Handbook of Best Management Practices for the Upper Illinois River Watershed and Other Regional Watersheds

Executive Summary

What Are Management Actions and Why Are They Needed?

Management actions are strategies carried out by stakeholders in the Upper Illinois River Watershed that are designed to implement water quality protection and restoration activities within the watershed. This chapter presents a range of beneficial management actions from simple to complex that address the pollutant potential that is common across the watershed landscape. Some management actions can be undertaken by any watershed stakeholder at any time, while others need to be carefully planned or lobbied to local and state government—all of which can be recommended by the Illinois River Watershed Partnership.

Whether the stakeholder is an individual that can undertake simple stewardship steps at home, during recreation, or at the workplace, or a large entity like a municipality, corporation, or government, there is always something positive that can be done to maintain and improve water quality.

Who Is Responsible for Undertaking Management Actions?

Anyone who lives, works, or recreates within the Upper Illinois River Watershed can degrade, maintain or improve the water quality of the Illinois River through their personal actions. Furthermore, every household, business, farm, institution, industry, corporation, and government can influence the water quality of the Illinois River through their policies and operational protocols. Therefore, everyone in the watershed is responsible for contributing to the maintenance and improvement of the water quality within the Upper Illinois River Watershed.

Handbook Highlights:

The following chapters address potential management actions that can be taken by individuals or groups at households, businesses, institutions, municipalities, industrial facilities, farms, and construction sites to maintain or improve the water quality of the Illinois River.

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Chapter 1: Management Actions for Developments

Why are Management Actions Needed for Developments?

As the population in the Illinois River Watershed increases, so does the need for new developments. Increases in impervious surface areas associated with developments can have negative impacts on water quality. The resulting impacts of developments and land use changes are reflected in stream flow, stream water physical and chemical properties, stream water uses, and the plant and animal species that live within the ecosystem. However, management actions can be taken to lessen these impacts throughout the watershed.

How Can Management Actions for New Development be Encouraged in the Upper Illinois River Watershed?

Management actions for new development can be encouraged through collaborative efforts by partnering organizations, agencies, and governments to disseminate information to all stakeholders of the Upper Illinois River Watershed. Furthermore, city, county, and state governments can make new policies that provide tax incentives or reduced impact fees for stakeholders that reward and encourage the use of beneficial new development practices. The IRWP should seek to work with local and state governments, agencies and conservation organizations in cooperative effort to develop a plan to reduce the impacts of development.

- **NEW DEVELOPMENT:** New Structures or improvements to pre-existing structures that often equate to the conversion of natural landscape to urban, rural, and industrial uses.
- **LANDUSE CHANGE:** Alteration of land cover from one use to another. Land use changes can influence the hydrology and pollutant potential of a watershed by increasing runoff.
- **RUNOFF**: Water from rain, snowmelt, or irrigation that does not get soaked into the ground (infiltrate) but instead, flows over the ground surface and returns to streams.
- **STORMWATER:** Rain water and snowmelt that runs off from impervious surfaces and flows into storm drain collection systems rather than being absorbed into the soil.

The following sections will discuss the effects of stormwater, low impact development practices, green infrastructure, stream and riparian restoration, and construction BMPS.

1.1 Stormwater Runoff from Urban Areas

When rain events occur, some precipitation is infiltrated into the soil surface, taken up by plants, or evaporated into the atmosphere. The rest of the precipitation that runs off the landscape and into streams or other waterbodies is called stormwater runoff or runoff. Stormwater runoff increases with increased impervious areas—surfaces that are covered by impenetrable materials such as asphalt, concrete, brick and stone—that repel water and prevent precipitation from infiltrating into the ground. Impervious areas are often associated with developments; examples of impervious surfaces include rooftops, sidewalks, roads and parking lots.

Stormwater can impact the environment by eroding land areas and streambanks and by transporting pollutants such as oil and grease, chemicals, nutrients, metals and bacteria from the landscape to nearby waterbodies.

Table 1.1. Common pollutants found in stormwater and their sources and impacts on the environment.

Pollutant	Sources and Environmental Impacts
Sediment	♦ Sediment is one of the largest pollutant loads in stormwater in urban settings. ♦ Sediment is associated with numerous impacts in surface waters including ♦ increased turbidity and aquatic habitat disturbance. ♦ Other pollutants can bind to and be carried by sediment particles. ♦ Sources of sediment include construction activity and streambank erosion.
Nutrients	♦ Nitrogen and phosphorus are often detected in stormwater. ♦ In surface waters, nutrient loads can lead to algal growth, eutrophication of ♦ streams and lakes and low dissolved oxygen levels in waterbodies. ♦ Sources of nutrients include fertilizers, leaks from sanitary sewers, and pet ♦ and wildlife wastes.
Organic Matter	♦ Organic matter in surface water reduces dissolved oxygen. ♦ Sources of organic matter include septic systems, garbage, and yard waste, and ♦ naturally occurring plant life.
Bacteria	♦ Bacteria in surface waters may impact recreational water use, aquatic life and ♦ impose human health risks. ♦ High bacteria levels may be found in stormwater as a result of improperly ♦ Operating septic tanks, overflowing sanitary systems, garbage, land-applied ♦ manure, and wastes.

Oil and Grease	♦ Vehicle traffic and maintenance, leaks and spills, and manufacturing ♦ processes within an urban area contribute to the presence of these ♦ pollutants in nearby waterbodies.
Toxic Substances	♦ Toxic substances associated with stormwater include metals, pesticides, ♦ herbicides, and hydrocarbons. ♦ Toxic compounds may affect biological systems and may accumulate in ♦ stream bed materials. ♦ Sources include vehicle fluids, some cleaning products, paints, pesticides, and and industrial wastes
Heavy Metals	♦ Heavy metals such as copper, lead, zinc, arsenic, chromium and cadmium ♦ may be found in stormwater runoff. ♦ Metals in stormwater runoff may be toxic to aquatic life and may accumulate ♦ in some aquatic animals. ♦ Sources of heavy metals include automobiles, paints, preservatives, motor oil, ♦ and industry wastes.
Temperature	♦ Elevated water temperatures can impact a watebody's ability to support ♦ certain aquatic life. ♦ Stormwater runoff increases in temperature as it flows over impervious surfaces. ♦ Removal of riparian vegetation opens water bodies to direct sunlight.

Controlling Stormwater Runoff

Traditional stormwater management involves conveying runoff via stormwater drainage systems, untreated, into nearby waterbodies. This approach often involves hard infrastructure such as curbs, gutters and pipes which can be costly to install and maintain. In addition, traditional stormwater management typically does not minimize runoff volumes or control pollution which can lead to downstream flooding and water quality problems. However, new approaches that are designed to use natural drainage features to prevent and control runoff are being utilized more frequently to accomplish stormwater management goals.

PREVENTATIVE MEASURES: Measures that work to reduce the impacts of stormwater runoff through changes in the design, operation, or management of a development in an effort to minimize or prevent the generation of runoff and the transportation of pollutants. Preventative measures can be very efficient and effective since they are implemented to keep pollutants from ever getting into stormwater.

CONTROL MEASURES: Devices that are put in place to capture stormwater and provide pollutant removal through sedimentation, filtration, infiltration, retention, or other related processes. While beneficial, these measures may be limited in their ability to efficiently remove some pollutants and can be costly. Control measures also require long-term maintenance and monitoring to assure the structures are functioning properly.

Developmental strategies that prevent and control stormwater runoff and promote stream health are discussed in the following sections.

1.2 Green Infrastructure

Green infrastructure is a big-picture concept related to land development that highlights the importance of natural environment in land-use planning. Green infrastructure is an interconnected framework of thoughtfully planned linkages of preserved, undeveloped landscapes, working landscapes, and developed landscapes. In addition, the US EPA uses the term to describe an approach of stormwater management that is cost-effective, sustainable, and environmentally friendly and includes low impact development practices.

Did You Know? **A green infrastructure network exists in the Upper Illinois River Watershed along the Scull Creek and Mud Creek trails in Fayetteville that consists of natural areas, farmlands, parks, private and developed properties, streams and ecological corridors.**

Green infrastructure consists of a network of hubs and links. Each hub serves as a site that allows critical ecological functions to take place. On a large scale, hubs are large, open areas such as state parks, farms, forests and city parks, while on a small scale, hubs include rain gardens, porous pavements, green roofs, and tree boxes. The links are the connections between the hubs that serve as green corridors for ecological processes and provide other social and economic benefits. The links can be riparian areas, conservation easements, urban trails, bioswales or other vegetated buffers.

Some of the guiding principles behind green infrastructure are to be proactive and systematic in the collaborative planning of a large scale and multifunctional green space network; this more or less equates to well-planned conservation of land and water resources in the midst of developed areas. These guiding principles are essential because, as urban and rural populations grow, there is a great potential to lose natural areas and the associated ecological processes including the loss of wildlife habitat and the degradation of water quality.

The benefits of green infrastructure can span across the needs of the community in terms of economic, social, ecological and environmental health.

Environmental Benefits of Green Infrastructure:

- Reduced and delayed stormwater volumes
- Enhanced groundwater recharge
- Stormwater pollutant reductions
- Reduced sewer overflow events
- Increased carbon sequestration
- Reduced energy demands
- Improved air quality
- Increased wildlife habitat
- Improved human health
- Increased land values

Did You Know? **In 2008, a green infrastructure planning effort was undertaken within Washington County by Beaver Water District and the Fayetteville Natural Heritage Association. This has been a collaborative effort between these organizing entities, elected officials, city planners, businesses, landowners, and other local stakeholders as part of the Arkansas Forestry Commissions Urban and Community Forestry Program.**
www.fayettevillenatural.org/userfiles/Project_Brief%20Rev.pdf

Green Infrastructure Practices

- ***Conservation Easements:*** Voluntary agreements that allow individuals or groups to limit the type or amount of development on their property to conserve green space.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=85
- ***Green Space:*** Land area with preserved or restored natural landscape features (forests, floodplains, wetlands, grasslands, riparian areas) that can protect ecologically sensitive areas, improve water quality, and provide wildlife habitat. In addition, green space can be used for recreational purposes.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=126
- ***Infrastructure Planning:*** Involves changes in the regional growth planning process to limit 'sprawl' development and maximize infrastructure cost-effectiveness.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=86
- ***Low Impact Development:*** The use of small-scale measures such as open space design, native landscaping, or constructed wetlands to preserve or mimic natural infiltration processes on a developed or developing site. LID practices are discussed in detail in Section 5.1.3 of this plan.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=124
- ***Protection of Natural Features:*** Ensures that natural features are preserved in the development process which maintains ecological functions and reduces stormwater runoff.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=126
- ***Riparian Buffers:*** Areas of woody vegetation located next to water bodies. Riparian buffers reduce pollutants from the surrounding land area that are found in stormwater, maintain stream bank integrity, and prevent stream bank erosion.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=82

- ***Urban Forestry:*** The planned re-establishment or conservation of trees and forested areas in urban environments.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=84

1.3 Low Impact Development

Low impact development (LID) is an approach to land development and stormwater management that utilizes existing site features and biological components integrated with small-scale stormwater controls to regulate runoff. Properly implemented LID practices slow, store, and infiltrate stormwater runoff by reducing total impervious area, by increasing stormwater storage, infiltration and evaporation, and by stormwater providing dispersion areas in open spaces such as wetlands and retention ponds. In addition to managing stormwater, open spaces also provide community space, ecological services, and natural animal habitat.

Did You Know?

Habitat Trails is a single-family residential LID located on a five-acre plot of land in Rogers, Arkansas that contains 17 residential units and three acres of open space. This new housing development implements a suite of LID practices such as bioswales, filter strips, permeable pavements, rain gardens, a wet meadow, parking strips, and narrow streets. The development is the result of collaboration between Benton County Habitat for Humanity, University of Arkansas Community Design Center, University of Arkansas Ecological Engineering Group, and private engineering firms. More information about this development and other LIDs in the area can be found on the Community Design Center's website at http://uacdc.uark.edu/project.php?project=18.

Are Low Impact Developments Feasible in the Upper Illinois River Watershed?

Many LID practices such as such as constructed wetlands, rain gardens, vegetated rooftops (green roofs), rain barrels, and permeable pavements have been implemented by Upper Illinois River stakeholders ranging from large corporations and municipalities to individuals. LID practices offer both economical and environmental benefits. Several case studies have also shown that LID practices can reduce project costs due to the reduced costs for site grading and preparation, stormwater infrastructure, site paving, and landscaping. Details about cost comparisons of conventional and LID practices can be found online at http://www.epa.gov/nps/lid/.

Did You Know?

The University of Arkansas Community Design Center is developing an LID design manual that will be added as a chapter in the City of Fayetteville's stormwater manual.

Low Impact Development Practices

The following are common LID practices that can be implemented in existing and or new developments in the Upper Illinois River Watershed. More information about these practices can be found at the link provided.

- ***Alternative Pavers***: Permeable surfaces that can replace asphalt and concrete to increase infiltration and reduce stormwater runoff.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=134

- ***Alternative Turnarounds***: Turnarounds that reduce impervious cover by replacing cul-de-sacs.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=90

- ***Bioretention:*** Utilization of soils and plants to remove pollutants from stormwater runoff.
  http://www.epa.gov/owm/mtb/biortn.pdf

- ***Cisterns:*** Liquid storage units that are used to catch and store rainwater for a variety of later uses. Cisterns come in a wide range of sizes and can either be stored above or underground.
  http://www.lowimpactdevelopment.org/ffxcty/7-1_rainbarrel_draft.pdf

- ***Conservation Easements:*** Conservation easements are agreements designed to preserve current land uses, natural resources, ecological processes, or historic structures.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=85

- ***Constructed Wetlands:*** Artificial wetlands that are constructed to treat wastewater and stormwater that flows through them by detaining the waters and trapping pollutants for biological break drown or sequestration.
  http://www.epa.gov/owm/mtb/wetlands.pdf

- ***Dry Retention Ponds:*** Collection basins in which outlets have been designed to detain stormwater for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle out.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=67

- ***Elimination of Curbs and Gutters:*** The use of vegetated swales and ditches as an alternative to curbs and gutters along residential streets.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=88

- ***Green Roofs:*** Vegetated rooftops that reduce stormwater runoff by absorbing, storing, and evapotranspiring water from rainfall.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=114

- ***Infiltration Planters:*** Flower beds with absorptive soils and built up edges that receive downspout drainage from buildings and allow for temporary storage of stormwater runoff from rooftops until the water filters down through the planter and into existing soils. http://www.epa.gov/owm/mtb/infltrenc.pdf

- ***Infiltration Trenches:*** Excavated trenches that are backfilled with rock aggregate and perforated drainage pipes that slow, store, and filter stormwater. http://www.epa.gov/owm/mtb/infltrenc.pdf

- ***Narrow Streets:*** Narrower streets reduce impervious area created by new residential developments. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=87

- ***Open Space Design:*** A development practice that concentrates dwelling units in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=83

- ***Perforated Curbs:*** Curbs built specifically to allow stormwater drainage to be conveyed into a grassy median, a bioswale, or sand filter before going down a storm drain and into a stream or drainage ditch.

- ***Permeable Pavements:*** Special pavement that increases water infiltration and reduces peak and total stormwater runoff flows in comparison to impervious pavements. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=71

- ***Rain Barrels:*** Barrels used to catch and retain stormwater from rooftops so that it can be used later to water landscaping features or for other purposes that require the use of water. http://www.lowimpactdevelopment.org/ffxcty/7-1_rainbarrel_draft.pdf

- ***Rain Gardens:*** Landscape depressions planted with hardy native plants that can withstand drought and flood conditions. These gardens are useful for catching and slowing runoff water in grassed areas to increase stormwater infiltration. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=72

- ***Redevelopment Assessment:*** The thoughtful consideration of redevelopment planning to complement efforts that improve the quality and reduce the quantity of stomwater runoff. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=127

- ***Stormwater Wetlands:*** Constructed wetlands treat stormwater runoff and are similar to wet ponds, but have a variety of wetland plants incorporated into the structural design. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=74

- ***Vegetative Strips:*** Strips of vegetation that are designed to treat sheet flow from adjacent surfaces by slowing stormwater and filtering sediment and other pollutants. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=76

- ***Vegetated Swales:*** Landscape features that are intended to slow stormwater and remove pollutants through the promotion of infiltration and reduction of stormwater flow. The swales are usually a grassed or vegetated depression that is more wide than deep. http://www.epa.gov/owm/mtb/vegswale.pdf

- ***Wet Detention Ponds:*** Wet detention ponds are storm water control structures that provide both retention and treatment of contaminated storm water runoff. http://www.epa.gov/owm/mtb/wetdtnpn.pdf

1.4 Urban Stream and Riparian Restoration

The size and flow of a stream are directly related to the stream's contributing watershed area. A natural stream maintains a stable channel and supports ecological processes. However, urban development changes watershed hydrology and streams must respond to:

- Greater and more frequent peak storm flows, and longer durations of channel-altering flows
- Enlargement of channels through incision and widening
- Decreased recharge of shallow and medium-depth aquifers
- Increased stream temperature
- Altered channel substrate
- Reduced stream system function
- Reduced corridor function
- Reduced native wildlife species

Benefits of Stream Restoration:

- Reduces property damage caused by flooding or erosion
- Restores, enhances, or protects the natural ecological values of streams
- Promotes community involvement, education and stewardship

Thus, urban development in a watershed can cause rapid physical adjustments to the stream channel. In addition, as land in a watershed is developed, natural riparian vegetation is often removed or thinned down to the stream edge which destroys the ecological benefits that natural riparian vegetation can provide. Riparian vegetation slows and filters runoff from roads, parking lots and other paved areas, provides shade to regulate soil and stream temperatures, and stabilizes stream banks. Restoring

streams to their natural state with well-managed and healthy riparian buffers can minimize stream impairment, restore healthy stream dynamics, and protect water quality and aquatic wildlife habitat.

In-Stream Restoration Practices

Impacted streams can be engineered to mimic their natural flow pattern and function by the addition of channel and flow modifying structures and design features for habitat enhancement. The engineered structures used to control stream grade and protect streambanks from scour and erosion vary based on the stream's flow, loading, location, channel shape, and channel stability among other characteristics, and these engineered structures should only be implemented by trained, experienced professionals.

Examples of these structures include:

- ***J-Hook:*** J-hooks are rock structures that roll water away from the banks. The "J" portion provides fish habitat by creating scour in the center of the channel.
- ***Vane:*** Vanes are rock structures that roll water away from the bank and prevent erosion
- ***Cross Vane:*** Cross vanes are rock structures that roll the water away from the banks, provide grade control, and prevent down-cutting of the channel.
- ***Double Wing Deflector:*** Double wing deflectors are rock structures that redirect the flow of the stream, narrow the bottom of the channel, and create a scour hole below the structure for fish habitat.
- ***Root Wad:*** Root wads are tree root masses that deflect water away from the bank and create fish habitat.
- ***Constructed Riffle:*** Constructed riffles are rock structures that provide grade control, set the slope of the riffle, aerate the water and create bug habitat.

Riparian Vegetation Restoration

While most in-stream restoration practices must be engineered for specific stream reaches and implemented by professionals, all stakeholders play a part in maintaining proper riparian vegetation. Riparian vegetation is the vegetation that grows adjacent to rivers, lakes and other waterbodies. Riparian vegetation provides ecological, environmental, recreational and economic benefits to a community by:

- Reducing stormwater runoff volume and velocity
- Increasing flood control
- Decreasing water treatment costs
- Providing an ecological corridor for wildlife
- Increasing pollutant filtration
- Increasing property value
- Providing aquatic and terrestrial wildlife habitat
- Increasing recreational potential
- Increasing streambank stability
- Improving water quality
- Preventing erosive land loss

EXAMPLE: A riparian buffer alongside a smallmouth fishing stream near an urban development was excessively thinned in some places and completely removed in others. As a result, the water temperature increased, the dissolved oxygen decreased, sedimentation from streambank erosion increased, and algal growth accelerated. Because of the degraded water quality, the smallmouth bass population was replaced with carp, a non-sport fish. Other negative changes also occurred including property loss from streambank erosion, increased stormwater volume and velocity, as well as increased pollutant loads from the nearby urban area.

What does a Healthy Urban Riparian Zone Look Like?

The characteristics of a healthy riparian zone vary from stream to stream, but the healthiest riparian area is usually one that has not been disturbed and has developed over time alongside a naturally occurring aquatic environment. However, riparian areas that have been altered, reduced or restored can still be healthy if management practices ensure that they are vegetated with diverse and appropriate plants and are maintained at an appropriate width.

Pollutant filtration and absorption that occurs in riparian buffers is directly related to runoff retention time. The following factors influence runoff retention times in urban buffers:

- ***Stormwater Flow Path through Riparian Areas:*** Healthy vegetation can slow and decrease concentrated stormwater flows. Stormwater, however, will flow downhill along the path of least resistance and can cut erosive channels causing the flow to concentrate. Once a channel is formed, the functional cleaning capacity of the riparian area is lessened. This shortcutting can often be avoided by preventing the direct routing of artificial drainages to or through riparian areas.
- ***Riparian Area Width:*** In general, any presence of urban riparian vegetation is better than none at all, and the pollutant removal potential of a riparian area increases as its width increases. However, this is dependent on how water flows through the riparian area. If water flows through the riparian zone in a diffuse, widespread manner, then the pollutant removal potential is increased, but if water flows through in a concentrated manner, then the pollutant removal potential is reduced. According to the Natural Resource Conservation Service standards for the Wildlife Habitat Incentive Program and the Environmental Quality Incentive Program, the minimum recommended width for riparian area is 35 feet on both sides of the stream where possible. If feasible, the riparian area width should be increased to increase water quality and wildlife habitat benefits.
- ***Topography:*** A riparian area of healthy width becomes more important as the steepness of the bank increases—the steeper the slope, the shorter the stormwater retention time.
- ***Riparian Vegetation and Density:*** The most functional way to remove pollutants and maintain wildlife habitat in a riparian zone is to retain natural vegetation type and density. In most cases, native tree and shrub vegetation in the Upper Illinois River Watershed consists of oak, hickory, sycamore, cottonwood, elm, maple, willow, pawpaw, dogwood, and redbud among others. Native grasses and wildflowers common to this region include switchgrass, broomsedge, sea oats, bluestem, spiderwort, violets, mosses and ferns. Riparian vegetation, whether living, decaying or dead, should be left in place whenever possible to maximize vegetation detention capability and wildlife habitat potential. Excessive cleaning of riparian areas by raking, clearing, or removing fallen logs or other removal of plant material from the ground and or streambank can reduce stormwater detention and filtration time.

Did You Know? **In January of 2009, The Arkansas Private Wetland and Riparian Zone Creation, Restoration and Conservation Tax Credits Act was amended to provide a tax credit to any qualified individual, corporation, trust, estate or partnership that is engaged in the creation or restoration of wetlands and riparian zone or donates qualified real-estate for conservation purposes. http://www.anrc.arkansas.gov/WetlandTaxCredit.html**

1.5 Construction Best Management Practices

The construction phase of a commercial or residential development is temporary, but the effects of soil erosion and sedimentation produced by the land development can cause lasting impacts to stream health and aquatic life. Construction best management practices (BMPs) are strategies designed to decrease the negative effects associated with developments on water quality throughout the construction phase. These practices prevent or decrease the movement of sediment and associated nutrients, hazardous materials, and other potential pollutants in stormwater from the construction area to surface or ground waters. While specific BMPs are tailored for a particular construction activity, situation, site characteristic, or geographical location, all BMPs are implemented for the same basic goal of protecting soil and water resources. Practical consideration for BMP use on construction sites is important, because there is no one size fits all combination of BMPs that will be affordable or appropriate for every construction site. Additionally some BMPs are intended to limit pollutant loss at the source, while other practices are designed to limit the transport potential of pollutants.

Potential pollutants of concern associated with construct sites include sediment, oil and grease, metals, and organics—all of which can be treated with proper BMPs.

Use and Effectiveness of Construction BMPs in Upper Illinois River Watershed

To aid in the protection of water quality some federal, state, and local programs have been developed in an attempt to reduce pollutants transported from construction sites to aquatic environments by requiring permits and BMP use (e.g., Stormwater Pollution Prevention Plans). So now, there are extra regulations and considerations that focus on how developers must provide drainage pathways in which runoff can be contained and removed or treated by BMPs before it reaches waterbodies or storm drains.

US EPA Phase II stormwater management regulations require a stormwater pollution prevention plan (SWPPP) for any construction activity disturbing more than one acre of land. The effectiveness and use of BMPs at construction sites depend on proper BMP planning, selection, training, implementation, inspection and maintenance. More information about controlling stormwater discharges from construction sites can be found at http://cfpub1.epa.gov/npdes/stormwater/const.cfm and http://www.adeq.state.ar.us/whoweare/water.htm.

Did You Know? **The development owner is fined if sediment and erosion control practices are not properly implemented by a contractor.**

What Are the Types or Categories of Construction BMPs?

EROSION PREVENTION BMPS: Practices that prevent soil erosion by protecting soil with vegetation, mulch, or synthetic cover materials and providing artificial drainage pathways for the purpose reducing raindrop impact and erosive energy of stormwater.

SEDIMENT CONTROL BMPs: Practices that manage loose soil carried in stormwater runoff by preventing its offsite transport through filtration, retention, and diversion techniques.

STORMWATER CONTROL BMPs: Practices that reduce or prevent potential stormwater pollution by treating or diverting runoff away from a construction site before it reaches nearby storm drains and waterbodies.

POLLUTION PREVENTION BMPs: Practices that address and control other potential pollution sources that exist on construction sites by using good housekeeping practices such as properly storing construction materials, practicing vehicle maintenance, and managing construction waste.

BMP objectives that prevent or reduce pollution from construction sites:

1. Address Potential Pollutant Sources by:
   - Minimizing disturbed areas
   - Implementing construction in phases
   - Rapidly stabilizing disturbed areas
   - Practicing good housekeeping

2. Address Potential Pollutant Transport by:
   - Protecting slopes and channels
   - Controlling site perimeters
   - Retaining sediment

What BMPs are Applicable to the Upper Illinois River Watershed?

SOURCE BMPS:

- ***Construction Track Out Control:*** Provides construction site entrances and exits that reduce the tracking of soil onto roads by construction vehicles. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=35

- ***Concrete Washout:*** Prevents or reduces the potential discharge of pollutants to stormwater from concrete waste by performing on-site washouts in designated areas away from streams, ditches, and storm drains. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=117

- ***Geotextiles:*** Porous fabrics that protect hillsides, drainage channels, and other disturbed areas from erosion.

http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=45

- ***Good Housekeeping:*** The proper management and disposal of construction materials and wastes to reduce potential stormwater runoff contamination. Good Housekeeping practices include:

1. **Dewatering Management** involves the removal of storm and non-storm water (e.g., groundwater, cofferdams, construction waters) from a construction site work area in such a way that the water is filtered or conveyed through existing BMPs.

2. **Hazardous Waste Management** prevents or reduces the potential of pollutants from hazardous wastes from contacting stormwater by implementing proper material use and disposal practices.

3. **Illicit Connection / Discharge Management** ensures that illicit discharging or dumping is reported before construction work begins or is addressed if it occurs during construction.

4. **Material Delivery and Storage Management** involves the prevention, reduction, or elimination of pollutant discharge from delivery and storage areas to storm drains and waterbodies. This is done by using designated delivery and storage areas, proper storage techniques, covered storage areas, providing secondary containment, and making regular inspections of storage areas and stored materials.

5. **Material Use Management** involves the thoughtful use and placement of materials during the construction process. This can be easily done by following manufacturer label instructions, training personnel, and by not leaving materials on the ground unattended.

6. **Paving and Grinding Management** involves preventing runoff from encountering construction areas where paving and grinding occur.

7. **Potable Water / Irrigation** ensures that landscape irrigation water, waterline flushes, or other water is filtered before leaving the construction site, or is diverted away from the construction site and into stormwater drainages.

8. **Solid Waste Management** Prevents or reduces the potential discharge of pollutants to stormwater from construction waste. This is done by thoughtful actions such as using a covered dumpster, placing an uncovered waste dumpster in a covered area, collecting site trash daily, and making sure that hazardous wastes are not disposed of in the dumpster.

9. **Stockpile Management** is the protection of stockpiled material (e.g., soil, salt, aggregate, and mechanical fluids) from stormwater.

10. **Temporary Batch Plant Management** involves locating batch plants (an off-site mixing plant that produces batches of concrete) away from waterbodies, drainages, and drain inlets.

11. **Temporary Stream Crossings** are temporary culverts, fords, or bridges that cross both perennial and intermittent waterways on construction sites that address erosion and sedimentation caused by work vehicles and machinery.

http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=61

- ***Mulching and Hydromulching***: Application of mulch to promote water infiltration, prevent soil erosion, and prevent seed washing from seeded areas that have not rooted yet. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=41

- ***Preserve Existing Vegetation:*** Preservation of existing site vegetation, such as riparian areas, that protect soil and streambanks from erosion and act as a filter for stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=34

- ***Riprap:*** A layer of large stones used to slow stormwater velocity, protect soil from erosion, and diffuse energy in areas of concentrated stormwater runoff such as inlets and outlets for culverts, bridges, slope drains, grade stabilization structures, and storm drains. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=39

- ***Sequencing:*** A detailed work schedule that coordinates the timing of land-disturbing activities with the implementation of erosion and sediment control BMPs to reduce on-site erosion and sediment transport. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=51

- ***Slope Drains:*** Drains that intercept and redirect stormwater into a stabilized area or waterbody; these drains are often used with diversion dikes and drainage ditches. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=48

- ***Spill Prevention and Control Management:*** A BMP for small spills that can be cleaned by stopping the spread with dry materials (i.e., sand, kitty litter, or rags), and disposed of properly. However if the spill is large it should be reported to major spills to the Arkansas Department of Emergency Management 1-800-322- 4012. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=62

- ***Stream Crossings:*** Structures that provide a safe, stable way for vehicle traffic to cross a watercourse and reduce streambank stabilization, damage to the streambed or channel, and minimize sediment loading from traffic. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=49

- ***Vegetation Establishment:*** Temporary or permanent vegetation establishments stabilize bare soil from erosion and increase filtration of construction site stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=42

- ***Vehicle and Equipment Cleaning and Maintenance:*** A BMP to eliminates or reduce source pollutant discharge from vehicles and equipment where it can be transported by stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=63

TRANSPORT BMPS:

- ***Barriers:*** Sand bags, gravel bags, and water-filled barriersthat serve as check dams, inlet protection, outlet protection, and perimeter control measures for sediment. Other types of barriers such as sand bags, gravel bags, and water-filled barriers, can also be used for the same purpose. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=122

- ***Brush Barriers:*** Perimeter structures consisting of tree branches, root mats, stone, or other debris left over from site clearing and grubbing that reduce sediment transport. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=55

- ***Check Barriers:*** Small barriers of material (e.g., rock, sandbags, gravel bags, fiber bags) that are placed across constructed swales and drainage ditches to reduce stormwater velocity by reducing channel slope which allows sediment to settle and reduces erosion. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=36

- ***Compost Filter Berm:*** A berm made of compost that is covered with vegetation and is generally placed along the perimeter of a site or along a slope to capture and treat stormwater that runs off as sheet flow. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=119

- ***Compost Filter Socks:*** A special type of contained compost filter berm composed of a mesh tube filled with composted material that is placed perpendicular to sheet-flow runoff. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=120

- ***Diversion Berms:*** Earthen or gravel berms that divert clear stormwater away from construction sites. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=53

- ***Drain Inlet Protection:*** Placement of sediment filters or drain inlet barriers around storm drain inlets to reduce the delivery of sediment and associated pollutants to waterways. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=60

- ***Fiber Rolls:*** Tubular rolls of bound material that are entrenched and staked along the contour of slopes that slow stormwater, reduce sediment in stormwater and reduce bank erosion. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=121

- ***Filter Berms:*** Temporary ridges made up of loose gravel, stone, or crushed rock that slow, filter, and divert flow from open traffic areas. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=37

- ***Gradient Terraces:*** Terraces that can be incorporated into the grading plan of a site to shorten the length of the slope and reduce the velocity of stormwater flows. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=46

- ***Grass Lined Channels:*** Stable vegetated conduits that slow concentrated runoff and prevent erosion. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=38

- ***Permanent Slope Diversions:*** Diversions that collect, direct, and transport stormwater down a slope in a manner that minimizes erosion potential. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=33

- ***Sediment Basins:*** Temporary basins that allow sediment to settle; sediment basins are formed by excavation or embankment creation and have a controlled release mechanism such as a riser-pipe outlet. This BMP can be used with surface skimmers or filter bags. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=57

- ***Sediment Filters:*** Sediment-trapping devices that remove sediment from stormwater through inflow regulation, pretreatment, filter beds, and outflow mechanisms. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=58

- ***Sediment Traps:*** Small impoundments that allow sediment to settle out of stormwater and are usually installed in drainage ways or other points of discharge from disturbed areas. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=59

- ***Silt Fences:*** Fabric supported by stakes that detain stormwater and allow sediments to settle out. This practice can be used on construction sites as a means of perimeter and interior sediment control. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=56

- ***Vegetative Buffers:*** Strips of vegetation placed between disturbed areas of construction sites and environmentally sensitive areas such as ditches, streams, and ponds that reduce the amount of potential pollutants transported in runoff from construction sites. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=50

Chapter 2: Management Actions for Municipalities

Why are Management Actions Needed for Municipalities?

Municipalities within the Upper Illinois River Watershed provide many services to their residents such as stormwater conveyance and wastewater treatment and manage public property such as parks. However, some negative and unintentional impacts to water quality can potentially occur when untreated water from county and city land surfaces is transported to waterbodies within the watershed as a result of these services. Management actions can be taken to lessen these impacts while still allowing day to day municipal services to occur.

Who is Responsible for Carrying out Management Actions within a Municipality?

All actions that take place on land within a municipality can have potential impacts on water quality so all municipal departments, businesses, households, industries, agricultural operations, developers and recreation seekers should be responsible for their own actions. However, some municipalities are responsible for managing municipal stormwater. This is discussed in detail in Section 5.2.1.

What Best Management Practices Should Be Overseen by Municipalities?

According to Arkansas Department of Environmental Quality regulations, there are six categories of BMPs that should either be carried out or supervised by municipalities:

- Public Outreach and Education
- Public Participation
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention

The following sections will address municipal stormwater management, park management, wastewater management, and municipal best management practices.

2.1 Stormwater Management Programs for Municipalities

The more urbanized a municipal area is, the greater the potential for water quality degradation through stormwater contributions. Common pollutants from municipal areas include pesticides, oils, fertilizers, road salt, sediment, bacteria and litter. These pollutants are usually introduced into the landscape through regular day-to-day urban activities such as park and lawn maintenance, roadwork, construction activities, littering and pet care. After pollutants are introduced to the urban landscape, they often remain in place until precipitation washes them into storm drains. Once in the storm drain, polluted stormwater runoff is transported through municipal separate storm sewer systems (MS4s) and discharged untreated into waterbodies.

To prevent harmful pollutants from being discharged or dumped into MS4s, some municipalities are required to follow Phase I or Phase II stormwater permitting as part of the National Pollution Discharge Elimination System (NPDES). The Arkansas Department of Environmental Quality (ADEQ) is the designated stormwater permitting agency for the State of Arkansas. Detailed information about NPDES permitting is provided in Chapter 4.

What are Phase I and Phase II MS4s?

MS4s can be classified as large, medium or small and are separated into two categories, Phase I and Phase II, based on population size.

PHASE I: A regulation that was issued in 1990 to require "medium" and "large" cities or certain counties with populations of 100,000 or more to obtain an NPDES permit for their stormwater discharges.

PHASE II: A regulation that was issued in 1999 to require "small" MS4s inside and outside of urbanized areas to obtain NPDES permit coverage for their stormwater discharges as designated by ADEQ based on delineation by the Census Bureau.

An urbanized area is defined as an area of land that contains one or more places, central places, and adjacent densely populated surrounding area (urban fringe) that combined has a population of > 50,000 and an average population density of 1,000 or more people per square mile. In the Upper Illinois River Watershed, there are 13 municipalities that currently fall under the Phase II designation including Benton County, Bentonville, Bethel Heights, Elm Springs, Fayetteville, Greenland, Johnson, Lowell, Rogers, Springdale, University of Arkansas, and Washington County.

Voluntary Stormwater Management Programs for Municipalities

Not all municipalities in the UIRW are designated as urbanized or required to have a NPDES permit, however these municipalities can still voluntarily protect water quality by properly managing stormwater. The following voluntary programs are designed to help such municipalities. More information about each program is available at the provided weblink.

Arkansas Natural Resource Commission Community Block Grants Program

This program is designed to allow small cities to address their own unique needs. Since states are in the best position to respond to the needs of local governments, the program gives states the opportunity to administer Community Development Block Grant (CDBG) funds for non-entitlement areas. Non-

entitlement areas include those units of general local government which do not receive CDBG funds directly from the U.S. Department of Housing and Development (HUD) as part of the entitlement program (Entitlement Cities and Urban Counties). Non-entitlement areas are cities with populations of less than 50,000 and counties with populations of less than 200,000.
www.anrc.arkansas.gov/CDBG/CDBG%20Website%20Files/CDBG%20Main%20Page.htm

Arkansas Natural Resource Commission Water Resources Cost Share Revolving Fund Program
The Water Resources Cost Share Revolving Fund may provide up to 25% of total project cost in grants and loans to the State of Arkansas and its local political subdivisions for the purpose of funding the non-federal share of the grand funding. Non-federal grant match is required for any grant that a local municipality receives from the federal government in connection with financing a water resources development project.
www.anrc.arkansas.gov/WaterRevolvingFund.html

Arkansas Natural Resource Commission Water Development Fund Program
This program can provide funding in many forms for water development projects that could be undertaken by municipalities for several purposes including flood control and/or drainage, erosion and sediment control, and streambank stabilization among others.
www.anrc.arkansas.gov/WaterDevelopmentFund.htm

EPA Smart Growth Program
The smart growth program offered by the EPA helps communities improve their development practices to get the type of successful and environmentally sound development that they want. The EPA smart growth program was developed on researched based information and provides grants, technical assistance, and brings together diverse interests to encourage smarter community growth and development.
www.epa.gov/smartgrowth/

The Nature Conservancy's Ozark Rivers Program
The Nature Conservancy's Ozark Rivers Program is in place to ensure that streams in the Ozark Mountains remain in desirable condition. This program consists of workshops that show how better management practices on city, county, and private lands can be ecologically and economically sustainable.
www.nature.org/wherewework/northamerica/states/arkansas/projectprofiles/art18835.html

2.2 Park Management

Parklands within the Upper Illinois River Watershed provide recreational opportunities, open green spaces, wildlife habitat and ecological services—all of which can improve quality of life for residents and quality of environment for conservation related purposes. However, not all parklands are developed or managed equally which can often limit the potential social and ecological benefits that a park is capable of providing. This subsection will address key management actions that can be added on to existing park management plans, or inserted into park management plans if a plan has not been created or initiated.

Park Development

As new parks are developed and existing parks are expanded, environmentally sensitive areas which should not be developed or should have restrictions for development should be identified. Some examples of environmentally sensitive areas are riparian areas, wetlands or places where endangered species or species of conservation concern exist. In addition to identifying and protecting sensitive areas from development, a park management plan should be created so that the established park can meet the intended design purposes and support natural resource conservation such as the protection of water quality.

Park Management Plans

A park management plan is a plan that identifies and outlines the purpose, maintenance, growth potential, and conservation potential of a park. Recreational activities, facilities, open areas, greenways, trails, and conservation of environmentally sensitive areas can be planned and created for optimal use and maintenance efficiency, environmental stewardship, and recreational enjoyment. Development of park management plans should include city officials, staff, and employees, as well as residents, local clubs, and non-governmental organizations.

Park Maintenance

Park maintenance is a necessary service that includes fertilizing, seeding, mulching, mowing and weedeating, flowerbed upkeep, trash removal, parking improvements, facility repairs, and trail establishment and upkeep among other tasks. One goal of park maintenance is to keep the park in good, working condition in order to meet quality of life and recreational standards, but another important goal of park maintenance should be to achieve a high level of environmental stewardship. The goal of achieving environmental stewardship can be easily attained by implementing appropriate BMPs which are discussed in detail at the end of this section (i.e., Municipal Best Management Practices). Park managers can encourage residents to help carry out environmental stewardship efforts within parks by providing trash receptacles, stations with pet waste pick-up bags, and informational kiosks about the function and protection of environmentally sensitive areas within the park.

Soil, Nutrient and Turf Management within Parks

Soil, nutrient and turf management practices are all interconnected; the management or mismanagement of one will impact the other, as well as impact the quality of water of adjacent streams and waterbodies. The key to managing soil, nutrient and turf resources for environmental stewardship purposes is to focus on all three aspects together, not individually.

A good way to manage all of these resources at once is to obtain and follow a maintenance plan specific to an individual park, as well as a nutrient management plan (NMP) that includes all of the parks for a given municipality. The use of a NMP will provide existing soil fertility status, soil test recommendations of soil amendments for specific grasses, and maps of sensitive areas that should not be fertilized for each individual park. NMPs are free and can be obtained from local conservation districts.

Did You Know? **The state of Arkansas requires certification from the Arkansas Natural Resources Commission before areas greater than 2.5 acres can be fertilized collectively?**

2.3 Municipal Wastewater Treatment

Domestic, commercial and industrial wastewater is generated in the Upper Illinois River Watershed from homes, businesses, industries, and other entities. This wastewater is treated by several major wastewater treatment plants (WWTPs) that discharge into tributaries of the Illinois River near Fayetteville, Springdale, Rogers, and Siloam Springs; by several minor WWTPs near Gentry, Prairie Grove, Lincoln, Arkansas and other locations; and by individual and clustered facilities that discharge treated effluent onto soil throughout the watershed. The pollutant load discharged by a WWTP depends of the effluent volume, the type of treatment employed by the WWTP, and the contributing sources of wastewater. The minor and cluster WWTPs contribute relatively low effluent discharges (i.e., < 1 million gallons per day (MGD)), but the major WWTP discharges range from 3 MGD to >20 MGD. These WWTPs have likely been a nutrient source in the past, but most have undergone major renovations in recent years and have considerably reduced nutrient (nitrogen and phosphorus) outputs. The treatment processes used at each plant are driven by effluent permit limits established by the ADEQ. Currently the phosphorus limit for major wastewater treatment plants in the watershed is 1.0 mg L^{-1}.

Fayetteville Wastewater Treatment Plant

Since May 2008, the City of Fayetteville has had two operating WWTPs. Prior to May 2008, the Fayetteville Noland WWTP treated all wastewater from the City of Fayetteville and discharged the treated effluent into both the White River Watershed and into Mud Creek, a tributary to the Illinois River. However, the City of Fayetteville built a brand new facility, the Westside Wastewater Treatment Plant that began discharging into Goose Creek, a tributary to the Illinois River, in May 2008. When the new facility went online, the discharge to Mud Creek from the Noland plant was turned off. The Westside WWTP treats effluent through screening, biological treatment, clarification, deep bed sand filtration and UV disinfection.

Springdale Wastewater Treatment Plant

The Springdale WWTP serves Springdale and the surrounding areas including parts of Lowell. The Springdale WWTP treats residential and industrial wastewater before discharging 12 MGD on average and up to 24 MGD into Spring Creek, a tributary to the Illinois River. The facility has implemented nitrogen management since the 1990s and phosphorus management in 2002. The WWTP's average monthly effluent phosphorus concentration is 0.32 mg L^{-1}, which is considerably less than their 1.0 mg L^{-1} permit limit. The plant currently treats its wastewater by screening, biological treatment, clarification, filtration and chlorination.

Rogers Wastewater Treatment Plant

The Rogers WWTP serves Rogers and the surrounding areas including parts of Lowell. The Rogers WWTP discharges an average of 7 MGD and has the capacity to discharge up to 14 MGD into Osage Creek, a tributary to the Illinois River. During the dry season, about 10% (up to 1.0 MGD) of the treated effluent is pumped to a nearby golf course for reuse as irrigation water. This plant began operating under voluntary phosphorus management strategies in 1997 to achieve an effluent limit of 1 mg L^{-1}. Currently, the plant treats its wastewater by screening, biological treatment, clarification, sand filtration and chlorination and average phosphorus concentrations are < 0.5 mg L^{-1}.

Siloam Springs Wastewater Treatment Plant

The Siloam Springs WWTP serves the City of Siloam Springs; the plant discharges 3 MGD of treated effluent on average into Sager Creek, a tributary to Flint Creek which is a tributary to the Illinois River. The WWTP has been recently upgraded and now treats its wastewater by screening, biological treatment, clarification, filtration and disinfection. Average phosphorus concentrations are less than the permit limit of 1.0 mg L^{-1} compared to 1.9 mg L^{-1} before the upgrades.

Northwest Arkansas Conservation Authority Wastewater Treatment Plant

The NACA WWTP is a 4 MGD, regional WWTP that is scheduled to go online in 2010. The plant will serve ten cities including Rogers, Lowell, Bentonville, Springdale, Tontitown, Centerton, Highfill, Bethel Height, Cave Springs and Elm Springs. A 1.0 mg L^{-1} phosphorus limit will apply to the WWTP.

2.4 Municipal Best Management Practices

Municipalities within the Upper Illinois River Watershed provide services and support activities that create a need to use best management practices (BMPs) that maintain or enhance water quality for residents and wildlife of the Upper Illinois River Watershed. These BMPs include a wide range of pollution prevention, public participation, maintenance and inspection, development and re-development planning, education and outreach, and soil, nutrient and stormwater management practices. When managerial, structural, source and transport BMPs are properly used together, potential pollutant sources and transport processes are eliminated or reduced which can increase BMP efficiency and can be quite effective in protecting water resources.

Municipal BMPs are additional services that can be provided to residents as a means of improve quality of live through water quality preservation and improvement. These practices work not only to directly help a municipality improve water quality, but they also provide a chance for other who live, work or play in the watershed to be directly involve in improving water quality. When municipalities implement BMPS, the potential negative impacts of urban stormwater runoff speed, volume, contaminants can be reduced or controlled.

According to Arkansas Department of Environmental Quality regulations, there are six categories of BMPs that should either be carried out or supervised by municipalities:

1. **PUBLIC OUTREACH AND EDUCATION**: An approach to improving water quality through increasing the public's awareness of their impacts on water quality. This approach can garner greater community support and compliance for stormwater programs by forming partnerships, using educational materials for increasing both awareness and understanding of the issue, and reaching a diverse audience. www.epa.gov/npdes/pubs/fact2-3.pdf

2. **PUBLIC PARTICIPATION:** A crucial component for the development and implementation of a successful stormwater program. Public participation can result in greater awareness, program support, and perspective sharing. As a result of the increased public program implementation and development, other beneficial stormwater programs can occur more rapidly. www.epa.gov/npdes/pubs/fact2-4.pdf

3. **ILLICIT DISCHARGE DETECTION AND ELIMINATION:** Ensures that non-permitted discharges of non stormwater are reported and ceased to ensure further protection of surrounding waterways. www.epa.gov/npdes/pubs/fact2-5pdf

4. **CONSTRUCTION SITE RUNOFF CONTROL:** Ensures that disturbed land areas of one acre or more in size have stormwater permits and BMPs implemented. www.epa.gov/npdes/pubs.fact2-6.pdf

5. **POST CONSTRUCTION RUNOFF CONTROL:** Measures to control or reduce stormwater and associated potential pollutants from new developments greater than or equal in size to one acre in size.
   www.epa.gov/npdes/pubs.fact2-7.pdf

6. **POLLUTION PREVENTION:** The equivalent of good housekeeping by municipalities that provides municipal employee training regarding BMPs to be used at maintenance facilities, parks, office complexes, and other municipal sites. www.epa.gov/npdes/pubs.fact2-8.pdf

In addition to the six BMP categories that urbanized municipalities should carry out, there are four other general categories of BMPs that can be implemented including structural, managerial, source and transport BMPs. Various combinations of these types can also be implemented.

STRUCTURAL BMP EXAMPLE: A municipality uses Low Impact Development (LID) practices in new development and redevelopment projects.

MANAGERIAL BMP EXAMPLE: A municipality creates a tax incentive or waives an impact fee in exchange for the implementation of LID practices in any development or redevelopment project, and provides BMP education and training for its employees about BMP installation, maintenance, and inspection.

SOURCE BMP EXAMPLE: All riparian areas on municipal property are preserved or restored to prevent streambank erosion and associated sediment transport.

TRANSPORT BMP EXAMPLE: A municipality does not use concrete for ditches, but instead leaves all stormwater drainage ditches grassed which increases infiltration and filtration and slows and reduces stormwater velocity and volume.

SOURCE AND TRANSPORT EXAMPLE: A new municipal facility is constructed using LID practices that catch and store roof runoff so that stormwater is reduced at the source which reduces the amount of stormwater that can transport pollutants from the landscape to a nearby waterway.

Municipal BMPs for the Upper Illinois River Watershed

SOURCE BMPS

- ***Construction Track Control:*** Provides access areas to and from construction sites that are stabilized to reduce the tracking of soil by construction vehicles onto roads. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=35

- ***Concrete Washout:*** Prevents or reduces the potential discharge of pollutants from concrete wastes to stormwater by practicing off-site washout or performing on-site washouts in designated areas away from streams, ditches, and storm drains. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=117

- ***Vegetation Establishments:*** Temporary or permanent vegetation establishments that stabilize bare soil, preventing erosion and increasing filtration of construction site stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=42

- ***Geotextiles:*** Porous fabrics that protect hillsides, drainage channels, and other disturbed areas from erosion that can be caused by stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=45

- ***Good Housekeeping:*** The proper management and disposal of construction materials and wastes to reduce the potential of polluting stormwater runoff. Good Housekeeping practices include:

    1. **Dewatering Management** involves the removal of storm and non-storm water from a site work area in such a way that the water is filtered or conveyed through existing structural BMPs.
    2. **Hazardous Waste Management** prevents or reduces the potential discharge of pollutants to stormwater from hazardous waste by implementing proper material use and disposal practices.
    3. **Illicit Connection / Discharge Management** ensures that illicit discharges are recognized and eliminated.
    4. **Material Shipment, Delivery and Storage Management** involves the prevention, reduction, or elimination of pollutant discharge from delivery shipment and storage areas to storm drains and

waterbodies. This is done by using designated delivery and storage areas, proper storage techniques, covered storage areas, providing secondary containment, and making regular inspections of storage areas and stored materials.

5. **Material Use Management** involves the thoughtful use and placement of materials during work processes. This can be easily done by following manufacturer label instructions, by training personnel, and by not leaving materials on the ground unattended.
6. **Paving and Grinding Management to** prevent runoff from flowing through construction areas where paving and grinding occur.
7. **Potable Water / Irrigation** ensures that landscape irrigation water, waterline flushes, or other water encounter structural BMPs before leaving the site and entering stormwater drainages.
8. **Solid Waste Management** prevents or reduces the potential discharge of pollutants to stormwater from solid waste. This is done by thoughtful actions such as using a covered dumpster, placing an uncovered waste dumpster in a covered area, collecting site trash daily, and making sure that hazardous wastes are not disposed of in the dumpster.
9. **Stockpile Management** protects stormwater from of stockpiled material.
10. **Temporary Batch Plant Management** involves locating batch plants away from waterbodies, drainages, and drain inlets.
11. **Temporary Stream Crossings** are temporary culverts, fords, or bridges that ccross both perennial and intermittent waterways that address erosion and sedimentation caused by work vehicles and machinery.

- ***Inspections and Maintenance:*** Either as routine or as needed assessment and repair of structural BMPs to ensure that they are functioning properly.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=91

- ***Mulching and Hydromulching:*** Application of mulch to promote water infiltration, prevent soil erosion, and seed washing from seeded areas that have not yet rooted.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=41

- ***Municipal Employee Training and Education:*** Teaches municipal directors, staff, and employees about preventing potential stormwater pollution from municipal activities such as park maintenance, storm drain maintenance, development activities, and vehicle and facility maintenance.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=129

- ***Municipal Landscape Maintenance:*** Protects water quality through the careful planning and design, soil and nutrient management, appropriate plant selection and use, and appropriate maintenance.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=1

- ***Municipal Vehicle Fueling:*** Practices that prevents spills and leaks of fuel that can be washed into the storm drain system by stormwater runoff.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=113

- ***Ordinances and Incentives:*** Help reduce or control the effects of development on water quality. Ordinances and incentives promote public welfare by guiding, regulating, and controlling the design, construction, use, and maintenance of any development while also providing benefits for developers.
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=92

- ***Post-Construction Plan Review:*** A process by which a municipality reviews and approves development plans after they have been drafted. This procedure ensures that water quality is a primary concern early on in the development process
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=123

- ***Preserve Existing Vegetation:*** Preservation of existing vegetation, such as riparian areas, protects the soil and stream banks from erosion and acts as a filter for stormwater to reduce potential pollutants found in stormwater.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=34

- ***Riprap:*** A layer of large stones used to slow stormwater velocity and protect soil from streambank erosion in areas of concentrated stormwater runoff such as inlets and outlets of culverts, bridges, slope drains, grade stabilization structures, and storm drains.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=39

- ***Sequencing:*** A detailed work schedule that coordinates the timing of land-disturbing activities with the implementation of erosion and sediment control BMPs to reduce on-site erosion and sediment transport.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=51

- ***Slope Drains:*** Drains that intercept and redirect stormwater into a stabilized area or watercourse and are often used with diversion dikes and drainage ditches.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=48

- ***Spill Prevention and Control Mechanisms:*** A BMP for small spills that can be cleaned by stopping the spread with dry materials (i.e., sand, kitty litter, or rags) and disposing of the materials properly. However if the spill is large it should be reported to major spills to the Arkansas Department of Emergency Management 1-800-322- 4012.

http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=62

- ***Stream Crossings:*** Provide a safe, stable way for construction vehicle traffic to cross a watercourse and reduce streambank stabilization, damage to the streambed or channel, and minimize sediment loading from construction traffic.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=49

- ***Vehicle and Equipment Cleaning and Maintenance:*** A BMP to eliminate or prevent vehicles and equipment pollution from contacting stormwater.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=63

TRANSPORT BMPS

- ***Bale Barriers:*** Straw or hay bales that serve as check dams, inlet protection, outlet protection, and perimeter control measures for sediment. Other types of barriers such as sand bags, gravel bags, and water-filled barriers, can also be used for the same purpose.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=122

- ***Brush Barriers:*** Perimeter structures consisting of tree branches, root mats, stone, or other debris left over from site clearing and grubbing that reduce sediment transport.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=55

- ***Check Barriers:*** Small barriers of material (e.g., rock, sandbags, gravel bags, fiber bags) that are placed across constructed swales and drainage ditches to reduce stormwater velocity by reducing channel slope which allows sediment to settle and reduces erosion.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=36

- ***Compost Filter Berm:*** A berm made of compost that is covered with vegetation and is generally placed along the perimeter of a site or along a slope to capture and treat stormwater that runs off as sheet flow.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=119

- ***Compost Filter Socks:*** A special type of contained compost filter berm composed of a mesh tube filled with composted material that is placed perpendicular to sheet-flow runoff.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=120

- ***Diversion Berms:*** Earthen or gravel berms that divert clear stormwater away from construction sites.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=53

- ***Drain Inlet Protection:*** Placement of sediment filters or drain inlet barriers around storm drain inlets to reduce the delivery of sediment and associated pollutants to waterways.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=60

- ***Fiber Rolls:*** Tubular rolls of bound material that are entrenched and staked along the contour of slopes that slow stormwater, reduce sediment in stormwater and reduce bank erosion.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=121

- ***Filter Berms:*** Temporary ridges made up of loose gravel, stone, or crushed rock that slow, filter, and divert flow from open traffic areas.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=37

- ***Sediment Basins:*** Temporary basins that allow sediment to settle; sediment basins are formed by excavation or embankment creation and have a controlled release mechanism such as a riser-pipe outlet. This BMP can be used with surface skimmers or filter bags.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=57

- ***Sediment Filters:*** Sediment-trapping devices that remove sediment from stormwater through inflow regulation, pretreatment, filter beds, and outflow mechanisms.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=58

- ***Sediment Traps:*** Small impoundments that allow sediment to settle out of stormwater and are usually installed in drainage ways or other points of discharge from disturbed areas.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=59

- ***Silt Fences:*** Fabric supported by stakes that detain stormwater and allow sediments to settle out. This practice can be used on construction sites as a means of perimeter and interior sediment control.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=56

- ***Vegetative Buffers:*** Strips of vegetation placed between stormwater discharge at industrial or commercial sites and environmentally sensitive areas such as streams.
  http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=50

- ***Gradient Terraces:*** Terraces that can be incorporated into the grading plan of a site to shorten the length of the slope and reduce the velocity of stormwater flows. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=46

- ***Grass Lined Channels:*** A stable vegetated conduit that conveys stormwater from industrial or commercial areas while slowing flow and filtering pollutants. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=38

- ***Permanent Slope Diversions:*** Diversions that collect, direct, and transport stormwater down a slope in a manner that minimizes erosion potential. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=33

- ***Zoning:*** A classification technique for land use planning that can serve several functions. Proper zoning can control or reduce stormwater runoff problems by facilitating better site designs. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=93

Chapter 3: Industrial Best Management Practices

Why are Industrial and Best Management Practices?

Industrial best management practices (BMPs) manage and reduce the effects of industrial pollutants including sediment, nutrients, hazardous waste products, oil and grease and others. BMPs reduce or prevent contact between pollutants and stormwater which can transport untreated pollutants offsite and into a nearby waterbody. Some BMPs are mandated by governing agencies such as the US Environmental Protection Agency and Arkansas Department of Environmental Quality, but others can be implemented voluntarily.

Why should These Practices Be Used in the Upper Illinois River Watershed?

The Upper Illinois River Watershed is the home of several industries that can contribute to water quality degradation. However, these same industries can also maintain or improve water quality by adopting industrial and commercial best management practices (BMPs) that reduce stormwater generation and treat contaminated stormwater to lessen resulting environmental impacts.

The ranges of actions that can be undertaken by industrial operations vary greatly by industrial operation and by site. However, all industrial management actions serve the same goal of protecting and maintaining water quality within the Upper Illinois River Basin.

The following sections will discuss industrial conservation programs, industrial ecology, and industrial BMPs.

3.1 Industrial and Commercial Conservation Programs

Industry and commercial activities within the Upper Illinois River Watershed provide many social, economic and environmental benefits to the citizens, communities and municipalities of northwest Arkansas. However, industry can have a potential negative impact on water quality; stormwater can come in contact with industrial pollutants associated with material handling and storage, equipment maintenance and cleaning, industrial processes, and other industrial operations and transport these pollutants to the Illinois River and its tributaries. So, industries can further contribute to maintaining and improving the quality of northwest Arkansas by taking additional steps to adopt industrial and commercial conservation practices and BMPs. Two conservation programs that are applicable to the Upper Illinois River Basin are summarized below. More information about these programs can be found at the link provided.

National Industrial Competitiveness through Energy, Environment, and Economics Program

This is a grant funded program that is offered by the United State Department of Energy as a means of creating industrial processes and equipment that reduce the use of energy, creation of waste, and generation of potential pollutants. This program encourages the development of industrial demonstration projects, identification of barriers that restrict cleaner production practices, implementation of waste stream reduction, and coordination of improvements for industrial efficiency with institutions responsible for energy, the environment, and industrial competitiveness at the federal, regional, state and local levels.
http://www.federalgrantswire.com/national-industrial-competitiveness-through-energy-environment-and-economics.html

Environmental Sustainability Program

The National Science Foundation's Environmental Sustainability program encourages the development of projects that involve real world industrial applications with engineering research. The goal of this program is to promote sustainable production systems that support economic stability, human well-being and the environment. http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501027

3.2 Industrial Ecology

Industrial Ecology (IE) is a concept that has been around since the late 1980's but has not received a lot of attention until recent times and is currently being used mostly outside of the United States. The concept of IE focuses on a combination of sustainable environmental, economical, and technological practices. The framework for this concept seeks to achieve eco-efficiency by balancing production and profitability with environmental and social values by minimizing energy usage, material usage, and ecological impacts. There are several components to the IE concept:

INDUSTRIAL METABOLISM: The process of following development of a product from raw materials to the finished product, during which all phases of the production process are evaluated for potential efficiency related improvements.

DEMATERIALIZATION: The process in which the amount of raw materials, energy, and waste are reduced, but the same product is produced.

LIFE CYCLE ASSESSMENT: The process of analyzing the environmental aspects related with the development of a product including raw material extraction, product and byproduct creation, and product disposal by the consumer.

ECO-DESIGN: A sustainable way to create or retro-fit established structures such as buildings or manufacturing equipment that increases social, environmental, and economic benefits.

More information about IE is available at
http://www.epa.gov/innovation/international/ecology.htm#tools.

What Are the Benefits of Industrial Ecology?

Use of IE in the Upper Illinois River Watershed can play a part in maintaining or enhancing water quality and wildlife habitat, as well as increasing industrial production efficiency and minimizing wastes. The reduction of industrial wastes can decrease the load on the municipal infrastructure for sewer and landfills, decrease the demand on natural resources such as drinking water. and reduce the waste stream size which can lead to enhanced economic performance for industries while also encouraging more sustainable communities.

EXAMPLE: Sam's Club located on Highway 112 in Fayetteville has decreased potential stormwater pollution and energy and water costs through an energy efficient building design that includes skylights, a constructed wetland, and cisterns. In addition to the structural components which make this franchise facility more financially and environmentally friendly, there are also informational kiosks located next to these IE components which serve as educational material to the public and a showcase to other innovative companies whose products and services are good for people, business, and the environment.

3.3 Industrial Best Management Practices

Industrial best management practices (BMPs) include facility, site, material, human resource, and stormwater management actions that prevent or control the movement of potential pollutants from industrial facilities to nearby waterbodies. While some BMPs will be appropriate at one industrial sector, facility or site, these practices may not be appropriate at other sites. Practical consideration for BMP use at industrial sites is important, because not all BMPS are appropriate for all industries—selected BMPs should consider industrial activity, site location, resource availability and sustainability, as well as water quality issues, target pollutants, geographic location and landscape position.

According to regulations set by Arkansas Department of Environmental Quality, there are eight categories of BMPs that should be carried out by industries:

1. ***Good housekeeping:*** Maintaining a clean work environment in an effort to reduce or prevent stormwater contamination.
2. ***Preventative Maintenance:*** Inspecting, testing, and maintaining facility equipment, systems, and work areas and identifying and correcting potential malfunctions, spills, leaks, or other situations that could lead to the potential contamination of stormwater.
3. ***Visual Inspections:*** Checking work sites and areas to ensure that good housekeeping, preventative maintenance, and record keeping are being performed.
4. ***Spill Prevention and Response:*** Identifying areas where spills can occur and their drainage points, specifying material handling, storage, and use, and providing appropriate spill cleanup materials and training for employees.
5. ***Sediment and Erosion Control:*** Identifying areas where there is a high potential for soil erosion and implementing specific BMPs to prevent or reduce erosion.
6. ***Stormwater Management:*** Planning and utilizing best management practices to treat or prevent potential stormwater contamination from industrial facilities and sites.
7. ***Employee Training:*** Training employees about stormwater pollution potential, BMPs to prevent potential stormwater pollution, and each component of a stormwater pollution prevention plan.
8. **Record Keeping:** Documenting BMP implementation, inspection, and maintenance.

BMP Fact Sheets for Industries in the Upper Illinois River Watershed

The EPA has compiled fact sheets that discuss permitting regulations under the National Pollutant Discharge Elimination System (NPDES) to control stomwater discharges associated with the eight categories of industrial activity. These fact sheets discuss the types of facilities that are required to obtain a permit, pollutants associated with facility activities, and recommended BMPs for various industries. Fact sheets for current industries and potential industries within the Upper Illinois River Watershed can be found at the provided links.

Table 3.1. Current and Potential Future Industries in the Upper Illinois River Watershed Factsheets

Industry	Link to Fact Sheet
Timber Products Facilities	http://www.epa.gov/npdes/pubs/sector_a_timber.pdf
Paper and Allied Products Facilities	http://www.epa.gov/npdes/pubs/sector_b_paper.pdf
Chemical and Allied Products Facilities	http://www.epa.gov/npdes/pubs/sector_c_chemical.pdf
Asphalt Paving, Roofing, and Lubricants	http://www.epa.gov/npdes/pubs/sector_d_asphalt.pdf
Glass, Clay, Cement, Concrete and Gypsum Products	http://www.epa.gov/npdes/pubs/sector_e_glass.pdf
Primary Metals Facilities	http://www.epa.gov/npdes/pubs/sector_f_primarymetals.pdf

Metal Mining Facilities	http://www.epa.gov/npdes/pubs/sector_g_metalmining.pdf
Coal Mines	http://www.epa.gov/npdes/pubs/sector_h_coalmines.pdf
Oil and Gas Extraction Facilities	http://www.epa.gov/npdes/pubs/sector_i_oilgas.pdf
Hazardous Waste Treatment, Storage and Disposal	http://www.epa.gov/npdes/pubs/sector_k_hazwaste.pdf
Landfills, Land Application Sites, Open Dumps	http://www.epa.gov/npdes/pubs/sector_l_landfills.pdf
Automobile Salvage Yards	http://www.epa.gov/npdes/pubs/sector_m_autosalvage.pdf
Recycling Facilities	http://www.epa.gov/npdes/pubs/sector_n_scraprecycling.pdf
Steam Electric Generating Facilities	http://www.epa.gov/npdes/pubs/sector_o_steamelectricpower.pdf
Land Transportation Warehouse Facilities	http://www.epa.gov/npdes/pubs/sector_p_transportationfacilities.pdf
Water Transportation Facilities	http://www.epa.gov/npdes/pubs/sector_q_watertransportation.pdf
Ship and Boat Building and Repair Yards	http://www.epa.gov/npdes/pubs/sector_r_shipbuilding.pdf
Air Transportation Facilities	http://www.epa.gov/npdes/pubs/sector_s_airtransmaint.pdf
Treatment Works	http://www.epa.gov/npdes/pubs/sector_t_treatmentworks.pdf
Food and Kindred Products Facilities	http://www.epa.gov/npdes/pubs/sector_u_food.pdf
Textile Mills, Apparel, and Other Fabric Products	http://www.epa.gov/npdes/pubs/sector_v_textilemills.pdf
Furniture and Fixtures Facilities	http://www.epa.gov/npdes/pubs/sector_w_furniture.pdf
Printing and Publishing Facilities	http://www.epa.gov/npdes/pubs/sector_x_printingpublishing.pdf
Rubber, Plastic Products, and Other Manufacturing	http://www.epa.gov/npdes/pubs/sector_y_rubberplastic.pdf
Leather Tanning and Finishing Facilities	http://www.epa.gov/npdes/pubs/sector_z_leather.pdf
Fabricated Metal Products Facilities	http://www.epa.gov/npdes/pubs/sector_aa_fabmetal.pdf
Transportation Equipment and Industrial Machinery	http://www.epa.gov/npdes/pubs/sector_ab_transport.pdf
Electronic and Electrical Equipment and Components, Photographic and optical Goods Facilities	http://www.epa.gov/npdes/pubs/sector_ac_elect_photo_op.pdf

In addition to these eight BMP categories that must be carried out, other source and transport BMPs can be implemented voluntarily to further protect water quality in the Upper Illinois River Watershed.

SOURCE BMPS:

- ***Alternative Pavers***: Permeable surfaces that can replace asphalt and concrete to increase infiltration and reduce stormwater runoff. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=134
- ***Alternative Turnarounds***: Turnarounds that reduce impervious cover by replacing cul-de-sacs. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=90
- ***Bioretention:*** Utilization of soils and plants to remove pollutants from stormwater runoff. http://www.epa.gov/owm/mtb/biortn.pdf
- ***Cisterns:*** Liquid storage units that are used to catch and store rainwater for a variety of later uses. Cisterns come in a wide range of sizes and can either be stored above or below ground. http://www.lowimpactdevelopment.org/ffxcty/7-1_rainbarrel_draft.pdf
- ***Concrete Washout:*** Prevents or reduces the potential discharge of pollutants from concrete wastes to stormwater by practicing off-site washout or performing on-site washouts in designated areas away from streams, ditches, and storm drains. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=117
- ***Conservation Easements:*** Conservation easements are agreements designed to preserve current land uses, natural resources, ecological processes, or historic structures. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=8
- ***Vegetation Establishments:*** Temporary or permanent vegetation establishments that stabilize bare soil, preventing erosion and increasing filtration of construction site stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=42
- ***Excavation:*** Removing contaminated material to reduce potential contamination of stormwater. http://www.clu-in.org/download/citizens/excavation.pdf
- ***Gelling Agents:*** Materials that interact with liquids to form gels. These agents can be used to clean-up spilled liquids but must be disposed of properly. http://www.epa.gov/emergencies/content/learning/gelagnts.htm
- ***Geotextiles:*** Porous fabrics that protect hillsides, drainage channels, and other disturbed areas from erosion that can be caused by stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=45
- ***Good Housekeeping:*** The proper management and disposal of construction materials and wastes to reduce the potential of polluting stormwater runoff. Good Housekeeping practices include:

1. **Dewatering Management** involves the removal of storm and non-storm water from a site work area in such a way that the water is filtered or conveyed through existing structural BMPs.
2. **Diversion Dikes or Berms** are structures that prevent stormwater from flowing into unwanted areas and divert water into conveyances or other stormwater treatment measures.

3. **Drip Pans** are small depressions or pans used to collect leaks, drips, and spills that occur at a maintenance facility. The chemicals collected in the drip pans can be recycled or disposed of properly to prevent storm water contamination.
4. **Employee Training** ensures that employees are exposed to the BMP concept which can increase their knowledge of what BMPs are, how they work, why they are needed and increases awareness about water quality and why it must be protected.
5. **Hazardous Waste Management** prevents or reduces the potential discharge of pollutants to stormwater from hazardous waste by implementing proper material use and disposal practices.
6. **Illicit Connection / Discharge Management** ensures that illicit discharges are recognized and eliminated.
7. **Inspections and Maintenance** either as routine or as needed assessment and repair of structural BMPs to ensure that they are functioning properly.
8. **Material Shipment, Delivery and Storage Management i**nvolves the prevention, reduction, or elimination of pollutant discharge from delivery shipment and storage areas to storm drains and waterbodies. This is done by using designated delivery and storage areas, proper storage techniques, covered storage areas, providing secondary containment, and making regular inspections of storage areas and stored materials.
9. **Material Use Management i**nvolves the thoughtful use and placement of materials during work processes. This can be easily done by following manufacturer label instructions, by training personnel, and by not leaving materials on the ground unattended.
10. **Paving and Grinding Management to** prevent runoff from flowing through construction areas where paving and grinding occur.
11. **Potable Water / Irrigation** ensures that landscape irrigation water, waterline flushes, or other water encounter structural BMPs before leaving the site and entering stormwater drainages.
12. **Preventative Maintenance** is the practice of timely inspection, management, and record keeping of work or checks on stormwater management devices (e.g., oil water separators, pumps, catch basins).
13. **Recordkeeping and Reporting** ensures that all BMP actions are conducted and that BMPs are maintained through regular inspection and maintenance.
14. **Solid Waste Management** prevents or reduces the potential discharge of pollutants to stormwater from solid waste. This is done by thoughtful actions such as using a covered dumpster, placing an uncovered waste dumpster in a covered area, collecting site trash daily, and making sure that hazardous wastes are not disposed of in the dumpster.
15. **Spill Prevention and Response** is the preparation for spills by storing cleanup materials on site, planning clean up procedures, educating personnel, and identification of problematic areas.
16. **Stockpile Management** protects stormwater from of stockpiled material.
17. **Temporary Batch Plant Management** involves locating batch plants away from waterbodies, drainages, and drain inlets.
18. **Temporary Stream Crossings** are temporary culverts, fords, or bridges that ccross both perennial and intermittent waterways that address erosion and sedimentation caused by work vehicles and machinery.
19. **Visual Inspections** involve the surveying and identification of problematic spots around material storage areas, disposal areas, and other places where spills have occurred in the past.

- ***Graded Areas:*** Areas that funnel stormwater away from unwanted or polluted areas to desirable areas where stormwater will encounter treatment measures. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=32

- ***Green Parking:*** Parking areas that reduce the amount of stormwater runoff by infiltrating precipitation. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=89
- ***Green Roofs:*** Vegetated rooftops that reduce stormwater runoff by absorbing, storing, and evapotranspiring water from rainfall. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=114
- ***Infiltration Trenches:*** Excavated trenches that are backfilled with rock aggregate and perforated drainage pipes that slow and filter stormwater. http://www.epa.gov/owm/mtb/infltrenc.pdf
- ***Infiltration Planters:*** Flower beds with absorptive soils and built up edges that receive downspout drainage from buildings and allow for temporary storage of stormwater runoff from rooftops until the water filters down through the planter and into existing soils. http://www.epa.gov/owm/mtb/infltrenc.pdf
- ***Mulching and Hydromulching:*** Application of mulch to promote water infiltration, prevent soil erosion, and seed washing from seeded areas that have not yet rooted. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=41
- ***Narrow Streets:*** Use of narrower streets to reduce impervious area created by industrial or commercial developments. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=87
- ***Open Space Design:*** A development practice that concentrates dwelling units in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=83
- ***Permeable Pavements:*** Pavements that infiltrate water, reducing total stormwater runoff and peak stormwater runoff flows in comparison to impervious pavements. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=71
- ***Preserve Existing Vegetation:*** Preservation of existing vegetation, such as riparian areas, protects the soil and stream banks from erosion and acts as a filter for stormwater to reduce potential pollutants found in stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=34
- ***Riprap:*** A layer of large stones used to slow stormwater velocity and protect soil from streambank erosion in areas of concentrated stormwater runoff such as inlets and outlets of culverts, bridges, slope drains, grade stabilization structures, and storm drains. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=39

- ***Secondary Containment Systems:*** A secondary barrier that surrounds a container in which something is stored to protect against leaks. http://www.epa.gov/oust/fedlaws/secondco.htm
- ***Sequencing:*** A detailed work schedule that coordinates the timing of land-disturbing activities with the implementation of erosion and sediment control BMPs to reduce on-site erosion and sediment transport. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=51
- ***Slope Drains:*** Drains that intercept and redirect stormwater into a stabilized area or watercourse and are often used with diversion dikes and drainage ditches. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=48
- ***Sorbent:*** A material that can be used to clean up spills without using water through the process of adsoption and absorption and then disposed of properly. http://www.epa.gov/OEM/content/ncp/factsheet.htm
- ***Spill Prevention and Control Mechanisms:*** A BMP for small spills that can be cleaned by stopping the spread with dry materials (i.e., sand, kitty litter, or rags) and disposing of the materials properly. However if the spill is large it should be reported to major spills to the Arkansas Department of Emergency Management 1-800-322- 4012. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=62
- ***Vehicle and Equipment Cleaning and Maintenance:*** A BMP to eliminate or prevent vehicles and equipment pollution from contacting stormwater. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=63
- ***Vehicle Fueling Practices:*** Prevents fuel spills and leaks which can be washed into the storm drain system by stormwater runoff. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=113

TRANSPORT BMPS

- ***Constructed Wetlands:*** Artificial wetlands that are constructed to treat wastewater and stormwater that flows through them by detaining the waters and trapping pollutants for biological break drown or sequestration. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=74&minmeasure=5
- ***Diversion Berms:*** Earthen or gravel berms that divert clear stormwater away from construction sites. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=53
- ***Drain Inlet Protection:*** Placement of sediment filters or drain inlet barriers around storm drain inlets in areas where liquid hazardous materials are used, drained, or spilled to control or reduce the delivery of these substances to waterways via storm drains.

http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=60

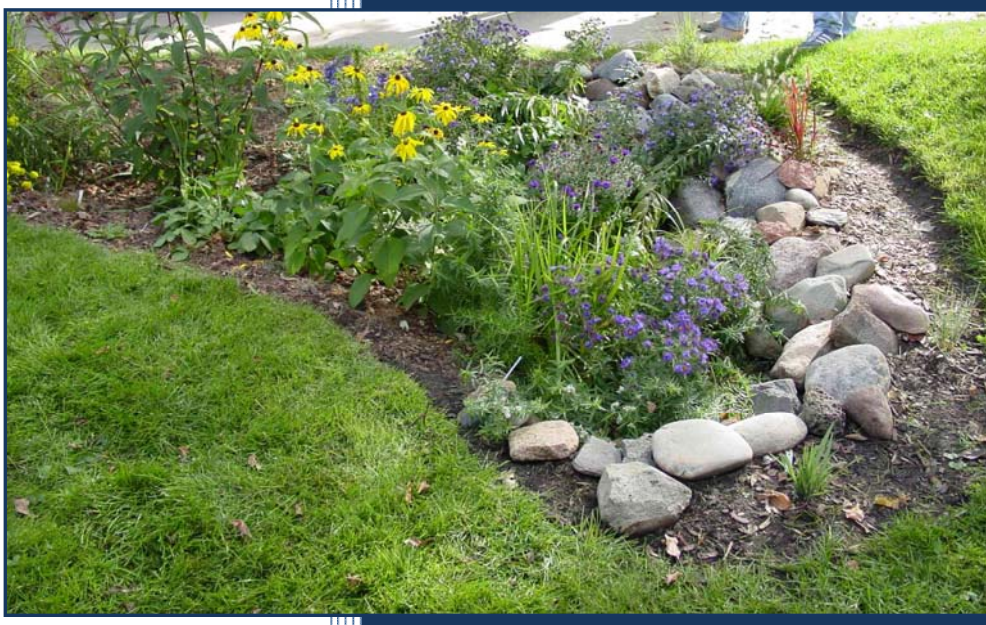
- ***Dry Detention Ponds:*** Collection basins in which outlets have been designed to detain stormwater for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=67&minmeasure=5
- ***Elimination of Curbs and Gutters:*** Use of vegetated swales and ditches as an alternative to curbs and gutters along residential streets. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=88&minmeasure=5
- ***Excavation:*** Removes contaminated material to reduce potential contamination of stormwater. http://www.clu-in.org/download/citizens/excavation.pdf
- ***Grass Lined Channels:*** A stable vegetated conduit that conveys stormwater from industrial or commercial areas while slowing flow and filtering pollutants. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=38
- ***Infiltration Trenches:*** Trenches that allow temporary storage of stormwater runoff in the porous areas between the stones. The stored storm water then infiltrates into the surrounding soil or drains into underground pipes and routed to an outflow destination. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=70&minmeasure=5
- ***Preservation of Natural Vegetation:*** Vegetation decreases stormwater generation and velocity while increasing pollutant removal from stormwater through increases of infiltration and filtration. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=34&minmeasure=4
- ***Riparian Buffers:*** Buffers that slow stormwater and remove associated pollutants while also providing stream bank stability. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=82
- ***Stormwater Wetlands:*** Constructed wetlands treat stormwater runoff and are similar to wet ponds, but have a variety of wetland plants incorporated into the structural design. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=74&minmeasure=5
- ***Vegetative Buffers:*** Strips of vegetation placed between stormwater discharge at industrial or commercial sites and environmentally sensitive areas such as streams. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=50
- ***Rain Gardens:*** Landscape depressions planted with hardy native plants that can withstand drought and flood conditions. These gardens are useful for catching and slowing runoff water in grassed areas to increase stormwater infiltration. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=72
- ***Rain Barrels:*** Barrels used to catch and retain stormwater from rooftops so that it can be used later to water lawn features or for other purposes that require the use of water. http://www.lowimpactdevelopment.org/ffxcty/7-1_rainbarrel_draft.pdf

- ***Redevelopment Assessment:*** Assessing established developments to improve the quality and reduce the quantity of stomwater runoff. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=127
- ***Wet Detention Ponds:*** Stormwater control structures that provide both retention and treatment of contaminated storm water runoff. http://www.epa.gov/owm/mtb/wetdtnpn.pdf

Chapter 4: Household Best Management Practices

What Are Household Best Management Practices?

Everyday household activities and practices can impact water quality within a given watershed. Stormwater runoff from residential property may contain urban pollutants such as fertilizer, pesticides, hazardous wastes and litter that negatively impact water quality. Household Best Management Practices (BMPs) are practices and actions that residents of the Upper Illinois River Watershed can implement on their own property to manage the effects that their household has on the watershed and even improve water quality.



Why Should Household Best Management Practices Be Used in the Upper Illinois River Watershed?

Residential management practices in the Upper Illinois River Watershed are directly tied to the health of the Illinois River. Stormwater runs off residential property, into storm drains, and eventually into the Illinois River and its tributaries. During this process, stormwater can transport pollutants from residences to the river system.

Good Household Practices Should be Related to:

- Landscaping and gardening practices that minimize the use of excess nutrients and pesticides and minimize stormwater runoff
- Disposing of hazardous wastes properly and not pouring them down the sink or stormwater drain.
- Disposing of pet wastes in the trashcan and not leaving it in the yard
- Maintaining and washing automobiles in a place where contaminants are not washed into stormwater drains.
- Using environmentally friendly cleaners.

The following sections will address residential stormwater management, household hazardous wastes, trash management.

4.1 Residential Stormwater Management

Residential stormwater is generated when precipitation runs off roofs, over paved roads, driveways, and parking lots, and into storm drains that empty into waterbodies. In residential areas, stormwater can transport urban pollutants such as sediment (soil), nutrients, pesticides, oil and grease, disease-causing organisms and toxic chemicals to streams—all of which can negatively impact water quality. Every resident of the Upper Illinois River Watershed can contribute to improving water quality by reducing stormwater volumes and velocities from their property, by capturing and utilizing stormwater on their property, and by keeping harmful pollutants out of stormwater.

RECOMMENDED HOUSEHOLD BMPS FOR STORMWATER MANAGEMENT

- ***Homesite Assessments*** can help you see what you can do to prevent stormwater. Familiarize yourself with the stormwater pathways on your property such as, slopes, drainages pathways, storm drains, and streams. Also, look to see if your gutter downspouts are pointed towards the lawn or an impervious surface.

- ***Riparian Buffers*** are areas of woody vegetation that are located next to water bodies. Riparian buffers reduce pollutants from the surrounding land area that is found in stormwater. Riparian buffers also maintain stream bank integrity which prevents stream bank erosion and loss of land due to stream bank erosion.

- ***Bioswales*** are landscape features similar to ditches that are usually placed within or adjacent to parking lot drainages and adjacent to roadside drainages that are intended to slow stormwater and remove pollutants. They are usually a grassed or vegetated depression that is more wide than deep and consist of a series of small check dams to slow and disperse water flow. When these features are in parking lots the stormwater will enter the bioswale from curb perforations.

- ***Rain Gardens*** are landscape depressions planted with hardy native plants that can withstand drought and flood conditions. These gardens are useful for catching and slowing runoff water in grassed areas and for increasing infiltration in lawn and park settings.

- ***Rain Barrels*** can be used to catch and retain water from rooftops so that it can be used later to water lawn features or for other purposes that require the use of water.

- ***Cisterns*** are fluid storage units that are commonly used to catch and store rainwater for a variety of later uses. Cisterns come in a wide range of sizes and can either be stored above or below ground.

- ***Infiltration Planters*** are flower beds with absorptive soils and built up edges that receive downspout drainage from buildings. Utilizing these planters allows for temporary storage of stormwater runoff from rooftops until the water filters down through the planter and into existing soils. These planters can either be a closed or flow—through type of planter.

- ***Diversion Berms*** divert stormwater from homesites into rain gardens and bioswales to filter and limit the quantity of stormwater runoff that makes it to a storm drain.

- ***Limit Imperviousness*** at your homesite to increase water infiltration and prevent decrease stormwater runoff into storm drains.

RECOMMENDED HOUSEHOLD BMPS FOR YARDS

- ***Soil Testing*** should be conducted to assess the fertility of lawns and to receive accurate fertilizer recommendations to avoid over fertilization. Knowing the fertility of a lawn can help in establishing and maintaining the growth of turfgrass.

Did You Know? Benton and Washington County Cooperative Extension Services will analyze your soil sample for you free of charge.

- ***Turf Management*** methods and practices that promote quality turfgrass and reduce bare soil and erosion.

- ***Composting*** of yard trash is a great way to manage leaves and grass clippings in such a way that you end up with a valuable soil enhancing fertilizer product.

- ***Lawn Clipping Management*** is the practice of sweeping lawn clippings from driveways, sidewalks, and streets back into the yard, mulching clippings with a mulching lawn mower, or composting clippings with other yard waste.

- ***Pet Waste Collection and Disposal*** removes bacteria and nutrients from your yard where they can be transported by stormwater to streams. Pet wastes should be disposed of in the trash.

- ***Nutrient Management*** involves testing soil, following soil test results when applying fertilizers, and properly storing fertilizers.

- ***Non-Stormwater Management Practices*** prevent the transport of nutrients and other pollutants from the yard to the storm drain from non-storm water related activities such as lawn watering, vehicle washing, power washing, and chlorinated swimming pool water emptying.

4.2 Household Hazardous Waste Materials

Leftover household products that contain corrosive, toxic, ignitable or reactive ingredients are considered household hazardous wastes and must be disposed of in a way that does not pollute the environment or pose a threat to human health. Improper disposal of these products includes pouring them down the sink, on the ground, into storm drains, or in some cases, putting them in the trash. Several cities in the Upper Illinois River Watershed have household hazardous waste collection centers including Fayetteville, Springdale, Rogers and Siloam Springs.

- Washington County Office of Environmental Affairs
  2615 Brink Drive, Fayetteville
  479.444.1725

- Springdale Street Department
  Randall Wobbe Road, Springdale
  479.750.8135

- The Benton County Household Hazardous Waste Collection Center
  2633 Laurel Circle, Rogers
  479.621.9707

- Siloam Springs Recycling and Transfer Station
  1008 East Ashley, Siloam Springs
  479.524.8512

Table 4.1 Common household hazardous waste materials.

Environmental Hazards	Common Household Examples
Cleaning Products	Oven cleaners, drain cleaners, wood and metal polishes, toilet cleaners, bleach and pool cleaners
Indoor Pesticides	Flea and bug sprays, houseplant insecticides, mouse and rat poisons
Automotive Products	Motor oil, fuel additives, air conditioning refrigerants, starter fluids, automotive batteries, transmission and brake fluid, and antifreeze
Workshop Supplies	Some adhesives and glues, paint strippers and removers, oil or enamel based paint, stains and finishes, and paint thinners
Lawn and Garden Products	Herbicides, insecticides, and wood preservatives
Other Flammable Products	Propane tanks, kerosene, gas/oil mix and lighter fluid
Miscellaneous	Batteries, mercury thermostats and thermometers, fluorescent light bulbs and driveway sealer.

RECOMMENDED HOUSEHOLD BMPS FOR HOUSEHOLD HAZARDOUS MATERIALS

- ***Maintenance Vehicles*** regularly in designated areas so that automobile fluids (e.g., oil, antifreeze, transmission fluid) are contained in an area with BMPs in place. Make sure maintenance materials are properly disposed of and properly stored.

- ***Select Less Hazardous Products*** when buying cleaning products, automobile fluids, pesticides, or home improvement supplies.

- ***Read the Product Label*** to ensure that you are using the recommended amount of product, are aware of safety precautions including storage, and are knowledgeable of proper disposal methods.

- ***Buy Only What is Needed*** to avoid having excess product and using more than the recommended amount.

- ***Proper Use*** of hazardous materials means ensuring that product use is consistent with product labeling.

- ***Proper Storage*** of hazardous materials ensures that they are stored in a way that prevents spills, avoids contact with stormwater, and makes potential clean up quick and easy.

- ***Proper Disposal*** involves following the label directions that describes methods of disposal and does not include burying, burning, or pouring down the drain.

4.3 Trash Management

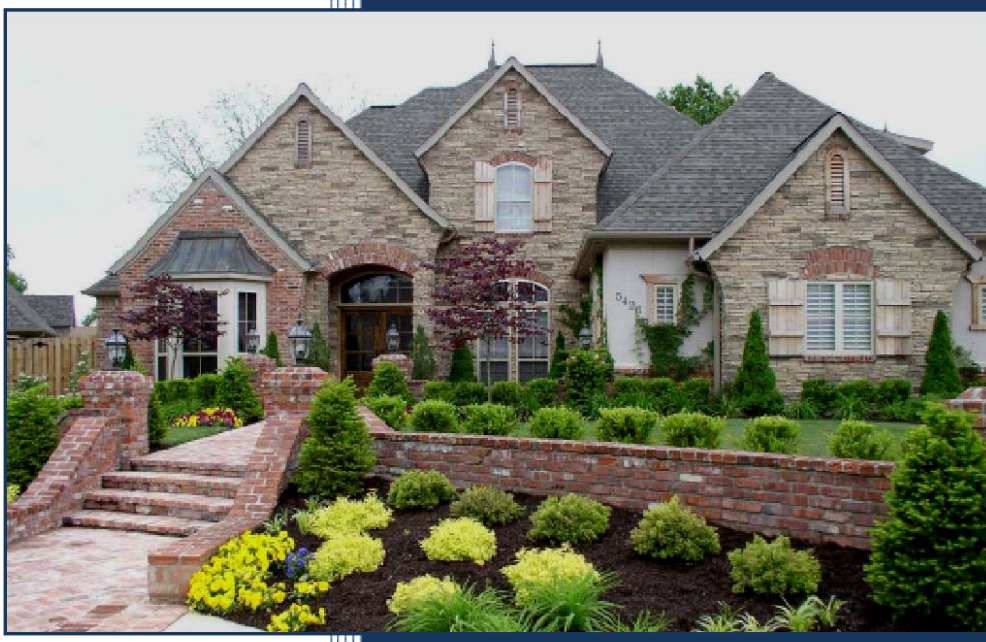
The EPA estimates that the average American produces 4.6 pounds of trash per day. Trash that is not properly disposed of can end up in storm drains and eventually in waterbodies. There, trash can impair the growth of aquatic vegetation, impair aquatic habitat contaminate sediment and serve as a media for bacteria growth. Stakeholders in the Upper Illinois River Watershed should follow best management practices for solid waste management:

- ***Properly Dispose of Trash*** to ensure that it does not get transported offsite in stormwater to a storm drain or stream. Disposal of trash by illegal dumping, burying, or burning can have negative impacts on water quality.

Chapter 5: Management Actions for Landscape and Turf

What are Landscape and Turf Best Management Practices?

Landscape and turf best management practices (BMPs) are guidelines and procedures that are designed to promote sustainable landscape and turf areas. These guidelines include the design, installation and management practices that promote the function, conservation, preservation and regeneration of ecological services provided by healthy landscapes and are designed as a guide to education green industry practitioners and property owners who are involved in the installation and management of landscaped areas.



Why Should These Practices Be Used in the Upper Illinois River Watershed?

Landscapes with accompanying turf can enhance property values along with providing aesthetic qualities to residential and commercial sites. Properly managed landscapes can reduce stormwater runoff, sedimentation, nutrient leaching, and other possible sources of non-point source pollution from urban and rural areas while meeting client or public visual expectations. Properly designed and installed landscapes and turf can also generate disturbed sites allowing for improved water rainfall interception, infiltration, purification, and thus contribute to protecting the water quality of the Illinois river Watershed.

The Goals of Landscape and Turf BMPs are to:

- Reduce sediments, nutrient and pesticide runoff into the Upper Illinois River Watershed
- Use careful site analysis, proper design, and appropriate plant selection to install sustainable landscapes
- Use recommended rates and methods to apply plant nutrients and use efficient irrigation systems
- Incorporate integrated pest management in pest control systems

The following sections discuss landscape and turfgrass BMPs, design and installation practices, irrigation practices, plant care management, and integrated pest management.

5.1 Designing and Installing Landscape and Turf Area

The long-term sustainability of turfgrass and landscaping of a site depends on a careful analysis prior to the project design phase. Site information that needs to be gathered includes topographical data such as slope severities, grading requirements, soil types and erosion potential, internal soil drainage, proximity to waterways, and a survey of existing vegetation. Other factors to consider include soil chemistry (pH, soluble salts), potential irrigation water quality and availability, and light levels. In addition to these environmental factors, overhead and underground utilities and other obstructions should be also considered when planning a site.

Selecting Turfgrass in the Upper Illinois River Watershed

No one type of grass is best suited for all situations; the type of lawn grass selected to be planted in the Upper Illinois River Watershed should be based on climate, sustainability, intended use, and desired appearance. Cool-season grasses (northern) and warm-season grasses (southern) are both grown in Arkansas. Cool-season grasses grow best in the spring and fall, are less active in the summer and stay reasonably green in the winter. Warm-season grasses are slow to green in the spring, grow best in summer, and go dormant after the first heavy frost. The characteristics of each site and the goals for the site will determine which type of grass is appropriate. Table 5.1 rates the performance of various grasses in Arkansas.

Because quality turfgrass requires periodic irrigation and a minimum amount of sunlight, shade and lack of water are often the primary limiting factors for maintaining a quality home lawn.

Selecting Trees and Groundcovers in the Upper Illinois River Watershed

The correct selection of trees, shrubs, and groundcovers determines how functional and successful a landscape will be in the long term. Plants should be selected to fulfill specific functions such as physical barriers and screening, aesthetic value, soil protection, weather moderation, and sensory stimulation. Other functions include directing the flow of traffic, providing habitat for wildlife and providing recreational spaces.

Plants should be selected based on their ability to adapt to a particular locale and other variables such as sunlight exposure and duration, soil pH and types, water quality, and mature plant size. In particular, trees should be sited and selected to avoid growing into electric or utility lines. Trees with aggressive root systems should not be used around sanitary septic systems, close to paved surfaces, or over underground utility easements.

Plants native to the Upper Illinois River Watershed should be used whenever possible. Adapted plant material should be used when a suitable native is not available. However, when using non-native adapted plants, it is crucial that the plant species is not invasive and does not create other problems such as allergies due to a high pollen load. In addition, known poisonous or toxic plants should be avoided in public areas where small children or pets may be tempted to eat the leaves or fruit.

Table 5.1 Comparison of turfgrasses that could be used in the Upper Illinois River Watershed

	Bermuda Grass	Kentucky Bluegrass	Tall Fescue	Zoysiagrass
Winter Hardiness	Good	Excellent	Excellent	Very Good
Heat Tolerance	Excellent	Fair	Good	Excellent
Drought Tolerance	Excellent	Poor	Good	Excellent
Shade Tolerance	Poor	Good	Good	Fair
Optimum Soil pH	5.8 to 7.0	5.8 to 7.0	5.8 to 7.0	5.8 to 7.0
Maintenance Level	Low to High	High	Moderate to High	Low to Moderate
Color	Medium to Dark Green	Medium to Dark Green	Medium to Dark Green	Pale to Medium Green
Leaf Texture	Medium to Fine	Medium	Coarse	Medium to Fine
Mowing Height	0.5 to 2.5	2.5 to 3.5	2.5 to 4.0	0.75 to 2.5
Establishment Methods	Seed, Sod, Plugs, Sprigs	Sod, Seed	Sod, Seed	Sod, Seed, Plugs, Sprigs
Growth Rate	Fast	Slow	Moderate	Slow
Growth Habit	Stolons and Rhizomes	Rhizomes	Bunch or Clump Type	Stolons and Rhizomes

Planting Practices for Turfgrasses

The first step in establishing a home lawn is to obtain a soil test. Soil tests provide key information including soil pH, potassium and phosphorus levels.

Did You Know? **Benton and Washington Cooperative Extension Services provide free soil testing. Collect soil samples in a bucket from the upper 4 to 6 inches of soil from 10 or more locations around the yard. Remove any vegetative material such as stems and leaves. Air dry and mix the samples thoroughly. Take about one pint of the mixture to your county Extension office for analysis.**

The following practices should be implemented to plant and establish turfgrass:

- ***Determine the Size of the Lawn.*** This will aid in calculating how much seed, soil, fertilizer and other materials you might need to establish the lawn. The best way to do this is to divide your lawn into several squares, rectangles, or circles. Calculate the area of these smaller shapes and then add them together to determine the total size of the lawn.

- ***Remove Trash.*** Remove all wood, concrete, pipe, rock, and construction scrap that may interfere with turfgrass root growth and water movement. Insist that the builder not use the site as a dumping ground for paint, concrete, etc.

- ***Determine the Rough Grade.*** If extensive grading is necessary, stockpile existing topsoil and replace it after the rough grade is set. The rough grade should slope gradually away from the house at least

15 feet in all directions. A 1 foot drop in 50 feet will usually supply adequate surface drainage. Grades steeper than a 1 foot drop in 4 feet may cause mowing and erosion problems. Alternatives to a steep grade include terraces, retaining walls or planting a ground cover.

- ***Consider Topsoil.*** Add topsoil if removed previously for rough grading or if necessary due to poor soil fertility. If suitable topsoil is not available, existing soil may be modified. If the topsoil lacks organic matter, additives including peat, decomposed manure, or composted rice hulls may be incorporated. These materials should be mixed with the native soil at least 6 to 8 inches deep.
- ***Add Amendments If Necessary.*** Uniformly apply phosphorous, potassium, and lime according to soil test recommendations and then mix (till) into the upper 6 inches of soil.

- ***Determine Soil pH.*** A pH of 7.0 is neutral. Values less than 7.0 indicate acid conditions while readings over 7.0 indicate alkaline conditions. Turfgrass selection may be affected by soil pH. Nutrients essential to plant growth are most available between pH 5.8 and 6.5. Lime may be used to reduce soil acidity.

- ***Determine Final Grading.*** The final grade is best accomplished by tilling the surface to a depth of 2-3 inches. This will smooth the surface soil in preparation for planting.

- ***Avoid Damaging Trees.*** Care should be taken not to destroy or damage existing trees. Tilling around trees may cut a large percentage of a tree's roots and can severely damage or kill the tree. Trees can also be killed by placing large amounts of soil over the roots, because this practice deprives the roots of oxygen.

- ***Seeding.*** It is important to purchase quality grass seed. According to state law, each seed bag must be labeled as to what exactly is in the bag. Make sure that the seed was tested within the last six months as well as check that the germination rate is 85% or better. Also, make sure that the seed label specifies the cultivar that you had in mind and contains less than 0.3% weed seed and no noxious weeds. Other things to look for are less than 5% inert matter and less than 0.5% of any other crop.

- Small lawn areas may be seeded with a 2 to 3 foot drop spreader. Drop spreaders are more accurate than rotary spreaders and allow planting along driveways, sidewalks and beds without wasting seed. The spreader must be calibrated to deliver the appropriate seeding rate. Divide the total amount of seed equally and plant in two directions to assure uniform distribution of the seed. Immediately after seeding, the soil surface should be lightly raked to cover the seed with 1/8 to 1/4 inch of soil.

- ***Mulching.*** While mulching is not essential for lawn establishment, it will help prevent erosion on sloped sites, conserve moisture, and reduce seed loss from wind, birds, and washing. Weed-free straw is a good choice for mulching. Half to one square bale of straw will cover 1,000 ft^2. The tendency for most homeowners is to apply too much straw. Applying straw too thick can be detrimental to establishment and require removal after seedling germination. There are also many other types of erosion blankets available to help prevent soil loss.

- ***Watering Seedlings and Sod.*** Seedlings and sod are very susceptible to moisture stress during the first few weeks after seeding. The upper 1 inch of soil should be kept moist with frequent irrigations for the first two or three weeks after planting. After the seed germinates, the lawn should be

watered less often. Eventually, the lawn should be watered deeply and infrequently only when the plant shows signs of water stress.

Planting Practices for Trees, Shrubs, and Groundcovers

The following practices should be implemented to plant and establish trees, shrubs and groundcovers.

- ***Determine Soil pH.*** If soil pH is outside accepted ranges for normal plant growth, corrective measures should be made by incorporating soil amendments to adjust the pH. Soil pH ranges from 6.5 to 7.5 are ideal for most landscape plant species. A soil test will determine if pH needs to be adjusted.

- ***Fertilize If Necessary.*** Fertilization is not normally required during the installation process for trees and most shrubs unless soil tests indicate a specific nutrient deficiency. Fast growing annuals and perennials may need fertilizing during installation, but fertilization should be based on soil tests and recommended rates should be followed

- ***Add Amendments If Necessary.*** Soils that are reasonably fertile with good structure will not need additional soil amendments that are recommended in some planting guidelines. Typically, trees and large shrubs should not have soil amendments added so that root system will expand outside the amended area. Small shrubs and plants may have soil amendments added to facilitate planting or to establish a smooth seedbed.

- ***Use Stakes If Necessary.*** Trees should only be staked if planted in an area susceptible to high winds. Staking should be removed as soon as the tree is established and steps should be taken to ensure that trunk damage does not occur due to wires or other parts of the staking system.

5.2 Irrigation

The Environmental Protection Agency (EPA) estimates that 50 to 70 % of household water consumption is used outdoors with an estimated 2.9% of total yearly water used for landscaping or exterior purposes. A correctly designed, installed, and maintained landscape/turf irrigation system is important should conserve water resources, save money, and prevent excess runoff into stormwater systems. Irrigation systems can be complex under certain situations and may require specialized knowledge to function properly. Irrigation and other landscape professionals should be aware of federal, state, and local regulations concerning the design, installation, and management of irrigation systems. Many locales have licensing requirements and require the services of a registered professional.

Irrigation System Design

Recent innovations in irrigation technology have increased the ability to design systems that improve water use efficiency and conserve water resources while reducing runoff. Design considerations should include the following:

- System capacity should be determined by the available water supply
- Operating pressure and supply line pressures should be designed for peak application rates
- The application rate should equal the soil infiltration and storage rate

- The system should be flexible enough to allow for changes in pressure during peak water use times or periods of water restrictions
- Soil types and grade should be considered
- Landscape and turf areas should be zoned differently
- Rain sensors or soil moist meters should be considered
- Drip or low volume irrigation should be considered for landscape beds
- Back flow preventers or check valves should be used to protect potable water supplies from contamination
- Systems should be designed to deliver even distribution
- The homeowner or landscape manager should be provided with information on irrigation scheduling and schedule modification recommendations for the system design.

Irrigation Installation

The best designed irrigation system is compromised if not correctly installed. Poorly installed systems can require constant maintenance or will not meet design requirements, will waste water, or will fail to adequately irrigate the desired area. The following practices should be followed during the irrigation installation process:

- Professional licensed installers should be used
- Design specifications should be followed
- Changes in orders must be approved by the designer
- All building materials and equipment should meet industry standards
- Established industry installation standards and safety practices should be met
- All underground utilities or other obstacles should be located and marked prior to construction
- Irrigation controller and other system manuals should be copied and given to the owner along with warranties, and written instructions on how to adjust or reset the system's timers or controllers
- A detailed map of main and secondary feed lines, valves, solenoids, and wiring should be given to the owner

Irrigation Management

Irrigation systems should be routinely monitored for proper operation. It is especially important to inspect rotary or directional heads to insure they are not misdirected and watering paved or other undesirable areas. This is best accomplished by manually turning on the system and making a visual inspection. Adjustments may have to be made to sprinkler heads over time. Worn or defective heads should be replaced as soon as they are discovered. Sprinkler heads located next to driveways and high traffic areas are prone to more damage. Drip type emitters should also be checked for clogging or tears. When replacing heads, be sure that compatible parts that meet design specifications are used. In areas with cold winters, a winterization plan to drain and protect the overall system will be needed. Inspect spray patterns over time to see if plant growth is obstructing proper water distribution. In many cases, it may be necessary to modify spray heads or extend irrigation risers to correct the problem.

5.3 Plant Care Management

MULCH: Mulching is used to conserve soil moisture, reduce weed growth, and lessen the chance of soil erosion in planting beds. Mulches can be synthetic or derived from natural sources. Synthetic mulches decompose slowly while natural mulches decompose more quickly but add organic matter to the soil as

they decompose. Mulches range from conifer needles and ground bark to gravel, river rock and recycled materials such as tires. Mulch should be applied to a depth of 2 to 3 inches with the depth tapering down toward the trunk of a tree or shrub.

MOWING AND TURFGRASS: Proper mowing technique, equipment, frequency, and height improves the quality of a lawn while also increasing the health of the turfgrass plants and decreasing weeds. Mowing frequency varies greatly based upon the turfgrass species, time of year and rainfall, but a typical frequency is 1 to 2 times per week during the growing season. In general, mowing turf at higher mowing heights helps increase overall plant health and reduces weed presence.

Did You Know? Removing more than 1/3 of the leaf blade in a single mowing is detrimental to plant health. Mow as often as needed but never remove more than 1/3 of the leaf blade in a single mowing. In other words, if your mower is set at 3 inches, mow before your lawn reaches 4.5 inches high.

When you mow regularly and at the proper height, your lawn is improved by recycling grass clippings. When grass clippings are allowed to decay naturally on the lawn, they release valuable nutrients such as nitrogen and organic matter which improve the soil. If clippings are returned, fertilizer applications can be reduced by 30 percent.

FERTILIZERS: Fertilizers supply essential chemical elements for plant growth and promote vegetative and root growth, increase and improve flower or fruit production, improve foliage color or plant aesthetics, and or correct known nutrient deficiencies. Macronutrients, nutrients required in greater amounts, include nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), and silicon (Si). Micronutrients, nutrients required in lesser amounts, include boron (B), chlorine (Cl), copper (Cu), iron (Fe), molybdenum (Mo), manganese (Mn), nickel (Ni), sodium (Na), and zinc (Zn). Other elements that are thought to be either beneficial or essential to some plant species include selenium (Se), vanadium (V), and cobalt (Co). Carbon (C), hydrogen (H), and oxygen (O) are essential for plant growth, but are not normally considered nutrients.

Did You Know? By law, all fertilizers sold must have a descriptive label stating the fertilizer manufacturer, grade, net weight, fertilizer source, and most importantly, the guaranteed chemical analysis of both macro and micronutrients. The three most important elements supplied by most fertilizers are N, P, and K. Nutrients are listed as a percent (%) nutrient or as a ratio. A fertilizer with a 3-1-2 ratio could contain 30% N, 10% P, and 20% K.

Fertilizers can be soluble or insoluble depending on their manufacturing process and content. Soluble fertilizers quickly release nutrients into the root environment and are readily available for plant uptake. This solubility, while quickly making nutrients available, can also contribute to the rapid movement of nutrients through stormwater runoff or through percolation into groundwater systems. Insoluble fertilizers release nutrients at a much slower rate into the root environment making nutrients available to the plant over a longer time span. Disadvantages are that “hot spots” of concentrated nutrients can occur if soil moisture is not sufficient to set up a moisture gradient and distribution of the fertilizer.

Fertilizer type and application rate should be based on soil type, rainfall/irrigation frequency, and soil chemistry. Before any fertilization program is initiated, a soil test should be done to determine nutrient requirements and establish application rates. Differing plant species will vary in nutrient requirements.

Extreme soil pH values can affect nutrient availability. Soil pH should be determined and adjusted if required. Periodic tests will be needed over time to monitor nutrient levels.

The timing of N fertilizer applications depends on the lawn species. Warm-season turfgrasses such as bermudagrass and zoysiagrass should be fertilized in the summer months when they are actively growing. Cool-season turfgrass species such as tall fescue should be fertilized mainly in the autumn. Lawns damaged during summer months and newly seeded lawns may need an additional N fertilizer application in October to help with recovery and establishment. Regardless of species, turf should only be fertilized when it is actively growing. Therefore, warm-season lawns should not be fertilized during winter months, and no species should be fertilized during drought.

Fertilizer Guidelines:

- Test soil before fertilizing
- Contact a County Extension Agent for soil test instructions
- Follow suggested fertilizer rates based on test results
- Split fertilizer applications over time to even out nutrient availability
- Adjust soil pH if needed
- Use the minimum amount of fertilizer needed
- Control any pests or diseases prior to fertilization
- Consider controlled release fertilizers or low rates of soluble fertilizer applied more often

5.4 Pesticide Management in Arkansas

Restricted use pesticides are those that have higher risk potential for humans, wildlife, and the environment. The Federal government has determined that the benefits provided by these pesticides outweigh the risks as long as they are handled, applied, and disposed of properly. Knowledge and prevention are the keys to avoiding accidents and unwanted exposures.

Did You Know? **Federal law requires that a person who purchases or applies a restricted use pesticide must have a current pesticide applicator license and receive periodic pesticide safety training.**

In Arkansas, the licensing of pesticide applicators and the enforcement of pesticide laws and regulations is the primarily the responsibility of the Arkansas State Plant Board. The Arkansas Department of Pollution Control and Ecology is responsible for certain pesticide regulations concerning transportation and disposal. The required safety training, also known as certification or recertification, is provided by the University of Arkansas Cooperative Extension Service.

Types of Pesticide Applicators

There are three basic types of pesticide applicators: private, commercial, and non-commercial.

PRIVATE APPLICATORS are individuals such as farmers who use restricted use pesticides to produce agricultural commodities on property owned or rented by them or their employer. Restricted use pesticides are not labeled for home gardens. Therefore, a pesticide license is not required, nor available, for home gardeners.

COMMERCIAL APPLICATORS are individuals such as aerial applicators or custom applicators who use restricted use pesticides (normally for hire) for any purpose or on property other than that specified for defining private applicators.

NON-COMMERCIAL APPLICATORS are individuals such as researchers, extension agents, and chemical company representatives who use restricted use pesticides but do not qualify as a private applicator nor require a commercial applicators license.

Integrated Pest Management

Integrated pest management (IPM) is a multi-faceted approach to pest control that considers cultural, biological, genetic, and chemical components. The overall goal of using IPM is to reduce the frequency of pesticide applications thereby decreasing the amounts of toxic chemicals used in the environment in addition to reducing either plant production, or landscape management costs. The concept of IPM is a direct offshoot of past concerns about increased use of pesticides in the environment and issues of pesticide resistance in insects, pathogens, and weeds.

CULTURAL: Use plant culture practices to reduce plant stress induced pest susceptibility. Cultural practices includes applying proper types and amounts of fertilizers, efficient irrigation practices, mulching, correct mowing heights for turf or correct pruning practices for landscape plants. A healthy plant is much less susceptible to pests. Pest monitoring and early detection is the keystone to successful IPM practices.

BIOLOGICAL: Use a biological approach where appropriate. Encourage and build a landscape friendly to beneficial insects and other organisms that are parasitic, predatory, or antagonistic to various kinds of pests. A healthy landscape with a diverse ecology is much more likely to withstand periodic pest infestations than a monoculture landscape or landscape under environmental stress.

GENETIC: Select plant species or genotypes selected for pest resistance. Also select climate tolerant plant species that are native or adapted to a specific site. Proper plant selection is a key component of IPM to reduce production and management costs in addition to saving water.

CHEMICAL: After the above three strategies have been considered and met, pest damage threshold levels may reach a point where chemical control is needed. Both natural and synthetic chemicals are available in both broad spectrum and pest specific products. The goal is to always use the least toxic material that will give an acceptable level of control. Remember that many "organic" derived chemical compounds are still very toxic even if "natural" or plant based. Only use highly toxic compounds if all other attempts at control fail.

References

More information about these topics can be found at the provided weblinks:

- ***Landscapes:*** http://www.arhomeandgarden.org/landscaping.htm
- ***Pesticide training, licensing and education:*** http://www.aragriculture.org/pesticides/#manuals
- ***Sustainability:*** http://www.epa.gov/Sustainability/basicinfo.htm#sustainability:
- ***Lawns:*** http://www.arhomeandgarden.org/lawns.htm
- ***Turfgrass:*** http://turf.uark.edu

Chapter 6: Agricultural Conservation Practices and Programs

What Are Agricultural Conservation Practices?

Agricultural conservation or best management practices (BMPs) include nutrient, soil and water management practices, other management techniques, and social actions that are developed as practical and effective tools for environmental protection for a particular region or even watershed, i.e. Upper Illinois River. While BMPs are often tailored to a particular land management situation or geographic location, BMPs are implemented for the same basic goal of protecting our water resources.

Why Should These Practices Be Used in the Upper Illinois River Watershed?

Agricultural conservation practices are strategies that prevent or decrease the movement of sediment, nutrients, pesticides and other synthetic organic chemicals, bacteria and other pathogens, and other potential pollutants from land to water resources; these practices are specially designed to minimize the impacts of agricultural land use and management on water quality.

How Effective Are Agricultural Conservation Practices?

The effectiveness of conservation practices or BMPs are dependent upon several factors including:

- Proper Installation and Maintenance
- Selection of Appropriate Practices Based on Water Quality Issues
- Pollutant of Concern, Landscape Position, and Geographical Location
- Practical Considerations Regarding Production, Profitability, and Sustainability

The following sections address conservation easement, soil and nutrient management, stewardship programs, livestock and grazing management principles, and specific best management practices.

6.1 Conservation Easements for Agricultural Lands

Conservation easements are legal agreements that provide a way to preserve privately owned land through maintaining the existing uses or limiting other potential future uses. Conservation easements are most commonly used to limit development on ecologically sensitive lands or to restore or preserve the natural, aesthetic or historical values or processes that are associated with a piece of land. The use of conservation easements in the United States has successfully protected millions of acres of wildlife habitat and open space by keeping private land in private hands and generating substantial public and ecological benefits.

MISCONCEPTION: Although agricultural producers may think that conservation easements on agricultural lands limit agricultural practices and production, this is NOT the case. In many situations, the owners of agricultural lands can enter conservation easements without altering the historic land usage. Agricultural producers could choose to use a historic, forestry or wildlife specific easement, and conservation easements can be worked on in a fashion that is acceptable to both the land owner and the agency or land trust involved.

TAX BENEFITS: Tax deductions can be provided by the Internal Revenue Service depending on the conservation easement terms.

What Programs are Available?

There are many conservation easement programs that are applicable to the Upper Illinois River Watershed, and several of these programs are summarized below. Additional information about these programs can be found at the respective web address provided.

Arkansas Historic Preservation Program (www.arkansaspreservation.org)

This program offers a flexible way for property owners to insure that historic land and structural resources will be here for future generations within the Upper Illinois River Watershed; the sites that qualify for this program must be certified as a historic structure or located within a National Register Historic District and certified by the National Park Service. Each easement accepted by the Arkansas Historic Preservation Program is negotiated on an individual basis with the property owner, and the program accepts easements that are granted in perpetuity.

Who is Eligible? Individual Property Owners, Municipalities, etc. – The staff of this organization will help individual property owners identify and discuss the historic elements of individual properties, as well as individual goals, plans, and needs.

Conservation Reserve Enhancement Program (www.fsa.usda.gov/FSA/)

The Conservation Reserve Program (CRP) provides temporary easements of land. The easements obtained through the CRP usually last 15 years, and in this time, technical and financial assistance is provided to eligible participants to address soil, water, and other related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program is funded through the Commodity Credit Corporation (CCC).

Who is Eligible? Agricultural producers are eligible for this program on a competitive basis. The CRP is administered by the Farm Service Agency, and NRCS determines technical land eligibility.

Ducks Unlimited (www.ducks.org)

This program accepts easements in perpetuity through its affiliation with the Wetlands American Trust, where Ducks Unlimited agrees to monitor the conservation property on a yearly basis to insure the protection of the land's natural resources for years to come. This program desires to protect wetlands, riparian habitats and important uplands that benefit waterfowl and other wildlife, and to insure that future generations can enjoy these ecological services. Ducks Unlimited believes that most easements can benefit wildlife while producing economic return to individual property owners, and this partnership may result in reduced income and estate taxes for the landowners.

Who is Eligible? Individual Property Owners, Corporations and Other Organizations – With limited funds available, Ducks Unlimited makes every effort to ensure that conservation dollars are efficiently used.

Farms and Ranch Lands Protection Program (www.nrcs.usda.gov/programs/frpp)

This is a USDA program that allows government and non-government organizations to acquire conservation easements from landowners, where the participating property owner agrees not to convert farmland into non-agricultural uses and to implement a conservation plan. Under this program, landowners would retain rights to use their property for agricultural purposes within the Upper Illinois River Watershed, while the IRWP would get individual commitments to implement conservation plans that minimize the potential impacts of agricultural practices and future non-agricultural development on agricultural lands.

Who is Eligible? Government Agencies and Non-Government Organizations –Proposals for this program must be submitted by the IRWP through the NRCS State Office during the application window. Funding availability for this program is variable.

Arkansas Forestry Legacy Program (www.forestry.state.ar.us/manage/legacy.html)

This program was created to protect forested areas from potential land use changes, while still providing landowner rights to harvest and sell timber. The Forest Legacy Program would provide federal funding up to 75 percent of the cost of conservation easements or fee acquisition to the IRWP or other organizations entering into these agreements.

Who is Eligible? The Arkansas Forestry Commission is the lead state agency for this program, and the Assessment of Need Plan documents eligibility criteria, sets guidelines, and identifies priority areas which includes the Upper Illinois River Watershed.

Northwest Arkansas Land Trust (www.nwalandtrust.org)

The Northwest Arkansas Land Trust is dedicated to the conservation and responsible use of land in Benton, Carroll, Madison and Washington Counties; this organization helps to secure easements for agricultural, ecological, historic, recreational and scenic purposes across this region including the Upper Illinois River Watershed. Landowners can preserve special features on the property, define development limitations, and or conserve the landscape as a whole.

Who is Eligible? There are opportunities for the Northwest Arkansas Land Trust and the IRWP to partner with private landowners, government entities, and even real estate developers within the Upper Illinois River Watershed.

The Nature Conservancy (www.nature.org)

For more than four decades, The Nature Conservancy has been using conservation easements to protect landscapes from development – ultimately, conservation easement programs often provide better protection than could be accomplished with outright purchase.

Who is Eligible? Private Property Owners – Private property under conservation easement remains privately owned, and landowners often continue to live on the property. The Nature Conservancy is already active within the IRWP, and this existing partnership can be used to promote conservation easements throughout the Upper Illinois River Watershed.

6.2 Agricultural Conservation Programs

Farms within the Upper Illinois River Watershed use fertilizers, manure, pesticides and other inputs that are necessary for agricultural production, but these inputs and agricultural management practices can potentially impact the quality of the Illinois River and its tributaries. Adoption of agricultural conservation practices and or BMPs by agricultural producers is a voluntary process in most cases, and federal conservation programs are available that provide incentives or cost-share funds to aid in conservation practice and or BMP adoption and implementation process. Voluntary conservation cost-share programs specify who is eligible to receive payments, how much can be received, what practices are eligible, how applicants are selected, and the terms and conditions of the contract for the lifetime of the designated conservation practices.

What Conservation Programs are Available within the Upper Illinois River Watershed?

This section details several federal conservation programs that are available to land owners and agricultural produces within this watershed, and the IRWP should encourage its agricultural stakeholders to participate in these programs. The funding availability for these programs varies annually.

Agricultural Water Enhancement Program (www.nrcs.usda.gov/programs/awep/)

The Agricultural Water Enhancement Program (AWEP) is a voluntary conservation initiative that enables the use of the Environmental Quality Incentives Program (EQIP) along with resources of eligible partners to provide financial and technical assistance to owners and operators of agricultural lands. Eligible producers who participate in a project area that is identified in an approved partner agreement and who have an active EQIP program application may be approved for assistance. Under AWEP, the Natural Resources Conservation Service (NRCS) enters into partnership agreements with eligible entities such as local or state government, agricultural associations or groups, and non-governmental organizations that

work with agricultural producers who want to promote ground and surface water conservation or improve water quality on agricultural lands.

Conservation Reserve Program (www.nrcs.usda.gov/programs/crp/)

The Conservation Reserve Program (CRP) provides technical and financial assistance to eligible farmers and ranchers who want to address soil, water, and other related natural resource concerns on private lands in an environmentally beneficial and cost-effective manner. The program is either offered as a general program in which sign up is continuous and qualification is competitive, or as a prioritized program in which qualification is determined by priority area location, and the cost-share funds are distributed on a first come, first serve basis. CRP is funded through the Commodity Credit Corporation (CCC) and is administered by the Farm Service Agency (FSA). Technical land eligibility, conservation planning, and practice implementation are determined by NRCS. This program encourages farmers to convert environmentally sensitive acreage to vegetative cover, such as native grasses, wildlife plantings, trees, vegetative filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract, and cost sharing is provided to establish the NRCS conservation standard.

Did You Know?

The Conservation Reserve Enhancement Program (CREP) is a priority CRP program that seeks to enroll 15,000 acres of eligible, marginal cropland or pastureland, and this program is currently only available for the Arkansas portion of the Illinois River Watershed. This priority CRP has $30 million available for voluntary participation to establish or restore riparian forest buffers and wildlife habitats that filter runoff, stabilize streambanks, shade stream channels, and improve aquatic habitat. http://www.fsa.usda.gov/Internet/FSA_File/ark-irwcrep.pdf

Environmental Quality Incentives Program (www.nrcs.usda.gov/PROGRAMS/EQIP/)

The Environmental Quality Incentives Program (EQIP) is a voluntary USDA Natural Resource Conservation Service (NRCS) Program that provides assistance to farmers to implement conservation practices and BMPs in order minimize potentially negative environmental impacts of agricultural management practices to water resources. EQIP specifically targets locally identified problems with natural resources, and high priority is given where agricultural improvements will help meet water quality objectives. EQIP offers contracts that provide incentive payments and cost sharing for conservation practices, such as manure management systems, pest management, erosion control, and other practices that maintain or improve the health of natural resources. EQIP requires that NRCS conservation practice standards be used in all incentive and cost-sharing projects.

Grazing Lands Conservation Initiative (www.glci.org)

The Natural Resources Conservation Service (NRCS) offers this program to help landowners address natural resource concerns related to pasture management. NRCS grassland specialists and conservation planners work with farmers on resource assessments of pastures to help design effective grazing systems. All owners and managers of private grazing lands are eligible to receive technical assistance from NRCS. Available assistance includes the following:

1. Maintaining and improving private grazing land and its management;
2. Implementing grazing land management technologies;
3. Protecting and improving the quality and quantity of water;
4. Maintaining and improving wildlife habitat;
5. Enhancing recreational opportunities;
6. Maintaining and improving the aesthetic character of private grazing land;
7. Identifying opportunities and encouraging diversification; and
8. Encouraging the use of sustainable grazing systems.

Wetland and Riparian Zones Tax Credit Program (www.anrc.arkansas.gov/WetlandTaxCredit.html)

The Wetland and Riparian Zones Tax Credit Program is a state program that provides a credit against the tax imposed by the Arkansas Income Tax Act for any taxpayer engaged in the development or restoration of wetlands and riparian zones. This program is designed to encourage private landowners to restore and enhance existing wetlands and riparian zones, and when possible, create new wetlands and riparian zones.

Wildlife Habitat Incentives Program (www.nrcs.usda.gov/programs/whip)

The Wildlife Habitat Incentives Program (WHIP) is a voluntary conservation program for landowners who want to develop and improve wildlife habitat primarily on private land. Through WHIP, the USDA NRCS provides both technical assistance and up to 75 percent cost-share assistance to establish upland, wetland, riparian, and aquatic habitat areas on private property. WHIP agreements between NRCS and the participant generally last five to 10 years from the date the agreement is signed. Participants in this program voluntarily limit future use of the land for a period of time, but retain private ownership.

What Conservation Programs could be Available within the Upper Illinois River Watershed in the Future?

Conservation Security Program (www.nrcs.usda.gov/programs/csp)

The Conservation Security Program (CSP) is a voluntary conservation program that supports ongoing stewardship of private, agricultural working lands and rewards those producers who are meeting the highest standards of conservation and environmental management on their operations. The program is administered by USDA's Natural Resources Conservation Service (NRCS). The CSP is a voluntary program that provides financial and technical assistance to producers who advance the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on tribal and private working lands. Such lands include cropland, grassland, prairie land, improved pasture, and range land, as well as forested land and other non-cropped areas that are an incidental part of the agriculture operation.

To apply for CSP, NRCS asks potential participants to complete a CSP self-assessment workbook—available on the Web or from local NRCS offices—to find out if potential participant's operation meets the requirements of the program and qualifies for program participation. The self-assessment process is completed using a self-screening questionnaire for each land use to be enrolled. When this process is complete, the producer submits the CSP workbook to the local NRCS office during the sign-up period and meets with NRCS personnel to go over any additional needed documentation. NRCS will then

determine if eligibility requirements are met and provide options for the producer's decision on enrollment category placement.

Wetlands Reserve Program (www.ar.nrcs.usda.gov/programs/wrp.html)

The Wetlands Reserve Program (WRP) is a voluntary program offering landowners the opportunity to protect, restore and enhance wetlands on their property. Restoring, protecting and enhancing the functions and values of wetland ecosystems remain the focus of the Wetlands Reserve Program in Arkansas. Currently, this program is specifically focused on restoring bottomland hardwood forest ecosystems and improvement of water quality in the Lower Mississippi River Valley through reforestation and hydrology restoration.

How Can Conservation Programs Not Currently Offered within the Upper Illinois River Watershed Become Available in the Future?

The first step to making additional conservation programs available within the Upper Illinois River Watershed is to contact your local NRCS office and express interest in the program. An NRCS service provider will then assess your local watershed area for applicability of the program of interest. If the program is applicable, the service provider will contact the state office along with the interested party to make it known that program of interest is valid within this area and that its availability would enhance conservation efforts within the area of interest.

6.3 Soil and Nutrient Management in Agroecosystems

SOIL: The unconsolidated mineral and organic material throughout the surface of the Upper Illinois River Watershed that serves as a storage reserve for nutrients, a medium for the growth of terrestrial plants and microorganisms, and a filter for the water that percolates through it and into regional aquifers.

NUTRIENTS: Any substance used as a fertilizer that can be taken up through plant roots and promote growth; the major or primary nutrients that are used as fertilizers include nitrogen, phosphorus and potassium (N–P–K), secondary nutrients might include calcium (Ca), magnesium (Mg), and sulfur (S), and micronutrients usually include boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn).

Soils and fertilizer applications have several aspects that need to be properly managed in order to reduce the potential for adverse environmental effects to water resources.

Soil and nutrient management are complimentary practices that affect plant growth, and each is crucial in terms of both economic and environmental sustainability of agricultural operations. Plants require some minimum level of soil fertility for optimal growth but, there is also an optimum level of fertility above which nutrients might be taken up by the plants with no positive effect on crop yield (luxury uptake). In such cases where these nutrients are in excess, the nutrients could go unused and are vulnerable to be transported offsite via water moving downward through the soil profile (leaching) or surface runoff processes. Nutrient application in excess of plant needs can be costly in terms of the

farmer's pocket book, and excess nutrients transported offsite might produce negative environmental impacts within the Upper Illinois River Watershed. Regardless of the fertility level of the soil, nutrients can be transported offsite through natural processes, i.e. water movement downward through the soil profile and water lost via surface runoff following rainfall events, even with precise nutrient application rates.

Soil Management

Besides achieving the ability to sustain agricultural production, the goal of soil management is to maintain or increase the fertility of the plant root zone. The maintenance and enhancement of soil fertility is necessary to fuel plant growth for agricultural production, livestock consumption, and even to keep the soil surface protected and covered by plants. Soil management practices are inclusive of many things, including fertilizer and lime applications, grazing and forage management, and soil sampling. Soil quality has many different definitions, but the USDA NRCS definition is most suitable – according to the NRCS, soil quality is the ability of the soil to perform certain functions (USDA NRCS, 2003), such as:

1. Effectively cycling nutrients, minimizing leaching and runoff, while making nutrients available to plants
2. Maximizing water-holding capacity and minimizing runoff
3. Adsorbing and filtering excess nutrients, sediments, and pollutants
4. Providing a healthy root environment and habitat
5. Providing a stable foundation for structures.

Maintaining and increasing soil quality in the pasture areas of the Upper Illinois River Watershed is perhaps the most critical aspect of soil management, because pastured land spatially accounts for the largest active agricultural production sector within the watershed. Furthermore, water quality and the agricultural producers benefit from properly maintaining soil quality. Several soil management practices can be used throughout this watershed, and each management practice focuses on improving soil porosity, soil stability, ground cover and forage growth, and or soil organic matter which directly improves soil quality and function as defined above.

Soil Porosity is the ratio of air space relative to solid soil matter and is usually expressed as a percentage; the more pore space that there is in a soil the less compact the soil is which means:

- Water infiltration is increased and runoff is reduced
- Plant roots grow more easily to attain water and nutrients
- The soil surface is more likely to be covered by forage
- Micro-fauna presence in the soil is increased and more diverse
- The soil is not excessively compacted from overgrazing

Soil Stability is the measure of a pasture soil's ability to maintain aggregate structure and resist destruction; the more stable a pasture soil is in the Upper Illinois River Watershed the better it:

- Increases water infiltration and water storage capacity
- Increases vigorous forage growth and vegetative soil cover
- Increases soil organisms and promotes nutrient cycling
- Reduces runoff and soil erosion

Ground Cover and Forage Growth keeps the soil protected from erosion, contributes organic matter to the soil, encourages the presence of soil organisms, promotes nutrient cycling, and prevents nutrient leaching through the following processes:

- Increased vegetative soil cover and plant root-anchoring
- Increased habitat and food source for soil organisms – resulting in increased organic matter formation
- Increased nutrient uptake and cycling

Soil Organic Matter is a soil constituent that contains undecayed plant and animal tissues, animal wastes, partially decomposed plant and animal materials, and soil biomass. Soil organic matter contributes to the following:

- Increased water infiltration and water storage capacity
- Increased soil porosity
- Increased nutrient cycling maintenance
- Increased forage growth
- Increased resilience and recovery from compaction

These soil properties of porosity, stability, forage presence, and organic matter are inter-related are equally important in promoting the overall environmental quality of both soil and water. These properties are all influenced by a myriad of agricultural best management practices (BMPs), including:

- Controlled grazing management or prevention of overgrazing,
- Use of cool and warm season forages, especially legumes
- Soil sampling and testing
- Following soil test or nutrient management plan recommendations
- Proper fertilizer or manure fertilization

Although row crop production is currently very minimal within the Upper Illinois River Watershed, soil management practices that are more suited for row crop production, such as conservation tillage and cover crops used in combination with soil testing and other BMPs, could become increasingly important in the future. The IRWP needs to be aware that increased public and corporate sustainability initiatives could result in increased local agricultural production of certain crops, particularly some fruits and vegetables. The concept of food miles, defined as how far agricultural produce are transported to local commercial markets, might drive increased production of local fruits and vegetables in the future. And, this might place increasing importance on agricultural BMPs specific to these kinds of agricultural operations.

Nutrient Management

Nutrient management in the Upper Illinois River Watershed is defined by Titles 20, 21, and 22 set forth under and regulated by the Arkansas Natural Resource Commission (ANRC). These titles are for designated nutrient surplus areas (NSAs) of Arkansas and require:

- That nutrient management plan (NMP) training is provided for all NMP writers;
- That NMPs are required for application of animal manure or other organic nutrient sources; and

- That all nutrient applicators fertilizing more than 2.5 acres with any fertilizer are trained and certified.

NMPs are plans that must be updated every 5 years and are designed to manage the amount, source, placement, form, timing, and record keeping associated with the application of nutrients to the landscape. NMPs are phosphorus based in the Upper Illinois River Watershed and that means that the Phosphorus Index (P-Index) for pastures is used to determine how much manure or commercial fertilizer can be applied to a given field in a given year. NMPs provide a field by field inventory of soils, soil fertility, nutrient applications, and nutrient transport sensitive areas which can aid in improved nutrient use-efficiency.

NMPs are necessary to land-apply nutrients from animal manure or other organic nutrient sources (e.g., compost) and are developed based on the P-Index; however, NMPs are not required to apply commercial fertilizers. Instead, protective rates are followed after soil samples are collected and soil test results are received – the soil test results provide guidelines for the application of the primary nutrients (N-P-K) and other materials such as lime.

One of the first steps in the development of a NMP is the collection of soil samples, and the two counties in northwest Arkansas that contain the Upper Illinois River Watershed have different regulations on who can collect the samples. In Washington County, the conservation district has determined that only a technical service provider (extension agent, NRCS employee, conservation district employee) or a trained NMP writer can take soil samples for the development of a NMP. While in Benton County, farmers are allowed to take and submit their own soil samples for the development of a NMP by the Benton County Conservation District or another qualified plan writer.

In addition to obtaining and using NMPs for nutrient management and nutrient loss prevention in runoff, there are other key practices that can help prevent the loss of nutrients or ensure more efficient nutrient distribution. The conservation practices that can be used in the Upper Illinois River Watershed are discussed further in the next section (i.e., 6.5—Agricultural Best Management Practices). Nutrient management is in the interest of all watershed stakeholders alike, and it is imperative to begin efforts aimed at controlling nutrient transport offsite from agricultural fields at the nutrient source. Nutrient management must begin with increasing the nutrient-use efficiency at the agricultural field and farm-level within the Upper Illinois River Watershed, and long-term goals must include shifting nutrient management to balancing inputs with outputs at a watershed-scale.

6.4 Livestock Grazing Management

There are about 220,578 acres of forage and pasture in the Upper Illinois River Watershed, which is a 10 percent decline since 1999. Forages consist of the cool-season grass tall fescue and the warm-season bermudagrass, and both are well adapted to the area providing forage growth for up to 9 or 10 months out of the year. Cutting for hay usually occurs once in spring for tall fescue and once or twice in summer for bermudagrass. Most pastures are used for cow-calf beef production systems with some stocker calves. Benton and Washington counties rank first and second, respectively, for beef production in Arkansas with a total herd size of 226, 238 head of cattle, of which about half are located within the Upper Illinois River Watershed. Beef production in this area has become integrated with poultry and to

a lesser extent, swine production, with manure providing a cheap and ready source of nutrients that, in addition to liming, has greatly improved area pastures. Because of P-based management of poultry litter and increased costs of mineral fertilizers, there is the potential for nutrient inputs to pastures to decrease. Thus, grazing management has become much more important for maintaining beef productivity and sustainability.

RECOMMENDATION: Legumes incorporated in pastures can provide N that is fixed from the atmosphere. However, nitrogen contributions are highly variable and depend on many factors. To take advantage of legume-derived nitrogen, producers need to be committed to a much more complex style of grazing management. Nevertheless, the investment in education and intensified management practices should pay off in the long term.

Beef-Cattle Grazing Management

In general, the following factors need to be taken into consideration for designing and maintaining sustainable grazing systems:

- **LAND**—including geographic location, soil type, slope, erosion potential, and fertility status;
- **PLANTS**—including species, varieties, weeds, growth stage, ground cover, quality, and quantity;
- **ANIMALS**—including number, kind, size, sex, production status, and age; and
- **MANAGEMENT**—including grazing methods, stocking rate, paddock number and size, pesticide use, and fertilization strategies.

Besides these basic considerations, other factors like wildlife habitat development, carbon sequestration, soil and water conservation, and open space aesthetic value are becoming increasingly important.

Grazing systems are not necessarily transferable from one area to another like nutrient management planning and should be farm specific to achieve a high degree of sustainability. As a first step to optimizing such a system, each producer should develop an overall forage plan for his or her operation. This plan should encompass a year-round management plan and match the forage program to the livestock enterprise. Forage quality is the first limiting factor in beef production, while forage quantity directly affects stocking rates. Matching both with nutritional needs of the present livestock optimizes animal production. Guidance and recommendations for establishing a forage plan and grazing system can be obtained from the Cooperative Extension Service of the University Of Arkansas Division Of Agriculture.

Grazing methods that can improve livestock production and enhance environmental stewardship include controlled continuous and or rotational stocking, creep grazing, sequence grazing, strip grazing, buffer grazing, frontal grazing, and others. Those more common to the Upper Illinois River Watershed are further explained below.

Controlled Continuous Grazing allows livestock unrestricted and uninterrupted access to a specific area for a specific time, and no subdivision fences are used during this period. To respond to changes in forage supply, producers can add or remove livestock, move livestock to another pasture, or provide supplemental feed. In the Upper Illinois River Watershed, many producers utilize this grazing method

due to low labor and minimal fencing requirements. However, if not managed carefully, overgrazing can increase soil compaction and lead to a much greater erosion and runoff potential.

Rotational Grazing is a recurring period of grazing among two or more paddocks with periods of forage rest and regrowth in between grazing periods. When forage production is high, some paddocks can be used for hay before the forage becomes too mature. Rotational grazing is particularly important for pastures that contain vegetation that benefits from rest periods. Legumes such as clovers and alfalfa should be grazed rotationally to provide times for regrowth. Although rotational grazing is labor intensive, there are advantages in terms of profitability, as well as, operational and environmental sustainability. There is evidence that nutrient runoff may be lower under rotational than continuous grazing. Additionally, rotational grazing gives the producer flexibility to deal with fluctuations in production and species maturity of warm- and cool-season forages.

Strip Grazing (Management Intensive Grazing) confines animals to a relatively small area that is grazed during a relatively short period of time. Forage utilization is high with this grazing method, up to 80-90%, thereby reducing waste due to trampling. Stocking density is set high enough to utilize the available forage quickly.

Buffer Grazing is an approach of continuous stocking that adjusts forage supply by using temporary electric fencing to exclude livestock from certain areas that can be harvested either as hay or grazed during a time when environmental impacts are minimized. This grazing method is well suited to make use of sensitive riparian areas by providing only infrequent access for grazing livestock yet allowing extra forage when needed.

Grazing Management of Goats, Sheep, and Horses

Although goats, sheep, and horses make up a small percentage of grazing livestock within the Upper Illinois River Watershed, they can be potentially mismanaged and contribute to negative environmental Impacts. Mismanagement is usually characterized by overstocking, which results in overgrazing and leads to the following:

- Damage to trees including damage to seedlings, shoots, branches, bark, and overall tree health
- Increases in soil compaction and soil bare spots, which lead to increased runoff and erosion
- Change of pasture species from desired forages to nuisance forages or weeds

Riparian Zones and Grazing Management

The condition of stream banks in the Upper Illinois River Watershed is of utmost importance for maintaining or improving water quality standards in the future. Numerous studies have shown that grazing livestock can damage stream banks in the process of grazing and seeking access to water and shade. Besides the trampling of stream-bank vegetation resulting in sediment loss and stream-bank erosion, water quality is impaired and farm nutrients can be lost through the deposition of manure and nutrients directly in streams instead of pastures.

RECOMMENDATION: There are two main options to limit livestock access to streams. One option is to partially fence off a stream to restrict access and the other is to fence off the stream completely. Either way, an alternative watering system should also be used if no ponds are available to provide water to

livestock. In a situation where pastures are divided by streams or channels, crossings for livestock should be installed to minimize the impact on banks. These crossings can be constructed relatively inexpensively from readily available materials. Plans for construction of stream crossings can be developed with help from NRCS personnel.

Watering Systems and Grazing Management

In many cases, producers rely on access to streams and ponds to provide water to livestock. Unfortunately both options are not ideal solutions in terms of livestock health, farm sustainability, or water quality. Livestock access to ponds creates some of the same problems as access to stream banks, including eroded banks, sediment intake, eutrophication, and parasite-infested waters that can reduce profitability of the entire livestock operation.

RECOMMENDATION: An alternative to these two watering methods is to establish watering systems. Establishment of alternative water sources requires some financial investments, but improved cattle health, farm sustainability, farm profits, and reduced environmental impacts can often justify those costs.

Heavy-Use Areas and Grazing Management

Heavy-use areas are places where livestock tend to congregate, including feeding and watering areas, shady areas, loafing areas, travel lanes, working facilities, and holding pens. These areas are characterized by lack of vegetative cover, compacted soil, and a concentration of manure.

RECOMMENDATION: Producers should choose sites for these areas that are slightly elevated to reduce the amount of standing water and use vegetative filter strips to protect water quality by reducing nutrient and sediment losses in runoff. Travel lanes should not be wider than necessary, and working facilities should be designed efficiently to make maximum use of minimum space. At the same time, locations with steep slopes should be avoided to reduce the risk of runoff. Livestock feeders and hay rings should be moved around regularly aid in the even distribution of nutrients from animal excretion and to allow areas to recover. Also, unrolling hay bales may help to spread the feeding area and avoid excess soil compaction and unequal nutrient distribution. Shade can be important to livestock productivity but should also be rotated if possible to avoid muddied areas and nutrient accumulation.

6.5 Confined Animal Management

Some agricultural operations keep animals in a confined situation instead allowing them to roam freely in pastures. Confined animal management is the practice of raising animals at a high stocking density where the animals, feed, waste and production operations are congregated on a small land area. In a confined situation, limited natural vegetation is available for animal consumption or animal waste processing. Therefore, feed management and manure export should be addressed to maintain a healthy living environment.

What is Feed Management?

Dietary manipulation is the process of supplying the appropriate amount of nutrients required by livestock and poultry for growth, maintenance, and reproduction. Dietary standards for swine, dairy,

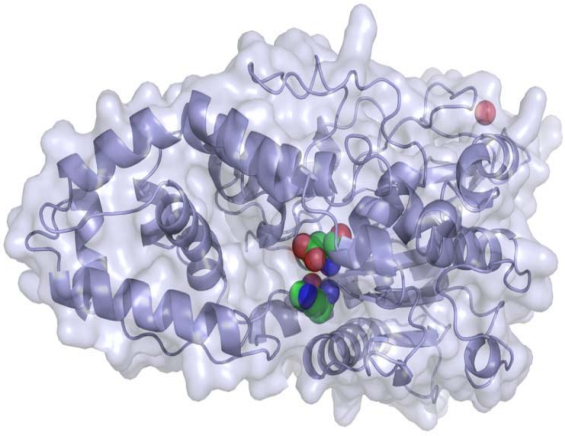
and poultry production are usually developed based on land grant university recommendations and professional animal nutritionists of agricultural production and feed companies.

What is the Purpose of Feed Management?

The purpose of dietary manipulation is three-fold. One purpose is to develop diets that are designed to meet animal nutritional requirements for each stage of growth and for the intended production purpose. The other purposes are attainment of economic efficiency and management of environmental concerns. Feed nutrients represent a large portion of input cost and nutrient import to a farm and have a direct impact on economic sustainability and the nutrient content of manure.

Managing nutrients in feed is key to getting closer to balancing nutrient inputs and outputs on farms.

How Does Feed Management Work?



3D Ribbon/Surface Model of 3-phytase From *Aspergillus niger* (from Wikipedia Commons)

Feed management aims to reduce the amount of phosphorus imported into concentrated animal feeding operations (such as poultry and swine farms) by decreasing mineral phosphorus supplements in feed, by including enzymes in feed that enhance nutrient utilization and absorption by poultry, and by using crop hybrids that contain lower levels of relatively indigestible phytate-phosphorus. However, with integrated poultry and swine production, feed ingredients are controlled by integrator companies such that individual farmers have few options for dietary or feed manipulation. This contrasts with feed management of dairy cows, where individual farmers have more flexibility to tailor mineral phsophorus supplements to meet recommended dietary requirements. http://www.extension.org/pages/NRC_Recommendations_for_Dairy_Cows#.

Chickens, turkeys, and swine need phosphorus primarily for bone and muscle development, but also to better utilize energy in their diet. Insufficient phosphorus intake results in reduced bone and muscle accretion and can lead to loss of skeletal integrity. However, these animals can't digest phosphorus from feed grains because they lack sufficient levels of phytase, the enzyme that releases phosphorus from grain. In fact, only 20-30% of phosphorus in feed grains is available to meet nutritional requirements, with the remainder excreted in manure.

As a result, mineral calcium phosphates are added to feed to ensure adequate dietary requirements. However, supplementing poultry and swine diets with an enzyme such as phytase that breaks down phytate into digestible forms, reduces the need for phosphorus supplements and can thus, decrease the total phosphorus content of manure.

The main benefits of adding enzymes or reducing mineral phosphorus supplements in poultry and swine feed include:

- A decrease in the phosphorus content of manure reduces the area of land needed to apply manure on a phosphorus basis.
- A lowering of phosphorus concentrations in manure relative to nitrogen, serves to bring the N:P ratio of manures (about 2 or 3:1) closer to plant needs (about 8:1). This is a key to more efficient utilization of nitrogen and phosphorus in manures, to over application of phosphorus relative to nitrogen, and to decrease the need to purchase mineral fertilizer nitrogen to supplement plant needs.

More expensive mineral phosphorus supplements and cheaper phytase enzymes make feed management a cost-effective option.

However, there has been conflicting research regarding the benefits of using phytase and whether land application of manure or litter from poultry or swine fed phytase, translates into decreased losses of phosphorus in runoff, unless litter application is phosphorus-based. Some have attributed the inability of dietary phytase to decrease runoff phosphorus to the possible post-excretion of microbes that continue to solubilize both manure and soil phosphorus.

Corn hybrids are also available which contain low amounts of indigestible phytate phosphorus. Poultry that were fed "low-phytic acid" corn grain have been found to excrete less phosphorus in manure than those fed conventional corn varieties. Currently, the challenge to plant breeders is to incorporate the low-phytate trait into other crops, such as soybean, because of greater pressures being placed on corn for biofuel production.

Did You Know? **Dietary manipulation (also called Feed Management by NRCS Conservation Practice Standard) is considered a Best Management Practice. For example, an independent dairy, swine or poultry farmer can enter into an agreement with the USDA-NRCS to develop a Feed Management Plan.**

Feed Management Plans

A feed management plan that assists in the management of nutrients fed to livestock and poultry can be developed for individual farms. The goal of such a plan is to tailor feed to aid in animal growth, production, and performance while also reducing nutrient contents of manure and improving farm-level economics through improvements in feeding efficiencies. Such plans are developed for specific species of animals and should be made based on the recommendations of the National Research Council and land grant university recommendations, in addition to standards developed by animal production industries. These plans are developed by animal scientists and professional nutritionists and can be made to specifically address the following:

- Formulate diet to more closely meet animal needs
- Reduce excess nutrient content
- Increase nutrient digestibility to reduce feed-nutrient inputs

- Increase nutrient digestibility to increase feed efficiency
- Reduce manure nutrient content

RECOMMEDENDATIONS:

1. The Illinois River Watershed Partnership should encourage the use of phytase in poultry and swine diets to decrease mineral phosphorus supplements.
2. The Illinois River Watershed Partnership should encourage the use of corn and soybean hybrids with low levels of phytate phosphorus to decrease mineral phosphorus supplements.
3. The Illinois River Watershed Partnership should work with governmental agencies to provide incentives for farmers to reduce mineral phosphorus supplements in dairy cows to nationally recommended dietary levels.

Manure Transport Programs

In many areas, manure is rarely transported more than 10 miles from where it is produced. As a result, an increasing number and variety of programs are coming into existence to meet the needs of poultry producers to move manure across farm, county and even state boundaries. For instance, poultry producers in the Eucha-Spavinaw Watershed are using the services of brokers to arrange for the sale and transport of their litter to crop producers, because of restrictions on land application of litter in the watershed, as a result of a lawsuit settlement agreement.

As an example, BMPs Inc. a non-profit corporation was established by representatives of five poultry integrator companies to assist in litter export. BMPs Inc. coordinates broiler house clean-out, litter hauling, and spreading of litter for poultry producers and litter buyers (http://www.litterlink.com/). This broker currently serves poultry producers, litter buyers and haulers in Arkansas, Oklahoma, Missouri and Kansas. Such brokers will provide increasingly valuable services to poultry and crop producers, while establishing a sustainable system for the future.

Transporting poultry litter out of the Upper Illinois River Watershed is a viable nutrient management option.

The concept of poultry litter brokers and banks has grown to meet the needs of litter buyers who have signed up for subsidized programs and are requesting a “turn-key coordination process,” similar to that used to obtain commercial fertilizer. Crop producers purchasing litter want to be able to contact a broker, order litter to be delivered, and have it spread on their fields. On the other hand, poultry producers need the security of knowing their houses will be cleaned in a timely manner and that they will receive compensation for the nitrogen, phosphorus, and potassium sold in their litter. In the case of

Eucha-Spavinaw Watershed, brokers have been successful at facilitating the movement of 74% of the poultry litter produced out of the watershed annually since 2004, rather than have it continue to be applied in the watershed.

How far we can economically transport or haul the litter is a difficult question to answer because of all the inherent fixed and variable costs (i.e., fuel, litter, labor, insurance, etc.). However, with some general assumptions, the question can be put in perspective.

Transporting poultry litter out of the Upper Illinois River Watershed is highly dependent on fluctuating energy prices (e.g., fuel and fertilizer costs).

EXAMPLE: A well-managed 25,000-bird poultry house usually produces 5.5 flocks of birds a year and generates about 125 -140 tons of litter, annually which, because of recent increases in fertilizer prices, can now be transported greater distances. Recent litter hauling costs are estimated at $0.15/mile/ton of litter. Given the one-time house clean-out, loading and spreading costs of $28.50/ton; at 2004 fertilizer nitrogen, phosphorus, and potassium prices ($36/ton litter based upon litter value), litter could be transported about 63 miles. At 2008 fertilizer prices ($107/ton litter based upon litter value), hauling distances increased to nearly 600 miles.

Poultry litter is loaded onto truck and then transported to another farm as a fertilizer nutrient source.

Clearly, the viability of manure transport programs is intrinsically linked with energy costs. Higher fuel prices will increase transportation costs. Offsetting this to a certain extent is that increases in natural gas prices are translated into higher nitrgen fertilizer costs. To a certain extent, this raises the value of litter or manure as a fertilizer.

RECOMMENDATIONS:

1. The Illinois River Watershed Partnership should encourage the development of programs to provide financial support or credits to producers selling poultry litter to offset the purchase of fertilizer nitrogen and potassium to maintain pasture productivity.
2. The Illinois River Watershed Partnership should continue to support coordination of linking sellers and buyers of poultry litter

3. The Illinois River Watershed Partnership should continue to find ways to increase the market value and geographic scope of manure produced in the Upper Illinois River Watershed.

For Additional Information about the Scientific Studies Presented in This Subsection See:

- Ajskaiye, A., M.Z. Fan, T. Archbold, R.R. Hacker, C.W. Forsberg, and J.P. Phillips. 2003. Determination of true digestive utilization corn-soybean based diet fed to early-weaned pigs. J. Anim. Sci. 81:1806–1813.
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- Ertl, D.S., K.A. Young, and V. Raboy. 1998. Plant genetic approaches to phosphorus management in agricultural production. J. Environ. Qual. 27:299-304.
- Maguire, R.O., J.T. Sims, and T.J. Applegate. 2005. Phytase supplementation and reduced-phosphorus turkey diets reduce phosphorus loss in runoff following litter application. J. Environ. Qual. 34:359-369.
- Penn, C.J., G.L. Mullins, L.W. Zelazny, J.G. Warren, and J.M. McGrath. 2004. Surface runoff losses of phosphorus from Virginia soils amended with turkey manure using phytase and high available phosphorus corn diets. J. Environ. Qual. 33:1431-1439.
- Sharpley, A. N., Herron, S., West, C., and Daniel, T.C. 2009. Outcomes of phosphorus-based nutrient management in the Eucha-Spavinaw watershed. p. 192-204. In A. Franzluebbers (ed.), Farming with Grass: Sustainable Mixed Agricultural Landscapes in Grassland Environments. Soil and Water Conservation Society, Ankeny, IA.

For Additional Information about Confined Animal Management See:

- **DIETARY PHOSPHORUS LEVELS FOR DAIRY COWS.** Mark Powell and Larry Satter, USDA-ARS Madison, WI. 2009. http://www.sera17.ext.vt.edu/Documents/BMP_dietary_phosphorus.pdf
- **DIETARY PHYTASE TO REDUCE PHOSPHORUS LOSSES FROM ANIMAL MANURES.** Doug Smith, USDA-ARS< West Lafayette and Brad Joern, Purdue University, West Lafayette, IN. 2009. http://www.sera17.ext.vt.edu/Documents/BMP_dietary_phytase.pdf
- **FEED MANAGEMENT.** USDA-NRCS Conservation Practice Standard 592. ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/592.pdf

- **NUTRIENT MANAGEMENT.** USDA-NRCS Conservation Practice Standard 590.
  ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/590.pdf
  ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/cppe/examples/590info.pdf
  ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/jobsheets/590js.pdf

- **NRC RECOMMENDATIONS FOR DAIRY COWS.** Livestock and Poultry Environmental Learning Center and Cooperative Extension System. 2008.
  http://www.extension.org/pages/NRC_Recommendations_for_Dairy_Cows#

6.6 Best Management Practices for Agricultural Lands

Agricultural Best Management Practices (BMPs) are land and nutrient management strategies which prevent, limit or decrease the movement of sediment, nutrients, pesticides and other potential pollutants in runoff water from the landscape to surface or ground water; these practices are designed to minimize the impacts of agricultural activities on water quality. While BMPs were developed for a particular land or nutrient management situation and geographical location, they are implemented for the basic goal of protecting our soil and water resources. Practical consideration is important because there is no one size fits all combination of BMPs that will be affordable or appropriate for every field, farming operation and or watershed. Additionally, some BMPs are intended to limit pollutant loss at the source, while other practices are designed to limit the transport potential of pollutants. The efficiency and costs of the variety of BMPs differs greatly; for example, many structural BMPs are relatively expensive to implement whereas some managerial BMPs are simply more sustainable pollutant reduction measures and have a more system wide application than others.

What Do the Use and Effectiveness of Best Management Practices Depend on in the Upper Illinois River Watershed?

- Practical consideration related to production, profitability, and sustainability;
- Selection of appropriate practices for the given combination of water quality issues, target pollutants, landscape position, and geographical location; and
- Proper installation and maintenance.

There are four general categories of BMPs that can be implemented including structural, managerial, source and transport BMPs. Various combinations of these four types can also be implemented.

STRUCTURAL BMP EXAMPLE: A poultry farmer may have more use for a litter stacking shed than a beef cattle farmer, because the poultry operation produces large quantities of litter that must often be cleaned out from the houses before it is time to apply the litter; the stacking shed can store litter for a poultry farmer until used following nutrient management plans or sold as fertilizer. A beef cattle

farmer, however, will not need to store the letter, because it will be used to fertilize a pasture upon receiving it from the poultry farmer.

MANAGERIAL BMP EXAMPLE: A beef cattle farmer can make choices to control grazing by confining more cattle on less land for short durations and rotating them more frequently. These management actions allow for more uniform pasture nutrient distribution, more efficient grazing and forage utilization, and more pasture rest which result in reduced fertilizer inputs, improved pasture soil properties, and increased cattle weight gain.

SOURCE BMP EXAMPLE: Soil testing, fertilizer spreader calibration, and nutrient application based on a soil test report or nutrient management plan ensures that fertilizer is not over applied.

TRANSPORT BMP EXAMPLE: A vegetative filter strip or riparian buffer is placed between areas of agricultural use (i.e., pastures, feedlots, or row crops) and environmental sensitivity (i.e., streams, wells, or sinkholes).

SOURCE AND TRANSPORT BMP COMBINATION EXAMPLE: A proper fertilizer application was made to a pasture and vegetative filter strip is placed down slope of the application site upslope from an environmentally sensitive area.

Are Agricultural BMPs Financially Feasible within the Upper Illinois River Watershed?

Yes! Voluntary BMPs use can be implemented with financial cost share assistance from the local Conservation District and or various federal agency as covered in Section 6.2. Also, these practices can be implemented without cost-share assistance in a way that improves overall farm level efficiency, production, and sustainability with or without the help of technical service from the Cooperative Extension Service, NRCS, or Conservation District.

What is Cost-Share Assistance, and What is Available in the Upper Illinois River Watershed?

Cost-sharing means that a portion of the project or management practice costs are not borne by the landowner or project sponsor. Cost-share assistance is available through USDA-NRCS service providers and sometimes through local conservation districts. To receive cost-share assistance, a farmer or property owner must first check to make sure that it is available through the USDA-NRCS or Conservation District in a given county. Even though cost-share programs may exist in a county, it does not necessarily mean that funds will be available or received for cost share as applied. Each individual must also qualify in order to receive cost-share assistance, and applicants must comply with specific program requirements. Qualification is usually determined by the amount of potential environmental improvement that could be related to the implementation of BMPs on a given piece of land. Cost-share assistance is currently available in the Upper Illinois River Watershed for the following programs:

1. Agricultural Water Enhancement Program (AWEP)
2. Environmental Quality Incentives Program (EQIP)
3. Conservation Reserve Program (CRP) Non-Priority CRP
4. Conservation Reserve Enhancement Program (CREP) Priority CRP

5. Wildlife Habitat Incentives Program (WHIP)
6. Conservation Reserve Enhancement Program (CRP)

Cost share practices for these programs are somewhat interchangeable availability will vary on a case by case basis depending on specific land features, environmental risk factors, agricultural practices, and need.

EXAMPLE: Alternative watering is not a traditional CRP cost-share practice, but if implementing a riparian zone and stream fencing BMP combination presents a livestock need for water due to stream exclusion, then alternative watering can be included in the CRP cost-share package.

What if an Agricultural Producer Does Not Want Cost-Share Assistance?

BMPs implemented without cost-share assistance can be more flexible. Often, this encourages voluntary BMP adoption because practices can be implemented that are lower in installation cost and have more practical maintenance options over the long-term. The amount of paperwork, potential for financial penalty and property ownership burdens resulting from multi-year contractual stipulations are minimized when BMPs are implemented without cost-share assistance. However, the agricultural producer should still follow as closely as possible USDA-NRCS, local Conservation District or Cooperative Extension Service recommendations in the selection and implementation of BMPs to ensure that the water-quality benefits of these BMPs will be maximized.

EXAMPLE: Stream fencing or exclusion fencing is a great BMP, and it can be cost-shared through one of many USDA-NRCS programs. However, the cost-share contract stipulates certain requirements for materials (posts, gates, braces, wire, fasteners, etc.). In addition, if a flood damages or lays over the fencing, the farmer must replace the components for this practice out of pocket, without additional cost share. Whereas, a farmer not participating in cost-share assistance may want to fence off a stream and use the most cost-effective materials that are that are readily available and easily replaceable. This option also reduces the fear of a financial burden brought on by a 15-year contract that stipulates that the contract requirements be followed or fines will be assessed.

What Agricultural BMPs are Applicable to the Upper Illinois River Watershed?

SOURCE BMPS:

- ***Controlled Grazing:*** (NRCS Code 528) Managing the controlled grazing of livestock. http://efotg.nrcs.usda.gov/references/public/AR/528_ps.pdf

- ***Fertilizer Calibration:*** (NRCS Code 590) Ensures that intended application rates of fertilizer and soil amendments are being accurately delivered to the pasture which prevents over applications. http://efotg.nrcs.usda.gov/references/public/AR/590.pdf

- ***Legume Establishment:*** (NRCS Code 512) Seeding clover or other legumes into pastures provides ground cover, reduces the need for nitrogen fertilization in pastures and increases forage quality. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/512.pdf

- ***Litter Stacking Shed:*** (NRCS Code 313) Provides a covered storage facility for solid manures and litter until it is the recommended time to utilize the fertilizer product. http://efotg.nrcs.usda.gov/references/public/AR/313.pdf

- ***Manure Amendments:*** (NRCS Code 591) Chemical and biological additives for manure that reduce nutrient loss potential which can benefit water quality, air quality, and animal health. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/591.pdf

- ***Manure Composting:*** (NRCS Code 317) Provides a sound structure for the stabilization of organic material. http://efotg.nrcs.usda.gov/references/public/AR/317.pdf

- ***Manure Fertilization:*** (NRCS Code 633) Enhances soil organic matter, microbial communities, soil structure, and forage growth which leads to improved pasture. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/633.pdf; http://efotg.nrcs.usda.gov/references/public/AR/590.pdf

- ***Mortality Composting:*** (NRCS Code 316) Provides a sound structure for the stabilization of organic material and kills pathogens to reduce the pollution potential of agricultural waste carcasses. http://efotg.nrcs.usda.gov/references/public/AR/316.pdf

- ***Nutrient Management:*** (NRCS Code 590) Managing the amount, source, placement, form and timing of the application of plant nutrients and soil amendments. http://efotg.nrcs.usda.gov/references/public/AR/590.pdf

- ***Pesticide Management:*** **(**NRCS Code 595) Storing, applying and disposing of pesticides according to legal guidelines in order to exterminate pests. http://efotg.nrcs.usda.gov/references/public/AR/595.pdf

- ***Soil Testing*****:** (NRCS Code 590) Provides a report of soil nutrient content and other soil information for individual pastures including the recommended fertilization and lime rates. http://efotg.nrcs.usda.gov/references/public/AR/590.pdf

- ***Waste Storage Lagoon:*** (NRCS Code 359) Provides a storage facility for liquid manure where it can be biologically treated before it is utilized as a fertilizer. http://efotg.nrcs.usda.gov/references/public/AR/359.pdf

TRANSPORT BMPS:

- ***Alternative Watering:*** (NRCS Code 614) Portable or permanent water tubs where livestock can access water which reduces erosion, nutrient and bacteria hot spots. http://efotg.nrcs.usda.gov/references/public/AR/614.pdf

- ***Brush Management:*** (NRCS Code 314) Increases desirable forage species for livestock, increases ground cover, and prevents erosion by managing clearing and reseeding of land. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/314.pdf

- ***Channel Bank Vegetation:*** (NRCS Code 322) Establishes vegetation on conveyances and stream banks. http://efotg.nrcs.usda.gov/references/public/AR/322.pdf

- ***Conservation Cover:*** (NRCS Code 327) Provides year round vegetative cover protection from erosion for non-pasture areas. http://efotg.nrcs.usda.gov/references/public/AR/327.pdf

- ***Conservation Tillage:***(NRCS Code 329) Managing crop residue while only disturbing the soil to apply nutrients, condition residue and plant crops. http://efotg.nrcs.usda.gov/references/public/AR/329.pdf

- ***Cover Crop: (***NRCS Code 340) Seasonal establishment of plants for temporary cover of row cropped areas. http://efotg.nrcs.usda.gov/references/public/AR/340spec.pdf

- ***Diversions:*** (NRCS Code 362) Keep clean runoff water diverted away from feedlots or other areas where pollutants can be carried away in runoff water.
  http://efotg.nrcs.usda.gov/references/public/AR/362.pdf
  http://efotg.nrcs.usda.gov/references/public/AR/590.pdf

- ***Farm Ponds:*** (NRCS Code 378) Provide erosion control, nutrient containment, and a drinking water source that can complement a controlled livestock grazing system.
  http://efotg.nrcs.usda.gov/references/public/AR/378.pdf

- ***Fertilizer Setbacks or Buffers:*** (NRCS Code 590) Areas located adjacent to environmentally sensitive areas (i.e., sink holes, streams, or wells) that do not receive fertilizer.
  http://efotg.nrcs.usda.gov/references/public/AR/590.pdf

- ***Field Border*****:** (NRCS Code 386) A permanent vegetative border at the edge of or around a field that prevents the transport of sediment, nutrients, and bacteria in runoff.
  http://efotg.nrcs.usda.gov/references/public/AR/386.pdf

- ***Forage Harvest Management:*** (NRCS Code 511) The timely harvesting of forage crops by machines that maintains or increases desirable pasture forages and forage cover. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/511.pdf

- ***Grassed Waterways:*** (NRCS Code 412) are vegetated channels that collect runoff water and convey it at a non-erosive force to a stable outlet. http://efotg.nrcs.usda.gov/references/public/AR/412.pdf

- ***Heavy Use Area Protection:*** (NRCS Code 561) Protects areas heavily used by animals with the establishment of vegetation, surfacing with suitable material, or by installing needed structures. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/561.pdf

- ***Manure Exporting:*** (NRCS Code 633;634) The transport of manure from within NSAs of Arkansas to areas that are not designated as NSAs in which the receiver of the manure receive payment to offset transport costs. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/634.pdf; ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/633.pdf

- ***Pasture Fencing:*** (NRCS Code 382) Enhances ability to increase controlled grazing efforts, protect environmentally sensitive areas, and increase livestock production sustainability. http://efotg.nrcs.usda.gov/references/public/AR/382_specs.pdf

- ***Riparian Buffers*:** (NRCS Codes 391 and 390) Areas of permanent vegetation adjacent to streams that reduce pollutants in runoff, provide stream bank protection and stabilization from erosion, increase wildlife and aquatic wildlife habitat, and lower stream temperatures. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/391.pdf

- ***Roof Runoff Structure:*** (NRCS Code 558) A system to collect and covey or collect and store runoff water in a way that soil erosion and nutrient transport is minimized. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/558.pdf

- ***Sinkhole Management:*** (NRCS Code 527) Includes establishment of a vegetated buffer area from with nutrient and pesticide applications and grazing animals are excluded. http://efotg.nrcs.usda.gov/references/public/AR/527.pdf

- ***Stream Crossings:*** (NRCS Code 578) Provide a stabilized crossing area for animals and vehicles that reduces nutrient, sediment, and bacteria delivery to streams and also prevents stream bank erosion. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/578.pdf

- ***Stream Fencing:*** (NRCS Code 472) Limits or excludes livestock access to streams which maintains stream bank integrity and reduces the delivery of sediment, nutrients, and bacteria to streams. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/472.pdf

- ***Streambank Stabilization:*** (NRCS Code 580) Protects stream banks from erosion and stabilizes stream banks which maintains natural channel flows and reduces sediment loading into streams. http://efotg.nrcs.usda.gov/references/public/AR/580.pdf

- ***Vegetative Filter Strips:*** (NRCS Code 393) Filter strips reduce sediment, nutrients, and bacteria in runoff when they are placed between pastureland and environmentally sensitive areas. http://efotg.nrcs.usda.gov/references/public/AR/393.pdf

- ***Warm and Cool Season Forages:*** (NRCS Code 512) Provides year round forage cover for ground protection or extended grazing and prevents soil erosion and nutrient loss from pastures. ftp://ftp-fc.sc.egov.usda.gov/AR/efotg/4/512.pdf

BMP Used	Which Pollutant Is Reduced?				Relative Cost+
	Sediment	Nitrogen	Phosphorus	Bacteria	
Fertilization Setbacks		↓	↓	↓	Minimal
Fertilizer Spreader Calibration		↓	↓	↓	Minimal
Field Border	↓	↓	↓	↓	Minimal
Forest Harvest Management	↓	↓	↓	↓	Minimal
Nutrient Management	↓	↓	↓	↓	Minimal
Sinkhole Management		↓	↓	↓	Minimal
Soil Testing to Match Crop Needs	↓	↓	↓	↓	Minimal
Controlled Grazing	↓	↓	↓	↓	Minimal to $
Manure Exporting		↓	↓	↓	Minimal to $
Manure Fertilization	↓	↓			Minimal to $
Riparian Buffer	↓	↓	↓	↓	Minimal to $
Vegetative Filter Strips	↓	↓	↓	↓	Minimal to $
Brush Management	↓	↓	↓		$
Channel Bank Vegetation	↓	↓	↓	↓	$
Conservation Cover	↓	↓	↓	↓	$
Conservation Tillage	↓	↓	↓		$
Diversions	↓	↓	↓	↓	$
Manure Amendments		↓	↓		$
Pasture and Hayland Planting	↓	↓	↓	↓	$
Use of Legumes		↓			$

BMP Used	Which Pollutant Is Reduced?				Relative Cost[+]
	Sediment	Nitrogen	Phosphorus	Bacteria	
Use of Cool and Warm Season Forages	↓	↓	↓	↓	$
Alternative Watering	↓	↓	↓	↓	$$
Manure and Mortality Composting		↓	↓	↓	$$
Pasture Fencing	↓	↓	↓	↓	$$
Roof Runoff Structure	↓	↓	↓	↓	$$
Farm Pond	↓	↓	↓	↓	$$$
Heavy Use Area Placement or Construction	↓	↓	↓	↓	$$$
Litter Stacking Shed		↓	↓	↓	$$$
Manure Storage Lagoon		↓	↓	↓	$$$
Stream Bank Stabilization	↓	↓	↓		$$$
Stream Crossing	↓	↓	↓	↓	$$$

[+] ***Reduction costs can be farm-specific and variations will occur from operation to operation.***

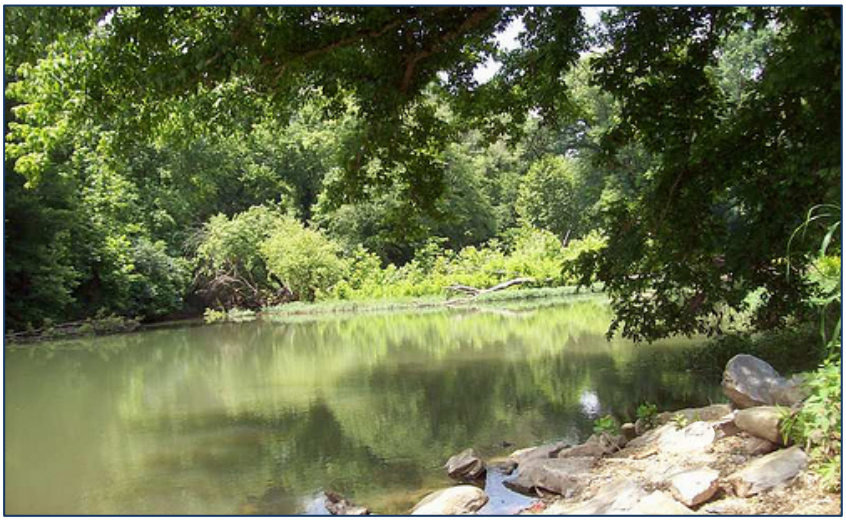
Chapter 7: Forest Management Practices

What are Forest Management Practices?

Forest management practices are planned operations conducted to assist in meeting forest management goals and to maintain or improve current forest conditions. Forest management practices can be designed to use a mix of different tree species and various ages to modify forest structure and open areas to maximize forest health and provide water quality benefits. These management operations may include thinnings, regeneration harvests, fertilization, soil management, competition control, and streamside maintenance.

Why Should These Practices Be Used in the Upper Illinois River Watershed?

Properly managed forests are a cornerstone of clean water and many other ecosystem services within a given watershed. Forests within the Upper Illinois River Watershed serve as a filter to reduce nutrient and sediment delivery to the Illinois River and its tributaries, and riparian forest buffers are essential to protect water quality. Targeting appropriate forest management strategies for sensitive areas such as streamsides, steep slopes, erodible soils, and other areas can prove beneficial for water quality and aquatic habitat.



How Are Forests Related to Water Issues?

Research shows that forests are linked to water yield and quality in the following ways:

- Riparian forest buffers can filter nutrients and sediments in runoff from upslope land uses.
- Forest canopies shade streams and intercept rainfall, protecting the soil from erosion and reducing runoff.
- Forest root systems increase water infiltration into the soil, groundwater recharge, and soil stabilization.

The following sections will address managing existing forests, choosing harvest and regeneration methods, establishing forest buffers, protecting forests from recreational usage, and specific best management practices.

7.1 Forests Types in the Upper Illinois River Watershed

There are approximately 179,170 acres or 36.5% of forested lands within the Upper Illinois River Watershed which primarily consist of upland hardwood timbers. These forests are often dominated by oak and hickory species, with smaller components of elm, maple, ash, black cherry and others. Upland hardwood forests within the Upper Illinois River Watershed also contain coniferous tree species such as shortleaf pine and eastern red cedar, with scattered loblolly pine plantations. Additional hardwood species such as sycamore, sugarberry, willow, black walnut, and others often occur in areas along stream and wetlands within the watershed. These mixed forests provide an excellent multiple use resource that can protect water quality as well as assist forest landowners in meeting other objects such as timber production, wildlife, aesthetics, and recreation.

7.2 Managing Existing Forests

Existing forestlands, while serving to protect water quality, do require some form of active forest management to maintain vigor and health. In many instances, water quality may be one of several objectives for a forest management strategy.

Forests provide industrial, ecological and recreational services including timber production, wildlife, recreation, aesthetic value, as well as protecting water quality and other environmental components.

Properly managed forests can achieve all of these objectives and still provide environmental benefits such as protecting water quality. Management of existing forest stands involves operations falling into one of two categories: 1) intermediate treatments or 2) regeneration harvests.

INTERMEDIATE TREATMENTS may include thinning, fertilization, timber stand improvements (TSI), and other operations. When managing solely for water quality, operations such as fertilization or some forms for TSI (such as using herbicides) may not be desirable. However, thinning trees from existing forest stands may benefit overall forest vigor, health and composition.

REGENERATION HARVEST METHODS consist of several timber harvesting methods, and should be conducted to achieve specific goals that maintain sustainability and minimize the effects on soil and water resources. These should always be designed to successfully regenerate a new stand. Several regeneration harvest methods may be implemented for hardwood forests within the Upper Illinois River Watershed, which fall into two categories:

1. ***Even-Aged Management*** means that the majority of trees in a forest stand are within a few years of being the same age. Even-aged management is typically the method of choice for desirable tree species (i.e., pine, oak, and ash), because they are usually intolerant of shade. There are several types of harvests that produce an even-aged stand including clearcutting and shelterwood harvesting.

    - Clearcutting (removing all canopy trees in one operation) is often viewed negatively, because of the belief that it can leave degraded stands and potentially impact runoff. In many cases, this concept is true because the operation is not properly planned and implemented. However, if forest stand and site conditions are favorable, clearcutting is a viable regeneration harvest

altern-ative. These prerequisite con-ditions include an adequate amount of desirable forest regeneration (seedlings) present prior to harvest, and forest sites that are significant distances from waterways and exhibit low soil erosion potential.

- Shelterwood harvesting involves a series of cuts (2 or 3) which leave mature, desirable trees, such as oaks, on a site to produce and protect regeneration. A critical first step in a shelterwood harvest is to remove the majority of small diameter and undesirable, such as elm and maple, in order to reduce competition and promote the growth of desirable species. The next step is to harvest a significant portion of the merchantable stems present, generally between 50 to 60 percent of the stand, which will produce optimal conditions for desirable (oak) regeneration. This partial harvest is designed to remove a large portion of the stand, while leaving trees to provide an environment that will allow desirable regeneration to become established prior to the final harvest. After desirable regeneration has been established (typically 3-5 years), some or all of the residual trees can be removed in the next harvest. If water quality protection is the primary objective, the residual trees may be left indefinitely. Though a shelterwood harvest is an intensive management operation, it allows for trees to remain on a site during regeneration harvest period. The shelterwood method proves an opportunity to meet multiple management objectives simultaneously.

2. ***Uneven-Aged Management*** involves maintaining a wide range of tree ages within a stand. This type of management is desirable when protecting water quality. However, due to a shading effect created by a significant presence of overstory trees, uneven-aged management can be difficult when attempting to regeneration tree species that are intolerant of shade. Two methods of uneven-aged management include single tree selection and group selection.

   - Single Tree Selection is a harvest method where scattered individual trees are removed and new regeneration is established in the opening. The primary concern with this method is that it often promotes shade tolerant species, which are usually the undesirable stems (such as elm, maple, and others).

   - Group Selection involves removing groups of trees to create opening for regeneration. Group selection creates a small opening (usually about 2 acres) that will regenerate similar to a clearcut harvest. Group selection is often viewed as a method that is basically a series of small clearcuts. Due to the small “patches” or openings, this method can help maintain diversity of species and size classes of trees across a landscape, which can be beneficial in maintaining water quality.

7.3 Choosing a Harvest Regeneration Method

Choosing a regeneration harvest method depends greatly on current stand conditions and the overriding management goals for the forest stand. The following four recommendations provide insight for choosing the correct regeneration harvest method for a particular forest stand. Each of the

regeneration harvest methods recommended below is discussed in detail in the previous section (i.e., 7.2, Managing Existing Forests).

RECOMMENDATION: Gently sloped forested areas that are significant distances away from streams may allow for more intensive regenerations methods such as clearcutting; clearcutting is not recommended for areas near streams or on steep slopes, because clearcutting in sensitive areas (e.g., near stream banks) could cause an increase in sedimentation in streams and other water bodies.

RECOMMENDATION: Lower impact regeneration methods (relative to clearcutting) should be used near environmentally sensitive areas that serve both to regenerate a forest stand and conserve soil and water quality; these harvests could include the shelterwood method or the group selection method.

RECOMMENDATION: If harvesting is to occur in close proximity to streams or water bodies, an uneven-aged management method should help to maintain continuous forest cover and reduce impacts from runoff; the individual tree selection method would be the method of choice in such areas.

RECOMMENDATION: In forested areas immediately adjacent to streams and waterways, a no harvest (or no management) policy should be employed; these areas should be allowed to utilize natural processes to regenerate, and only in extreme circumstances should management be applied to these areas, such a severe insect and disease outbreaks.

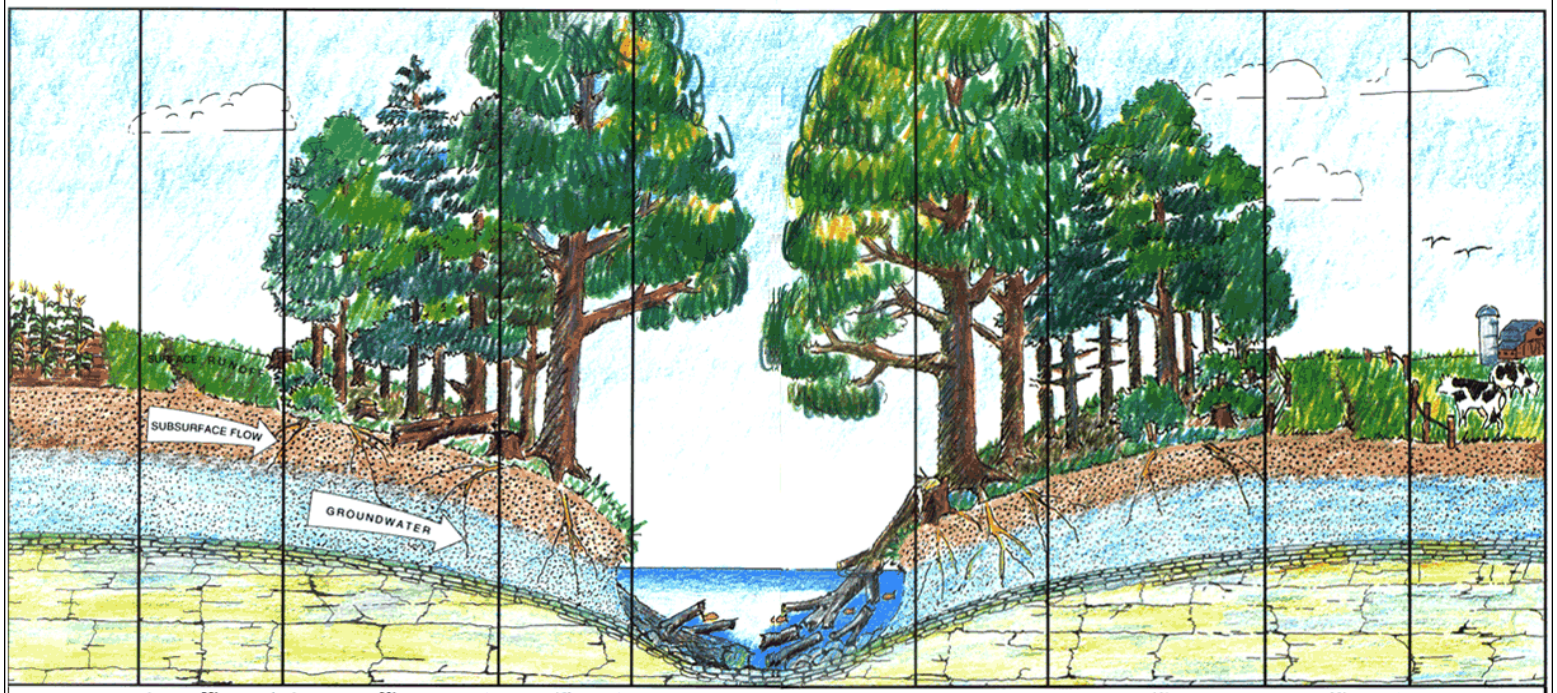
7.4 Establishing Forests to Buffer Waterways

As stated earlier, forests play an important role in protecting water quality. Trees and forests growing along streams and other drainage ways are very effective at intercepting sediment, nutrients, and other pollutants in runoff. Leaves and branches in the tree canopies intercept rainfall and reduce ground disturbance by raindrop impact. The humus layer on the forest floor acts like a giant sponge, soaking up and storing up to six inches of rainfall. This can greatly reduce runoff volume, with more water infiltrating to ground water. Tree roots take up water and nutrients that are required for growth, and transpire water through their leaves to the atmosphere; these roots help stabilize stream banks. The overall result is improved water quality and healthier aquatic life in the buffered stream with a riparian forest buffer.

Forests provide the most cost effective method of watershed protection by acting as living filters.

There are multiple styles of buffers that can be implemented, and the type of buffer that is used depends on the conditions that are near the waterway as well as the type of pollutant that is being guarded against. The five common types of buffers include grass buffers, three zone forest buffers, wildlife buffers, urban buffers and naturalized buffers. These buffers conserve water quality while simultaneously meeting other objectives.

THE STREAMSIDE FOREST BUFFER



	20'	60'	15'		15'	60'	20'	
CROPLAND	**ZONE 3 RUNOFF CONTROL**	**ZONE 2 MANAGED FOREST**	**ZONE 1 UNDISTURBED FOREST**	**STREAM BOTTOM**	**ZONE 1 UNDISTURBED FOREST**	**ZONE 2 MANAGED FOREST**	**ZONE 3 RUNOFF CONTROL**	**PASTURE**
Sediment, fertilizer and pesticides are carefully managed.	Concentrated flows are converted to dispersed flows by water bars or spreaders, facilitating ground contact and infiltration.	Filtration, deposition, plant uptake, anaerobic denitrification and other natural processes remove sediment and nutrients from runoff and subsurface flows.	Maturing trees provide detritus to the stream and help maintain lower water temperature vital to fish habitat.	Debris dams hold detritus for processing by aquatic fauna and provide cover and cooling shade for fish and other stream dwellers.	Tree removal is generally not permitted in this zone.	Periodic harvesting is necessary in Zone 2 to remove nutrients sequestered in tree stems and branches and to maintain nutrient uptake through vigorous tree growth.	Controlled grazing or haying can be permitted in Zone 3 under certain conditions.	Watering facilities and livestock are kept out of the Riparian Zone insofar as practicable.

Table 7.1. Examples of Species that are Suitable for Planting in Riparian Buffers.

Large Trees	Small Trees	Shrubs	Grasses
Green Ash	Redbud	Roughleaf Dogwood	Indian Grass
Sycamore	American Plum	Elderberry	Little Bluestem
River Birch	Serviceberry	Red Chokeberry	Big Bluestem
Sugarberry	Fragrant Sumac	Shrub Willow	Switchgrass
Shumard Oak	Crabapple	Beautyberry	
White Oak			
Willow Oak			
Black Walnut			
Persimmon			

There are a variety of trees that are suitable for planting in riparian buffer zones (e.g., see Table 7.1). The number, type and variation in species recommended varies depending on management goals and on what resources you are trying to protect.

Grass Buffer. This buffer consists only of grasses, and is typically used along small streams and other drainages that flow through crop fields and pastures. Grass filter strips are usually narrow, and may contain several grass species that slow down and disburse runoff. Grasses are most effective at filtering sediment and can promote the retention of nutrients and other contaminants. Suggested buffer width should be at least 30 feet.

Three-Zone Forest Buffer. Zone 1 contains trees along the edge of stream, and is usually left undisturbed. Zone 2 contains trees that can be managed by thinning to maintain vigorous growth needed to take up water and nutrients. Zone 3 is usually a grass strip that functions to slow down and spread runoff. A modified 3-Zone buffer contains a shrub and small tree zone between the edges of Zones 2 and 3 to give a feathered effect which is more desirable for wildlife. Suggested buffer width is a minimum of 100 feet on each side of a stream, and recommended width increases with increasing slope of adjacent land.

Wildlife Buffer. This buffer is similar to the three-zone buffer, but puts more emphasis on trees, shrubs and grasses that are beneficial to wildlife. A wildlife buffer is usually wider, up to 300 feet, to better function as a travel corridor between larger tracts of forest.

Urban Buffer. Buffers in urban areas are important for intercepting runoff from developed areas. These buffers are designed to better withstand human impacts, and may require larger planting stock. Urban buffers can also function as greenways along stream, and may include a recreational trail. Urban buffers and greenways can be used to teach homeowners and developers about the importance of protecting streams and water quality, and still allow limited use. Suggested buffer width is a minimum of 100 feet.

Naturalized Buffer. This buffer would be established from tree, shrub and grass seed that has blown in or has otherwise been carried in naturally from the surrounding area. Vegetation that already exists or establishes naturally can be supplemented by inter-planting tree and shrub seedlings as needed to achieve desired stocking densities. This buffer type represents an inexpensive buffer that can still effectively intercept runoff. Suggested buffer width is a minimum of 100 feet.

7.5 Timber Harvest and Regeneration Best Management Practices

No matter the harvest and or regeneration method employed, each practice should be carefully implemented to reduce site impacts on soil and water resources. In Arkansas, guidelines are available that provide instruction for protecting soil and water quality during and after timber harvests. These guidelines are known as "Best Management Practices" or BMPs. Oversight of BMPs is carried out by the Arkansas Forestry Commission (AFC). The AFC promotes the use of BMPs to timber harvesters and forest landowners throughout the state; the commission also conducts annual surveys to evaluate BMP awareness and implementation. BMP practices are currently voluntary, but should be utilized in timber harvest areas.

What Can Forest BMPs Be Applied to in the Upper Illinois River Watershed?

HARVESTING. In addition to considering what and where trees should be harvested, harvesting BMPs include layout and construction of access roads, skid trails for transporting logs, and strategic planning of landing locations. The AFC provides BMP guidelines that should be conducted to minimize the effects on soil and water at www.forestry.state.ar.us/bmp/harvesting.html, and the guidelines discuss:

- ***Design of Harvest Sites***: Overall design of the harvest site including harvest size, skid trails and landing location.
- ***Log Landings:*** Areas of concentrated equipment use and site traffic during harvesting.
- ***Felling and Bucking***: Cutting trees down and cutting them into useable lengths.
- ***Skidding:*** Removing trees, logs, and other materials from the felling location.
- ***Weather Conditions:*** Logging should be avoided in excessively wet areas or during excessively wet weather.
- ***Harvest Site Closeout:*** On-site examination of harvest area to ensure proper implementation of BMPs.

SITE PREPARATION. Preparation of the harvest site involves the use of equipment to manipulate vegetation and soil conditions before reforestation. Specific guidelines for both high and low intensity BMP practices can be accessed online at the following address: www.forestry.state.ar.us/bmp/site_prep.html.

STREAMSIDE MANAGEMENT ZONES. Streamside vegetation and soils act as buffer zones and have a strong influence on the health of adjacent aquatic systems. Streamside management zones protect water quality by providing bank stability and acting as a filter. Guidelines for streamside management can be found at http://www.forestry.state.ar.us/bmp/smz.html, and the provided guidelines discuss:

- ***Ephemeral Streams:*** Streams that only flow during or immediately after precipitation.
- ***Non-Ephemeral Streams:*** Streams that flow all or most of the year, though some may stop flowing up during hot, dry seasons.
- ***Braided streams:*** Streams with multiple, frequently interconnected channels.
- ***Lakes and Ponds:*** These water bodies follow SMZ guidelines recommended for ephemeral streams.

- ***Discouraged Activities:*** Some management practices (i.e., harvesting and prescribed burning) can be harmful to water quality when implemented on land directly adjacent to a waterbody.

FIRE. Controlled burns can stimulate the growth of desirable trees, but if a fire is not controlled, it can become too hot, consume the humus layer, and expose the underlying soil to erosion. Guidelines for BMPs can be found at http://www.forestry.state.ar.us/bmp/fire.html. These BMPs discuss:

- ***Prescribed Fires:*** Controlled fires that stimulate forest growth
- ***Wildfire Suppression and Reclamation:*** Controlling wildfires and restoring damaged areas caused by fire suppression
- ***Fire Lines:*** Areas of land cleared of vegetation that stop the spread of wildfires

FOREST CHEMICALS. The AFC provides BMP guidelines for handling and applying forest chemicals including pesticides, herbicides and fertilizers at http://www.forestry.state.ar.us/bmp/fertilizer.html.

ROADS. Road construction and maintenance influence erosion and water quality. The AFC recommends BMPs for active and inactive roads at http://www.forestry.state.ar.us/bmp/roads.html. This provides guidelines for road location, construction, drainage, maintenance, ditches, culverts, and stream crossings. With regard to forest management.

7.6 Protecting Forests from Recreational ATV Usage

Recreational usage, such as ATV traffic, can cause damage to forest vegetation and result in a reduced ability to conserve water quality. Careful planning, evaluation, and maintenance procedures can help guard against damage from recreational forest usage. Planning for ATV usage should involve properly locating new trails. Soil surveys, topographic maps, or site visits can aid in determining proper locations for ATV trails. For instance, trails should be located so that the number of stream crossings are minimized or avoided completely. If streams must be crossed, the trail should cross at a right angle. Trails should be placed along topographic contours away from streamside management areas. Isolating ATV traffic to well designed trails will help to minimize environmental impact from usage.

Trails and vegetation should be periodically evaluated for effectiveness and signs of damage. A systematic method for evaluation should be utilized to ensure a proper evaluation is being conducted. A sample method, such as line transects, millacre plots (6 foot by 6 foot square), and photo files can be effective for examining site impacts. Monitoring points should always be from a permanent location so that repeated measures over time can be obtained. Sample points should be located in zero-use, moderate-use, and heavy-use zones in order to make comparisons to vegetation and site conditions.

Maintenance of ATV trails may include cultural treatments to restore an area. These operations could include soil scarification to loosen compacted soils, seeding in new vegetation, or other operations. Maintenance operations can be employed under different usage conditions. If minimal deterioration has occurred, it is possible to leave a site open to usage and perform maintenance operations. However, if significant deterioration has occurred a site should be closed and either allowed to recover

naturally, or revive cultural treatments. Where possible, a rest and rotate program can be very effective. Under this program, additional sites (or trails) are available to utilize while disturbed areas are allowed to rejuvenate.

Chapter 8: Unpaved Road Management Practices

What Are Unpaved Road Management Practices?

Unpaved road management practices are activities that ensure the proper functioning of roads for various uses, while minimizing impact to the surrounding landscape and watershed. These activities include the planning, designing, constructing, maintaining, and closing of unpaved roads. Within an established road system, maintenance is generally the most significant unpaved road management practice. Important management practices include road surfacing and grading, drainage of runoff, and stream crossings.

Why Should These Practices Be Used in the Upper Illinois River Watershed?

A well planned, located, designed, constructed and maintained unpaved road system is essential for local commerce, agriculture, forestry and other industry, as well as access for outdoor recreation. They also provide residential access for a large portion of the watershed's citizens. Proper design and maintenance of the road system will minimize adverse impacts to water quality.

How Are Unpaved Roads Related to Water Quality?

- Roads and construction can create more soil erosion than most other land use activities that occur in rural areas.
- Unpaved roads can impact streams by interrupting natural drainage patterns, concentrating runoff, generating additional sediment, and transporting sediment and other pollutants into streams.
- Stream crossings can alter stream hydrology and prevent some fish and aquatic animals from migrating through crossing structures.

The following sections address best management practices for constructing and maintaining new and existing unpaved roads.

8.1 Unpaved Roads in the Upper Illinois River Watershed

The Upper Illinois River Watershed (UIRW) contains about 2,997 miles of roads and highways, of which approximately 1,295 miles (43%) are unpaved. About 80% of these unpaved roads occur in the rural portion of the watershed (i.e., outside city limits; analysis completed using AHTD All Roads 2006, AHTC City Boundaries 2005, and EPA HUC-08). These unpaved roads play an important role in the UIRW by supporting economic activities including farming and ranching, poultry production, timber, recreation, and commuting. However, unpaved roads can also contribute to water quality degradation in the watershed. Concerns about water quality, connectivity of roads to streams, sensitive species and wildlife, land use, and watershed and ecosystem health may influence the way that unpaved roads are viewed and managed. These concerns, along with strained road maintenance budgets, are pressing road managers to better assess road conditions and impacts. A variety of tools exist for assessing road infrastructure and maintenance needs.

- The US Forest Service (USFS) has a long history of road assessment; the USFS assessment tool can be located at http://www.fs.fed.us/GRAIP/index.shtml.

- The Nature Conservancy (TNC) in Arkansas conducts road inventory and assessment work to identify priority roads for reducing sedimentation in some Ozark rivers. See http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1398&context=jmie/roadeco.

In addition, a variety of best management practices can be implemented to improve and maintain existing unpaved roads and construct new unpaved roads.

8.2 Best Management Practices for Existing Unpaved Roads

Both structural and non-structural best management practices (BMPs) can be implemented to maintain or improve unpaved roads in the UIRW. Structural BMPs involve the physical use or manipulation of materials to build or enhance structures that reduce potential impacts from unpaved roads. Non-structural BMPs include management activities, inspections of structures,

and other maintenance activities. Effective non-structural BMPs can often reduce or eliminate the need for structural BMPs.

What can Unpaved Road BMPs be Applied to in the UIRW?

OFF RIGHT-OF WAY ISSUES: It is important to first consider features off the managed road right-of-way (ROW) that potentially deliver water and runoff onto the road system. Off ROW sources include driveways, logging and farm access, pipeline and utility ROW, ATV trails, agricultural fields, wet weather channels, springs and others. Excess water from off ROW sources can cause a saturated road base, potholes, increased ditch erosion, and increased sedimentation. Addressing off ROW runoff before it reaches the road system may be easier than managing the water on the road system.

- ***Public Relations.*** It is important to work with landowners living adjacent to the road ROW to identify opportunities to address off ROW water sources.
- ***Interceptor Swale.*** An interceptor swale is a slight landscape depression that intercepts runoff before it reaches the road system. The swale can either direct runoff to a stable outlet, or can promote infiltration of runoff into the ground.
- ***Bank Bench.*** A bank bench is a flat step or terrace that is constructed on a road bank to prevent the concentration of runoff and reduce bank erosion. See http://www.dirtandgravel.psu.edu//resources/tech_bulletins/tech_bulletins/Bank_benches.pdf for a technical bulletin about bank benches.
- ***Through Drain.*** A through drain is a pipe or other conduit that carries clean water from a spring or other upslope source under the road. This practice helps to avoid the need to manage additional water on the road system and prevents the source water from becoming laden with sediment.
- ***Access Road Drainage.*** Access roads that carry road surface or ditch water directly to the road system can be a significant source of water. Working with landowners and managers to reduce this source of runoff is important. Many of the BMPs described below are applicable to access roads as well as county, forest or other public roads. Structural BMPs such as crowning and outsloping, broad based dips, grade brakes, and others can be used to shed water to stable outlets. These and other techniques are discussed in sections below.

ROAD BANKS: On hills and mountains, roads are often built by excavating the roadway from native hillside soil and using the excavated material to extend the roadway to the downhill side as fill for road base. Road banks are often also created by the down cutting of the road profile over time from erosion and grading. The exposed cut banks become a significant potential site of erosion within the road system.

- ***Reduce Upslope Runoff.*** Use interceptor swales, bank benches, through drains or other structures (described above) to prevent upslope water or runoff from flowing onto the road bank.

- ***Stabilize with Vegetation.*** Use deep-rooted vegetation for biotechnical stabilization on slopes. Use a mixture of good ground cover plus deep-rooted vegetation, preferably with a native species, to minimize mass instability as well as offer surface erosion control protection. Remove infertile subsoil if necessary, and replace with organic topsoil and mulch. Use geosynthetics, root wads, stumps, logs, or rocks to reinforce a bank slope.
- ***Avoid the Bank.*** During grading and ditch maintenance activities, avoid cutting the the road bank.

- ***Underdrain.*** Use an underdrain to keep subsurface water clean and off the road. A persistently wet ditch can destabilize the adjacent road bank. An underdrain is a buried conduit installed under a road or ditch that transports subsurface water. The use of geotextile in underdrain construction can allow water to pass through, while not allowing sediment through the conduit. More information about underdrains can be found at: http://www.dirtandgravel.psu.edu//resources/tech_bulletins/tech_bulletins/underdrains.pdf

- ***Raise the Road Profile.*** Fill and entrenched road section up to the elevation of the tops of the road banks. Entrenched roads are downcut from years or decades of road grading and erosion, and pose a significant management challenge. This is a long-term approach for managing entrench sections. It requires locally available, inexpensive fill to be feasible. Filling an entrenched road not only eliminates road banks, but can also eliminate ditches, and give the road manager more flexibility to place other drainange structures. See http://www.dirtandgravel.psu.edu//resources/tech_bulletins/tech_bulletins/raising_roadprofile.pdf for a technical bulletin about the raising the road profile.

ROADSIDE DITCHES

Roadside ditches are a typical feature of many unpaved roads. Ditches generally occur on the inslope side of the road, though some roads have ditches on both sides of the road. Ditches are especially susceptible to scouring and erosion because they are generally narrow features that capture, concentrate, convey runoff from larger areas such as the road surface, road banks, and off ROW areas. Best management practices for ditches include eliminating ditches when feasible, providing stable outlets to reducing the volume of runoff and subsurface water entering the ditch, reducing the volume of ditch water, and stabilizing ditch materials.

- ***Ditch Elimination.*** Ditches can sometimes be eliminated using several techniques. As described with *Road Banks* above, raising the road profile is one way to eliminate the need

for a ditch. Outsloping, which is described with *road Surfacing and Drainage* below can also be used to eliminate ditches.

- ***Reduce Upslope Runoff.*** Use interceptor swales, bank benches, through drains or other structures (described above) to prevent upslope water or runoff from flowing onto the road bank.

- ***Stabilize Ditch.*** Ditch material should be stabilized when possible with by seeding grass, or by placing rock. Rock should be large enough to stay in place even with significant flow in the ditch.

- ***Underdrain.*** As described with *Road Banks* above, an underdrain can be effective at transporting subsurface drainage beneath a ditch to help stabilize both the ditch and the adjacent bank in areas with subsurface seepage or flow. An underdrain can also be used to stabilize a ditch, especially in an area with highly erodible soil, or in an area where it is difficult to provide a ditch relief outlet.

- ***Ditch Shape.*** A shallow, wide ditch is easier to keep clean and cause less erosion than a typical deeper ditch. A parabolic shaped ditch is ideal. (include pic of parabolic ditch)

- ***Ditch Maintenance.*** Maintaining ditches is important for protecting water quality.
  1. The simplest maintenance practice for ditches is to not grade ditches that do not need it. Grading destabilizes the soil in the ditch and can cut the toe of the road bank.
  2. A parabolic or other shallow ditch can be maintained with a shaped plate attached to the end of a grader blade.
  3. Avoid leaving a berm of road material along the edge of a ditch that can prevent road surface runoff from getting into the ditch.
  4. Cleaning leaves out of ditches can be accomplished with a nozzle blower instead of a grader blade.

DITCH OUTLETS: It is important to provide ditch relief outlets often enough to minimize the erosive power of flowing water in the ditch. Important aspects of ditch relief include the spacing and location of the outlets, proper installation and maintenance of outlet structures,

and the stability of the outlet location. Common outlet structure types include crossdrain (sometimes called a crosspipe) and wing ditch (sometimes called lead-off ditch or turn-out).

- ***Ditch Outlet Spacing.*** It is important to provide ditch outlets to relieve water volume and velocity in the ditch. Many BMP documents prescribe minimum spacing standards for outlets. Spacing should generally decrease with increased road (ditch) gradient. Spacing should also be decreased in unstable or native soils. See http://www.forestry.state.ar.us/bmp/bmp_final.pdf for a sample spacing standard. This link is for the document titled *Arkansas Forestry Best Management Practices for Water Quality Protection*, which has useful BMPs and guidelines for many aspects of forest roads.

- ***Ditch Outlet Location.*** Though spacing standards can be useful, it is important to work with the surrounding landscape and place outlets strategically.

    1. The most important consideration is to provide ditch relief outlets in advance of stream crossings.
    2. Provide outlets in locations where off ROW or subsurface water has entered the ditch, at grade changes or curves in the road.
    3. Avoid outletting both a crossdrain and a wing ditch at the same location.

- ***Crossdrain Installation.*** A crossdrain is a structure that transfers water from an upslope ditch and outlets the water at a downslope area, or less commonly transfers water to a downslope ditch. On low-volume or forest roads, a crossdrain is sometimes a constructed earth bar or dip. On a typical county or rural road, a crossdrain is a buried culvert pipe. Best management practices for crossdrain installation include proper pipe selection and placement, the use of headwalls and endwalls, and shallow pipe installation where possible.

    1. Pipe Installation. As described above, a crossdrain should be placed strategically at appropriate spacing and locations. Additionally, pipe placement angles, fill compaction, and other factors are important. For more information on pipe installation see http://www.dirtandgravel.psu.edu//resources/tech_bulletins/TB_pipes_overview_web.pdf. For technical information covering the proper installation of crossdrains see http://www.dirtandgravel.psu.edu/resources/tech_bulletins/TB_Crosspipe_installation_web.pdf.
    2. Headwall and Endwall. Headwalls and endwalls are important structures for any pipe installation. These walls serve to protect the road and pipe from erosive forces and also maximize the capacity and efficiency of the pipe. For more information see http://www.dirtandgravel.psu.edu//resources/tech_bulletins/headwalls_n_endwalls.pd

f. For technical information on proper headwall installation using native stone see http://www.dirtandgravel.psu.edu/resources/tech_bulletins/Natural_stone_headwall.pdf.

3. Shallow Crossdrain. Roadside ditches are often deeper than necessary. Consequently, crossdrain pipes are often also placed deeper than necessary. Maintenance of deep crossdrain pipes can lead to the need for deep outlet trenches and other practices that increase the maintenance costs and potential for erosion. A shallow crossdrain installation places the pipe at natural ground level, and requires additional fill over the pipe. The rise of the road surface acts as a grade break to divert road surface water off the road. For technical information describing shallow crossdrain installation see http://www.dirtandgravel.psu.edu/resources/tech_bulletins/TB_Shallow_crosspipes_web.pdf.

- ***Wing Ditch Installation.*** Construct wing ditches that minimize erosion and require minimal maintenance. A wide, flat wing ditch is better than a narrow, deep trench. Ensure the wing ditch has enough gradient or fall away from the road that it does not back water up onto the road surface or ditch. Vegetate wing ditches with grass to stabilize soil and increase deposition of sediment.

- ***Through the Bank Pipe.*** A through the bank pipe can provide an outlet on an entrenched road, or on a road with a large downhill berm that would otherwise prevent the pipe from being placed. For more technical information on bank pipes see http://www.dirtandgravel.psu.edu//resources/tech_bulletins/TB_Throughthebank_pipes_web.pdf.

- ***Outlet Maintenance.*** Keep crossdrain inlets, outlets and pipes free of debris. Proactively clean crossdrains prior to rainy season or specific storms. Clean out wing ditches if sediment has filled in and there is not enough slope to carry water away from the road.

- ***Outlet Protection.*** Managing water as it exits the outlet structure (crossdrain or wing ditch) is important for protecting water quality. Ensure that outlets vent ditch water onto a stable surface.

1. Ensure an adequate distance between the outlet and stream or other water body.
2. For crossdrains, make sure the end of the pipe is at the same elevation as the natural landscape. If the pipe is above the ground, it will erode ground beneath it, causing scour and head cutting. Us a large flat native or other stone as a splash guard to

prevent such scour. Use rip-rap or other large stone directly at the pipe outlet to dissipate the energy of the water and help settle sediment.

3. Outlet water to an area with established vegetation, especially woody vegetation. It can be useful to make brush piles of downed vegetation to slow outlet water and help settle sediment.

ROAD SURFACING AND DRAINAGE: A critical aspect to maintaining an unpaved road surface is to preserve and maintain a proper shape or crown so that rainfall runoff on the road surface will drain away from the road. Dips and grade breaks can also be used to force a road to shed surface runoff.

- ***Road Surface Cross Slope.*** Road slope influences runoff.
  1. Crown. A crowned road has a high center, with runoff flowing to an inboard ditch or to the fill slope on either side of the crown. Use a crown road profile on a wide road with a gentle slope or flat ground. Maintain a crown slope of ½ to ¾ inch for every foot of road width.
  2. Inslope. An insloped road is formed and graded with a slope toward a ditch, generally on the uphill bank. An insloped road profile is especially useful on roads with steeper slopes, generally greater than a 10% grade.
  3. Outslope. An outsloped formed and graded with a slope toward the downhill bank of the road. Water is not collected in a ditch, but rather flows off the road continuously. One advantage of an outsloped road is that road surface runoff is not concentrated to a particular location or structure. Maintain a slope similar to a crowned road. Outsloped roads should generally be used on slopes of less than 10%, and only on roads with relatively low traffic levels. Consider not using outslope on roads that experience icing.

  See http://www.dirtandgravel.psu.edu//resources/tech_bulletins/crown_cs.pdf for more information describing crown, inslope and outslope road surfaces.

- ***Road Surface Longitudinal Slope.***
  1. Broad-Based Dip. A broad-based dip is a small increase in road elevation on a down slope that is intended to convey water from the uphill ditch across the road surface to a stable outlet. A broad-based dip is a form of cross drain, but is also a part of the road surface drainage. For more information see http://www.dirtandgravel.psu.edu//resources/tech_bulletins/TB_Broad_based_dips_web.pdf
  2. Grade Break. A grade break is a small increase in road elevation on a down slope that is intended to convey water from the road surface to both sides of the road. A grade

break may be installed to accommodate a shallow culvert crossdrain or other culvert pipe. For more information see http://www.dirtandgravel.psu.edu//resources/tech_bulletins/Grade_Breaks.pdf

- ***Road Surface Material.***
  1. It is usually desirable and sometimes necessary to add subgrade structural support to native soil base with materials such as gravel, coarse rocky soil, crushed aggregate or others.
  2. For surface material blend coarse aggregate with fine clay rich soil or stone fines to produce a desirable composite roadway material that is coarse yet well-graded with 5-15% fines for binder.
  3. Optimal aggregates such as driving surface aggregate are more durable than typical gravels and aggregates used for road surfacing. For more information see http://www.dirtandgravel.psu.edu//resources/dsa/dsa_general_info.pdf
- ***Road Surface Grading.***
  1. Scarify the existing road surface to mix aggregate and improve compaction. Consider using a carbide-tipped toothed grader blade attachment. See http://www.dirtandgravel.psu.edu//resources/tech_bulletins/carbide_blade.pdf to learn about the benefits of using toothed grader blades.
  2. Limit the amount of surface disturbance to that which can be stabilized by the end of the work day.
  3. Grade when gravel is moist, such as during or after light rain. This will reduce loss of fines
  4. Add new material to the road surface by dumping down the center of the road, then blend the old and new material with a grader.
  5. Add two to three inches of new material to correct road surface faults.
  6. Compact the entire width of newly graded road way, preferably with a wheel roller, whether or not new material is added.

ROAD-STREAM INTERFACE: The road stream interface is one of the most critical places for reducing the impacts of unpaved roads on streams. This interface is generally a local low point in the landscape, so runoff on the road surface or in a roadside ditch can lead directly into the stream. Often, stream crossings modify the hydrology of the stream by constricting the channel

width, leading to destabilization of the stream channel, its banks, and the stream crossing structure.

- ***High-Water Bypass.*** A high-water bypass is a flat, low-lying section of the road that serves as an overflow to allow water to cross the road with minimal damage during extreme flow events. For more information see http://www.dirtandgravel.psu.edu//resources/tech_bulletins/tech_bulletins/high_water_Bypass.pdf.
- ***Clearwater Crossing.*** A Clearwater crossing refers to the practice of re-profiling a roadside ditch near a streamside crossing so that the ditch outlet is directed away from the stream crossing. For more information see http://www.dirtandgravel.psu.edu//resources/tech_bulletins/tech_bulletins/CCC.pdf.

It is important to stabilize disturbed or unstable streambanks immediately upstream or downstream of a crossing. Bioengineering techniques can be implemented to stabilize streambanks using live vegetation. Many technical resources exist for streambank stabilization projects.

PIPES: Culvert stream crossings are a common type of crossing. Improved crossing design, pipe selection and installation can reduce the impacts of the crossing by reducing erosion potential as well as reducing the potential for the crossing acting as a migration barrier for aquatic animals. The BMPs described below are applicable for stream crossings as well as pipe crossdrains.

- ***Pipe Considerations.*** Use a pipe that is larger than needed to accommodate expected stream flows. Use multiple pipes if needed. Use a bottomless pipe when possible to allow for higher capacity with less depth. Place pipe at the natural elevation and angle of the stream channel. See the pipes overview bulleting in the *Ditch Outlets* Section above.
- ***Headwall and Endwall.*** As with crossdrain pipes, headwall and endwall are important structures for culvert stream crossing pipe installation. These walls serve to protect the road from erosive forces and also maximize the capacity and efficiency of the pipe. See the bulletin covering headwalls and endwalls in the *Ditch Outlets*

8.3 Best Management Practices for New Unpaved Roads

Although construction of new unpaved roads in the Upper Illinois River Watershed is relatively rare compared to the length of existing unpaved roads, potential impacts during construction could be significant. A variety of principles and practices can be implemented during planning,

design and construction of new roads to reduce the potential for impacts to water quality. These principles and practices may also reduce the vulnerability or limit the damage of roads to natural disasters such as rainstorms and flooding.

These factors are important for planning and design of new roads, but are also important principles for maintenance and reengineering of existing roads.

What BMPS should be Followed When Planning a New Unpaved Road?

- Minimize road width and area of disturbance.
- Locate roads on high topography and ridges when possible.
- Identify and avoid areas of historic or potential geologic vulnerability, such as steep slopes and unstable soils where possible.
- Identify and avoid areas with wetlands, saturated soils, and floodplains where possible.
- Minimize the number of stream crossings.
- Minimize changes to natural channel patterns at stream crossings.
- Locate bridges and other crossing structures on narrow sections of rivers and in areas of bedrock where possible.
-

What BMPs should be Followed When Designing a New Unpaved Road?

ROAD SURFACE:

1. Use a crown cross-section on wide roads or roads with gentle slope to prevent water from standing on the road surface.
2. Inslope roads to an inboard ditch on steep roads.
3. Out slope roads and use rolling dip cross drains to divert runoff to downhill slopes whenever practical and safe, especially on low-gradient road segments.

DRAINAGE:

1. Provide good roadway drainage and rolling road grades so that storm runoff is dispersed off the road frequently and water concentration is minimized.
2. Minimize the use of ditches and culvert crossdrains that require more maintenance and can more easily plug during major storm events.
3. Use vegetative filters or energy dissipaters at ditch outlets to keep ditches disconnected from streams.
4. Install subsurface drainage when needed.

CROSSINGS:

1. Approach stream crossings at the lowest gradient possible

2. Cross streams and floodplains at right angles to minimize the length and of the crossing and minimize the interface with the stream.
3. Use simple fords or vented low-water crossings for small or low-flow stream crossings instead of culvert pipes that more easily plug during major storm events.
4. Design bridges and culvert crossings with armored overflow areas near the structure to withstand overtopping.
5. Avoid constricting the natural channel when building stream crossings.
6. Design crossing structures to allow for passage of fish and other aquatic species.

CONSTRUCTION:

1. Activities in floodplains or near streams should be minimized or modified to ensure that stream channels and banks are protected from disturbance.
2. Keep cut and fill slopes as flat as possible and well covered and stabilized with vegetation.
3. Use silt fences, hay bales, or other adequate sediment traps during construction activities.

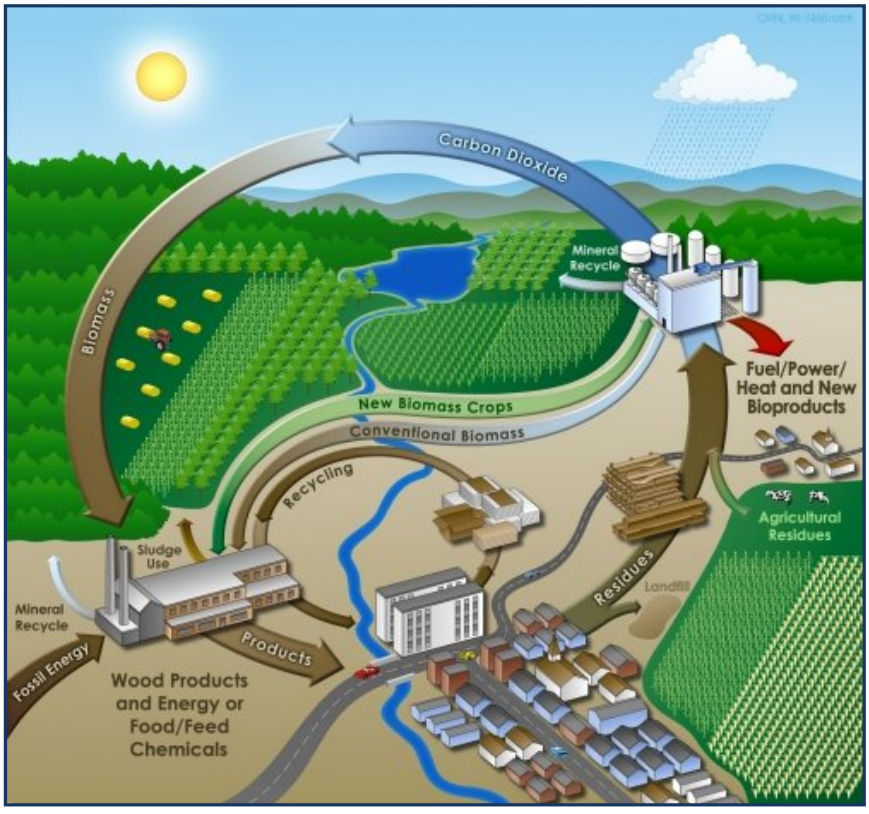
Chapter 9: By-Product Treatment

What is By-Product Treatment?

By-product treatment is the treatment of wastes and residuals from agricultural and municipal activities. Co-product generation refers to the treatment and or mixing and use of these materials to produce a value added product that may increase marketability, land use opportunities, transportability or generate energy in the Upper Illinois River Watershed.

Co-product generation can increase ecosystem services and sustainability.

From Oak Ridge National Laboratory at http://bioenergy.ornl.gov/papers/misc/bioenergy_cycle.html.



Several by-products of agricultural and municipal activities in the Upper Illinois River Watershed can be a valuable nutrient and organic resource such as:

- Poultry Litter
- Wastewater Treatment Residuals
- Water Treatment Residuals

However, when produced in large quantities and in nutrient surplus areas, they can present a land management challenge.

The following sections address Co-Product Generation, Alternative Uses for By-Products, and Energy Feedstocks.

9.1 Co-Product Generation

Municipal Waste-Streams

Most of the wastewater biosolids produced in the Upper Illinois River Watershed is land filled outside the watershed at increasing costs to municipalities. Biosolids have the potential for reuse as agricultural amendments due to their high concentrations of plant nutrients and the rising costs of chemical fertilizer. However, they are greatly enriched in phosphorus relative to nitrogen, in terms of what pastures or crops need each year, limiting their use in watersheds with phosphorus-impaired waters. This nutrient imbalance and possible use on agricultural land may be further limited as stricter limits on phosphorus discharge by wastewater treatment plants increases the phosphorus content of biosolids.

Water treatment residuals are waste products formed during the production of drinking water, where Al or Fe salts are added as part of the process to promote flocculation of solids to remove turbidity and color. Most water treatment residuals are either discharged to wastewater treatment plants, lagooned, or landfilled. Increased landfill fees, along with more stringent requirements placed on disposal of water treatment residuals to surface waters has led treatment plants to identify alternatives. One option may be mixing biosolids and residuals for co-application on agricultural land, because water treatment residuals have the ability to bind phosphorus in biosolids making it less available for transport from the land application site.

Mixing biosolids and water treatment residuals may generate a product suitable for land application in certain cases.

Poultry Litter Co-Products

Poultry litter can be ground, pelletized, and mixed with additives to change overall physical and chemical properties. For example;

- Gels and coagulants can be added to help form granules and increase market value.
- Mixing poultry litter with biosolids may decrease the water solubility of phosphorus in the co-product generated, due to interaction of phosphorus with metal, such as Al and Fe salts added during the wastewater treatment process.
- Additives (such as dicyandiamide) can decrease nitrogen loss as gases from poultry litter, thereby increasing the overall nutrient value of the co-product.
- Fortifying poultry litter with mineral and organic nitrogen fertilizer, such as urea or feathermill can produce a more nutrient balanced co-product.

The co-generation process can change the physical, chemical solubility and nutrient release characteristics, to produce new products that have added or greater value as urban and agricultural fertilizers.

Depending on formulation, nitrogen-fortified poultry litter and biosolid granular fertilizers may have similar production costs to urea on a per pound of nitrogen basis. Thus, manures, wastewater treatment biosolids, and water treatment residuals can be transformed into valuable co-product fertilizer sources. This offers the opportunity for a synergistic market to develop among poultry producers, fertilizer consumers, and municipalities to relocate materials from regions with surplus nutrients to areas with soil nutrient deficiencies.

9.2 Alternative Uses

Composting may also be considered a management tool to improve manure distribution because composting makes manure more uniform in its physical and chemical properties. A more uniform product can be spread more evenly and at more accurate rates. Although composting tends to increase the P concentration compared with original manure, volume is decreased and thus, transportation costs reduced. Comosting also makes the bulk product more stable and less likely to over-heat (due to microbial activity) during storage and transport, compared to raw manure. Additional urban markets may also become available for composted materials.

Manure can be used along with biosolids and woodchips to reclaim soils, which have been disturbed for example, by gravel or dirt mining and urban construction. In these cases, manure can be used as an excellent soil conditioner for reclamation of mined sites, urban lawn improvements, and major developments where topsoil or subsoil conditioning is needed.

Manures and composts are an excellent soil conditioner for reclamation of urban construction sites and composted manures are widely used in landscaping and gardening.

9.3 Energy Feedstocks

There is interest in using some manure as sources of "bioenergy." For example, dried poultry litter can be burned directly or converted into oils suitable for use to generate electric power. This could be at the scale of contributing to power networks or to supplement on-farm energy needs.

Burning a pound of poultry litter produces about 4,000 BTUs, which is an acceptable yield, and is about a third of the energy gained from burning a pound of coal; however, economic feasibility plays an important role in feasibility.

As the cost of conventional fuel continues to rise and as the cost and supply of poultry litter is relatively stable, burning litter will be an increasingly viable approach to power generation. This process reduces the volume of manure that needs to be managed and produces a phosphorus and potassium rich ash that has potential fertilizer value. On the negative side, however, valuable nitrogen is burnt off and lost from the remaining ash.

In the Upper Illinois River Watershed, poultry litter has an economic value, usually anywhere from $5 to $10 per ton loaded onto a truck or manure spreader on the farm. Poultry litter has around 10 million BTUs per ton, and at $5 per ton, a penny worth of litter would have 20,000 BTUs. At a propane price of $1.50 per gallon, a penny worth of propane would have 611 BTUs. Clearly, burning poultry litter has the potential to provide a cheap source of energy, especially where there is more poultry litter produced than local pasture or crop needs.

Burning litter to heat poultry houses could bring back the era of "cheap" energy, if technology moves from the research to commercial scale.

On-Farm Energy Production

Poultry litter can be burned in a furnace and the heat can be used for space-heating the broiler houses and might offer an alternative to land application. Propane or natural gas saved by utilizing the heat from combustion of litter, might provide an economic incentive to justify the investment in the furnace system. For instance, with growers spending as much as $10,000 annually per house for heat using propane, the capital cost of a litter furnace might be justifiable. However, it is important to examine the facts and weigh the pros and cons for an individual farming operation, before investing in an on-farm litter burning furnace. See http://www.uark.edu/depts/posc/pdfs/avianadvice_sp07.pdf for a recent feasibility study by Tom Costello, Biological and Agricultural Engineering Department, University of Arkansas, of on-farm litter combustion.

High natural gas and propane prices coupled with a large number of poultry growers that do not utilize litter as a fertilizer on their own land, can make using litter as a fuel a potentially attractive alternative.

RECOMMENDATION: Relevant State agencies should consider the possibility of renewable fuel credits for growers who burn litter.

Centralized Energy Production

In April of 2000, the Minnesota legislature voted to include poultry litter as biomass in its mandate that Minnesota utilities generate 125 megawatts of electricity using wind power or biomass. Shortly after this, the British company Fibrowatt, which had developed three poultry litter fired electricity generating plants in the United Kingdom, formed a subsidiary – Fibrominn - to head up the company's efforts to build a plant in Minnesota.

As the value of clean water and cost of by-product use of landfilling is realized, it is expected that alternative entrepreneurial uses for manure will be developed, become more cost-effective, and thus, create expanding markets.

The plant began operations in the City of Benson, MN in 2007, and it will generate 55 megawatts, enough power for about 60,000 homes. Around 700,000 tons of biomass will fuel the plant; around 90 percent of the total fuel will be turkey litter. One advantage of centralized combustion of poultry litter for electricity generation compared to on-farm utilization is the emission controls and monitoring required by air quality permits for the big systems.

Even with the increase in the cost of fossil fuels, poultry litter purchased from the grower for around $5 per ton generates electricity at costs which are 30 to 50 percent higher than those of coal fired plants. Ultimately, consumers will pay higher rates for electricity derived from poultry litter; however, fossil fuel prices may rise even higher in the future.

From a climate change perspective, electricity derived from poultry litter has a much smaller carbon footprint than fossil fuel generated electricity.

Poultry growers will likely receive a lower price for litter for power generation than its nominal value as a fertilizer nutrient source. In areas where farmers are still able to locally land apply, this lower price will remain one of the main impediments to large-scale energy production from poultry litter combustion, unless incentives are developed. Incentives will be needed to help farmers pay for commercial N and potassium to replace the nutrient from litter (about $50 per ton of litter at 2008 fertilizer prices). Otherwise, nitrogen-deficient pastures could become more erodible, which could increase phosphorus loss to surface waters.

Liquid wastes can be anaerobically digested to produce methane, which can be used for heat and energy.

Built in 1992, this small unit burns agricultural wastes (poultry litter, feathers, etc) in a conventional boiler supplying a steam turbine, to export 12.7 MW to the grid. Eye power station was the first station in the World to burn poultry litter as a fuel. It is located in Suffolk, England.

Anaerobic Digestion of Manures

This is the process where manure and other organic materials are broken down by microorganisms in the absence of oxygen. The biogas, methane, that is produced can be captured and used as a valuable energy source. It also widely used to treat wastewater sludges and manures because it reduces the volume and mass of the input material.

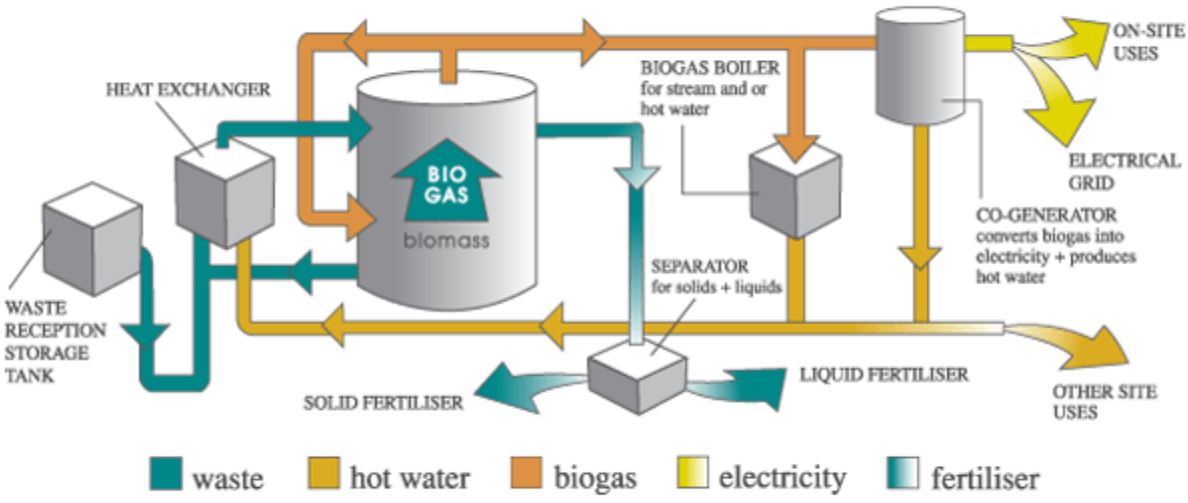
As part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere. Anaerobic digestion is a renewable energy source because the process produces a methane and carbon dioxide rich biogas suitable for energy production helping replace fossil fuels. Also, the nutrient-rich solids left after digestion can be used as fertilizer.

Anaerobic digestion along with the heat generated has the potential to kill bacteria or pathogens.

The methane that is produced powers a specially designed internal combustion engine or gas turbine, generating electricity. It can also be used for heat production in a steam-generating boiler, to supplement traditional sources of heat in farms.

Previously, the technical expertise required to maintain anaerobic digesters coupled with high capital costs and low process efficiencies had limited the level of its industrial application as a waste treatment technology. Anaerobic digestion facilities have, however, been recognized as one of the most useful decentralized sources of energy supply, as they are less capital intensive than large power plants.

At the present time, however, the residual material, while rich in phosphorus, will still need some secondary treatment to either de-water or concentrate the solids to a form suitable for land application. It is likely that this technology will advance over the next five to 10 years into a commercially viable system.



A schematic configuration of an anaerobic digester (from the website of Enviro Control Ltd. http://www.enviro-control.co.uk/waste/configure.html#)

More information about co-product treatment to produce additional revenue sources is available at:

"*Feasibility of On-Farm Broiler Litter Combustion*," by Tom Costello, Biological and Agricultural Engineering Department, University of Arkansas, Fayetteville, AR. Avian Advice 9(1):7-13. http://www.uark.edu/depts/posc/pdfs/avianadvice_sp07.pdf 2007.

"*A Review of Biomass Furnaces for Heating Poultry Houses in the Northwest Arkansas Region*," prepared for Winrock International by Jim Wimberly, BioEnergy Systems LLC and available at: http://www.biomass2.com/furnaces/Biomass%20furnaces%20for%20heating%20poultry%20houses%20final%20report.pdf

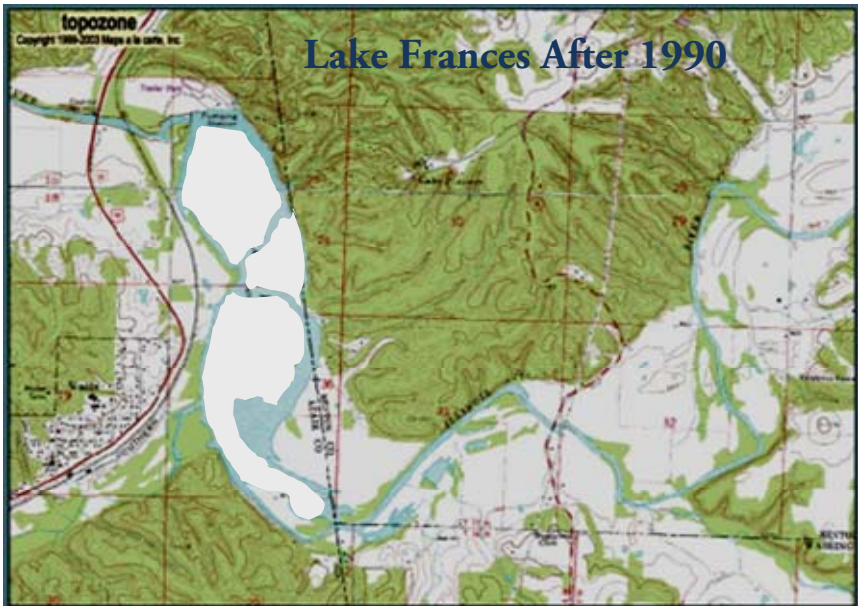
"*Commercialization of Biomass Direct-fired Heating Systems*," prepared for the Arkansas Energy Office and the U.S. Department of Energy by Jim Wimberly, Foundation for Organic Resources Management and available at: http://www.biomass2.com/furnaces/CVP%20final%20report.pdf

Chapter 10: Lake Frances Management

Why is Lake Frances Important to the Upper Illinois River Watershed?

Lake Frances is a run of the river impoundment located on the Arkansas and Oklahoma state border. This impoundment was built in 1931 and historically was used for recreational activities and as the municipal drinking water supply for Siloam Springs, Arkansas. Lake Frances is important because it is able to serve as an internal source of nutrients to the Illinois River—Lake Frances can release nutrients that have been stored in the lake over time into the Illinois River.

On May 4th, 1990, the Lake Frances dam was flooded during a high flow event and approximately 1 m was lost from the top of the earthen dam, lowering the impoundment's spillway. This event changed the characteristics of Lake Frances, reducing surface area, decreasing water depths, and exposing previous bottom sediments that have become part of the floodplain.



Prior to 1990, the Characteristics of Lake Frances Were:

- Surface Area: 2.3 km^2
- Mean Depth: 1.2 m
- Maximum Depth: 6.5 m
- Maximum Length: 2.5 m
- Hydraulic Retention Time: 2-3 Days

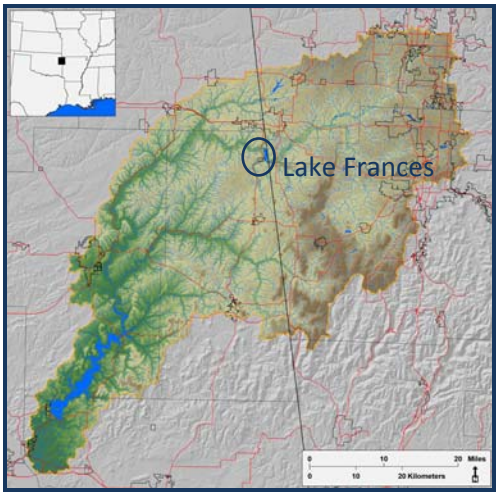
Lake Frances was a small impoundment before the May 4, 1990, flood and is even smaller now.

The following sections address Lake Frances as a Nutrient Source, Bottom Sediment Management Options, and a Lake Frances Feasibility Study.

10.1 Lake Frances as a Nutrient Source

Why is Lake Frances a Concern?

This small impoundment is located at a particularly important location – the Arkansas and Oklahoma border, and Lake Frances likely plays a major role in the transport and transformation of nutrients through the Illinois River.



Thus, this small impoundment has the potential to influence how each state (i.e., Arkansas and Oklahoma) perceives how water quality is changing within the Upper Illinois River Watershed, because Arkansas monitors water quality upstream from Lake Frances, and Oklahoma monitors water quality downstream.

Historical studies have shown that algae growing in the water column consume dissolved, bioavailable nutrients (like ammonia, nitrate and phosphate) and transform these nutrients into organic matter (particulate nutrients), which can be transported through the small impoundment or accumulated in bottom sediments. Small impoundments like this also have the potential to accumulate sediment and sediment associated constituents (like phosphorus) during high flow events, because the water may slow down as it moves through this lake system. Now that the wastewater treatment plants have reduced effluent phosphorus loads in the Upper Illinois River Watershed, it is likely that Lake Frances will release the phosphorus it has accumulated over time.

The overlying concern revolving around Lake Frances is its ability to serve as an internal source of nutrients to the Illinois River following implementation of the watershed management plan which will reduce nutrient and sediment loads.

When Lake Frances is referred to as an internal source, it simply means that nutrients are released from within this small impoundment; bottom sediments and active floodplains are two potential internal sources. Bottom sediments in impoundments and floodplain soils have the potential to release nutrients that have been accumulated through two processes:

1. Sediments and soils can take up or release nutrients like phosphate into the overlying water trying to reach an equilibrium between the solid (sediments or soils) and the water, and this equilibrium type release generally occurs when the water at the sediment surface contains sufficient dissolved oxygen (i.e., aerobic conditions). How this equilibrium concept works is:

    - When nutrient concentrations in the overlying water are less than the equilibrium concentration, then the sediments or soils release the chemical into the overlying water increasing the concentration toward the equilibrium concentration. **THIS RESULTS IN THE RELEASE OF THE NUTRIENTS.**

- When chemical concentrations in the overlying water are greater than the equilibrium concentration, then the chemical moves from the water column to the sediment or soil reducing the concentration toward the equilibrium concentration. **THIS RESULTS IN THE STORAGE OF THE NUTRIENTS.**

2. Sediments and soils can also release nutrients like ammonium and phosphate into the overlying water when dissolved oxygen is not present in the water at the sediment interface (i.e., anaerobic conditions), and the release of nutrients under these conditions is generally much greater than when dissolved oxygen is present in the water overlying the sediments. Technically, this is referred to as reductive dissolution – however, the reason this occurs is related to biochemical processes.

Various micro-organisms living in the bottom sediments usually consume oxygen (i.e., respiration), and when dissolved oxygen is not present in water overlying sediments or soils then these organisms use other chemicals like nitrate, manganese, iron and sulfate to complete respiration. When microbial respiration uses manganese and iron, minerals are changed from insoluble forms to more soluble forms releasing nutrients that have accumulated in the bottom sediments. Phosphate is released into overlying water as it was previously sorbed to minerals that are dissolving, and ammonium is released into the water through the process of mineralization, which is the breakdown of organic matter in bottom sediments.

Bottom sediments in Lake Frances have the potential to release large amounts of ammonium and phosphate into the overlying water in this small, shallow impoundment; studies have shown very high release rates of nutrients from these bottom sediments compared to other regional reservoirs, including Lake Eucha and Beaver Lake. These nutrients can then be entrained or moved into upper water layers of Lake Frances and the Illinois River, where these nutrients become available for algal growth, and dissolved nutrients are transformed into particulate forms and transported further downstream.

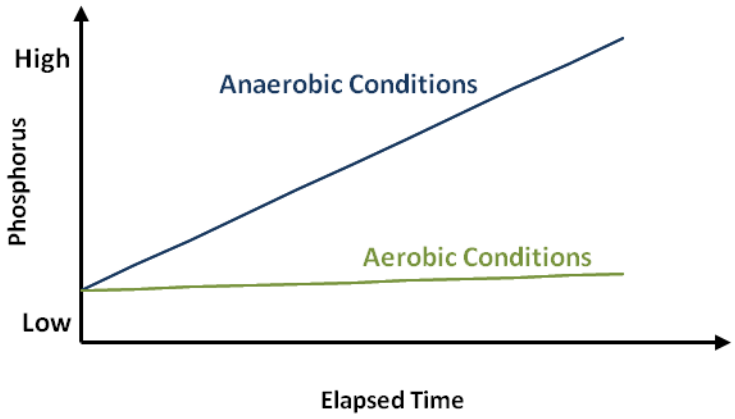


Figure 10.1 Comparison of phosphorous release under aerobic and anaerobic conditions.

10.2 Bottom Sediment Management Options

There are many methods that exist to decrease nutrient, particularly phosphate, and contaminant release from sediment to the overlying waters including:

- ***Dredging:*** The physical removal of contaminated, nutrient enriched or excess sediments in impoundments; the accumulated contaminants and nutrients are removed with the sediments and either land applied or land filled.

- ***Physical and Chemical Capping***: The actual placement of a cover over the sediments in order to seal it off and minimize the release of nutrients or other contaminants; these must be designed to withstand the various storm events that flow through the Illinois River and Lake Frances; if this system was needed.

- ***Chemical Treatment***: The addition of select metal salts such as aluminum sulfate (more commonly known as alum), iron sulfate, and or calcium sulfate to the overlying water column; these metal salts bind with the nutrients released from the sediments and reduce the amount in the water column.

The two most practical options for this small, shallow impoundment would be removing the sediments (dredging) and or using metal salts to bind the nutrients in a less available form (chemical treatment).

Recommendations:

DREDGING MIGHT BE A FEASIBLE MANAGEMENT OPTION. Dredging is commonly used to restore recreational access, improve water storage capacity, remove nutrient–rich sediments, lessen sediment resuspension by winds and water mixing, and improve fish habitat. The first step to evaluate the need for dredging might be a bathymetry survey, and there exist a variety of methods to accomplish this task, including the use of high and low frequency acoustic profiling to determine the depth of sediment accumulation, and use of manual probing at specified coordinates to determine depth to sediment and then depth to refusal (i.e., historic lake bottom). Once the depth of accumulated sediments is known, and a decision is made to dredge then the options generally are:

- ***Drain and Excavate***: The small impoundment is drained and heavy equipment is used to excavate; this method is least expensive but it takes the longest time to complete, has the greatest environmental impact, and would be susceptible to rain delays.

- ***Mechanical Dredging***: This method removes bottom sediment from the shoreline using drag lines or long – reach excavators; this method is suitable to remove bottom sediment within 50 to 100 feet of the shoreline of the river or small impoundment.

- ***Hydraulic Dredging***: A platform with a pump that vacuums the sediments from the lake bottom is used; sediment and water are pumped to the shore, and typically the sediments in water are separated at a location with the water being returned to the river or small impoundment.

The fact that the dam was breached in 1990 and that many of the shallow areas of the lake are now exposed floodplains might make excavation of some of the enriched sediments easier and more manageable in Lake Frances.

CHEMICAL TREATMENT MIGHT BE A FEASIBLE MANAGEMENT OPTION. The first step to evaluate the feasibility of chemical treatment using metal salts would be some laboratory studies to determine phosphorus release rates and or available phosphorus in the bottom sediments. Phosphorus release rates from bottom sediments have been estimated to be as much as 480 lbs phosphorus $acre^{-1}$ $year^{-1}$ (~550 kg ha^{-1} yr^{-1}), which is not much total load given the small surface area of this impoundment. But, phosphorus loss from forest areas only ranges from 0.1 to 0.5 lbs phosphorus $acre^{-1}$ $year^{-1}$ (0.1 to 0.4 kg ha^{-1} yr^{-1}) and that from pastures ranges 0.1 to 2.5 lbs phosphorus $acre^{-1}$ $year^{-1}$ (0.1 to 2.8 kg ha^{-1} yr^{-1}), respectively. Bottom sediments in Lake Frances contribute orders of magnitude more phosphorus on a unit area basis compared to the landscape, which suggests that chemical treatment might be a management option because these sediments have a direct influence on the overlying waters in Lake Frances and Illinois River.

A critical component of the success of chemical treatment in small impoundments is accurate and complete water quality determination for pH, alkalinity, and phosphorus concentrations as well as understanding the impoundment characteristics, inflow water quality and discharge, and sediment attributes. The application of chemical amendments can be a single dose determined to inactivate dissolved phosphate in the water column and to prevent internal phosphorus cycling from bottom sediments. Large lakes and reservoirs are usually treated with liquids (metal salt solutions), whereas small impoundments and ponds maybe treated with dry metal salts.

Operation and maintenance of nutrient inactivation programs such as chemical treatment includes continued water quality monitoring to make sure additional dissolved phosphate inputs are controlled. Periodic tests for pH, alkalinity, total and dissolved phosphorus, algal biomass (chlorophyll a), and turbidity will aid the assessment of effectiveness and longevity of treatment. The most common form of chemical treatment would be the use of alum to inactivate the phosphorus in Lake Frances and its sediments, and more than 200 lakes have been treated using this chemical since 1970.

Bottom sediments in Lake Frances contribute much more phosphorus on a unit area basis than the landscape, which suggests that chemical treatment might be a management option in this situation.

10.3 Lake Frances Feasibility Study

Lake Frances presents an opportunity to enact select management options that will influence nutrient retention and transport within the Upper Illinois River Watershed. Lake Frances will provide the opportunity for algae to uptake dissolved nutrients into particulate forms, and the bottom sediments have the potential to act as a source of nutrients, especially phosphorus, as the Illinois River Watershed Partnership implements its watershed management plan.

Nutrient release from Lake Frances sediments might mask improvements in water quality of the Illinois River at sites downstream of the impoundment.

This sub–section has specifically discussed remedial options within Lake Frances, i.e. dredging and chemical treatment. However, the long range vision for this small impoundment should include discussion of either removal of the dam or even rebuilding the dam to higher elevations to increase its water depth, storage and hydraulic retention time.

In order to understand which treatment options are best suited for Lake Frances, it is recommended that these alternatives (especially dredging and chemical treatment) be evaluated in a feasibility study that would need to focus on logistics, economics, and achieved reductions to meet specific goals for the Upper Illinois River Watershed. However, the fact that Lake Frances still serves as the water supply reservoir to the city of Siloam Springs, Arkansas means that all options evaluated must consider both short– and long–term impacts on water quality and availability to this municipality.

Additional Information about Lake Frances and the Scientific Studies that have been Conducted on the Lake Include:

Haggard, B.E. and T.S. Soerens. 2006. Sediment Phosphorus Release at a Small Impoundment on the Illinois River, Arkansas and Oklahoma, USA. Ecological Engineering 28: 280-287.

Søballe, D.M. and S.T. Threlkeld. 1985. Advection, Phytoplankton Biomass, and Nutrient Transformations in a Rapidly Flushed Impoundment. Arch. Hydrobiol. 105:187-203.