes in the flow of water in the stream can be unpredictable. Typically, the stream banks will be vegetated, but vegetation may be non-stabilizing ornamentals and turf grass common in residential areas. Varied bank stabilization strategies (hard armoring or vegetated banks) may still be in existence in the transitional stream, and therefore stream flow and flood potential will differ along the stream length.

Stabilization of the stream bank may also vary. Because of development pressures, changes in stormwater runoff into the stream are certain.

For these reasons, management strategies for transitional stream segments in the City need to be flexible to respond to varied corridor conditions (such as amount of built area and impervious surfaces, corridor width, and/or rapid changes in stream morphology). Adaptive management of transitional streams begins with evaluation of stream conditions to identify high-quality buffers and problem areas, and to assess the feasibility of changing the stream to an adaptive, natural community that improves flow volume and velocity. A primary goal is to broaden the stream buffer where possible, and re-establish native vegetation and stream morphology to alleviate damaging high water flows. Assessment allows the buffer manager to prioritize and adjust the timing and application of specific treatments to better improve the overall performance of the buffer. As each stream is evaluated, the management plan should be specific to that particular area and refined as necessary to account for changes in the stream and its performance.

### ***B. Transitional Stream Buffer Management and Restoration***

Implementation of the strategies should be phased with short-term practices implemented first, followed by medium-term and long-term strategies as conditions, resources, and experience permit. Additional information on long-term management is provided in **Sections VIII through X**.

#### **Short-Term Strategies**

The first and most basic transitional stream management approach is to preserve the existing riparian corridor—set aside a stream buffer that includes trees, shrubs, and herbaceous vegetation, and excludes permanent structures or impervious surfaces. This basic step will go along way to stabilizing stream banks and filtering runoff entering the stream, and is particularly important because transitional watersheds are themselves unstable.

The next step is to avoid damaging the stream buffer. The stream buffer should be managed to protect its integrity and to enhance and maximize the unique value of transitional streams. The following activities should be avoided to maintain the buffer's integrity:

1. Soil disturbance by grading, stripping, or other practices
2. Filling or dumping (including but not limited to soil, trash, construction debris, and yard waste)
3. Drainage by ditching, underdrains, or other systems
4. Use, storage, or application of pesticides, except for spot spraying of noxious weeds or non-native species consistent with recommendations of the City

5. Mowing: the streamside and middle zones are exempt from the City Code provisions requiring mowing.

Infrastructure crossing, such as roads, bridges, and utilities, should be constructed perpendicular to the stream and should occur at riffles (a rapid caused by a shallow sand bar or rocks extending across the streambed). Rights-of-way should be the minimum required for maintenance and installation of the infrastructure. See APWA Sections 5605.7 and 5605.8 for details. Stormwater discharge outfalls should be constructed in accordance with APWA Sections 5605.6 and 5605.9.

Finally, the transitional stream manager should physically inspect stream and bank conditions and address basic maintenance needs. The following tasks should be completed as basic maintenance for transitional stream corridors and buffers.

1. Inspect the stream for bank erosion and degradation, scouring, and changes since the last inspection. Keep records of all inspections, including photographs.
2. Inspect presence and condition of vegetation. Record percent cover and species type whenever possible. Clearing of existing vegetation, unless approved in the stream buffer plan, is prohibited.
3. Inspect for dumping of refuse, and remove all trash. No clearing of vegetation or storage of materials should be allowed in the buffer zones. Woody or vegetative detritus, such as logs or other large, natural objects in the stream will be left in place unless they threaten structures or infrastructure or cause blockages.
4. Transitional stream buffers will be inspected to assure that no un-permitted uses of buffer areas are occurring. Housing, grazing, or other maintenance of livestock, or storage and/or operation of machinery are not permitted in the buffer zone except for buffer maintenance and in case of emergency.
5. Assess and record surrounding land use to make sure that encroachment of the stream buffer by private landowners is not occurring, and to determine if changes to the surrounding land use may result in increased flow volume and/or decreased water quality.

In addition to the routine inspections, stream flow conditions will be inspected and recorded during specified storm events. Annual inspections will also include an evaluation of the need or feasibility of restoring the stream to natural conditions. The implementation of an effective restoration and management program is typically carried out in two phases: a medium-term, remedial phase and a long-term phase, the strategies for which are detailed in the next section.

### **Medium-Term Strategies**

The medium-term is when major efforts begin to identify and restore the stream corridor to a natural condition with native vegetation and biological diversity. In particular for transitional streams, the

medium-term, remedial phase will involve restoring and re-invigorating natural biological and physical functions of the stream. Opportunities exist to substantially restore natural stream conditions and habitat that will protect adjacent properties and provide enhanced qualities for the City. Transitional stream segments should be evaluated individually to determine the need for and prioritization for the remedial phase.

Strategies undertaken during this phase for transitional stream corridors include:

- repairing unstable bank walls (eroded cutbanks and steep slopes) and stabilizing with biotechnical engineering practices,
- removal of exotic invasive species,
- reduction of other undesirable trees and brush, and
- mechanical removal of hard armoring where feasible.

This phase may also include:

- the removal of dams or breaking of drain tiles,
- removal of debris, spoils, and fill,
- treatment of erosion and contamination problems, and
- manual or mechanical installation of native seeds and plants, including larger shrubs and trees.

Consequently, as with urban streams, the remedial phase for the transitional streams requires close planning, coordination with local landowners and stakeholders, the greatest short-term financial commitment, and substantial work effort.

When new- or redevelopment may be occurring it is important to coordinate with the City in regard to establishment of crossings for roads, bridges, and utilities. To protect riparian resources, and the land being developed, a minimum number of crossings should be used within each development, and no more than one crossing allowed for every 1,000 feet of stream buffer length. Infrastructure crossing, such as roads, bridges, and utilities, should be constructed perpendicular to the stream and should occur at riffles (a rapid caused by a shallow sand bar or rocks extending across the streambed). Rights-of-way should be the minimum required for maintenance and installation. See APWA Sections 5605.7 and 5605.8 for details. Stormwater discharge outfalls should be constructed in accordance with APWA Sections 5605.6 and 5605.9.

This phase requires site-specific assessment and detailed planning to address stream conditions and the level of effort for restoring the stream corridor. Site assessment and restoration should be conducted by trained staff or experienced professionals (see **Section VII** for training recommendations). APWA Section 5605.5 provides detailed stream assessment guidance, while Sections 5605.10 and 5605.13 cover grade control and bank stabilization, respectively. The remedial phase could take up to five years in any selected transitional stream segment identified by the City (See **Section X – Proposed Schedule**).

### **Long-Term Strategies**

The long-term management phase is guided by both regular management techniques and by strategies that are implemented in different areas of the watershed on a rotational basis. This phase will continually address changes in the watershed and associated changes in drainage volumes to the stream. Changes in the watershed may have profound effects on restoration of the stream, requiring adaptive management approaches.

Strategies during long-term management may include:

- hydrology and grade control (see APWA Section 5605.15),
- occasional use of chemical herbicides as well as mechanical/physical removal of invasive- or non-desirable vegetative species
- potential re-seeding and planting to assure vegetative establishment for appropriate species, and
- monitoring to assure that established vegetation is performing as planned.

For the transitional stream segments, the long-term management phase will require an ongoing effort designed to achieve a desirable and sustainable ecological system within the context of available funding, volunteer resources, and the commitment of all stakeholders. Because of changing land conditions, the goals of the transitional stream corridor will be different from the goals of urban- and agricultural/undeveloped stream segments and their buffers.

**Sections VIII and IX** provides more detailed guidance for long-term restoration and management.

## **V. Management of Agricultural Streams**

This section discusses the rationale and approach for managing agricultural streams, and provides specific, detailed management and restoration strategies.

### **A. Adaptive Management—Rationale and Approach**

Streams coursing through land that has been and/or continues to be used for agricultural production within the Independence city limits may typically be degraded and show impacts of poor water quality from tillage and grazing operations near the streams. Agricultural streams are affected by runoff from farm fields that may be high in sediment and nutrients (phosphorous and nitrogen), as well as other potential contaminants. Because many tillage and grazing operations in the past were completed to the stream bank, sometimes little to no buffer was maintained. Opportunities exist to create quality stream buffers that will provide existing and future benefits and the City grows.

#### ***Rationale***

Management and maintenance of agricultural stream corridors focuses on restoring and sustaining natural stream systems that provide a high level of riparian health. Because open space exists without encumbrances of nearby buildings or developed areas, buffers can be restored and maintained with less effort than stream buffers in more developed areas. Streams, however, may be significantly degraded and still require stabilization to restore quality stream functions.

The objective and success of agricultural stream adaptive management focuses on assessing stream conditions in the corridor for function and ecological value, identifying problem areas, and prioritizing areas that can provide a required buffer width and be restored, to the extent possible, to natural stream and floodplain morphology and vegetative structure. Adaptive management for agricultural streams depends on careful and efficient implementation of the tasks, regular monitoring and accounting of critical performance milestones, and a concerted, ongoing effort by land managers and other stakeholders.

#### ***Approach***

Much of the focus for management and restoration treatments in agricultural streams and their buffers is on water quality and quantity. Water quality can be substantially improved with stream buffers that filter runoff from adjacent properties and remove pollutants such as nutrients and pesticides. If areas continue to be tilled for crop production, runoff from fields that includes high sediment loads may continue to affect stream condition. Grazing areas may contribute high sediment loads, nutrients, and bacteria. Establishing ample stream buffer will allow for flood mitigation and removal of sediments. High stream flows, vegetation removal, and cattle access may

also have resulted in substantial stream bank degradation, creating very unstable conditions that need to be repaired. Because of the largely undeveloped areas, repair is less challenging than in urban or transitional streams.

Stream flow volume can generally be predictable. Typically, the stream banks will be vegetated, but vegetation may be undermined by erosion, and it may include invasive species that detract from the ecological function of the stream buffer. Bank stabilization may not have been implemented in agricultural streams, and erosion may be cutting into adjacent lands. However, stream stabilization, and establishment of protective buffers is relatively easy in agricultural areas.

Management strategies for agricultural stream segments in the City can be developed to take advantage of the undeveloped condition of surrounding land use, but they must also be flexible to address varied stream conditions, vegetation, and potential future changes in land use. A primary goal for agricultural streams is to establish an appropriate, broad stream buffer where possible, and re-establish native vegetation and stream morphology to alleviate damaging high water flows. Adaptive management of agricultural streams begins with evaluation of stream conditions to identify high-quality buffers and problem areas, and to assess the feasibility of changing the stream to an adaptive, natural community that improves flow volume and velocity. Assessment allows the buffer manager to prioritize and adjust the timing and application of specific treatments to better improve the overall performance of the buffer. As each stream is evaluated, the management plan should be specific to that particular area and refined as necessary to account for changes in the stream and its performance.

### ***B. Agricultural Stream Buffer Management and Restoration***

A phased approach is recommended for implementing the strategies: short-term practices should be implemented first, followed by medium-term and long-term strategies as conditions, resources, and experience permit. Additional information on long-term management is provided in **Sections VIII through X**.

#### **Short-Term Strategies**

The first and most basic agricultural stream management approach is to preserve the existing riparian corridor—set aside a stream buffer that includes trees, shrubs, and herbaceous vegetation, and excludes permanent structures or impervious surfaces. This basic step will go a long way to stabilizing stream banks and filtering runoff entering the stream. If surrounding land is no longer in agricultural production, the stream will usually stabilize. Upstream conditions, however, can still impact the stream corridor in agricultural areas, and therefore it is imperative to maintain the opportunity for a substantial stream buffer.

The next step is to avoid damaging the stream buffer. The stream buffer should be managed to protect its integrity and to enhance and maximize the unique value of agricultural streams. The following activities should be avoided to maintain the buffer's integrity:

1. Soil disturbance by grading, stripping, or other practices (such as tilling)
2. Filling or dumping (including but not limited to soil, trash, construction debris, and yard waste)
3. Drainage by ditching, underdrains, or other systems
4. Use, storage, or application of pesticides, except for spot spraying of noxious weeds or non-native species consistent with recommendations of the City

Finally, the agricultural stream manager should physically inspect stream and bank conditions and address basic maintenance needs. The following tasks should be completed as basic maintenance for transitional stream corridors and buffers.

1. Complete periodic inspection of agricultural streams, at least once per year. Inspect the stream for bank erosion and degradation, scouring, and changes since the last inspection.
2. Inspect the presence and condition of vegetation presence and condition and record the percent cover and species type, and buffer width and condition. This may be difficult with no clear indicators where a buffer begins if adjacent land is not tilled. Examine the stream channel, banks, and buffer for types of vegetation present, and if vegetative maintenance (removal of aggressive invasive species, seeding of bare areas, etc.) is needed.
3. Inspect for dumping of refuse, and remove all trash. No clearing of vegetation or storage of materials should be allowed in the buffer zones. Woody or vegetative detritus, such as logs or other large, natural objects in the stream, should be left in place unless they threaten structures or infrastructure or cause blockage.
4. Do not permit housing, grazing, or other maintenance of livestock, or storage and/or operation of machinery in the buffer zone except for buffer maintenance and in case of emergency.
5. Assess and record surrounding land use to make sure that encroachment of the stream buffer by private landowners is not occurring, and to determine if changes to the surrounding land use may result in increased flow volume and/or decreased water quality.
6. Include in annual inspections an evaluation of the need or feasibility of restoring the stream to natural conditions.

### **Medium-Term Strategies**

The medium-term is when major efforts begin to identify and restore the stream corridor to a natural condition with native vegetation and biological diversity. For agricultural streams, the remedial phase will encompass the process of restoring and re-invigorating natural biological and physical functions of the stream. Opportunities exist to substantially restore natural stream conditions and

habitat that will protect adjacent properties and provide enhanced water and stream quality and potential recreational opportunities for the City. Agricultural stream segments will be evaluated individually for determining the need for and prioritization for the remedial phase.

Strategies for this phase for agricultural stream corridors include:

- repairing unstable bank walls (eroded cutbanks and steep slopes) and stabilizing with biotechnical engineering practices,
- removal of exotic invasive species,
- reduction of other undesirable trees and brush, and
- mechanical removal of hard armoring.

The remedial phase may also include:

- the removal of dams or breaking of tiles,
- removal of debris, spoils, and fill,
- treatment of erosion and contamination problems, and
- manual or mechanical installation of native seeds and plants, including larger shrubs and trees.

Generally, restoration of streams and their buffers in agricultural areas will likely be less time-intensive than restoration in urban and/or transitional areas. The remedial phase for streams in agricultural areas still requires site-specific planning to address localized conditions of the stream and the level of effort to be completed for establishing a restored stream corridor. However, greater emphasis will be on ecological function in association with stream hydrology and function. The period of time required to conduct the remedial restoration phase depends on the level of effort required, the condition of the ecological systems, and physical opportunities and constraints (i.e., access, weather, biological response), and the level of funding available for the program. Site assessment and restoration should be conducted by trained staff or experienced professionals (see **Section VII** for training recommendations). In agricultural areas the U.S. Department of Agriculture *Stream Visual Assessment Protocol* (Technical Note 99-1) is appropriate for addressing stream conditions and restoration opportunities. The Jackson County Soil and Water Conservation District may provide technical assistance for assessment and installing conservation practices. In addition, APWA Section 5605.5 provides detailed stream assessment guidance, while Sections 5605.10 and 5605.13 cover grade control and bank stabilization, respectively.

## **Long-Term Strategies**

When the initial stream corridor and buffer objectives are achieved, the restoration program will be guided by both regular management techniques and by strategies that are implemented on a rotational basis through identified management units. The long-term management phase will need to examine potential changes in the watershed as land development continues in Independence. Changes in the watershed may have profound affects on restoration of the stream, requiring that land managers closely adhere to the concepts of adaptive management...

Strategies during long-term management may include:

- hydrology and grade control (see APWA Section 5605.15),
- occasional use of fire to control vegetation, and/or chemical herbicides as well as mechanical/physical removal of invasive- or non-desirable vegetative species
- potential re-seeding and planting to assure vegetative establishment for appropriate species, and
- monitoring to ascertain that established vegetation is performing as planned.

For the agricultural stream segments, the long-term management phase will require an ongoing effort designed to achieve a desirable and sustainable ecological system within the context of available funding, volunteer resources, and the commitment of all stakeholders.

**Sections VIII and IX** provides more detailed guidance for long-term restoration and management.

## **VI. Management of Streams in Undisturbed Areas**

This section discusses the rationale and approach for managing undisturbed streams, and provides specific, detailed management and restoration strategies.

### **A. Adaptive Management—Rationale and Approach**

Streams flowing through land within the City of Independence that is not or cannot be developed may vary in regard to stream stability and water quality, generally based on location of the stream segment in respect to land use and upstream conditions. Streams in areas that cannot be developed may retain some of their original riparian qualities, or if they are downstream from developed areas, but subject to degradation and bank erosion from increased high-water flows. Typically, stream buffers in undeveloped areas provide opportunities for maintaining necessary area for flood control and dispersion of floodwaters. However, erosive forces cause some stretches of these streams to become severely incised or deeply cut and continue to erode the surrounding buffer. In these areas, stream buffers may need remedial action to enhance the buffer zone and stabilize the stream and surrounding lands.

#### ***Rationale***

The rationale for management and maintenance of undisturbed stream corridors is very similar to management of agricultural streams, focusing on restoring and sustaining natural stream systems that provide a high level of riparian health. Because open space exists without encumbrances of nearby buildings or developed areas, buffers can be restored and maintained with less effort than stream buffers in more developed areas. However, streams still may be significantly degraded and require stabilization to restore quality stream functions.

The objective and success of adaptive management for streams in undisturbed areas focuses on assessing stream conditions in the corridor for function and ecological value, identifying problem areas, and prioritizing areas that can provide a required buffer width and be restored to natural stream and floodplain morphology and vegetative structure. Adaptive management for these streams requires careful and efficient implementation of stabilization procedures, if required, regular monitoring and accounting of critical performance milestones, and a concerted, ongoing effort by land managers and other stakeholders.

#### ***Approach***

Management and restoration treatments for stream buffers in undisturbed areas will focus on water quality and quantity, and ecological function. Opportunities for maintaining biological diversity and ecological support of the riparian system exist principally in these areas. Water quality can be

substantially improved with stream buffers that provide filtering of runoff from adjacent properties, removing pollutants such as nutrients and pesticides. Establishing ample stream buffers will allow for flood mitigation and removal of sediments. Because of the largely undisturbed areas, repair of stream damage and stabilization of banks is less challenging than in urban or transitional streams.

Stream flow volume in these areas can generally be predictable if not closely associated with unstable transitional streams. Typically, the stream banks will be vegetated, but vegetation may be undermined by erosion, and it may include invasive species that detract from the ecological function of the stream buffer. It is likely that bank stabilization strategies have not been implemented in streams of the undisturbed areas, and therefore erosion and cutting into adjacent lands may be occurring. However, because of the factors, stream stabilization, where necessary, and establishment of protective buffers in the stream corridors can be effectively achieved with comparative ease.

Management strategies for stream segments in un-developable areas of the City can be established to take advantage of the undisturbed condition of surrounding land use, but they must also be flexible to address varied stream conditions, vegetation, and potential future changes in nearby land use. A primary goal for these stream segments is to establish an appropriate, broad stream buffer where possible, and re-establish native vegetation and stream morphology to alleviate damaging high water flows. Adaptive management of undeveloped streams begins with evaluation of stream conditions to identify high-quality buffers and problem areas, and to assess the feasibility of changing the stream to an adaptive, natural community that improves flow volume and velocity. Assessment allows the buffer manager to prioritize and adjust the timing and application of specific treatments to better improve the buffer's overall performance.

### ***B. Undisturbed Stream Buffer Management and Restoration***

A phased approach is recommended for implementing management strategies: short-term practices should be implemented first, followed by medium-term and long-term strategies as conditions, resources, and experience permit. Additional information on long-term management is provided in **Sections VIII through X**.

#### **Short-Term Strategies**

The first and most basic agricultural stream management approach is to preserve the existing riparian corridor—set aside a stream buffer that includes trees, shrubs, and herbaceous vegetation, and excludes permanent structures or impervious surfaces. This basic step will go a long way to stabilizing stream banks and filtering runoff entering the stream. It is anticipated that the stream will

be more stable than other stream types, but upstream conditions can still impact the stream corridor. Therefore the opportunity for maintaining a substantial stream buffer remains imperative.

The next step is to avoid damaging the stream buffer. The stream buffer should be managed to protect its integrity and to enhance and maximize the unique value of agricultural streams. The following activities are prohibited unless approved by the City, and are to be avoided to maintain the buffer's integrity:

1. Soil disturbance by grading, stripping, or other practices
2. Filling or dumping (including but not limited to soil, trash, construction debris, and yard waste)
3. Drainage by ditching, underdrains, or other systems
4. Use, storage, or application of pesticides, except for spot spraying of noxious weeds or non-native species consistent with recommendations of the City

Finally, the undisturbed stream manager should physically inspect stream and bank conditions and address basic maintenance needs. Basic maintenance for stream corridors and buffers in undisturbed areas is very similar to that of agricultural streams. The following tasks will be completed as basic maintenance for undisturbed stream corridor:

1. Regularly complete periodic inspections of streams in undeveloped areas should (at least once per year). Inspect the stream for bank erosion and degradation, scouring, and changes since the last inspection.
2. Inspect the presence and condition of vegetation and record percent cover and species type. Record buffer width and condition. This may be difficult with no clear indicators where a buffer begins if adjacent land is not tilled. Examine the stream channel, banks, and buffer for types of vegetation present, and to determine if vegetative maintenance (removal of aggressive invasive species, seeding of bare areas, etc) is needed.
3. Inspect for dumping of refuse, and remove all trash. No clearing of vegetation or storage of materials is allowed in the buffer zones. Woody or vegetative detritus, such as logs or other large, natural objects in the stream should be left in place unless they threaten structures or infrastructure or cause blockage.
4. Do not permit housing, grazing, or other maintenance of livestock, or storage and/or operation of machinery in the buffer zone except for buffer maintenance or in case of emergency.

5. Assess and record surrounding land use to make sure that encroachment of the stream buffer by private land owners is not occurring, and to determine if changes to the surrounding land use may result in increased flow volume and decreased water quality.

Annual inspections will also include an evaluation of the need or feasibility of restoring the stream to natural conditions.

### **Medium-Term Strategies**

The medium-term is when major efforts begin to identify and restore the stream corridor to a natural condition with native vegetation and biological diversity. As with agricultural streams, the remedial phase for undisturbed streams will encompass the process of re-invigorating natural biological and physical functions of the stream. Opportunities may exist to substantially improve natural stream conditions and habitat that will protect adjacent properties and provide enhanced water and stream quality and potential recreational opportunities for the City.

Strategies undertaken during this phase for undisturbed stream corridors include:

- repairing unstable bank walls (eroded cutbanks and steep slopes) and stabilizing with biotechnical engineering practices,
- removal of exotic invasive species,
- reduction of other undesirable trees and brush, and
- mechanical removal of hard armoring.

The remedial phase may also include:

- the removal of dams or breaking of drainage tiles,
- removal of debris, spoils, and fill,
- treatment of erosion and contamination problems, and
- manual or mechanical installation of native seeds and plants, including larger shrubs and trees.

Restoration of streams and their buffers in undeveloped areas will likely be less time-intensive than restoration in urban and/or transitional areas. The remedial phase for streams in these areas requires site-specific planning to address localized conditions of the stream and the level of effort to be completed for establishing a restored stream corridor. Site assessment and restoration should be

conducted by trained staff or experienced professionals (see **Section VII** for training recommendations). In agricultural areas the U.S. Department of Agriculture *Stream Visual Assessment Protocol* (Technical Note 99–1) is appropriate for addressing stream conditions and restoration opportunities. The Jackson County Soil and Water Conservation District may provide technical assistance for assessment and installing conservation practices. In addition, APWA Section 5605.5 provides detailed stream assessment guidance, while Sections 5605.10 and 5605.13 cover grade control and bank stabilization, respectively.

### **Long-Term Strategies**

If stream corridor and buffer restoration is needed and its objectives are achieved, the restoration program, similar to restoration of any of the other stream types, will be guided by both regular management techniques and by strategies that are rotated through different areas of the watershed on a set schedule. The long-term management phase will need to examine potential changes in the watershed as land development continues in the City. Changes in the watershed may have profound effects on restoration of the stream, requiring that land managers closely adhere to the concepts of adaptive management.

Tasks during long-term management may include:

- hydrology and grade control (see APWA Section 5605.15),
- occasional use of fire to control vegetation, and/or chemical herbicides as well as mechanical/physical removal of invasive- or non-desirable vegetative species
- potential re-seeding and planting to assure vegetative establishment for appropriate species, and
- monitoring to ascertain that established vegetation is performing as planned.

For the agricultural stream segments, the long-term management phase will require an ongoing effort designed to achieve a desirable and sustainable ecological system within the context of available funding, volunteer resources, and the commitment of all stakeholders.

**Sections VIII and IX** provides more detailed guidance for long-term restoration and management.

## **VII. Training, Monitoring, and Reporting**

Specialized training, ecological monitoring, and annual reporting are instrumental aspects of a successful restoration and management plan. The following sections outline the important components of these topics.

### **A. Specialized Training for Restoration and Management**

For many of the restoration tasks (i.e., prescribed burning, herbicide use, erosion and sediment control, and monitoring) specialized training, often licensing or certification, and oversight and guidance are required well in advance of the dates for commencement of the restoration program. Personnel and volunteers involved in prescribed burning, brush control, monitoring, seed collection, etc., should receive training commensurate with the activity in which they would be involved. Training is especially important for those activities that may have risk and safety implications (i.e., prescribed burning), but also for monitoring, where an accurate assessment of the ecological performance of the ecological system to the restoration treatments is required. Highly skilled restoration tasks such as bank stabilization design and installation should be performed by experienced outside contractors or consultants unless qualified in-house staff (engineers and construction managers) obtain *in-depth* training in restoration activities. Courses are available from regional and national universities, not-for-profits, and consultants such as Wildland Hydrology Consultants ([www.wildlandhydrology.com](http://www.wildlandhydrology.com)) and Robbin B. Sotir & Associates, Inc. ([www.sotir.com](http://www.sotir.com)).

### **B. Ecological Monitoring**

The process of ecological monitoring provides important and regular data on the effectiveness of the restoration program. Effectiveness is to be judged against original and new goals and measurable objectives designed by the project. Goals are generally refined during the design phases and refined further as project performance is measured and evaluated.

Photographic monitoring, including digital photography of the restoration treatment process and results is required for keeping accurate and reproducible records. Semi-permanent photographic stations can be installed and regularly visited during the course of the restoration process. This documentation, when coordinated with monitoring of vegetation, birds, and insects, is immensely useful in development of interpretative and educational materials.

**C. Reporting**

Management reports detailing locations and dates of all management and restoration efforts undertaken should be completed annually during the restoration phase. Summary reports should also be prepared for this restoration program. A detailed technical analysis and summary of all the previous data is generally completed every five years. This report may best be termed "*Ecological Status Report*". It should be designed to assimilate all previous data into easily understood graphics and summary materials.

## **VIII. Restoration Recommendations for Riparian Corridors**

This section provides a series of recommended remedial measures to be conducted within the riparian corridors occurring within the City boundaries. They encompass extensive upfront effort to restore vegetation, habitat structure, and biological diversity. Given that minimum buffer widths on each side of the stream range from 85 feet in first order streams to 150 feet in fourth order streams, it is assumed that a number of possible habitats can be found within stream buffers. These may include woodland tracts, forests, savannas, wet prairie, upland prairie, wetlands (emergent, shrubby, and forested), cropland, and lawns. It is assumed that the more disturbed sites (cropland and lawns) will be restored or in the keeping of the terminology in this report, re-created, to prairie, while the other more intact plant communities will be protected, enhanced, or restored in its current nature. Level of effort will depend on the current degree of degradation. To better understand the steps involved in ecological restoration, this section has been divided into two separate subsections including general tasks and specific considerations.

### **A. General Tasks**

General tasks involve site preparation, installation, and maintenance. These must be undertaken to succeed in any restoration effort as explained below.

#### **1.) Site Preparation**

Site preparation will vary depending on the habitat to be restored and site-specific management objectives. For example, site preparation in prairie and savanna restorations will involve light tilling of bare ground followed by compacting to firm up the soil. On vegetated ground, herbiciding would be conducted to kill weeds and turf followed by light tilling or no-till seeding. In woodland or forest with a thick shrub cover lacking any herbaceous ground cover, site preparation would involve selective cutting of woody invasive species, possibly followed by a prescribed burn.

Furthermore, a wetland infested by reed canary grass would be treated with herbicide and followed by a spring burn; a treatment regime that may be repeated in successive years.

#### **2.) Installation**

This category involves the installation of live material whether it is seed, plug, or tree and shrub.

**Seeding.** Seeding is expected to be conducted in the early spring (as soon as the soil is free of frost and is in workable condition but no later than June 15) or if not in the spring then as a late fall dormant seeding (after December 15). Seeds (and live plants) should be native to North Central Missouri and obtained from within a 100-mile radius of the project site if at all possible. Depending on the size of the restoration area and habitat to be restored, seed may be hand broadcasted into a

lightly tilled soil or installed with a no-till drill such as the Truax or equivalent to limit soil disturbance. Within 24 hours or as soon as site conditions permit, seeded areas will be rolled or dragged perpendicular to the slope, and mulched with certified, weed-free mulch. On sloping ground, netting will be installed on top of the mulch. In drainage areas or swales, erosion mat will be installed on top of seed and mulch and secured with small pins or staples.

**Herbaceous Live Plants.** Installation of live plants or plugs is expected to be completed after May 15 (after the last possible freeze), but no later than July 15 (when precipitation drops off and temperatures are higher). Live plants should be native to North Central Missouri and obtained from within a 100-mile radius of the project site if at all possible). All live plants will be protected from desiccation upon delivery, and will be installed as quickly as possible. Emergent live herbaceous plants, will be installed in 0-6 inches depth of water, and clustered into groups of 75-125 individuals of the same species if feasible. Prairie and woodland live herbaceous perennial plants will be clustered into groups of 10-20 individuals of randomly mixed species.

**Trees and Shrubs.** Installation of trees and shrubs is expected to be completed in the spring before June 15 to preclude extensive watering into the summer when precipitation drops off and temperatures are higher. Trees should be native to North Central Missouri and obtained from within a 100-mile radius of the project site (if at all possible). All live plants will be protected from desiccation upon delivery, and will be installed as quickly as possible.

### **3.) Maintenance**

Maintenance is paramount in the successful establishment of native vegetation in any restoration effort. It most often involved herbicide application, mowing or brushing, and prescribed burn.

**Herbicide Application.** Application of herbicide will be used to prepare vegetated ground (e.g., woodland, forest, and savanna restoration) prior to planting in prairie and savanna restorations as well as to control weedy growth during the first few years of establishment and woody re-sprouts and weedy vegetation that appears in between mowing and prescribed burn events in prairie and savanna restorations. All cut trees and shrubs are treated with herbicide to limit re-sprouting. Spot herbicide applications are also effective in removing weedy invasives in woodland ground cover opening up the ground for reestablishment of native species already in the soil or recently seeded. Herbicide application will follow instructions on the label, and will be performed by certified herbicide applicators. Approved and appropriate herbicides will be used in uplands, wetlands and streams, and for woody vegetation. Herbicide applications typically start during the growing season of planting and continues thereafter twice yearly for three years in prairie and wetland restoration and when and where needed in woodland restorations.

**Mowing/Brushing.** Mowing is another important tool in the establishment of native grassland and savannas especially in the first few years after seeding. Selective cutting is important in woodland restorations after initial site preparation and following planting. It controls weedy growth and the cover crop (if planted) to allow for the establishment and continued growth of seeded species in both prairie and woodland areas and planted woody species in woodland habitat. In prairies and savannas, all seeded areas will be mowed to a height of 8-12 inches after vegetation in such areas has reached a height of 30 inches. Mowing will be done with a rotary brush hog style mower to ensure that clippings are dispersed rather than deposited in dense mats, which smother vegetation. In areas that are too wet or too difficult to mow with a brush hog and tractor, weed whackers or brush saws will be used. Mowing is usually done in mid-July and is expected to occur once or twice yearly for the first two years after planting.

**Prescribed Burning.** Planned burning or prescribed burning is an indispensable tool to maintain and restore native grasslands as well as woody habitat. Fire controls woody growth, either new seedlings or existing vegetation, while stimulating the growth of grasses and forbs (wildflowers) in native grassland or wetlands. In woodland habitat, fire stimulates the germination of native ground cover species stunted by invasives or more recently seeded or planted. Prior to the commencement of a burn, a burn plan should be compiled that outlines a plan of action, identifies contingencies, and lists the names and phone numbers of emergency agencies. Proper notice of intent to burn shall be given. All required permits will be obtained prior to the commencement of prescribed burning. Prescribed burns can be conducted in the late fall or early spring three to five years after planting and seeding in prairie and savanna habitat and in two of the first five years of woodland restoration. Subsequent burns should be implemented every two to three years thereafter depending on site conditions.

## **B. Specific Considerations**

Restoration considerations specific to the type of habitat to be restored or re-created are briefly highlighted below. They include oak savanna, woodland, forest, riparian corridor, wet prairie, upland prairie, and emergent wetland.

### **1.) Oak Savanna Restoration**

Oak savanna is a mix of upland prairie and sparse oak woods that historically occurred in the Midwest. General objectives and strategy for restoration are briefly described below.

**Objective.** Restore historic open oak savanna consisting of scattered solitary oaks and other native trees with an understory of herbaceous prairie and savanna species.

**Strategy.** This will be achieved by removing non-native and weedy native woody species to achieve an appropriate savanna canopy structure of no more than 50% cover, preparing soil by herbiciding where needed, installing prairie and savanna understory species by seed and plants, and installing oaks, hickories, and native shrubs, where needed.

## **2.) Woodland Enhancement**

Woodland enhancement involves the improvement of intact, less impacted, smaller-sized woodlands.

**Objective.** Enhance and restore the overgrown and degraded woodland areas within the designate stream corridors within the City to their historic character and increase their biological diversity and health.

**Strategy.** This will be achieved by removing non-native and weedy native woody species to achieve an appropriate woodland shrub and canopy structure; preparing soil by herbiciding for seeding where needed; and installing seeds and plugs of woodland understory species where appropriate.

## **3.) Forest Restoration/Protection**

Forest restoration or protection involves the improvement or protection of larger tracts of intact woods.

**Objective.** Restore Oak-Hickory forest native to the area consisting of a canopy of Bur Oaks, Chinquapin Oaks, and Shagbark Hickory with a diverse understory of native forest woody and herbaceous species.

**Strategy.** This is achieved by removing non-native and weedy native woody species, preparing soil by herbiciding, installing beneficial native trees to establish an appropriate forest canopy structure, and installing seeds and plugs of native woody and herbaceous understory species. A mature forest canopy covering greater than 70% creates a full, but not completely closed, canopy cover.

## **4.) Riparian Corridor and Floodplain Restoration**

This type of restoration involves the entire potential habitat within the riparian corridor and floodplain.

**Objective.** Restore historic floodplain and improve riparian corridor to the extent economical and practical.

**Strategy.** This will be achieved by restoring natural hydrology (runoff and flow patterns), if necessary and possible, reducing invasive non-native species cover, allowing native species to reestablish by germinating from the seed bank that survives in the soil, and enhancing native species cover and diversity through seeding and planting. The canopy along the stream will be thinned considerably to enable sunlight to reach soil stabilizing, native ground vegetation. If finances allow, the stream course should be studied and a plan for stabilizing the stream banks should be developed and implemented. This is an often necessary step to ensuring stream bank stability and erosion and sediment control.

### **5.) Prairie Restoration—Upland Prairie and Wet Prairie**

The objective and overall strategy for prairie restoration is explained below.

**Objective.** Restore native prairie vegetation in applicable areas in existing riparian corridors through seeding and live plant installation in upland and wet prairie habitat types. Given that restoration techniques and management practices are essentially the same for the two prairie types, they are lumped together in this section.

**Strategy.** This will be achieved by preparing the soil for planting (i.e., herbiciding and disking) where needed, and installing native prairie species.

### **6) Emergent Wetland Restoration**

**Objective.** Restore emergent wetlands along streams within the riparian corridors.

**Strategy.** This will be achieved by preparing the soil for planting (i.e. herbiciding and disking) where needed, and installing native emergent wetland species (seeds and plugs). Stream hydrology will allow for adequate water storage which will encourage the natural establishment of emergent vegetation over time.

## **IX. Adaptive Management Recommendations for Riparian Corridors**

It is difficult to recommend a suite of recommendations specific to the habitats within the City's riparian corridors prior to the start of any of the restoration efforts as many of the decisions are site-specific, dollar-dependent, and schedule-driven. It would probably be better to be mindful of the meaning of adaptive management and its ramifications to management decisions in the short- and long-term. Management strategies need to be flexible and allowed to change over time to respond to natural communities as they adjust to intentional restoration efforts. Decisions pertaining to land management may be as simple as substituting mowing for a prescribed burn during an uncharacteristically rainy or windy window of time. Or it could be rounding up a group of volunteers to remove the fire-susceptible garlic mustard in the late spring because a burn during the previous fall was not conducted due to foul weather. The change in strategy still achieved the ultimate goal in controlling garlic mustard albeit during a different year and season.

## **X. Initial Five-Year Restoration and Adaptive Management Schedule**

The following schedule outlines the recommendations for scheduling monitoring and management activities pertinent to the City stream buffer restoration and management guidance. The proposed schedule is provided as a road map for progressing from basic maintenance to a comprehensive management program that includes restoration and enhancement. Table 1 summarizes a step by step schedule by task and year for recommended restoration and management activities.

In most land management programs, tasks to be undertaken are relatively simple and often repetitive. The most difficult part of the restoration program is organizing tasks in a clear and easily understood format. It is important that the program and schedule be designed to be flexible. Flexibility is a requisite when activities are planned that require suitable weather conditions. The program needs to be flexible enough to allow for feedback from the monitoring program to identify changes in strategy, techniques, and timing that may be necessary or desirable to satisfy the restoration goals. The program should also be flexible to allow for shifting responsibilities and resources as the City and private landowners work among themselves and collectively to create the most efficient and effective management program.

**Initial Five-Year Restoration and Adaptive Management Schedule**

**TABLE 2. FIVE-YEAR RESTORATION AND MANAGEMENT SCHEDULE  
FOR CITY OF INDEPENDENCE STREAM BUFFERS**

	<b>YEAR 1</b> QTR	<b>YEAR 2</b> QTR	<b>YEAR 3</b> QTR	<b>YEAR 4</b> QTR	<b>YEAR 5</b> QTR
*[Bracket] indicates quarter when work will be conducted.					
<b>1 Brushing &amp; Herbiciding (riparian, savanna, woodland &amp; forest):</b>	[1] 2 3 4	[1] 2 3 4	[1] 2 3 4	1 2 3 4	1 2 3 4
Cut and stump treat or girdle non-native woody species and selected weedy native woody species.					
<b>2 Prescribed Burn Site Inspection (all areas):</b>	[1] 2 [3] 4	[1] 2 3 4	[1] 2 3 4	[1] 2 3 4	1 2 3 4
Assess site conditions to determine feasibility and appropriate fuel load conditions.					
<b>3 Burn Management (all areas):</b>	[1] 2 [3] 4	[1] 2 3 4	[1] 2 3 4	[1] 2 3 4	[1] 2 3 4
Apply for permits, schedule burn, contact local authorities, and finalize burn plan.					
<b>4a Conduct Burn (woodland, forest &amp; riparian):</b>	1 [2] 3 [4]	1 2 3 4	1 [2] 3 4	1 2 3 4	1 [2] 3 4
<b>4b Conduct Burn (prairie, floodplain &amp; savanna):</b>	1 2 3 4	1 2 3 4	1 [2] 3 4	1 2 3 4	1 [2] 3 4
<b>5 Site Inspection to recommend future management (all areas):</b>	1 [2] 3 4	1 [2] 3 4	1 [2] 3 4	1 [2] 3 4	1 [2] 3 4
Assess site conditions to identify needs for aggressive species management, brushing, herbiciding, and enhancement seeding where necessary.					
<b>6a Enhancement Seeding/Planting (woodland, forest, prairie &amp; riparian):</b>	1 2 [3] 4	1 2 3 4	1 2 3 4	1 2 [3] 4	1 2 3 4
<b>6b Seeding/Planting (prairie, savanna &amp; floodplain):</b>	1 2 [3] 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
<b>7 Mowing (prairie, floodplain &amp; savanna):</b>	1 [2] [3] 4	1 [2] [3] 4	1 2 3 4	1 2 3 4	1 2 3 4
Conducted for weedy species control.					
<b>8a Herbicide Management (woodland, forest &amp; riparian):</b>	1 [2] 3 4	1 [2] 3 4	1 [2] 3 4	1 2 3 4	1 2 3 4
Spot herbicide application to native aggressive and non-native shrubs and herbaceous species.					
<b>8b Herbicide Management (prairie, floodplain &amp; savanna):</b>	1 [2] [3] 4	1 [2] [3] 4	1 [2] [3] 4	1 2 3 4	1 2 3 4
Spot herbicide application to non-native and native invasive species (e.g., cool season grasses and weeds).					
<b>9 Summary Report (all areas):</b>	1 2 3 [4]	1 2 3 [4]	1 2 3 [4]	1 2 3 [4]	1 2 3 [4]
Annual report to client to provide specifics on activity and recommendations.					