# Watershed Planning Guidebook for Kentucky Communities

1st Edition
2010

Kentucky Waterways Alliance
Kentucky Division of Water

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# Guidebook Introduction

This section will help you:

- Understand why watershed planning is so important
- Learn how to use this Guidebook
- Become familiar with the icons used in the Guidebook
- Use website references
- Envision a successful contract for technical services
- Understand the implications of 319(h) funding

Kentucky is a state blessed with abundant waterways. In a 1998 survey performed by the University of Kentucky's Department of Economics, Kentuckians ranked water quality first among all environmental issues. Kentucky's underground streams, like the tributaries of the Green River that created Mammoth Cave, are internationally-recognized preserves for unique biological communities. Kentucky communities value their waterways and want to make plans that preserve their vitality.

This Watershed Planning Guidebook for Kentucky Communities was created to help Kentuckians work together to improve the waterways they appreciate and use. It provides a step-by-step process that Kentucky communities may use to create an effective watershed plan. It has been tested by several Kentucky planning teams, who learned from experience and want to make it easier for others.

Effective watershed planning requires participation from people who do not necessarily have technical expertise. This Guidebook provides explanations for those who are not familiar with waterway and water use terms and dynamics. By increasing your understanding of what is happening to and in your watershed, using this Guidebook will change how you think about your stream, how you talk about it to others, and how you and your community act towards it.

**Why Water Quality and Watershed Health Matters**

**To your community:**
Clean water means improved public health and a wider range of healthful outdoor recreation activities for all ages.

**To your quality of life:**
Fishing, swimming, boating, in-stream baptisms, and community events centered on your local waterway are central to a high quality of life.

A healthy stream can be appreciated for its cultural, historical, and spiritual significance to the community.

**To economic development:**
Clean waterways and healthy watersheds attract new investment. Modern employers are looking for attractive surroundings, including natural settings, as a benefit for top-notch employees and families.

Cleaner raw water for drinking water treatment reduces treatment costs. Tourism benefits from the attraction of natural areas with healthy waterways.

Clean water also allows your community to comply with regulations. This can prevent large fines that may lead to increased taxes and utility rates.

Effective watershed planning requires exploration and analysis of many factors related to your watershed and waterways' health and the activities that take place in the watershed. This Guidebook can lead anyone to find out many, many aspects of waterways and human impacts on them. Using this Guidebook will change how your community thinks about decisions impacting your waterways.

Words in **bold type** face are defined in the Guidebook glossary.

Effective watershed planning also requires some technical expertise. In many cases, and especially if your plan is conducted using **319(h) watershed funds** ("319"), the amount of technical expertise required is significant. This Guidebook helps clarify how to find technical assistance, what might be needed, and what to look for when contracting for technical assistance. Using this Guidebook can help avoid ineffective use of precious funds and information.

Effective watershed planning requires collaborative work and documentation of the work done and conclusions reached. This Guidebook can help you keep a planning team together and make your team work fun as well as productive; plus, it clarifies what kinds of information should be documented. Using the Guidebook will help your community come together to protect and improve your waterways and make better decisions about them.

This Guidebook offers advice for maintaining the vitality of your planning team and its links to the community. The team must remain involved and relevant if it is to continue to lead your community along the watershed management path. Using the Guidebook will not only lead you to a watershed plan that accurately and effectively guides your activities, but a plan that is marketable to those who can make the changes needed to protect and improve your waterways.

The watershed planning process is dynamic, iterative and adaptive. One reason this adaptive approach is necessary is because planning groups must often make decisions and take action based on imperfect information - while taking steps to get better information. Another reason is that targeted actions might not result in complete success during the first or second cycle. In fact, conditions always change, and effective planning is never linear but always adaptive, iterative. As a planning team gains experience and knowledge, decisions made in earlier steps are revised.

**Why Use a Watershed Approach?**
Since the 1972 enactment of the federal Clean Water Act, American communities have cleaned up much of the pollution that had been discharged into our waterways. Unfortunately, many waterways remain polluted.

One reason for a watershed approach is that **nonpoint source pollutants**, the result of human practices on the landscape, threaten waterway health.

Second, some piecemeal efforts to improve water quality have resulted in expensive but ineffective solutions.

Third, waterway protection has been neglected.

Since the late 1980s, in response to these shortcomings, citizens and governments have begun managing water quality with a watershed approach.

Using this Guidebook can sustain the long-term focus needed to continue to protect and improve the quality of water in your community.

## A Watershed Approach

A watershed approach is a flexible framework for managing water resource quality and quantity within specified drainage areas or watersheds. This holistic approach engages diverse individuals and groups and emphasizes the use of management practices supported by science and technology. The watershed approach to planning uses a series of cooperative, iterative steps to characterize existing conditions, identify and prioritize problems, define objectives, develop protection or remediation strategies, and implement and adapt selected actions as necessary. The outcomes of this process are documented in a watershed plan.

A watershed plan is a strategy that provides assessment and management information for a geographically-defined watershed, including the analyses, actions, participants, and resources for developing and implementing the plan.

A watershed plan will help you to clean up and protect your waterways and plan for your community's future.  A plan can also improve your chances of securing funds to restore and protect your waterways.  A plan is necessary if you seek 319 funding from US Environmental Protection  Agency (EPA).

## How to Use This Guidebook

This Guidebook is organized into seven chapters that represent components of the watershed planning process.  For best results, familiarize yourself with the entire book, and then use the chapters during your planning.  Documentation of work and draft sections of the watershed plan should be completed as the planning team progresses through each chapter, as described at the end of that chapter.

Here's an overview of the contents of the chapters of this Guidebook:

Chapter 1—**Getting Started**—This chapter helps you select your watershed planning area, identify who should be involved in the planning process, organize your planning team and understand Kentucky's statewide approach to watershed protection and planning.

**Who Will Use This Guidebook?**
Your planning team should follow the Guidebook carefully throughout the planning and implementation process.  In addition, supporters and contractors will benefit from reading it.

Ideally, everyone involved in your watershed plan will understand how the planning process works and will become familiar, over time and more or less, with the Guidebook's contents.

Some key participants may need a copy for themselves; others will only need an introduction.

Many participants will benefit from Guidebook excerpts when technical information must be presented.

**Watershed Basics** – This section provides an overview of watersheds, water quality and how our actions affect the health of our watersheds. This section can also act as an educational resource for members of your planning group.

Chapter 2—**Exploring Your Watershed**—This chapter provides resources for collecting existing data and information for your watershed and includes guidance for managing and organizing this information.

Chapter 3—**Learning More**—This chapter helps you identify monitoring data gaps and provides instruction on how to develop a phased monitoring program to fill these gaps. This chapter should be used with Chapter 4 to complete the phases of monitoring and assessment for your watershed.

Chapter 4—**Analyzing Results**—This chapter helps you understand what the data and information collected tell you about the watershed and how to use this information for source determination.

Chapter 5 – **Finding Solutions** – This chapter provides an overview of Best Management Practices (BMPs) and how to perform targeted BMP selection.

Chapter 6 – **Strategy for Success** - This chapter helps you understand the connection between BMPs and water quality, select BMPs based on realistic factors in your watershed, and organize a detailed plan of action.

Chapter 7—**Making It Happen**—This chapter helps you market your plan, find resources to implement your plan, and evaluate and adjust your plan for long-term success.

Each chapter includes:

active options **Active Options** – These sections offer ideas to help keep your planning team together, productive, and enjoyable.

write it down **Write It Down** – These sections clarify how the chapter's work is described in the plan and what other documentation is appropriate. Any project using 319 funds is expected to provide all the information mentioned in the Write It Down sections.

**Website references** – The Guidebook refers to helpful information available on the Internet. To facilitate access and updates, the Kentucky Division of Water (KDOW) has established a gateway to these sites. Each website icon refers to a site on that gateway website. In the electronic version of the document, these icons refer to direct links in a list on the gateway website. This gateway website address is **http://water.ky.gov/watershed/Pages/WatershedPlanningGuidebook.aspx**

**Appendices**

A. Watershed Plan Outline – This appendix combines the outlines from the Write It Down section of each chapter.

B. EPA's Elements of a 319(h) Watershed Plan – EPA has identified nine elements (a through i) required for a watershed plan qualifying for 319 funding, and these are provided in this appendix.

C. Sample Team Invitation and Brochure – This appendix offers samples groups can use to inspire invitations to potential team members and brochures.

D. Resources for Team Development – This appendix provides useful links and references to help your team be dynamic and productive.

E. Habitat Assessment (EPA Rapid Bioassessment Protocol Scoring Sheet) – This appendix provides a tool planning groups can use for evaluating habitat conditions at selected sites on your waterways.

F. Potential Pollutant Sources – This appendix is a chart to help identify the sources of any pollutant identified by data or information collected by a planning team.

G. Glossary – The glossary defines watershed terms that are printed in bold typeface throughout the Guidebook.

## Other Watershed Planning Resources

The Watershed Basics section is a comprehensive primer and reference for understanding watersheds and water quality. In addition, there are other key references available.

### US EPA Resources

Watershed Central is an EPA website designed to assist you with your watershed planning . The site includes guidance, case studies, and, scientific tools used for watershed modeling and assessment. In addition, useful water databases may be found on the site. The Watershed Central wiki, just like Wikipedia, allows registered user to submit and edit information that may be shared and updated by others.

The Kentucky Watershed Planning Guidebook will frequently refer to another tool found on the website, the US EPA Handbook on Developing Watershed Plans to Protect and Restore Our Waters, as well as its complimentary "Watershed Plan Builder," that help outline your watershed planning process."

### Kentucky Resources

Kentucky has developed its own *Kentucky Watershed Leadership Academy*, which provides training for groups that are developing watershed plans .

The *Kentucky Watershed Watch* program has designed overviews of stream science and watersheds for its adult citizen volunteers. These brief PowerPoint presentations may be helpful to you as you organize your planning team, particularly when the subject matter of your planning requires some basic understanding. These training materials are available at .

The *Kentucky Watershed Viewer* is an online mapping tool with information about land cover, pollutants, and protections [4].

The *Commonwealth Water Education Project* provides a website in support of its training and educational programs aimed at helping communities protect water resources as they grow [5].

## Contracting for Services

This Guidebook will also serve as a valuable tool if you hire others to assist in the plan development. While contracting for technical services can be rewarding and is often necessary to develop a plan, there are also many potential pitfalls in contracting. The Guidebook will help you identify what you require from a contractor. Detailed contracts are necessary to ensure that you receive the product you need. Furthermore, the contractor should read related sections so that they are familiar with the requirements outlined in this Guidebook.

> Here's a brief summary of the **nine key elements** of watershed plans, as defined by EPA:
>
> - Identify causes and sources of pollution
> - Estimate load reductions expected
> - Describe management measures and target critical areas
> - Estimate technical and financial assistance needed
> - Develop education component
> - Develop project schedule
> - Describe interim, measurable milestones
> - Identify indicators to measure progress
> - Develop a monitoring component

## Qualifying for "Nonpoint Source Section 319(h)" Funds

There are many sources of funds for watershed planning and plan implementation, described in Chapter 6. However, the predominant source of comprehensive funding is the KDOW, which administers EPA funds provided under Section 319(h) of the Clean Water Act (written simply as "319" throughout the Guidebook). These funds are distributed through KDOW's **Nonpoint Source program.**

For the KY Division of Water to use 319 funds to implement a watershed plan, that plan must meet all the requirements described in this Guidebook. Fortunately, the 319 program also currently funds the development of watershed plans that meet program criteria.

This Guidebook provides the watershed planning requirements for 319-funded plans in Kentucky. Some chapters contain 319-specific sections for portions of the planning process that contain detailed requirements. This Guidebook will be helpful in understanding the amount of work involved in developing an acceptable plan so that an appropriate budget can be prepared.

When considering an application for 319 program funding, you should familiarize yourself with the grant program and its requirements. This information can be found in the Grant Guidance document located on the Kentucky Division of Water website [6].

If you are considering applying for 319 program funds, you should consult with the Nonpoint Source Program at the Kentucky Division of Water: or 502-564-3410.

To qualify for 319 program funds, the watershed plan must adequately address the nine elements specified by the EPA. If you follow the steps in this Guidebook, you should meet these nine requirements. But you'll want to check whether the parts of your plan meet the specific 319 program requirements before you finalize your plan. They are listed in the "Nine Minimum Elements to be Included in a Watershed Plan for Impaired Waters Funded Using Incremental Section 319 Funds" in Appendix B.

Once a watershed plan has been developed that meets EPA specifications, sponsors can request 319 funds to implement strategies identified in the watershed plan.

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# Chapter 1: Getting Started

***Selecting Your Watershed and Getting Help***



This chapter will help you:
- Select your watershed
- Identify who should be involved in planning and implementing your watershed project
- Take some beginning organizational steps
- Understand Kentucky's approach to watershed protection and planning

As in every chapter, this one also provides:
- Active Options
- Write It Down

Find related information about this stage of watershed planning in Chapters 3 and 4 of US Environmental Protection Agency's Handbook for Developing Watershed Plans.

## Introduction

The purpose of watershed planning and implementation is to find collaborative, cost-effective ways to improve and protect streams and lakes. Thoughtful, comprehensive watershed planning enables you to effectively focus your efforts to get the most for your investment of your energy and resources. It helps you find the most efficient way to make a difference.

An effective **watershed plan** enables you to focus your efforts on the most efficient and effective methods for improving and protecting the streams, lakes, and groundwater in your watershed.

To be successful, watershed planning and implementation requires a collaborative effort: participation from many and support from even more. Section 1.1 explains why collaborative planning is crucial to success.

While you probably have a stream of concern, there are several factors to consider when selecting the exact location and extent of your watershed. Section 1.2 presents these factors.

A watershed plan helps you prioritize among the different problems you find and among the potential solutions available. Yet despite scientific observations and comprehensive information, it is rarely easy for a watershed team to decide what exactly is most important, what exactly will be effective. For this and other reasons, you want the membership of your watershed team to provide a wide spectrum of capabilities, experience and perspectives. Section 1.3 describes who you'll want to include, and why.

The members of your watershed team will participate either as individual volunteers or as representatives volunteered by businesses, organizations or agencies that have an interest in the watershed. Everyone's time is valuable, and you'll want to be productive from the very beginning. This is why Section 1.4 describes how to get your watershed team started.

Kentucky has a vital interest in improving waterways. The Kentucky Division of Water (KDOW) has a mandate from Kentucky state and US federal laws and regulations to protect waterways. Section 1.5 describes Kentucky's approach to watershed improvement. Additionally, many civil organizations, individuals, communities and businesses throughout the state care about Kentucky's waterways.

Watershed planning requires work. Participants will always need a sense of the importance and vitality of their work. Section 1.6 addresses planning team vitality.

Each chapter of this Guidebook will have Active Options, which offer tips for nurturing planning team and project vitality. Each chapter will also have a Write It Down section, which explains the kind of documentation you will want and need, plus the documentation required for projects funded under Section 319 of the Clean Water Act.

## 1.1 Why Collaborative Planning?

Once a decision is made to look comprehensively at a watershed, the team that works on the plan must also be comprehensive in membership. If, for example, your group has been composed of people who are committed to cleaning up a specific stream or lake, or concerned with water quality or biological systems, e.g. fish or mussels, you'll need to branch out to find new partners and members with additional interests. See Section 1.3 for ideas.

Building a functional, long-term collaboration among partners with diverse interests is both the hardest and most rewarding part of watershed planning. One of the most important aspects of watershed, collaborative planning is the inclusion of stakeholders—people and organizations with a stake in the outcome of the plan.

Collaboration makes the plan better and increases the possibility of successful implementation. There are a number of advantages when groups of partners, stakeholders, and advocates work together.

Advantages of broad-based participation:

- *Strength in numbers*. People have water-related concerns they cannot address alone, and they can accomplish more when working as a group.
- *Diverse expertise.* Collaboration draws on expertise and information from a wide range of people.
- *Inclusive representation.* Involving all the people who have an interest in the project means it will be more acceptable to the community and easier to keep going. This will also assist with implementing the plan in the future.
- *Creative solutions.* Discussing issues with a group produces solutions that might not have occurred to one individual.

## 1.2 Selecting Your Watershed

You probably already have a stream of concern or watershed of interest, but there are a number of factors critical to consider when selecting your watershed. Some are outlined below, but before you begin the selection process, take the time to explore the implications of your choices by familiarizing yourself with this entire Guidebook.

The “Kentucky Watershed Viewer” is an easy-to-use online mapping tool for learning the boundaries of your watershed and getting information about it: 8

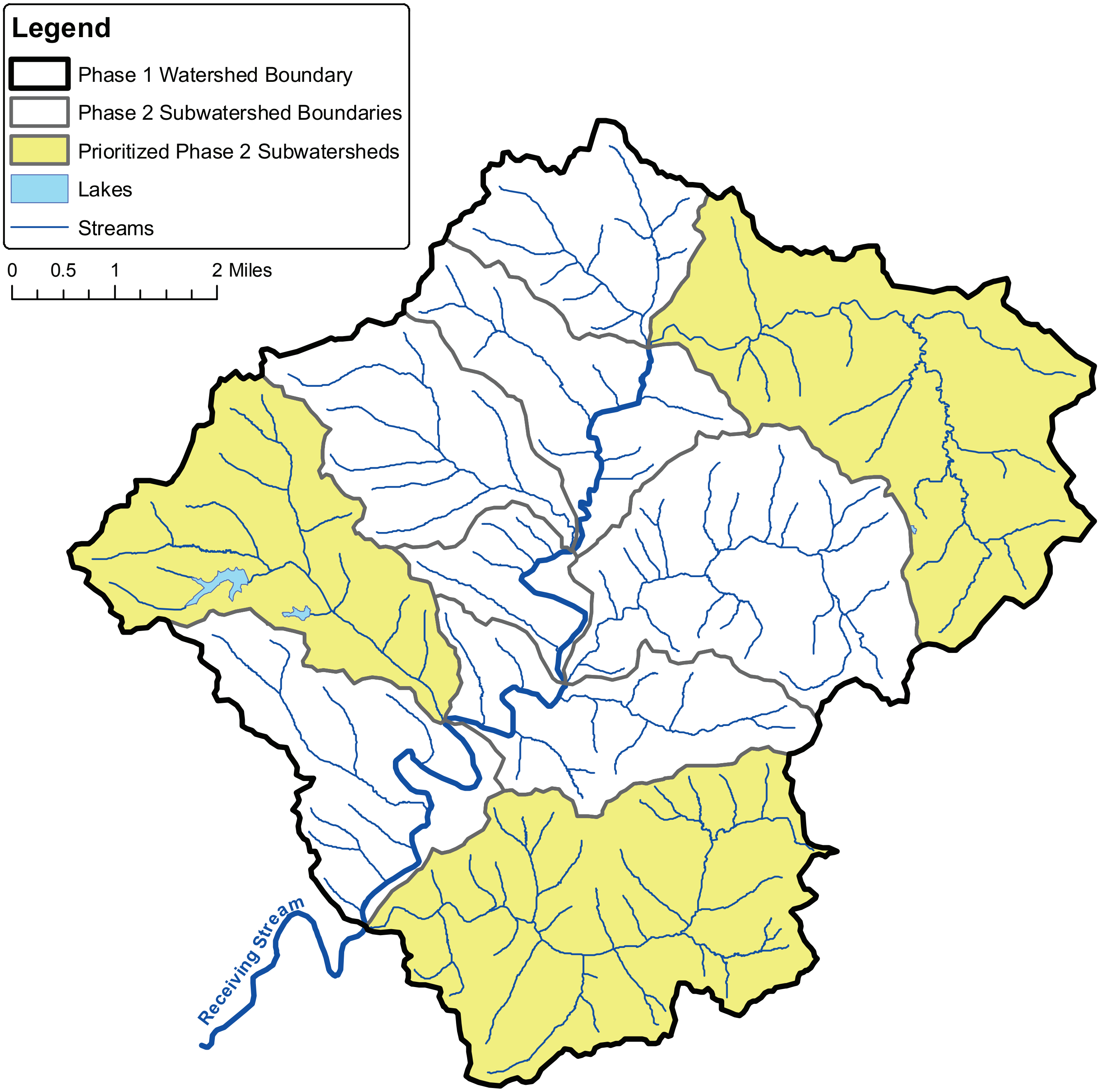
### 1.2.1 Scale

Scale, meaning the size of the watershed area, is important. It is generally not feasible to develop an effective plan for large areas, because both data-gathering and communications become unwieldy.

The current recommendation is to conduct planning in two phases, beginning Phase 1 with a larger watershed area and focusing, in Phase 2, on up to three smaller sub-watersheds. A good size watershed for Phase 1 is generally about fifty square miles. In a watershed area of that size, some solutions are feasible but others are not. For example, conducting educational programs aimed at a certain user group or to promote local ordinances or comprehensive planning works at the larger scale. When determining pollutant sources, implementing on-the-ground BMPs and measuring results, a smaller sub-watershed, about ten square miles, is more realistic. Phase 2 work is generally conducted in up to three of these sub-watersheds. Refer to Figure 1.1.

A watershed plan includes recommendations for implementation of practices that will improve and protect waterbodies. These practices are termed **best management practices (BMPs)**. Some BMPs are applicable at the county level, such as county ordinances. Some are neighborhood-specific, such as septic system upgrades.

Phases 1 and 2 are described more in Chapter 3.




## Figure 1.1 - Phase 1 and Phase 2 Watershed Scale

A watershed of about fifty square miles, as recommended for Phase 1, relates to a **Hydrologic Unit Code (HUC)** identified as a HUC 11, HUC 12, or a group of HUC 14s. See Watershed Basics for an explanation of HUCs.

A sub-watershed of about ten square miles, as recommended for Phase 2, may be parts of HUC 12s, HUC 14s, or multiple smaller delineated watersheds.

### 1.2.2 Regulatory Status

Your plan is more likely to achieve recognition for nonpoint source management grants if at least some of the stream segments have already been assessed by KDOW, and found to be **impaired** or designated as a **Special Use Water** according to state and federal standards. See Watershed Basics and Section 2.2.5 for an explanation of status and information. Impairment status can be found from the Watershed Viewer.

### 1.2.3 Public Interest

While current public interest should not determine whether you undertake watershed planning, there may be factors that you can consider when selecting the scale of your watershed project. Is there already widespread concern about flooding in one area? Is one stream so controversial that a reasonable planning effort might be overwhelmed by discord? Is there a healthy stream you want to include, to help protect it?

## 1.3 Enlisting Support and Help

Anyone can begin assembling a watershed planning team. Initiators need open minds, interest in learning, and willingness to contact a diverse team of potential members.

To help think broadly about putting together a watershed planning team, it is useful to think in terms of partners, stakeholders, and concerned citizens. Although these categories overlap, each should be specifically considered. In addition, your planning team will need to consider its relationship with the general public.

### 1.3.1 Partners

Partners are those who share your concerns, for whatever reason, and commit to helping with the plan over the long term. They frequently provide resources and/or expertise. You need a few at the outset and will find more as planning proceeds, as you learn more about your watershed and the health of your waterway. Partners include stakeholders and concerned citizens that have decided to participate in planning. These groups are addressed in following sections.

Be creative when thinking about potential partners, who may range from state government agencies to small local organizations or corporations. Partners will be motivated for diverse reasons: they may use the waterway, love the stream for its spiritual value or natural interest, worry about complying with existing or new regulatory requirements, be concerned about economic development, and/or have a job or political office with water-related responsibilities. Thus, your partners might be as diverse as a day-camp, the Chamber of Commerce, the Conservation District, a local industry, a local church, a citizen stream volunteer, the sewer authority, a college or university, and a city magistrate.

KDOW's Nonpoint Source and Basin Team Coordination Section can be a very helpful partner. This section provides information and leadership for watershed planning. Section members can tell you about previous or related efforts in your watershed. They can link you to people and agencies who share your interest and tell you if any of the waterways with which you are concerned fail to meet any water quality standard. Staff can direct you to extra resources. Some basins have a Basin Coordinator who may be able to provide individual attention to your planning team. This section also sponsors the Kentucky Watershed Leadership Academy. The Nonpoint Source and Basin Team Coordination Section can be reached at 502-564-3410 or 10.

Many organizations are already involved in watershed planning and protection, either locally or statewide. It's usually a good idea to contact them, because even if they don't directly join your effort, they may lead you to other partners or provide specific assistance later in the process.

- The Natural Resources Conservation Service, a federal agency, helps farmers and other land managers preserve water and soil resources. NRCS staff members have extensive relationships in their communities and have many technical skills you will need. Find your local service center at 11.
- Local Conservation Districts and local offices of the Kentucky Division of Conservation help farmers maximize production while minimizing environmental impacts 12.
- The University Cooperative Extension Service, which has offices throughout Kentucky, has been involved in a variety of related functions 13.
- Kentucky's Area Development Districts have a variety of planning responsibilities for the counties in their districts including drinking water, wastewater, and transportation. Their staff members may also have extensive community relationships and skills as planners. Many ADDs also have staff that is trained in using GIS and grant writing 14.
- The US Environmental Protection Agency (EPA) promotes and funds watershed planning (generally through the Kentucky Division of Water) and has published a comprehensive watershed planning guide. EPA sometimes partners on watershed planning for high priority watersheds and watershed plans funded with 319 funds 15.
- Parks, forests, or preserves have long-range plans for the protection of their natural resources, including rivers and streams within their boundaries.
- The non-profit Kentucky Waterways Alliance works to protect and restore Kentucky's waterways. One of its key goals is to foster local watershed groups. They can provide technical and other assistance and training 16.

### 1.3.2 Stakeholders

Stakeholders are people and organizations with a stake in the outcome of the plan. They are representatives of any group that will be expected to change something, gain something, or lose something when you implement your watershed plan. Stakeholders may make and implement decisions in the watershed, be affected by the decisions made, or have the ability to assist or impede implementation of the decisions. Your planning team formation

Each website icon refers to a site on that gateway website. In the electronic version of the document, these icons refer to direct links in a list on the gateway website. This gateway website address is **http://water.ky.gov/watershed/Pages/WatershedPlanningGuidebook.aspx** process should be designed to elicit the participation of a variety of stakeholders, often developing stakeholders into partners.

Which stakeholders you invite depends a lot on the reasons your waterway is impaired. Some stakeholders will be part of the problem; some will be part of the solution; some will have a connection to the stream because of their organization's regulatory, financial, economic, or political responsibilities. In any case, you will need each stakeholder group to understand the project, and you will need their support to be successful.

Stakeholders are important! The watershed planning process can derail in a hurry if key stakeholders are not engaged.

The following entities are already involved in waterway use and/or protection. If your plan is likely to involve or impact them, consider how to engage them. Might they be good partners? Could they direct you to other partners? Can they provide assistance or support down the road? If you suspect your plan will impact their operations, it's generally best to let them know sooner rather than later, to engage them during the fact-finding phases of planning. Expensive surprises are usually unwelcome!

- Drinking water utilities that draw from surface water sources are involved in Source Water Protection plans that are similar to watershed plans. Groundwater-dependent water systems have Wellhead Protection plans that are also similar, but usually cover smaller areas.
- Wastewater treatment facilities must plan for future needs, including expansion of their service areas, and collect water quality information about the receiving stream.
- Local governments plan the development of their jurisdictions and make decisions about land use. Look for political jurisdictions on the Watershed Viewer 17.

Ideally, your invitations will balance stakeholder interests, and your process will help everyone feel they are welcome, valued and contributing their share to a balanced and equitable plan that will achieve practical, positive goals for your community.

Be sure to consider stakeholders who might perceive they will be impacted, regardless of whether you think there will be real impacts to them or not.

It is also important to reach out to stakeholders who may be skeptical of or defensive about watershed planning. This can be a difficult task, but sometimes just offering someone a chance to voice their opinion in the process is enough to bring them to the table, where they will have an opportunity to become a partner. It is important to involve these parties early in the planning process so they are fully on board when the time comes to implement the plan.

### 1.3.3 Concerned Citizens

Concerned citizens include people who have specific or general concerns about your watershed, individuals who might be willing to lend a hand to the watershed planning and implementation effort. They, too, are crucial to the plan's success.

The EPA has more guidance information on reaching out to stakeholders, keeping the planning team motivated, resolving conflict, and making decisions using consensus. Download "Getting In Step: Engaging and Involving Stakeholders in Your Watershed" from 18.

You'll need a lot of different aptitudes and skills to keep the planning team alive and get the work done, and your citizens and advocates can help. You'll need local perspective. Your plan will be considerably better if your team is familiar with the watershed, including issues of concern but also with politics, history, business, and more.

Anyone can be an asset to your planning team. An elderly farmer might provide the key fact in analysis when he remembers the location of an industrial site, now indistinguishable from the surrounding landscape. A local activist may know of foundation grants that could help with implementation. A secretary at a local business may know how to set up computer files to help track the information you gather. A stay-at-home mom may be able to manage communications among team members. A developer may know or find ways of preventing negative impacts of construction.

It's important to include people who care specifically about the stream's health. If possible, your team should include several individuals who are concerned first and foremost for the stream, because they will help maintain focus on the stream's future, they might inspire others, and they can give each other moral support.

Citizen advocates for streams often belong to Kentucky Waterways Alliance or another environmental advocacy organization:

- Kentucky Waterways Alliance 19.
- Sierra Club Cumberland Chapter 20
- Kentuckians for the Commonwealth 21
- Kentucky Resources Council 22
- Northern KY Water Sentinels 23
- Western KY Water Sentinels 24

It's also helpful to engage several citizens who have some knowledge of stream science. You may find knowledgeable individuals who are willing to volunteer outside of their job, e.g. academics or government employees. Kentucky also has thousands of citizens who are not scientists but have received stream science training through one of two statewide water monitoring programs that train citizens in stream science and monitoring: Water Watch, a program of the Kentucky Division of Water; and Watershed Watch in Kentucky, a nongovernmental program.

Kentucky Water Watch 25
Watershed Watch in Kentucky 26

### 1.3.4 The General Public

It's never too early to think about how your planning team can engage the public. Many implementation activities require public support. At this early stage, it is often useful to hold a **Watershed Roundtable**, a publicly-announced event to both educate and engage the general public. A Roundtable, if properly planned and advertised, can be a good way to raise public awareness, find partners and stakeholders, identify issues of concern and potential opportunities, and begin building a mailing list.

Open the Roundtable by sharing what you know so far about the watershed, and identify the water quality issues that your plan will cover. If your scope is broad and your audience large, you might offer some “break-out” sessions that focus on particular problems or sub-watersheds. Every Roundtable should include a time for participants to meet in smaller groups that provide information and feedback that will help your planning team refine each step of planning.

## 1.4 Starting Your Planning Team

One of the main keys to a strong and effective watershed plan is a diverse, engaged planning team. This section should help your team lay a strong foundation.

### 1.4.1 Contacting Potential Members

Don’t be shy about contacting potential members. Remember, every note or phone call is helpful to increasing awareness and growing support, whether or not it yields you a team member or partner.

The purpose of contacting potential partners, stakeholders, or citizens is to elicit their willingness to come to an organizational meeting and get a feeling for the depth of their support.

Be prepared to clarify your goal of creating and implementing a watershed plan to improve and protect waterways. Let them know that the team intends to examine data and information, and creatively explore options. Clarify the reason(s) you have approached him or her: does he represent a specific audience in your watershed? Is she knowledgeable about practices of specific land users? Does he have influence in the community? Clarify also what you expect of planning team members; for example, attending most meetings and keeping an open mind.

> Here’s a **sample introduction** to a watershed project:
>
> “We would like to design a watershed plan, a plan for improving and protecting the waterways in our areas. We intend for the planning process to include:
> - A comprehensive, open-minded appraisal of our waterway and the watershed that influences it
> - Determination of the significant issues and the sub-watersheds that merit and would benefit from the most attention
> - Identifying measures to improve or protect those locations
> - Making a clear plan to proceed
> - Implementing a plan that will improve and/or protect our waterway”

### 1.4.2 Initial Meetings

Once you have a handful of interested parties, hold an informal meeting to talk about your mission, your vision, and the steps required for watershed planning. Save your work and post it at future meetings.

For your first planning meeting, notify invitees three weeks in advance.  A draft invitation, which can be sent to potential partners and stakeholders and shared with the press, can be found in Appendix C.

In-person, telephone or e-mail contact can be used to convey "welcome" to a stakeholder.  If you haven't heard from someone you've invited, send them a message or give them a call.

Almost always, there's work already underway by one or more stakeholders to improve watershed conditions.  Highlight these efforts by asking them for presentations early in your process. This assures that your effort will have a solid foundation, provides a basis for integrating their efforts with the efforts of others, and acknowledges their importance to the team.  Many grants, including those from the 319 program, require groups to contribute some resources or volunteer activities, called **match**, and efforts already underway in the watershed may fulfill part of the match requirement – or even fulfill the entire match.

After your planning team has an idea of watershed planning, you may want to ask each member to post each of their concerns where everyone can see them.    If you use Post-It notes, members of the team can reassemble the notes so that groups of concerns begin to emerge.  That process acknowledges everyone's contribution and gets everyone thinking about one another's.  This exercise gives your team a good idea of specific issues to explore and specific goals that are likely to emerge.

### 1.4.3 Effective Group Collaborations

Working in collaborative groups requires certain key functions.  Good communication and productivity are what keep people encouraged, engaged, and less likely to find themselves in conflict.

There are some things the planning team should do, *together*, at one of the first meetings – and no later than the third meeting: establish meeting logistics, team ground rules, and decision- making methods.

First, the team should establish where, when, and how often they will meet.  Rotating meetings among partners' offices is a good way to acquaint members of the planning team with one another, but holding meetings in a consistent location makes it easy for people to find and remember.

A second task to do at the beginning is to decide together on some behavioral and decision making ground rules. Typical behavioral rules might include:

- Starting and stopping meetings on time
- Speaking one at a time, without interrupting one another
- Assuring that everyone is heard

A third task, one of the most important, is deciding how the team will make decisions and resolve conflicts. Who will be included in decisions: official members only? If so, what makes a person an official member? Will anyone present be allowed to participate in decision making? If so, what if a crowd shows up that has not participated in earlier discussions, and has not heard information presented at other meetings? The rule can be as elaborate or simple as the team wants it to be, but groups that have failed to make a documented agreement as to how to proceed have become hopelessly entangled in conflict.

It is crucial to remember that tasks are rarely completed unless someone is assigned or volunteers to do so. From the very beginning, your planning team will be more successful if you identify who will take responsibility for each of these functions:

- Create and share clear agendas, preferably available in advance
- Make timely announcements of meetings
- Plan for and conduct meetings
- Make complete, readable, and available records of meetings
- Use past meeting records to keep track of unfinished business and ideas and information
- Start to *"Write It Down,"* begin keeping records. In addition to record-keeping, it's advisable to begin drafting plan sections – soon.

Sometimes, one experienced or organized person ends up taking care of many of the functions described above. However, in the long run, it is very important that different people take on responsibilities. This shares the burden, makes the planning team more dynamic and open, and helps avoid burn-out.

> Many excellent handbooks and guides are available to assist groups in developing into successful partnerships. A listing is provided in Appendix D.

### 1.4.4 Specialized Roles and Skills

Your planning team will need to collect, consider, analyze, organize, and communicate a large amount of information. The team may have to work through problems that are difficult to discuss, due to their complexity or controversial nature. If you are unable to find partners or members who have the skills to lead you through these tasks, you may require assistance from a consultant or non-profit organization. Ask your partners for assistance in fulfilling or funding contracts to fulfill the roles described below.

- **Watershed Project Coordinator**- serves many functions and assists the team members in carrying out their responsibilities. A competent watershed project coordinator is a key to success. He or she is usually either provided by a partner organization or paid through grant or other funding mechanisms. Frequently, a watershed coordinator has little decision-making authority, but this is determined by the team as a whole. If your coordinator isn't local, you will still want leadership from a local person.

- **Facilitator**- specializes in helping groups solve problems and maintain cohesiveness. It is helpful to find a facilitator with some experience in watershed or water resources.
- **Technical Consultant**- has expertise in managing information and filling data gaps. Increasingly, environmental consulting firms are developing a capability to provide extensive technical support to watershed planning.
- **Project Manager**- will be necessary if you secure funding, because funding usually requires tracking and reporting paperwork.

The following Kentucky organizations have staff trained as **watershed planning facilitators** who may be available for advice or continuing support:

- Soil and Water Conservation Districts
- Natural Resources Conservation Service
- UK Cooperative Extension Offices
- Kentucky Waterways Alliance
- Sierra Club Water Sentinels
- Environmental consulting firms

Sometimes setting up a watershed planning team is complicated by the fact that there are already contentious issues or even conflicts around the waterways. In that case, there are a couple of things to recommend. One is to have a social event, probably before the watershed planning team actually begins meeting. Have a barbeque! Have a stream float! If a small tributary isn't suspected or proven to have excessive pathogens or pollutants in it, get kids and adults in the stream to play, to learn how to measure pH and other attributes, or to look for bugs. Watershed Watch groups can help with the latter activities. The important thing, however, is to get the team together in a humanizing, non-confrontational situation. Step back; be social!

If you **contract for services**, be sure the contract is in writing and specific in products. Consider a limited contract, initially, so that you can refine it when the group has a better understanding of what is involved. Ask for advice from other groups or partners who have completed plans.

Groups that contract for services still need to remain involved, to manage the planning process and ensure they receive the products for which they pay.

Once your team has started meeting, consider setting up subcommittees to complete certain tasks, and especially if your team has more than ten or twelve active members. It can also be very useful for the team to elect several people onto an "executive committee" of officers. An executive committee, which can make decisions between meetings, can increase progress and allow the larger team to focus on more challenging and far-reaching discussion items.

## 1.5 Kentucky's Watershed Management Initiative

KDOW has been pursuing watershed management as a method to improve the health of Kentucky's waterways since 1997. The US EPA has required, encouraged and funded the effort.

The Division of Water began its own collaborative project, entitled the Watershed Management Framework, by securing partnerships with state and federal agencies and nonprofit organizations that have a stake in clean water.

Kentucky has twelve major river systems; all but one drain to the Ohio River. In addition to the major rivers, there are a number of minor streams that drain to the Ohio or Mississippi River but are not part of a major river system. For watershed program purposes, these tributaries are grouped with one major river system or another and connected to one of the twelve basins which are shown on a map in the Watershed Basics section.

A description of the Kentucky Watershed Management Framework: 27
A listing of Basin Coordinators: 28

**Basins** are useful for state-level program management, but too large and diverse areas for effective watershed planning.

Each basin has a **Basin Team**. These groups, which strive for diverse membership, develop basin-level strategies and prioritize watersheds for collaborative action.

Basin Coordinators work with the Kentucky Division of Water to provide support to the Basin Teams. Basin Coordinators are aware of previous or related planning in your watershed, can access the resources of the members of the Basin Team, and will link you with KDOW programs.

These agencies and organizations participate in the Kentucky Watershed Management Framework:

**State agencies:**
- Department of Agriculture
- Department for Health Services
- Department of Fish and Wildlife Resources
- Nature Preserves Commission
- Department for Environmental Protection
- Division of Conservation
- Division of Forestry
- Kentucky River Authority
- Kentucky Geological Survey
- UK Kentucky Water Resources Research Institute
- UK Cooperative Extension Service
- Department for Local Government
- Department for Natural Resources
- Division of Water

**Federal agencies:**
- Environmental Protection Agency (EPA)
- Army Corps of Engineers
- US Geological Survey (USGS)
- Natural Resources Conservation Service (NRCS)
- US Fish and Wildlife Service
- Ohio River Valley Water Sanitation Commission (ORSANCO)
- US Forest Service (USFS)
- Office of Surface Mining
- PRIDE

**Organizations:**
- Kentucky Resources Council
- Sierra Club
- Kentucky Waterways Alliance
- Area Development District Council
- Kentucky Association of Counties
- Kentucky Chamber of Commerce
- Kentucky League of Cities
- Farm Bureau Federation
- Kentucky Rural Water Association
- Kentucky Water and Wastewater Operators Association
- The Nature Conservancy
- Natural Heritage Trust Fund Board
- Colleges and Universities

## 1.6 Group Vitality

Watershed planning is a sustained process that asks planning team members to learn complicated science and to think geographically. It's challenging, and it's long-term!

Be respectful! Recognize contributions from each individual, no matter how small. Team members need a sense of the importance of each member's contributions. Be proud! Celebrate the group's accomplishments.

Unfortunately, things can go wrong. As your team develops, keep an eye out for nonproductive or even divisive behaviors or group habits. The following is a "lessons learned" list from watershed planners across the country, a list of characteristics that have complicated or even sabotaged watershed planning groups.

- *Unresolved conflict*—Key group members are unwilling to work at resolving conflict; opposing groups with historical conflicts refuse to talk or associate in your process.
- *Lack of clear purpose*—Problems are not clearly defined or are not felt to be important.
- *Vague goals*—Goals or time frames are either unrealistic or poorly defined.
- *Incomplete group*—Key interests or decision-makers are not represented or refuse to participate.
- *Unequal partnership*—Some interests have a disproportionate amount of power, or not all partners stand to benefit, or some members are not being given credit for their contributions.
- *Lack of commitment*—Financial and time requirements outweigh potential benefits to crucial members, or they are not comfortable with the level of commitment required.
- *Basic value conflict*—One or more crucial members have irreconcilable differences with the planning process or its goals, and there is no room for negotiation.

It's not too early to begin drafting your plan! It's best to draft these sections now, because:

- Reviewing chapter drafts can engage workgroup members, affirm their commitment
- It's better to write sections while the work is fresh on your mind
- Procrastinating will only make for a lot of work later on.

Whoever is responsible for planning and conducting meetings should collaborate to encourage participation from each member of the team. You can get facilitation advice from the organizations listed in Section 1.4.4.

- Give people specific things to do, and support their effort with technical assistance and resources as needed. The planning team needs to set clear deadlines and identify who is responsible for tasks.
- Find common ground so that no one feels alienated. One way is to appeal to people's sense of stewardship. Show how the problems in the watershed affect residents—in economic and social terms as well as environmental.

## Active Options

Do hands-on projects to give members a sense of ownership and involve your group's members directly and personally with the waterway. Ideas for hands-on projects include:

- Tree planting event
- Trash pickups
- Stream bank plantings
- Site visits
- Stream walks
- Monitoring events
- Canoe trips
- Driving tours.
- Explore the KY Watershed Leadership Academy program [29].

## Write It Down

Each section of this Guidebook includes a Write It Down section. This section makes recommendations for drafting your watershed plan document as well as for record-keeping. Planning funded with 319 funds requires all of this documentation.

Of course, these chapters will be revised later. For example, you'll probably add partners. Still, you'll be glad, later, that you began your draft right away. You will also need to update the plan, including changes in team membership and in verb tense. Your completed plan should accurately reflect work completed and work remaining.

Part I of your watershed plan introduces your audience to the project and clarifies the decisions you've made and the individuals, groups and organizations working with you.

## Chapter 1: Introduction

### The Watershed

Identify the waterway and watershed to which this plan pertains.
Explain briefly why this area was chosen.
Provide a summary or details of local concerns about the waterway.

### Partners and stakeholders

List the partners and stakeholders who are involved in your planning process. Identify their organizations, if any, and roles. This list will grow as your process proceeds, so be sure to update it regularly. Provide a contact person and contact information.

NOTE: Your planning team should never overstate the commitment of a partner or stakeholder, nor publish a list including a stakeholder without approval of the listing by the stakeholder. However, it may be appropriate to list partners that your team hopes to work with or you have contacted, clearly indicating their prospective status.

**Other Records**

Keep records of the contacts you made while looking for partners and workgroup members, including their contact information, the date(s) of contact, and their responses. Make a note of those who you may want to engage or query further into the planning process.

Keep minutes of all your workgroup meetings.

# Watershed Basics

### *Stream Systems and Human Influences*

This part of the Guidebook is intended to educate people who are just learning about our role in ensuring clean water, but also to provide a refresher for all who are involved in projects or activities related to clean water planning, protection, or restoration.



## Part I: Watersheds and Stream Systems

### I-A Why Clean Water Is Important

Every organism on Earth needs water. Clean water comes from healthy streams, but healthy streams are also an important part of the world around us. To have a steady supply of clean water to drink, we pay for our water treatment plants to withdraw water from local streams, wells, or springs and use chemicals and other processes to make it clean and safe. The dirtier the water, the more it costs to clean it, and the more we have to pay for drinking water. Water can be so dirty that it isn't feasible to make it clean enough for drinking water. The cleanliness of water also impacts agriculture, recreation, industry, wildlife, and other aspects of life.

To understand how our water can be kept clean so there is usable water now and in the future, we must first understand how the water cycle works. We must also understand how water moving through this cycle affects and is connected to the plants and animals that live in and around streams, lakes, and wetlands.

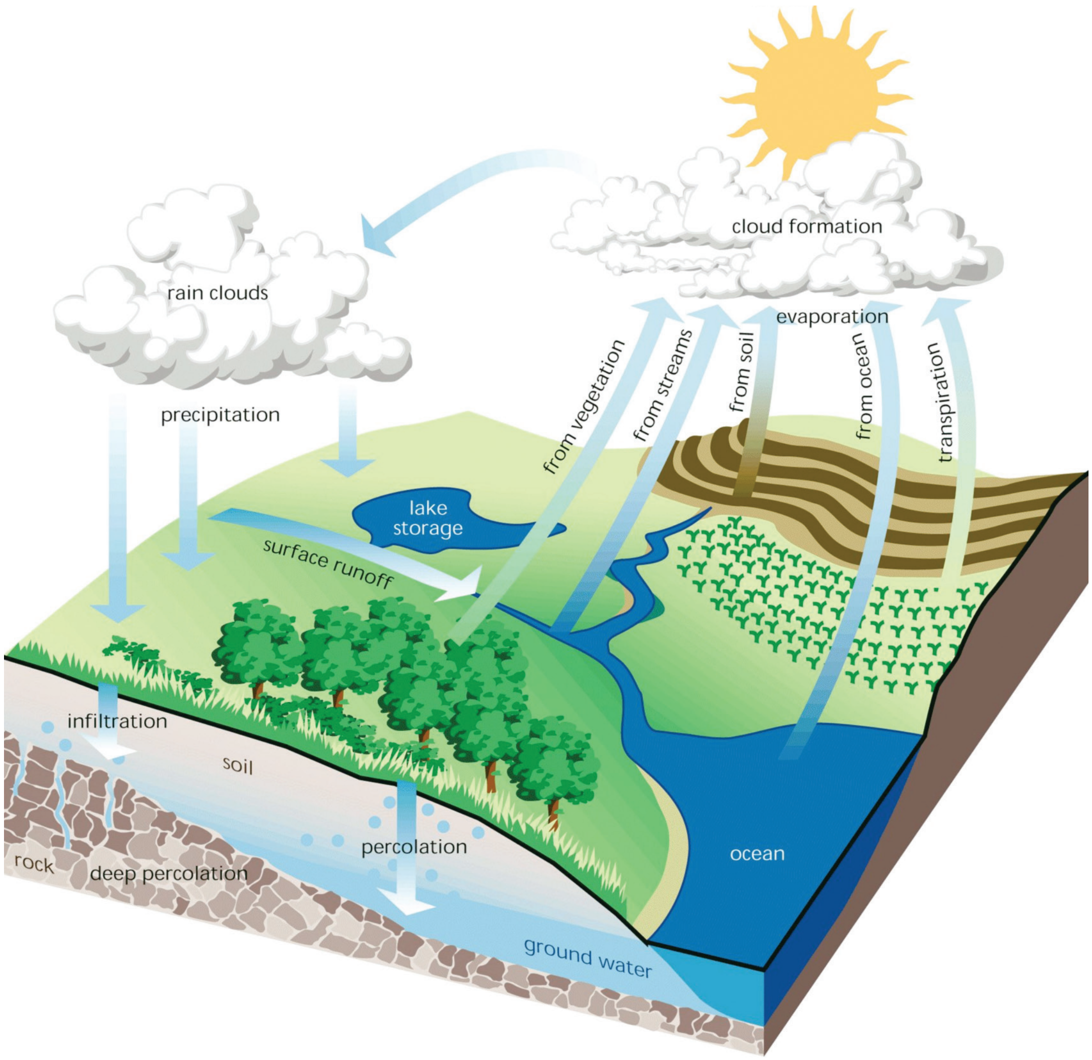
### I-B The Water Cycle

Words in **bold type** face are defined in the Guidebook glossary.

The **water cycle,** or **hydrologic cycle,** describes how water exists and moves on, in, and above the Earth. This cycle is continuous and doesn't have a point where it starts or ends. This description begins with the oceans, where most of the water on Earth exists. The sun heats water in the oceans and evaporates some of it into the air. As this water vapor rises, the air cools and causes the vapor to become clouds. As the wind moves the clouds over the land, the clouds become larger with water vapor that has evaporated from the water already on the land and with the water vapor given off by plants, **transpiration**. Changes in temperature cause the water vapor in the clouds to fall out of the sky as **precipitation**. The precipitation can fall as snow, sleet, or rain.

As rain falls or snow melts, it begins to soak into the ground. If there is too much water too quickly, the plants can't soak it up fast enough and the spaces between soil particles are filled. The water that can't soak in begins to move across the top of the land as **runoff**. Any materials on the land, such as dirt, chemicals, oils, fertilizers, etc., whether naturally occurring or put there by humans, are carried along with the

## The Water Cycle




*The Hydrologic Cycle* from Stream Corridor Restoration: Principles, Processes, and Practices (10/98); Interagency Stream Restoration Working Group

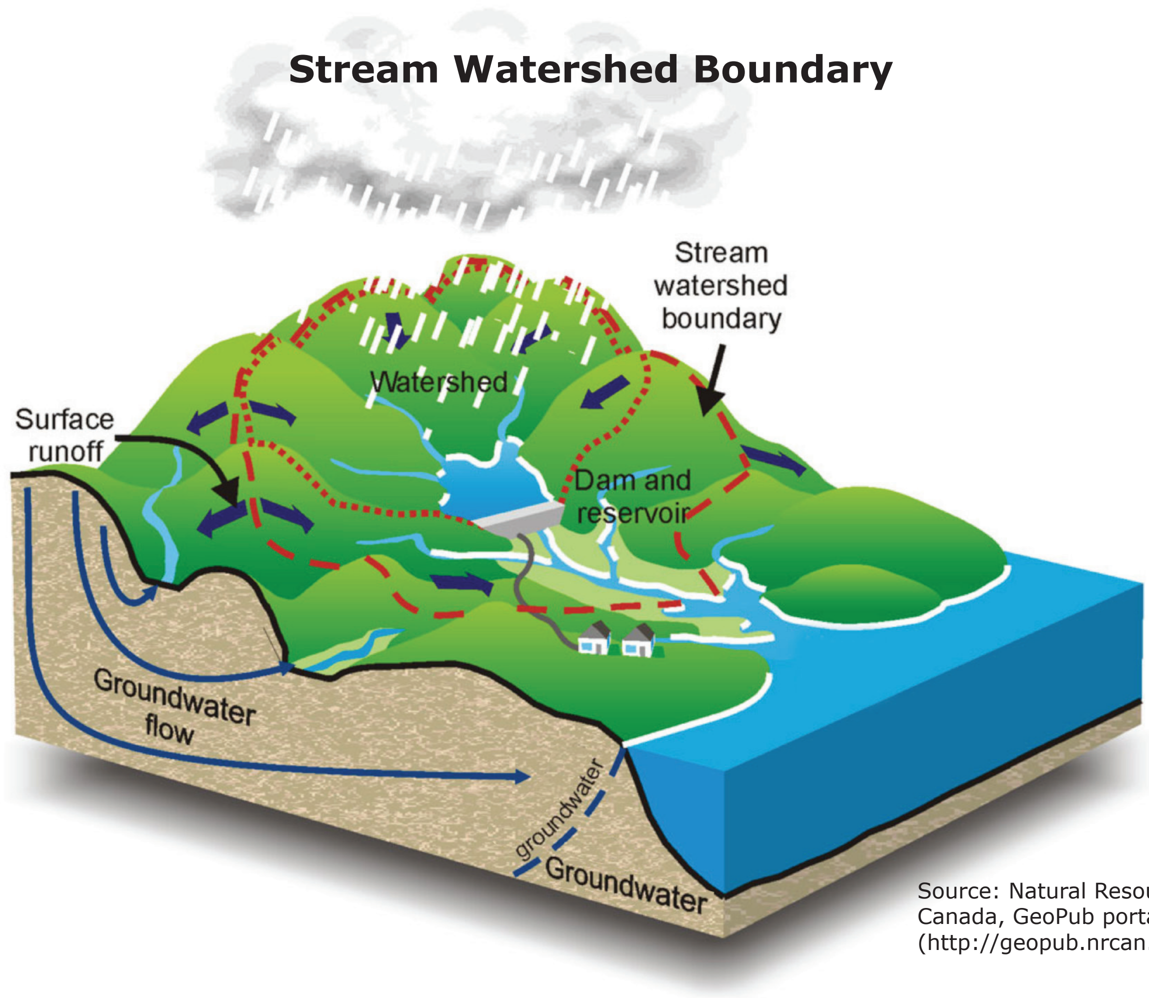
runoff. These materials that are picked up by the runoff and carried into streams and lakes pollute the water and are called **pollutants**. The water that soaks into the ground becomes groundwater which is discussed in section I-F.

The runoff is moved downhill by gravity until it reaches a common low point and forms a stream. This stream can join with another stream and become a bigger stream that continues to be moved by gravity to a common lower point on the land. These bigger streams can join together to form even bigger streams, and so on. A stream that flows into another stream is called a **tributary** of that stream. Eventually all streams flow to the lowest surface points on earth, our oceans, seas, and lakes, where the water cycle continues with evaporation.

## I-C What Is a Watershed?

The area of land where the runoff flows to a common stream is called a **watershed**. Each of us lives in a watershed. The boundary of the watershed is the imaginary line drawn around the highest points. This indicates where rainfall or snowmelt ends up: precipitation inside the line flows to one stream and precipitation outside the line flows to another stream. As two streams join together to form a larger stream, the two areas of land that drain to these streams also join together to form a larger watershed. Because smaller watersheds join to form larger watersheds, most people live in more than one watershed. Many watersheds joined together form a very large watershed that is sometimes called a **basin**. There are twelve major river basins in Kentucky.

**Stream Watershed Boundary**

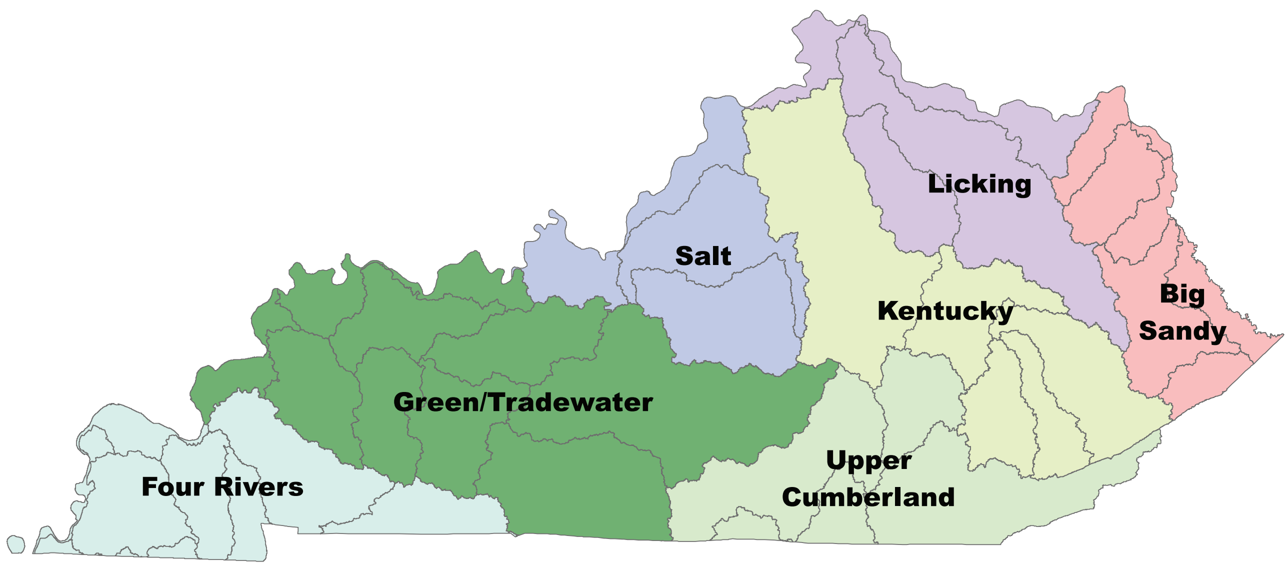



Source: Natural Resources Canada, GeoPub portal (http://geopub.nrcan.gc.ca)

This Guidebook focuses on watersheds that are smaller than basins. Smaller streams and creeks are sometimes thought of as sub-watersheds. Sub-watersheds are smaller, local drainages such as a creek that may run only a few inches deep. For instance, Eagle Creek is a tributary to the Red River, which in turn is a tributary of the Kentucky River. In this example, Eagle Creek is the sub-watershed, Red River and all its tributaries make up the watershed, and all of these are part of the Kentucky River Basin. A person who lives in the Eagle Creek watershed also lives in the Red River watershed and the Kentucky River Basin.

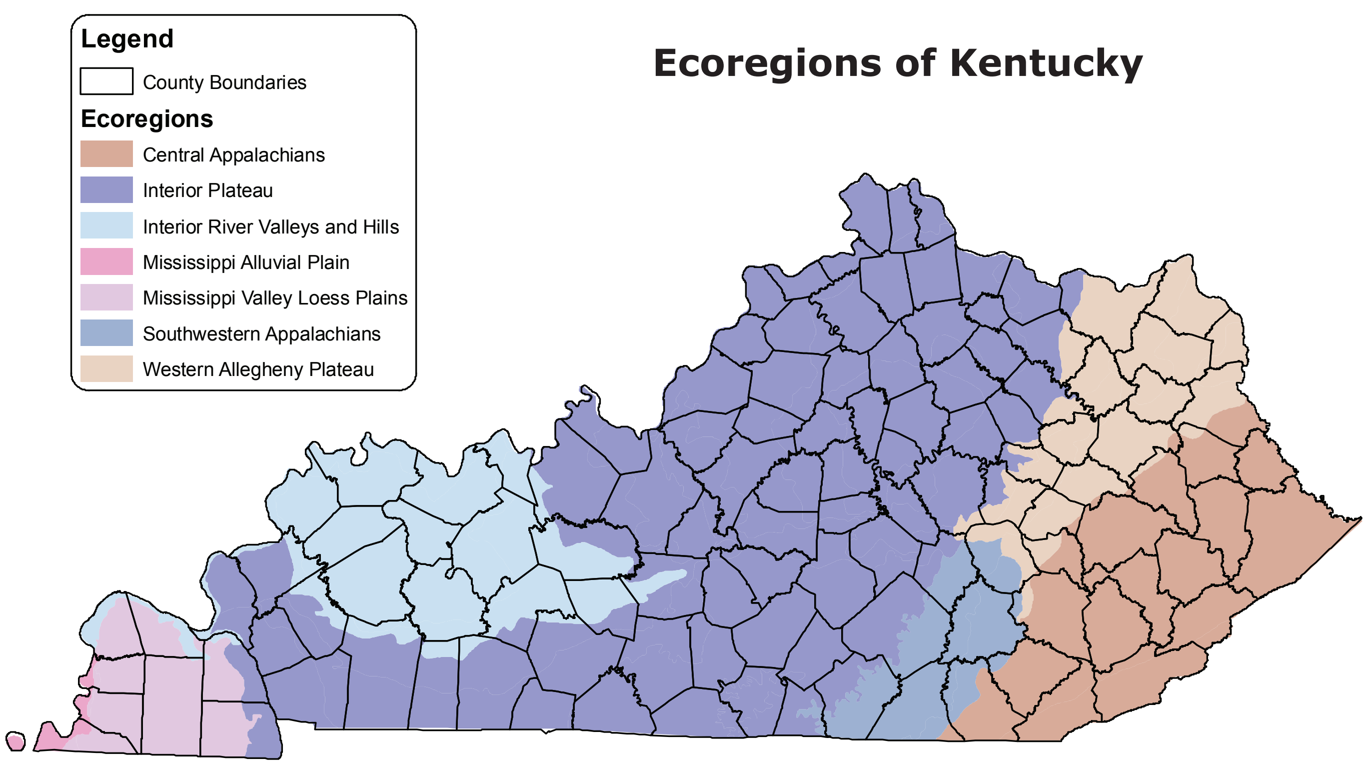
Streams flow through valleys in the landscape with ridges of higher land separating the valleys. The area of land between ridges that collects precipitation is a **watershed**, or basin.

## Major River Basins of Kentucky




There are many combined natural factors that distinguish watersheds. These include geology (rock types), soil type, slope, land surface features, climate, etc. The different combinations of these factors determine the types of plants and animals that grow there. The surroundings of a specific type of plant or animal, where it lives, is called its **habitat.** The plants, animals, and the habitat in which they live are called an **ecosystem**. Large areas where the patterns of ecosystems are similar are called **ecoregions**. The streams found in each ecoregion have similar properties.

## Ecoregions of Kentucky



## I-D Your Watershed Address

When settlers arrived in Kentucky, the Native Americans that lived in, traveled through, and hunted in the state already had names for many of the streams here. The settlers sometimes adopted the Native American names for the streams, but more often renamed them. These stream names weren't always recorded in documents and/or maps. As settlers established communities and towns and then moved on, the stream names were lost or forgotten and new names were given. In addition, the same name was often used for different streams in the same area or across the state. This created a very confusing situation when formal maps of the state were developed. To deal with this situation across the United States, a system was developed by the United States Geological Survey (USGS) that assigned a group of numbers to each permanently flowing stream. These numbers are called the **Hydrologic Unit Code (HUC)**. The HUC (pronounced "huck") is like a zip code for a stream. Just as the US Post Office has added four extra numbers to our five digit zip codes to make them more specific to a single home address, for example 40347-4502, extra numbers added on to the HUC make it more specific to a certain stream. As the HUC number gets larger, the watershed gets smaller. The following is an example of HUCs that have added numbers and become more specific to increasingly smaller watersheds:

| Stream | Hydrologic Unit Code (HUC) |
|---|---|
| Ohio River | 05 (2 digit HUC) |
| Licking and Kentucky Rivers<br>(tributaries of Ohio River) | 0510 |
| Licking River | 051001 |
| Mainstem Licking River | 05100101 |
| Triplett Creek<br>(tributary of Licking River) | 05100101130<br>(11 digit HUC) |
| Dry Creek<br>(tributary of Triplett Creek) | 05100101130120<br>(14 digit HUC) |

Depending on size, as shown above, HUCs are identified using two to fourteen digits. For watershed planning purposes in Kentucky, a HUC that is about 50 square miles in size is recommended. This means the eleven, twelve, and fourteen digit HUCs will be the most commonly used watershed size for planning. Chapter 2 of this Guidebook tells you how to find the HUCs for your watershed.

## I-E Erosion

As water is moved by gravity and flows to a lower point, it gains energy. This energy in the flowing water causes it to move particles of soil, rocks, and other material on the surface of the land. The greater the energy in the water, the faster it moves and the larger the particles moved by it. This continuous wearing away and movement of particles over time is called **erosion**. The trees, shrubs, grasses, and flowers that grow in the soil absorb some of the energy in the runoff and slow it down. The vegetation also holds on to the soil with its roots. This lessens the amount of soil carried into streams by erosion. Water running over areas of soil without trees and other vegetation can very quickly erode large amounts of soil and carry it into streams.

Some soils and rocks erode more easily than others. As a stream flows across the land, these different rates of erosion determine the shape of the stream that is carved into the land. The particles eroded from the stream bed and the particles eroded from the land are carried by the stream until curves or other obstacles slow it down and it loses the energy to carry them. As these particles are deposited on the bottom of the stream, the larger particles begin to settle out first, followed by the smaller ones. The accumulating piles of particles of soil and rock in the stream are **sediment** and sometimes form sand bars, or **point bars**, in the stream.


Following storm events, the runoff into a stream increases the flow and energy in the stream. Sediments that have been previously deposited in the stream can be picked up by the flow and re-deposited somewhere else in the stream. These processes of moving and re-depositing sediments are called **sediment transport** and **sediment deposition**.

Streams are constantly changing because the erosion, transport, and deposition are continuous processes. The study of these processes and the way they shape the surface of the earth is called **geomorphology**.

## I-F Groundwater

When you look at all the fresh water available for human use on the planet, most of it is in the form of groundwater. Groundwater is stored below the land surface in sediments or rock layers that are called **aquifers**.

Aquifers are replenished, or **recharged**, from some of the rain and snowmelt that soaks into the ground. The process of precipitation soaking into the ground is called **infiltration**. Depending on the land and rock types, this water may move slowly through the soil or it may sink rapidly into sinkholes or sinking streams. Water moving slowly downward through soils and sediments can be cleaned because these act as natural filters for most types of pollution.

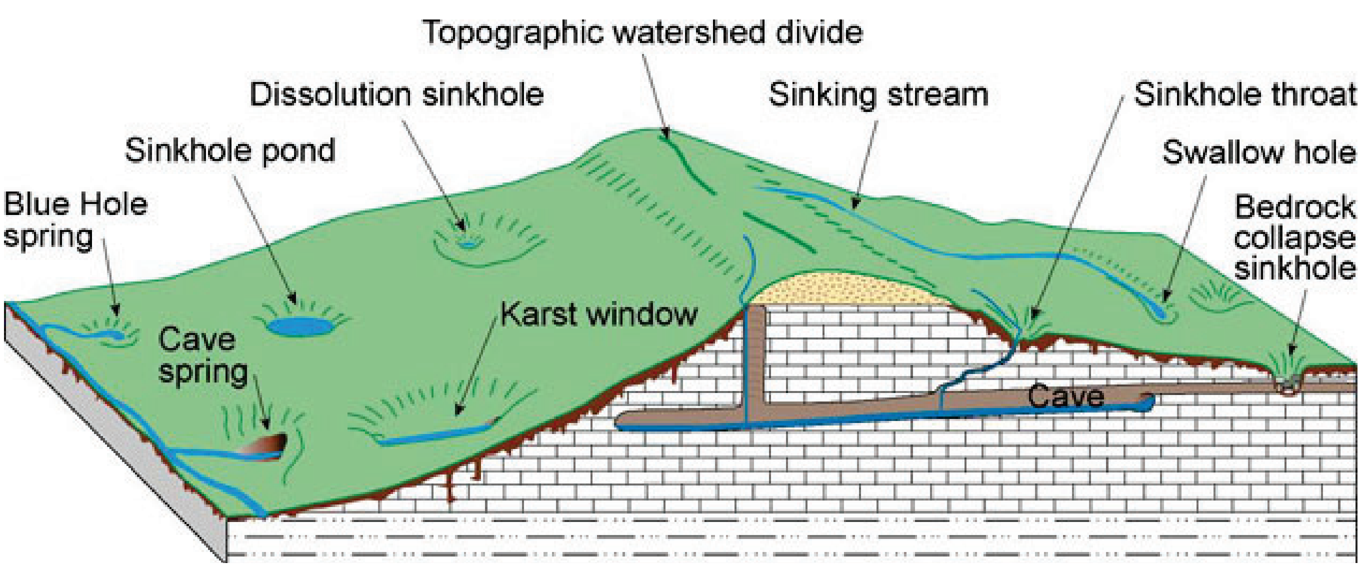
The water continues moving downward until it reaches a layer of sediment or rock (the aquifer) that is completely saturated with water. The dividing line where the saturated area begins is the **water table**. The distance from the ground surface to the water table is called the depth to groundwater, and this distance can range from very shallow to very deep. Once groundwater reaches the water table, it begins flowing more horizontally, generally parallel to the land surface. Groundwater can move through the tiny spaces (pores) between sand and gravel particles or it can move through the breaks in the underground rock. It moves very slowly, perhaps only inches or a few feet per day, through sand and gravel, and is much faster, can be several to tens of feet per day, when moving through broken rock.

Under natural conditions, all of this groundwater follows the slope of the underground sediment or rock, flowing "down hill" toward low points where the saturated layer comes to the land surface and the groundwater seeps out. This seepage discharge point is often in or near a stream. Seeps that have larger amounts of groundwater coming to the surface are called **springs**. Springs and seeps eventually or directly flow into streams. In this way, groundwater also contributes to the water flowing in streams. Streams that receive groundwater usually flow year-round and are called **perennial streams**. Streams that only flow during a rain or snow event are called **intermittent streams**. Some streams seep into the groundwater, instead of the other way around.

As the groundwater moves through the soil, it can become slightly acidic. In areas where the bedrock is mostly made up of limestone, this acidic groundwater will dissolve the limestone. This process of rock being dissolved is called **weathering**. It forms openings and channels in the bedrock called **conduits**. Some of these conduits keep dissolving until they are large enough to become caves.

Groundwater can flow very quickly through these channels and caves underground. During periods with large quantities of rain or snowmelt, the groundwater is recharged by runoff into surface openings. This does not provide for natural filtration of pollutants and the aquifer can be easily contaminated. This recharge also carries some soil from the surface into the aquifer. As more soil is removed depressions on the surface begin to form. These are called **sinkholes**. In some cases the sinkholes form very quickly as a collapse that can cause significant damage to roads and buildings. Aquifers that are formed in limestone geology with sinkhole and cave formations are called **karst** aquifers.

## Karst Features




Source: Kentucky Geological Survey

Much of Kentucky has karst aquifers, which results in some unique problems with groundwater pollution. Karst aquifers are present in about half of the state, from northeastern Kentucky through the Bluegrass Region and across south central into western parts of the state. The most famous example is Mammoth Cave in south central Kentucky, which is the longest known cave system in the entire world with approximately 365 miles of mapped cave. Special methods are required to test water for pollution in these areas and pollution prevention management practices must take the karst features into consideration.

Karst aquifers are very different from other groundwater systems. They can be thought of as subsurface river systems. Flow through a karst aquifer is similar to a surface river system. Water moves through bedrock conduits to form small tributaries that come together to form subsurface streams. Depending on the location, these streams may join together to form large subsurface rivers.

Karst aquifers do not always follow surface watershed boundaries. It is not uncommon for karst groundwater to flow beneath ridges and carry water into, or out of, a watershed. Karst groundwater-sheds cannot be determined by looking at features on the land surface. Cave mapping and special studies called dye traces must be conducted to determine the source area for water discharging from a spring.

## I-G Wetlands

A **wetland** is a natural area that is covered with water or soggy, but may not be wet all year round. Wetlands are known by several different names. Some of these are marsh, swamp, bog and vernal pond (temporary wetland). They provide a place to live, feed, and reproduce for plants and animals that are adapted to live in a waterlogged environment.

Wetlands are identified by the hydric (water-soaked) soils, hydrologic regime (water flow patterns), and hydrophilic (water-loving) plants found there. Identifying an area as a wetland requires a trained professional that is familiar with the sciences of these characteristics. Wetlands are found on all of the continents throughout the world except Antarctica.

There are two main types of wetlands, coastal tidal and inland freshwater. Since there aren't any oceans or tidal wetlands in Kentucky, they will not be discussed. Kentucky does, however, have a variety of freshwater wetlands. These are found along floodplains of rivers and streams (sometimes called **riparian** wetlands), along the edges of lakes and ponds, or in low areas with poorly draining soil where groundwater comes to the surface or rain and snowmelt collect.

In Kentucky, more than 80% of the original wetlands have been lost due to human activities. Much of this loss has occurred in Western Kentucky where large wetlands are common. However, losses of smaller wetlands add up statewide and significantly contribute to the overall total loss in the state. Today, wetlands compose less than 2.5% of Kentucky's land area, but they still have considerable value for the environment, economic and social factors, and natural beauty.

Once wetlands form, they are constantly changing. Runoff and floodwater from precipitation carry sediment and debris into wetlands. These settle among the roots to the bottom along with dead plant matter and build up over time causing the wetland to become shallower. Often this layer of sediment and decaying material can accumulate until it is thick enough to extend above the surface of the water and begin drying out. Though this surface layer may be dry, the soils below may still be saturated with water and influencing the types of organisms that live there. This area that appears dry may still be identified as a wetland. This situation emphasizes the need for following state, federal and local guidelines for accurate identification.

Wetlands are very unique ecosystems and support a large variety of organisms. As a result of the materials washed into wetlands by runoff and the accumulation of decaying plant matter, there are high levels of **nutrients** available for use by many species of plants and animals. These nutrients, combined with the availability of water, provide an ideal habitat for fish, amphibians, and insects. Also, many birds and mammals rely on wetlands for food, water, breeding grounds, and shelter. In the United States, one-third of the nation's threatened and endangered species live only in wetlands, while half use wetlands during at least part of their lives.

In addition to being unique ecosystems, wetlands also act as filters for pollution and trap harmful pollutants such as excess sediment, human and animal waste, fertilizers, and pesticides and herbicides that would otherwise be washed directly into streams or lakes. Runoff often carries a large amount of these pollutants and when it enters a wetland before draining to a waterbody, the pollution is filtered out. This filtering process is an extremely important function for ensuring clean water in streams and other waterbodies.

Wetlands also provide flood protection. They act as sponges and soak up large amounts of rain and floodwater. One acre of wetlands can store one million gallons of water and release it gradually after rains end. This reduces flooding downstream and allows water to soak into the soil and replenish groundwater. Over half of the wetlands in the United States have been drained or filled causing an increase in flooding in the watersheds where they are lost.

Wetlands prevent erosion, too. As damaging, high energy floodwaters rush into wetlands, the energy is absorbed by the plants and the water is slowed down. As a result, rather than washing away soil, the soil particles that are already in the floodwater are deposited in the wetland. Roots of trees, shrubs, and other plants in the wetland also help to anchor the soil.

More information on wetlands can be found at the US Environmental Protection Agency's website [30]. The US Fish and Wildlife Service keeps records of the number and condition of the wetlands in the United States. This is called the National Wetlands Inventory. It can be found at the website [31].

# Part II: People and Watersheds

To understand your watershed system, it's necessary to consider how human activities impact the streams, lakes, and groundwater within the system. The following sections provide general information on how activities such as farming, construction, mining, and pumping of groundwater affect the watershed. Many of the activities have negative impacts and being aware of the potential effects is important when planning watershed protection and improvement.

## II-A Land Use

Several factors can influence water as it moves through the watershed. Rivers and streams change with time. Rivers will flood, streams will run dry, and lakes will freeze. These natural events bring changes to the watershed system. However, human activities in the watershed have the biggest influence on rivers, streams, and groundwater. For example, streams channels are often changed (moved or straightened) to increase farming land or to provide water for industrial purposes. Frequently, the results of stream channel changes are reduced stream bank stability and increased erosion. A farmer, who altered a stream channel, may find some of his best soil and pasture washed away. One way to understand how human activity influences the watershed system is to look at land use.

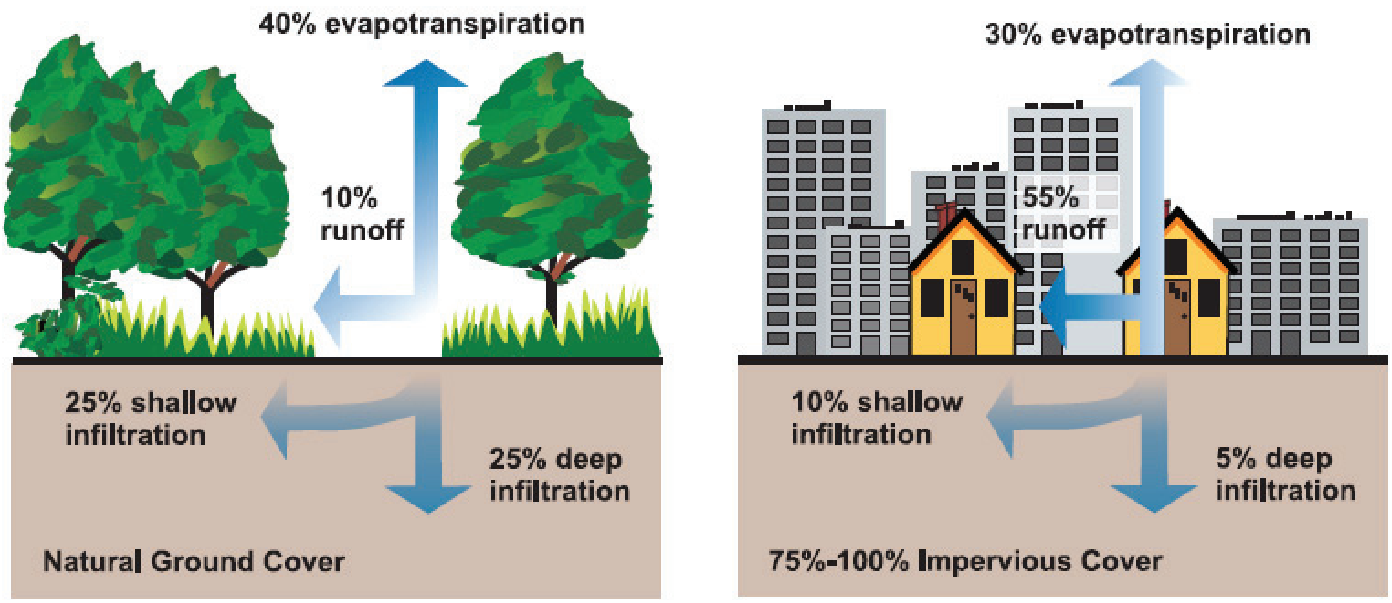
At first glance, it's easy to see alterations to the watershed landscape. Obvious changes include parking lots, neighborhoods, tilled farmland, highways, and dams. Changes can be found anywhere human activity occurs, even on a forest hiking trail. These changes are common features of a modern landscape and may seem normal; however, these changes alter water's natural flow and movement. Even the smallest human activity has the potential to affect the water cycle. For example, a car travelling on a dirt road will loosen soil which will then be carried by runoff, maybe into a stream. The list of activities with the potential to alter the hydrologic cycle is exhaustive and includes such routine acts as washing dishes, watering the yard, and even taking the dog for a walk. A few of the more common landscape alterations are included here for information purposes and to help visualize how land use might impact the flow of groundwater, streams, and rivers.

### II-A-1 Land Use in Cities and Towns

**Impervious surfaces** include parking lots, highways, neighborhood roads, sidewalks, driveways, and more. An impervious surface is any area that has either been paved over or is so hard packed that rainwater cannot soak through to the groundwater below. It's not just the pavement that's a problem; rooftops take up a lot of space. An urban area will have miles and miles of impervious surfaces that prevent infiltration and alter the way rainwater recharges the groundwater below.

Anyone who has driven by a construction site probably noticed the amount of exposed dirt and dust. Without a protective layer of grass or trees to hold the soil in place, erosion quickly becomes a problem. When rain hits the loose dirt, some of the water may sit and soak into the ground. But if the rain fall is moderate or heavy, or the ground is sloped, the water may run across the surface and straight to a nearby pond or stream, carrying soil with it.

# Impervious Impacts




In areas with a large amount of impervious surface, there is less rainwater recharge to the groundwater table.
Source: The US Environmental Protection Agency

What about all the water used in households' bathrooms and kitchens and in businesses every day for countless different purposes? Where does the used water go? The water may contain chemicals and **bacteria** that are harmful to the environment and have to be treated. Wastewater treatment facilities clean the water but sometimes can't handle the amount of dirty water produced. When a facility receives too much dirty water, the system will overflow and the polluted water will spill onto the surrounding land or stream.

Some communities in Kentucky have sewers that carry both stormwater and wastewater. These are called **Combined Sewer Systems (CSS)**. Normally, the water in these systems all goes to a treatment facility. When rainfall or snowmelt is heavy, the flow in the CSS can exceed pipe capacity, resulting in untreated water being discharged directly to the stream. These discharges are called **Combined Sewer Overflows (CSO)**.

Other communities in Kentucky have separate sewer pipes for wastewater and storm water. The pipes that carry wastewater in these systems are called sanitary sewer systems. Properly designed, operated, and maintained sanitary sewer systems are meant to collect and transport all of the sewage that flows into them to a wastewater treatment plant. However, occasional unintentional discharges of raw sewage from sanitary sewers occur in almost every system. These types of discharges are called **Sanitary Sewer Overflows (SSOs**). SSOs have a variety of causes, including but not limited to severe weather, improper system operation and maintenance, and vandalism.

Communities of certain sizes (a population of at least 50,000 and an overall population density of at least 1000 people per square mile) in Kentucky are required to manage their storm water. These communities are called **Municipal Separate**

**Storm Sewer System (MS4)** communities. Each regulated MS4 is required to develop and implement a stormwater management program to reduce the contamination of stormwater runoff.

### II-A-2 Land Use in Rural Areas

Changes to water flow paths are also visible in rural areas, including on agricultural or farm land. Whenever a patch of land is cleared of the vegetation, loose soil is exposed. This exposed soil is easily eroded by wind, ice, and running water. Farm animals are also a concern. Manure, or animal waste, can get washed into a stream or river. Animals may even disrupt streams directly by walking and standing in the stream bed. Many agricultural practices rely on pesticides, herbicides, and fertilizers. In the same way that loose soil is washed into a body of water, the chemicals or fertilizers may also be washed into a stream or soak into the groundwater. This is especially a problem if the products are not applied to the land or crop in the appropriate or prescribed manner.

Rural areas usually don't have as much impervious surface as populated areas, but imperviousness remains a problem. Even if only ten percent of a small area is covered with impervious surface, the stream will demonstrate negative impacts. In addition, looks can be misleading; a pasture that is overgrazed or grazed in winter or wet conditions can become quite impervious and hasten the passage of pollutants to the receiving stream.

Cows stand in a Kentucky stream. Animal waste can be detrimental for a stream system and overload the water with nutrients and bacteria.

Forests act as natural filters for water and help to keep the water runoff clean and free of pollutants. Forests are also natural resources and provide timber for construction and other uses. Logging in the forest creates changes to the system. Roads have to be built to transport harvested trees. Dirt roads impact water runoff in the same way as construction sites. Rainwater hits the road and carries away loose soil and dirt into streams.

Human waste isn't just a problem in a large city. Homes in rural areas may be connected to **package treatment plants**, **septic systems** or may even use **straight pipes** to discharge waste water. All package treatment plants and septic systems require maintenance and periodic cleaning. It's common for older or neglected septic systems to break down and leak. This waste water ends up in the groundwater or may flow into a stream. It is sometimes the case that homeowners are unaware of their responsibility to maintain and clean out their septic systems.

### II-A-3 Land Use for Water and Energy

Mining for energy resources or for valuable minerals or other materials present many of the same issues associated with construction and logging. Then there are problems that are unique to mining. One of the more obvious changes to the watershed is the clearing of vegetation and grasses. Soil is moved and transported. Once again, erosion is an issue. As the water runs across the mined earth, it interacts with the exposed minerals. The minerals are comprised of different elements that may make the water more acidic or heavy with metals. Water with acidic pH levels and high metal concentrations can be harmful to plants and animals. Different forms of mining common in Kentucky include coal mining and quarries, an open pit from which limestone and other earth materials are extracted. Water quality issues associated with quarries are an increase in sediment and a change in pH. Mining can impact both groundwater and surface water bodies.

## II-B Dams and Hydromodification

Dams, or impoundments – both large and small -are common in Kentucky's streams. These are hydro-modifications or alterations to the natural flow of water. Even small instream (low-head) dams can interfere with aquatic life. Larger impoundments can collect pollutants and impact water temperature in and below the dam. Dams can have both negative and positive impacts on oxygen content, due to stagnating water or aeration that occurs as water falls over a structure. Dams operated to release large quantities of water all at once contribute to downstream erosion.

Other alterations, hydromodifications, may be present in the form of stream straightening. Found in both urban settings and in rural areas where land owners want to control the stream channel, straightening a stream can lead to erosion problems. Water flows faster and with greater energy in a straight channel. Stream banks are less resistant to erosion. Large sections of stream banks often collapse and send more soil into the water to be carried downstream.

## II-C Water Extraction

Since water is such a vital component of life on this planet, it makes sense that humans use a large share of the available fresh water. Water use causes changes to stream flows and groundwater that are not easily recognized. Excess usage is obvious during drought conditions, when pumping can cause a stream to go dry. Reduced stream flow means less water is available for the plants and animals in the stream system.

# Part III: The Regulatory World

A few humans living in a large watershed and using the land in the watershed for various purposes usually don't have a large impact on the quality of the stream. However, as more humans move into the watershed and increase the amount of impervious cover and the number of land uses in the watershed, the stream begins to develop problems related to the cumulative impacts. Until the mid-1900's, streams were used to conveniently dispose of any unwanted or unusable item or substance. People didn't understand or didn't think about how watersheds worked and their importance until the accumulation of waste in the streams and lakes began to have impacts on their health and safety.

November 3, 1952 Cuyahoga River fire (photo credit James Thomas, from Cleveland Press Collection, Cleveland State University Library)

## III-A The Clean Water Act and Designated Uses

In the late 1960's and early 70's, citizens and government officials in the United States realized there was a crisis with our streams and lakes. The water was so polluted that the Cuyahoga River in Ohio was one of several that actually caught on fire – more than once! In order to address the problems, Congress made laws in 1972 to protect surface water that have come to be known as the **Clean Water Act (CWA)**. The US Environmental Protection Agency (EPA) is responsible for overseeing the requirements of the CWA.

The CWA is made up of many sections that address different issues related to protecting the water. In general, it requires that the waters of the nation be **fishable, swimmable**, **and drinkable.** Healthy watersheds produce water that is fishable, swimmable, and drinkable. Such watersheds support a wide variety of aquatic life and are a valuable resource.

It also identifies two different types of pollution that threaten the quality of water in our waterways. They are **point source pollution** and **nonpoint source pollution (NPS)**. At the time the Clean Water Act was developed, the major problems in the waterways were being caused by point source pollution, the waste being discharged through pipes into the waterways from industrial processes and sewage treatment plants. As the years of point source regulation passed, water quality began to improve, but there were still water pollution problems across the nation.

In the late 1980's, EPA began to focus on the impacts of NPS, or runoff pollution, that was being carried into the waterways and preventing states from achieving the fishable, swimmable, and drinkable requirements. NPS is addressed in Section 319(h) of the Clean Water Act. The funding that is provided by EPA to fix NPS is often called 319 funding.

To support the fishable, swimmable and drinkable goals, the CWA requires states to set water quality standards to protect and manage their streams, lakes, and rivers to minimize or eliminate point and nonpoint source pollution. In Kentucky, the standards include criteria for various water quality measurements like dissolved oxygen, temperature, pH, and other measurable qualities and are part of our state regulations.

As part of the development of the water quality standards, states must identify uses for each body of water in their state. In Kentucky, the Division of Water has identified the possible **designated uses** of streams, rivers, and lakes and they are listed here:

- drinking water for humans
- **primary contact recreation (PCR)** for humans - swimming
- **secondary contact recreation (SCR)** for humans – boating, fishing, wading
- Outstanding State Resource Water (OSRW) - have unique features
- aquatic habitat for plants and animals that live in water – can be **warm water aquatic habitat (WAH)** or **cold water aquatic habitat (CAH)**

**Words in bold typeface** are also defined in the Guidebook Glossary

The Kentucky regulations that set the water quality standards and designate the uses are found in Title 401 of the Kentucky Administrative Regulations Chapter 10 Sections 031 and 026 (401 KAR 10:031 and 10:026). These regulations can be found on the Kentucky Legislative Research Commission website [32].

## III-B Special Uses

Special use waters are streams and lakes that are worthy of additional protection and are identified and listed in state or federal regulations. The **special uses** for streams in Kentucky are:

- **Reference Reach Waters** – These are the most unchanged streams or lakes in each ecoregion. These reference streams are used as the best examples we have of how undisturbed streams in the regions are supposed to look and function. This is useful when we have the opportunity to restore streams that have been damaged, because it gives an ideal, something to aim for. It is important to know that very few, if any, of our streams are in pristine natural condition. The Reference Reach streams are the least changed in each region.
- **Cold Water Aquatic Habitats (CAH) –** These are surface streams that will support native aquatic life or self-sustaining or reproducing trout populations on a year-round basis.
- **Exceptional Waters (EW) –** These are streams or lakes that exceed the quality necessary to support reproduction of fish, shellfish and wildlife, and recreation in and on the water. Waters placed in this category are reference reach waters, Kentucky Wild Rivers, some outstanding state resource waters and waters with “excellent” fish or macroinvertebrate communities.
- **Kentucky Wild Rivers –** These are portions of nine rivers in the state that have exceptional water quality and beauty. The Wild River designation includes all visible land on at least 2000 feet on either side of the stream. Any change in land use within the Wild River boundary requires a permit, and clear cutting and strip mining are not allowed.
- **Outstanding State Resource Waters (OSRW) –** These are streams or lakes that have unique features, including those with federally threatened or endangered species.
- **Outstanding National Resource Waters (ONRW) –** These are streams or lakes that meet the requirements for an outstanding state resource water classification and are of national ecological or recreational significance.

- **Federal Wild Rivers –** These are specifically designated in the Wild and Scenic Rivers Act, which defines them as those rivers, or sections of rivers, that don't have dams, have undeveloped watersheds or shorelines, unpolluted waters, and can only be reached by trail.
- **Federal Scenic Rivers –** These are specifically designated by Congress as rivers, or sections of rivers that meet all of the requirements of a Federal Wild River, except they can be reached by roads in some places.

## III-C Required Reporting for Streams

The Clean Water Act, Section **305(b)**, requires states to submit a report to Congress every two years on the quality of the waters in the state that have been assessed. This report combines water quality information from state and federal agencies and tells which streams, rivers, and lakes have been monitored and assessed and are or are not supporting their designated uses. These waters are rated as:

- *good* if they *fully support* their use(s)
- *fair* if they *partially support* their use(s)
- *poor* if they are *not supporting* their use(s)

Another report that is required by the Clean Water Act is described in Section **303(d)**. This report is a subset of the list of the impaired (not supporting or partially supporting designated uses) streams from the Section 305(b) list of assessed streams. These 303(d) listed streams will require a study that identifies the types and amounts of pollutants in the water and how they will be reduced. These studies are called **Total Maximum Daily Loads (TMDLs)** and they determine the amount of pollutants a waterbody can receive and still meet its designated use(s).

These two reports, the 305(b) and the 303(d), have been sent to Congress through the U.S. Environmental Protection Agency (EPA) as two separate reports in the past. As of 2006, EPA has directed all states to submit these two reports combined into one report called the **Integrated Report.** The Integrated Report has **Volume I and Volume II** that correspond to the 305(b) and 303(d) lists respectively. The same types of information are in the report, but it is packaged differently. These reports are available on the Kentucky Division of Water's website 33.

It is important to know that the Integrated Report only provides information for the streams in the state that have been monitored and assessed. All of the streams in the state have not been monitored and assessed.

# Part IV: How Is Stream Health Evaluated?

While land use has the potential to affect the health of the watershed, assessing the impacts requires careful study. The health of a watershed and its water quality is measured using many different tests and assessments. These tests and assessments can generally be grouped as water chemistry and physical properties, habitat, and biological. The goals are to identify the condition of the stream, problems and concerns, and provide a health check for the water body system.

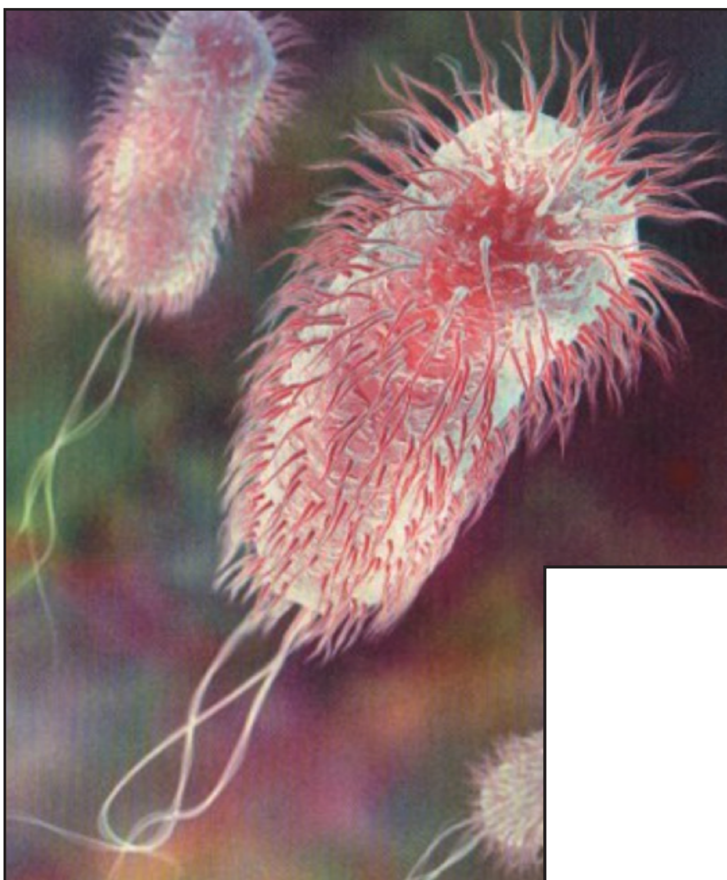
## IV-A Water Chemistry and Physical Properties

A water sample from a stream or lake can provide a very good snapshot of different water quality properties. Some of these tests are performed on the water in the stream at the time the sampler is there; these are called field tests or field analyses. Other tests are performed on water collected from the stream and sent to a laboratory; these are called lab analyses. Field tests are used to measure temperature, pH, conductivity, dissolved oxygen and suspended solids. Lab analysis is required to measure bacteria, metals, nitrates, phosphates, pesticides and other potential chemical or biological pollutants.

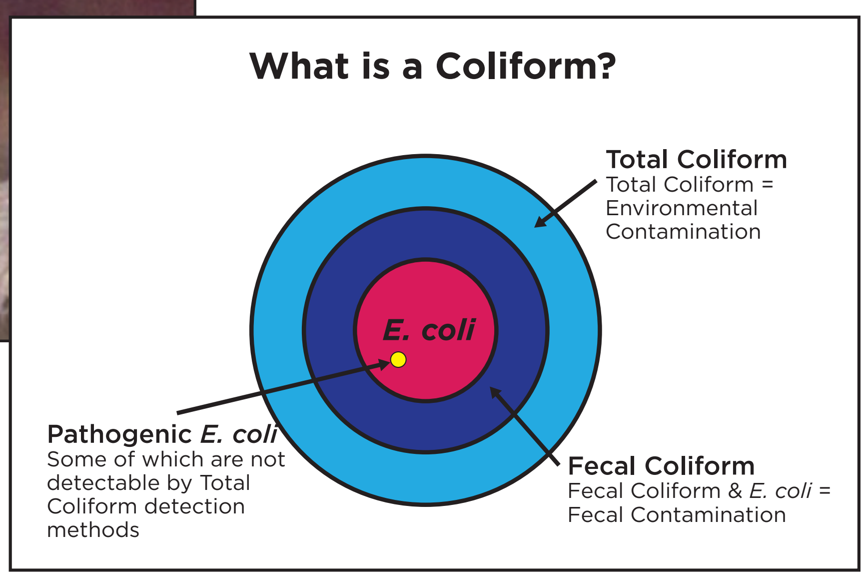
### *Bacteria:*

Bacteria are organisms that are microscopic, not able to be seen with the naked eye. They are found everywhere, on our skin, inside our bodies, in soil, in water, on plants, etc. Fortunately, most of these are harmless to humans. Some of them are actually very helpful to humans and are involved in the processes that keep our bodies functioning properly.

There is a group of 16 different bacteria that have similar properties. This group is called **total coliform** bacteria. These are found in soils, plants, and in the intestines and waste of warm-blooded and cold-blooded animals. Coliform bacteria aid in the digestion of food. Of these 16 total coliform, there are six that are found only in the fecal waste (poop) of humans and other warm-blooded animals. These six are called **fecal coliform**. Of the six fecal coliform, there is one member of the group called *Escherichia coli*, abbreviated as *E. coli*. *E. coli* has several different forms and one of these is a strain that can cause dangerous illness in humans.



Enlarged photo of microscopic *E. coli* bacteria



You can become infected with these bacteria by eating food and drinking water contaminated with them. You can also become infected when your mucus membranes (eyes or inside your mouth and nose), or cuts and open sores, come in contact with the contaminated food or water. Fecal coliform bacteria can enter the water through sewage or other sources of human and animal waste.

Human and animal wastes also contain other organisms that can't be seen with the naked eye and cause disease and illness. These include viruses and parasites. Bacteria, viruses, and parasites that cause disease and illness are called **pathogens**.

Samples of water are usually analyzed in a lab for the presence of fecal coliform and/or *E. coli*. The two main reasons the presence of these bacteria are used to indicate whether water is safe for use are:

1. These bacteria are fairly easy to detect in a lab test.
2. If these bacteria are present, then pathogens are possibly also present.

A controlled amount of the water sample is placed in a container with a source of food that allows the bacteria to reproduce. The container is then placed in an incubator for a specific amount of time to encourage the bacteria to reproduce in large clusters called colonies that can be seen with the naked eye. These colonies can then be counted. The bacteria are reported by the lab in **colony forming units (cfu)**.

Water samples that will be tested for fecal coliform and *E. coli* must be collected from the stream following very specific procedures and taken to a lab for analysis.

***Biochemical Oxygen Demand (BOD):***

**Biochemical Oxygen Demand (BOD)** measures the amount of oxygen consumed by microorganisms as they decompose organic matter in a water body. BOD also measures the loss of oxygen due to chemical reactions. Oxygen levels in water can vary widely depending on such factors as temperature. BOD directly affects the amount of dissolved oxygen in rivers and streams. The greater the BOD, the more rapidly oxygen is depleted in the stream. If BOD is high, then organisms that depend on a supply of dissolved oxygen become stressed, suffocate, and die.

BOD, or the rate of oxygen consumption in a stream, is affected by a number of variables: temperature, pH, the presence of certain kinds of microorganisms, and the type of organic and inorganic material in the water. A river with a greater amount of organic material, such as leaves and woody debris, will likely have a higher BOD level then a fast running river with riffles and little decomposing organic material.

Water bodies are more likely to exhibit high BOD levels if they are impacted by large amounts of dead plants and animals, animal manure, effluents from pulp and paper mills, wastewater treatment plants, feedlots, and food-processing plants, failing septic systems, and urban stormwater runoff.

The methods for collecting BOD samples are similar to steps described for collecting dissolved oxygen (DO) samples, with an important difference. At each site a second sample is collected in a BOD bottle and delivered to the lab for DO testing after a 5-day incubation period. BOD5 is measured in milligrams per liter (mg/L).

***Conductivity:***

**Conductivity** is a measure of the water's ability to conduct an electric current. It is an indicator of the presence of dissolved solids in the water. Pure water has a very low conductivity. Conductivity is affected by temperature; the warmer the water, the higher the conductivity. Discharges of some chemicals to streams can change the conductivity. The discharge from a failing sewage system would raise the conductivity because the sewage contains chlorides, phosphates, and nitrates. Oil that enters the stream from a leaking storage tank would lower the conductivity.

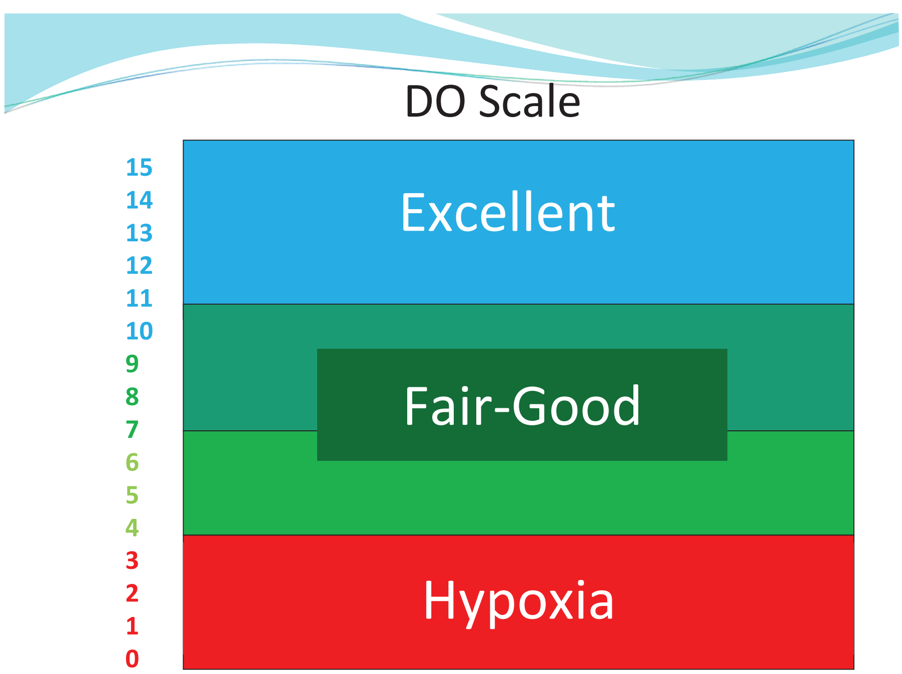
Conductivity in streams and rivers is affected by the geology of the area through which the water flows. Streams that run through granite bedrock will have lower conductivity, and those that flow through limestone and clay soils will have higher conductivity values.

Conductivity is measured in units called micromhos (pronounced mikro – moes) per centimeter or microsiemens (pronounced mikro – seemins) per centimeter. Studies of streams and lakes have shown that streams with measured conductivity levels between 150 and 500 micromhos per centimeter are the best for most fish and other stream animals. Conductivity levels that aren't in this range could mean that the water isn't livable for certain stream animals.

Conductivity is usually measured in the stream at the time that other samples are collected.

***Dissolved Oxygen (DO):***

Most aquatic organisms obtain the oxygen they need to survive from oxygen dissolved in the water. Oxygen enters water from the atmosphere and/or from groundwater. In streams with rapid currents or riffles, more oxygen is usually present compared to stagnant (still) water. Cold water can hold more **dissolved oxygen (DO)** than warm water. In winter and early spring, when the water temperature is low, DO concentrations are higher. During warmer months, the DO concentration falls. Loss of DO will occur if too many bacteria in the water consume oxygen as organic matter decays. Eutrophication causes the depletion of DO. This is especially a problem in a stagnant body of water such as a lake with a large amount of decomposing material and warm temperatures. In the summer, lakes around the country may report fish kills due to eutrophication. The amount of DO will vary during the day, with temperature changes.



DO is measured in the stream at the time that other samples are collected. It is measured in the unit milligram per liter of water (mg/L). The Kentucky surface water standard for DO is 4 mg/L, which is the acute level, and 5 mg/L, which is the chronic level. The daily average for DO should at a minimum be 5.0 mg/L. The minimum for an instantaneous measurement should be 4.0 mg/L.

***Metals:***

Metals are present in water as metal ions. They may be naturally occurring and the results of rocks, minerals, soils coming into contact with water. For example, water acts as a weathering agent on a rock. The rock slowly dissolves and releases the metals into the environment. The most common naturally-occurring metals are calcium and magnesium. These are generally the result of the weathering of limestone, a common rock type in Kentucky. Water hardness describes water that contains a relatively high concentration of metals. These can build up and cause "scaling" on pipes and plumbing systems. A high concentration of metals may also be the result of pollution. Metals from rusting cars are shed on parking lots. Runoff from the parking lots goes into storm drains which are then discharged into streams. Waste water from industry often contains metals which end up in streams. Metals from industrial activity are also discharged into the atmosphere. Mining activities also increase the amount of metals released. In waters with a low pH, (acidic) more metals are dissolved and the concentrations in the water can reach levels toxic to organisms and humans.

When deciding to test for metals, look at land use in the watershed. As in the case of pesticides and herbicides, the collection of water samples for metal analysis requires a careful monitoring or collection plan.

***Nutrients:***

**Nutrients** are the ingredients in soil, water, and organisms that are essential for life, yet excess nutrients are not healthy for streams. Nutrients in groundwater are also potentially harmful. Excess nitrogen in drinking water is dangerous to humans, especially small children and infants.

The amount of nutrients in the watershed will vary depending on several factors. In the summer, nutrients levels may increase due to fertilization of farmland, lawns and gardens. Not all of the fertilizing nutrients will be used by the land or plants and excess nutrients are washed away during a rainstorm. Decomposition of organic matter also releases nutrients and streams may experience greater nutrient loading during the winter as dead leaves and other organic debris decompose, or decay.

Excess nutrients are usually the result of pollution from land use activities. Nutrient sources include stormwater runoff, waste products from farm animals and domestic pets, failing septic systems, and discharges from industrial and municipal wastewater treatment plants.

A small pond provides a good example of excess nutrients and their impacts. A pond naturally supports a certain amount of plant life and fish life. Nutrients enter the pond and are taken up by the plants. The fish eat the plants, die, and decay. Thus, the nutrients are recycled. But what if extra nutrients are washed into the pond from the farmland around it? The extra nutrients mean more plants grow, especially if the temperatures are warm. More algae than normal will bloom, die, and decay. Bacteria breakdown the decomposing algae and consume more oxygen. This process causes a depletion of available dissolved oxygen. With less oxygen in the water, fish will suffocate and die. This entire process is called **eutrophication**. In streams, under the right conditions, stream plants called **periphyton** will grow on rocks or logs. Their algae blooms cause unsightly conditions, odors, and poor habitat for the organisms living in the water body.

A much larger example of the impacts of eutrophication is seen in the Gulf of Mexico. Over the past 100 years, nutrients from farmland around the Mississippi River basin have been washed into streams and rivers. The mouth of the Mississippi River is the final destination for these nutrients. While the Gulf of Mexico is a large water body, it is unable to process the excess nutrients. Large dead zones, or areas that periodically cannot support aquatic life (e.g., **hypoxia**), have developed. This is a good illustration of the concept that what happens in your watershed can have far-reaching impacts downstream.

***Nitrogen and Phosphorus:***
Two primary nutrients are nitrogen (N) and phosphorus (P). These two elements are essential for plant growth and are found in fertilizers applied to farm land and neighborhood gardens. They are also found in water bodies. Nutrients are measured in a water sample submitted to a laboratory.

The amount or concentration of nitrogen and phosphorus are measured and reported in the unit milligram per liter of water (mg/L). Most laboratory methods require samples to be collected and placed in coolers and maintained at a temperature of 4°C. Generally, the lab will need to analyze the samples within 48 hours of collection.

Phosphorus (P) and nitrogen (N) are measured in several forms. Formations of the various phosphorus and nitrogen compounds are governed by factors such as pH, temperature, oxygen concentration, and biological activity. The forms that are of primary concern are the forms that are used by plants and other organisms. It is important to know the amount that is available for growth.

Phosphorus (P) will bond with oxygen (O) to form Phosphate ($PO_4$). Phosphorus can be measured as the following:

- Total phosphorus (TP)
- Orthophosphate (OP). Orthophosphate represents the fraction of TP that is soluble in water and available to organisms for growth.

Nitrogen will bond with oxygen (O) to form nitrate ($NO_3$) or nitrite ($NO_2$). It will also bond with hydrogen to form ammonia ($NH_4$). Nitrogen can be measured as the following:

- Total Nitrogen (TN). TN refers to the total amount of nitrogen in a sample.
- Total Kjeldahl Nitrogen (TKN). TKN represents the fraction of TN that is unavailable for growth or bound up in organic form; it also includes $NH_4$.
- Nitrate-nitrogen ($NO_3$)
- Nitrite-nitrogen ($NO_2$)

The US EPA has set a safe-drinking water standard or maximum contaminant level (MCL) for nitrate of 10 milligrams per liter of water. If water contains nitrate at concentrations higher than the MCL, it is considered unsafe for human consumption. Kentucky surface water standards limit the amount of un-ionized ammonia ($NH_3$) to 0.05 mg/L in surface water systems.

***Pesticides and Herbicides:***
Pesticides and herbicides are human made chemicals used to control bugs, insects, and weeds that disrupt agricultural production. Pesticides and herbicides in groundwater and streams are a result of modern agricultural practices and are not part of the natural environment. If excess pesticides and herbicides are applied to land or if they are accidently spilled, the chemicals may be transported to the groundwater by soaking into the soil or by surface runoff to a stream. Since the chemicals are not naturally occurring, they may persist in the environment or degrade slowly. As they degrade, the resulting degradation compounds may also pose threats to the environment. While pesticides are commonly found in water bodies around the country, they may not be a concern in your watershed. Knowing how land is used in the watershed (e.g., for agricultural purposes) will help you decide if pesticide/herbicide water samples should be collected. Also, if you are aware of groundwater or surface water samples that have been tested for pesticides and herbicides, it would be useful to obtain the results. It's additional information that will help you determine all of the water quality problems in the watershed. Pesticides and herbicides are toxic to the plants and animals in streams at small concentrations. Public water supply systems frequently test the water supply to ensure that pesticides and herbicides are not present, since the chemicals are also harmful to humans. Many different collection and laboratory methods are used for pesticides and herbicides and a careful monitoring plan should be created prior to sample collection. The US EPA and the state of Kentucky have strict regulations for the amount of pesticides and herbicides allowable in water.

***pH:***
The pH of a sample of water is a measure of the concentration of hydrogen ions. The actual term "pH" refers to the way hydrogen ions are calculated. Measuring pH is important because it indicates whether the water is acidic or basic. The scale for measuring pH ranges from 0 to 14. A water sample with a pH of 7 is considered neutral, and is neither acidic nor basic. If the pH is below 7, then the water is acidic. If the pH is above 7, it's basic. Bleach is considered basic with a pH around 12.5. Vinegar is considered acidic with a pH around 3. The largest variety of animals living in water prefers a pH range of 6.5-8.0. pH outside this range reduces the diversity in the stream because it stresses most organisms and can reduce reproduction. Also, solutions that are too acidic or too basic change the solubility (amount that can be dissolved in the water) of materials in the watershed. For example, rocks with heavy metals may leach metals into acidic water because of the increased solubility. In other words, metals are more toxic and mobile in waters with a lower pH.

The pH of a stream will vary, but will depend on such factors as the local geology and the pH of rainfall. As rocks dissolve, hydrogen ions are released into the water. In the last several decades, rainfall has become more acidic as a result of particulates released into the atmosphere. The acid rain lowers the pH of a receiving water body. Another form of pollution that will change the pH of water is runoff from a mining operation. The runoff may be highly acidic and would likely kill any fish living in the system.

The test for pH is usually performed in the stream at the time that other samples are collected. The Kentucky surface water standard for pH is in the range between 6.0 and 9.0.

***Temperature:***
The plants and animals that live in a stream are dependent on certain temperature ranges for their optimal health. Variations above or below that range effect the life processes of these organisms. The best temperatures for fish depend on the species: some survive best in colder water, whereas others prefer warmer water. Most of the animals living in Kentucky's streams, lakes, or wetlands are sensitive to temperature and will move in the stream, to the extent possible, to find areas with their optimal temperature. If temperatures are outside this optimal range for a prolonged period of time, organisms are stressed and can die. In addition to having direct impacts on life processes, warmer water cannot hold as much dissolved oxygen. Low oxygen amounts cause many negative impacts to organisms living in the stream.

Temperature will vary depending on the weather and seasonal changes. Daily variation also may occur, especially in the surface layers, which are warmed during the day and cooled at night. Elevated temperatures can occur if the trees and other vegetation which normally provide shade for the stream are removed. Water body temperatures will also increase in impoundments (a body of water confined by a barrier, such as a dam), or may increase if the water receives industrial discharges, urban storm water, or groundwater inflows.

Stream temperature for scientific studies is usually measured in degrees Celsius (°C). For other purposes, temperature can be measured in degrees Fahrenheit (°F). Stream temperature is taken in the stream at the time that other samples are collected. In Kentucky streams designated as Warm water Aquatic Habitat (WAH), temperatures should not exceed 31.7°C (89°F). A stream designated as a Cold water Aquatic Habitat (CAH) must be able to support reproducing trout populations on a year-round basis.

***Total Suspended Solids (TSS) and Turbidity:***
**Total suspended solids** (TSS) concentrations and **turbidity** are each used to measure the amount of solid material (e.g., soil, algae) suspended in the water. However, the TSS test measures an actual weight of material per volume of water, while turbidity measures the amount of light scattered from a water sample (more suspended particles cause greater scattering of light). In a water body with a large amount of suspended material or high turbidity, the water will likely appear muddy or cloudy. The water in a stream or lake with little suspended material is clear; it is easy to see objects at greater depths. Less light is able to reach plants at deeper depths in the stream or lake when there is a higher concentration of suspended material in a water body. Suspended materials are also likely to be carrying other pollutants such as metals and bacteria.

The amount of TSS and turbidity is influenced by how much runoff enters the water. Heavy rains and fast-moving water cause erosion and carry soil and other materials into the water. After a heavy rain, a stream near a cleared patch of land may look muddy. Stream banks cleared of vegetation are especially at risks of increased TSS and turbidity. Stormwater drains are also sources of suspended material.

TSS and turbidity are both generally measured in the laboratory. TSS concentrations are measured in milligrams of suspended solids per liter of water – mg/L. Turbidity is reported as nephelometric turbidity units (NTU) or Jackson turbidity units (JTU), depending on the instrument used to perform the measurement. TSS and turbidity values will vary greatly between different water bodies.

## IV-B Habitat Assessment

The stream habitat includes all of the places where specific plants or animals can live; such as on rocks, under rocks, in the spaces in between rocks, in piles of leaves, on plants, in mud, in sand, under logs, in piles of twigs, etc. A large variety of habitat in the stream supports a large variety of plants and animals that live there. Some habitat is related to the features of the stream itself, while other habitat is related to the streambanks and adjacent land, or **riparian area**.

Habitat assessment is another way to measure the health of a stream. The purpose is to look at individual features that provide habitat in a particular length of a stream and determine how well they are functioning individually. These are then combined into one overall measurement of how livable the stream is for stream animals. The selected length of the stream that is to be assessed is called a **reach**.

A habitat assessment method that is used to perform this measurement was developed by the EPA. It is called the Rapid Bioassessment Protocols. It can be found in Chapter 5 – Habitat Assessment and Physicochemical Characterization at the following EPA website [34]. It uses a scoring sheet that focuses on ten stream features.

Some streams flow through hilly land and have many **riffles** and **runs**. Riffles are places in the stream where the height of the stream drops to a lower point and the bottom is rocky. Because of this drop in height, the bottom of the stream and the rocks located there, are very close to the surface of the stream or sticking out of the surface. This causes the surface of the water to look rough and bubbly instead of smooth. Runs are places in the stream where the water moves quickly out of a riffle. Runs are deeper than riffles, so rocks don't stick out of the water and the surface is smooth. These steep streams that have many riffles and runs are called **high gradient streams**.

Other flat streams are **low gradient streams**. These are streams that flow through flatter land and have few, if any, riffles, many glides and pools, and mostly fine sediment bottoms. **Pools** are the deepest parts of the stream and normally have the slowest flow. **Glides** are the areas where the water is flowing more quickly out of pools in the stream and becoming increasingly shallower.

To be able to accurately assess the habitat in both types of streams, there are two versions of the EPA scoring sheet: one for high gradient streams and another for low gradient streams. Copies of each of the scoring sheets are included in Appendix E.

### *Scoring High Gradient Streams*

When using habitat assessment to determine the health of a reach of a high gradient stream, the following ten questions must be answered and the features rated from zero to twenty on the scoring sheet:

1. **What are the types and sizes of natural materials, such as the rocks and sticks, in the stream?**

   This measures how many potential places are available for the animals in the stream to live. To have a healthy variety of animals living in the stream, there must be a lot of different places for these animals to live. Many of the stream animals are very small, so they don't need large places to live. Some live on the tops of rocks where the flow is fast and the dissolved oxygen levels are high. Others live in piles of decaying leaves where the dissolved oxygen level may not be as high, but a steady supply of food is provided by small particles, released as the leaves rot. Others may burrow in sand, where they are hidden and safe, to wait for a food to float by so they can jump out and ambush it. Still others may constantly swim or float in the water, prepared to swim away from danger or toward food. The possibilities are endless, and each type of living space is used by specific animals.

2. **How much of the rocks on the bottom of the stream are covered with sediment?**

   This is a measurement of the amount of sediment covering the places where animals live and making them unavailable. This results in fewer types of animals living in the stream.

3. **What are the depth and flow speed combinations found in the stream?**

   This measurement determines how many different combinations of depth and flow speed are available to support a variety of animals. The depth and flow speed of the water affects the temperature, amount of oxygen, and amount of food moving past in the water. Different animals require different depths and speeds of water to survive.

4. **What are the sizes and numbers of islands or point bars formed by sediment?**

   This is a measurement of how much sediment is being moved by the stream. If there is a lot of dirt being washed into a stream or worn away from the streambanks and carried by the water, it will settle out at a place in the stream where the water is slowed down by a curve in the stream, a tree that has fallen into the stream, a large rock, a bridge, etc. As more sediment begins to collect, the water is slowed down even further, so more sediment settles there. This will cause an island or point bar to form and appear above the surface of the water. This is a natural process, but too much sediment in the stream will cause too many islands and point bars. These may even get larger and cover the entire width of the stream. They will change frequently and don't provide good places for stream animals to live.

**5. How much of the stream bottom is covered by water?**

This is a measurement of how reliable the different areas of the stream are for the animals that live in it. Streams that regularly have parts of the bottom exposed, and are without water flowing over them, are not dependable places for stream animals to live.

**6. How much of the stream has been straightened?**

Determining the amount of stream that has been straightened is a measurement of how much the places for stream animals to live have been affected or destroyed. In the past and even today, it has been a common practice for humans to use tools and equipment, such as bulldozers and backhoes, to channelize the curvy, natural path of a stream into a straight, unnatural trench. This is done for a number of reasons, such as making it easier to mow, getting rid of flood water faster, it's cleaner looking, etc. However, channelization destroys all of the habitat and natural functions of the stream. In addition, as soon as the straightening project is completed, the stream will begin to wear away the banks to try to get back to its natural, curvy shape. This means a large amount of dirt will be eroded into the stream and the sediment will move downstream and damage or destroy the habitat for stream animals.

**7. How many riffles are in the stream?**

This is a measurement of how much of the stream provides places to live with high dissolved oxygen levels for stream animals. The stirring, bubbling, and churning of the water in a riffle causes a lot of oxygen in the air to dissolve in the water. Stream animals that need high levels of dissolved oxygen often live in or near riffles. There are a lot of riffles in streams that have mountains or hills in their watersheds, so there is usually a lot of dissolved oxygen in these high gradient streams. Streams flowing through flat land don't have these riffles or the high levels of dissolved oxygen, so stream animals that need a lot of dissolved oxygen will not be found in these streams. The habitat assessment for these flat, low gradient streams is based on different factors than those for steep streams.

**8. How stable are the banks of the stream?**

This is a measurement of how much of the streambanks are eroding and falling into the stream. When large areas of bare dirt, exposed roots, undercut areas, and trees falling into the stream are seen along the streambanks, it is a sign that the banks aren't stable and too much sediment is entering the stream. This sediment covers up and fills in the places where stream animals live. Also, the high levels of mud and sediment in the water make it difficult for fish and other stream animals to absorb the dissolved oxygen they need and make it difficult to find food.

**9. How much of the streambanks are covered with native plants?**

This is a measurement of what types of materials are being washed or dropped into the stream from the plants (trees, shrubs, grasses, wildflowers, etc.) growing on the streambanks or in the riparian area (the land adjacent to the streambanks), and how much cover is being provided for the stream. These plant materials, such as sticks, logs, and leaves, provide a food source and places to live for the animals living in the stream. When nonnative plants start growing in an area, they often take over, crowd out the native plants, and reduce the variety of sizes and kinds of plants. The animals living in the stream have developed by depending on the materials from the native plants, and often can't use the materials from the nonnative plants. This causes the native stream animals to die off. Also, when there is a healthy mix of native plants growing along streams, there is a variety of heights of plants that can provide shade for the streams. This helps keep the temperatures in the streams in the range that the stream animals need to survive.

**10. How wide is the riparian area?**

This is a measurement of how much nonpoint source pollution is being filtered out of the rain and snow melt runoff before it enters the stream. As this runoff moves across the land in the watershed, it picks up any pollution on the land and carries it along. As the runoff flows through areas of land covered with grass, shrubs, trees, etc., it slows down and drops some of the pollution it is carrying. Other pollution is absorbed by the plants or attaches to them. A wider riparian area covered with these plants provides the opportunity for more pollution to be filtered. This means less pollution enters the stream, so there is less effect on the stream animals.

***Scoring Low Gradient Streams***

When using habitat assessment to determine the health of a reach in a low gradient stream, most of the same ten questions must be answered and scored with the following three differences:

**2. What types of materials are covering the bottoms of the pools and is there a variety of types?**

This is a measurement of how fine or coarse are the sediments on the pool bottoms. Low gradient streams don't have rocky bottoms, so many of the small spaces for macroinvertebrates to hide in aren't present. If the pool bottoms are covered with gravel and firm sand, as well as mats of roots and underwater vegetation, then there will be more spaces available than if the pool bottoms are covered with soft sand, mud, or clay that pack tightly together without any spaces available for macroinvertebrates.

**3. What are the sizes and depths of the pools?**

This is a measurement of the variety of combinations of size and depth of the pools. These different combinations will create areas with different water temperatures and levels of dissolved oxygen, as well as different speeds of flow. Different animals require different depths and speeds of water to survive. This variety means more places for different macroinvertebrates and fish to live.

**7. How curvy is the stream?**

This is a measurement of how stable is the stream system. The increased number of curves, or bends, in a stream will absorb more of the energy in the water and slow down the force of the water during floods. This will decrease the amount of erosion of the banks and stream bottom. In addition, the increased number of curves adds to the length of the stream. This combination of changes in flow speed and additional stream area creates more variety of places for macroinvertebrates and fish to live.

## IV-C Biological Assessment

Mayfly larva
www.benthos.org
Photo by Rich Merritt

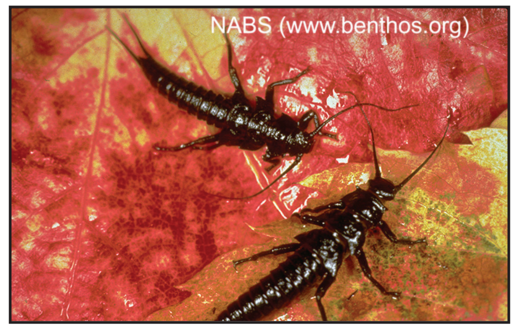
Since the water in a stream is constantly moving downstream, a sample of the water collected from the stream will only give information for that moment in time. There could have been a huge storm the week before that washed a lot of dirt into the water that had already settled out by the time the sample was collected. Or, the next day after the sample was collected a property owner could dump some old containers of pesticides in a ditch that flows to the stream and quickly flows downstream. These pollution events would not be detected in the sample collected. However, there is a sample that can be collected that shows the effects of any pollution from the watershed that enters the stream over time. This is a sample of the stream animals that are mentioned so frequently in the Habitat Assessment section. The stream plants, **algae** and **diatoms**, can be collected and used to determine pollution effects, too. The plants and animals are sometimes referred to as **flora** and **fauna**. Collecting a sample of these flora and fauna and identifying them is called a **biological survey**. Using a biological survey(s) to determine watershed health is called a **biological assessment.** When the stream animals are used in this way, they are called **biological indicators**. Since different organisms can tolerate different conditions and levels of pollution in the water, they can be used to indicate the quality of the water.

**Benthic Macroinvertebrates**

**Benthic** – live on the bottom

**Macro** – large enough to be seen with naked eye

**Invertebrate** – animal without a backbone



Stonefly larvae
www.benthos.org | Photo by Rich Merritt

Stonefly adult
www.benthos.org | Photo by Howell Daly


Dragonfly larva with zebra mussels attached
www.benthos.org

Many of the animals found living in streams are **benthic macroinvertebrates**. These are animals that live on, in, or around the bottom of streams, don't have backbones, and can be seen with the naked eye. They are often the immature forms, or **larvae**, of insects that live on land as adults.

There are several reasons to use the benthic macroinvertebrates for biological assessments. They make good indicators of watershed health because they:

- live in the water for all or most of their life
- stay in areas suitable for their survival
- are easy to collect
- tolerate different amounts and types of pollution
- are easy to identify in a laboratory
- often live for more than one year
- don't move very far in the stream
- are exposed to all conditions and pollution in the stream

**Sensitive Group**
- Stoneflies
- Water Penny Beetles
- Mayflies
- Caddisflies (except net spinning species)
- Dobsonflies
- Alderflies
- Snipeflies
- Mussels
- Riffle Beetles

**Moderately Tolerant Group**
- Damselflies
- Dragonflies
- Caddisflies (net spinning species)
- Crayfish
- Amphipods
- Blackflies
- Isopods
- Craneflies

**Pollution Tolerant Group**
- Midgeflies
- Worms
- Leeches
- Pouch Snails

*Source: www.epa.gov*

Benthic macroinvertebrates that are used as biological indicators for water quality can be grouped by their sensitivity to pollution. The presence in a stream of many or all of the individuals in the Sensitive Group would indicate good water quality. However, a variety of macroinvertebrates from each group should be found in a healthy stream. If only a few individuals, or none, of the Sensitive Group are present in a stream, and the macroinvertebrates are mostly from the Moderately Tolerant and Pollution Tolerant Groups, this would indicate fair water quality. If most or all of the macroinvertebrates present are from the Pollution Tolerant Group, then poor water quality would be indicated.

Dobsonfly larva feeding on stonefly larva
www.benthos.org
Photo by Larry Serpa


Pouch Snail
www.epa.gov
Photo by Wayne Davis

Benthic macroinvertebrates play an important role in a stream system. They provide a food source for larger animals, especially fish. Some of these macroinvertebrates eat algae and bacteria. Others shred and eat leaves and other decaying material that enters the stream. By feeding on and using the nutrients in these materials, the benthic macroinvertebrates make these nutrients available to the larger animals that eat them. Also, when they die and decay, the nutrients in their bodies


Damselfly larva
www.epa.gov
Photo by Ohio DNR

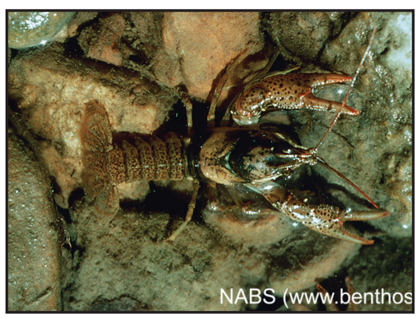

Freshwater Mussel alive in stream and empty shell (inset)
www.epa.gov
Photo by Jeffry D. Grabarkiewicz


Damselfly adult
www.benthos.org
Photo by John Wallace

become food for other benthic macroinvertebrates in the stream.

Native plants and animals live in a balance in a natural stream system with a healthy watershed. When nonnative plants and animals are brought into a stream, they can begin to grow and take over the stream system. These nonnatives move into the habitat of the natives, causing them to begin to disappear from the system. The nonnatives also use up the food sources that the natives have always depended on. This also causes the natives to begin to disappear from the system. When large numbers of nonnative plants or animals are observed in a stream or watershed, this is a sign that the stream isn't healthy. An example of a nonnative animal that has taken over in some streams and lakes in the United States is the zebra mussel. In addition to taking the habitat and food from native animals, the zebra mussels also grow on or cover up the animals and kill or weaken them.


Midgefly larva
www.benthos.org
Photo by Dave Penrose




Crayfish
www.benthos.org
Photo by Bob DiStefano


Case-making Caddisfly larvae
www.benthos.org
Photo by J.C. Hodges, Jr.

# Chapter 2: Exploring Your Watershed

***Inventory Available Data and Information***



This chapter will help you:
- Gather and organize existing data and information for your watershed

As in every chapter, this one also provides:
- Active Options
- Write It Down

> Find related information about this stage of watershed planning in Chapters 5 and 6 of EPA's Handbook

## Introduction

Now that you've identified your planning team and its concerns, it's time to gather information about your selected watershed. If your team does not already include a partner with the scientific background to assist in gathering this information, you'll need to find one now.

> Each website icon refers to a site on that gateway website. In the electronic version of the document, these icons refer to direct links in a list on the gateway website. This gateway website address is **http://water.ky.gov/watershed/Pages/WatershedPlanningGuidebook.aspx**

Your watershed plan should describe the features of your watershed that influence the health of your waterway. Your plan will both rely on and share available scientific information about your waterway's health. It will also identify both gaps in information and ways to fill the knowledge gaps.

There is a wealth of available data that can help you understand your watershed and identify the factors that influence its health. This information will be very useful if you take the time to collect it. In addition, you will want to know what's going on in your watershed so that you don't duplicate existing efforts. This chapter will help you create an inventory of the information you identify and collect.

Section 2.1 offers guidance for collecting and managing data and information. The rest of Chapter 2 provides sources of data and information for water resources (2.2), natural features (2.3), and human activities affecting water resource quality (2.4), and related demographics and social issues (2.5). As always, the chapter also provides Active Options and Write It Down.

## 2.1 Collecting Data and Information

You will need many types of information and data about your watershed to better understand the challenges it faces and to prepare a plan that is scientifically defensible. A plan based on objective information will gain broader community support, and will enable you to get the help and resources you need. The more concrete information you have, the more effectively you will be able to present your arguments for watershed protection and cleanup to others.

If you have questions about why any of the information described below is relevant, refer to the Watershed Basics section.

While collecting information about your waterway and watershed is vital to the planning process, it's also one of the most challenging jobs you will have. There will be a wide variety of information and likely gaps in water quality data. Chapter 3 Section 3.1 discusses identifying these gaps and collecting additional data. However, it is also important to remember that your team can move forward even if there are missing data. You may find it necessary to delay data collection, including it as an action item in your implementation plan.

Inventories of data are very important to organizing the information you will gather as you explore how your watershed influences the health of your waterway. Maps are crucial to understanding how land uses and other geographical factors in your watershed influence water quality in your waterway and to effectively present your findings. They are also very helpful in community outreach and education efforts.

When you are collecting information, don't overlook the experience of your team members and other local individuals. Local knowledge is extremely valuable.

### 2.1.1 Data Inventory

As you assemble the information for describing your watershed, you will want to create a list that contains information about the data, such as its type, source, and timeframe. This will be helpful in many ways, but especially to document information sources. The list can be as simple as a table in a word processing document. For planning efforts with larger scope or diverse information sources, a spreadsheet or database may be preferable (the flexibility of search functions in databases is a factor). The EPA Handbook, Figure 5-5, suggests three ways to inventory data sources using Microsoft Excel, depending on whether the source is a data table, a document, or a **GIS data layer**.

Besides tracking where vital information is located, the inventory will be valuable in identifying gaps in the data that you need to monitor the indicators of your planning team's concerns and goals.

### 2.1.2 Maps, With and Without GIS

Maps are very useful and condensed ways of displaying and organizing information. In watershed planning, they are indispensible for understanding and analyzing the dynamics of land use and upstream and downstream influences on waterbody health.

#### *Maps Using GIS*

Geographic Information Systems (GIS) can bring multiple maps "layers" together and in varying combinations, both for display and for analytical purposes. For example, if you are looking for the potential sources of a nutrient problem, you might highlight sampling sites with high nutrient results and also display residential areas, golf courses, and livestock operations on the same map, to see if there is a spatial connection.

If a partner or team member has the time and interest to acquire and study GIS, the Environmental Systems Research Institute (ESRI) website [35] offers some free software, manuals and training models. ESRI's conservation program page is [36]. In addition, ESRI has a book called "Getting to know Arc GIS," which comes with a disc with a one year license for an ArcView program that could be used by a motivated team to learn and use GIS quickly. An introduction to the use of GIS is available on the US Geological Survey (USGS) website [37].

However, comprehensive GIS software is expensive and a challenge to master. If you do not have a partner or team member who can provide experienced GIS support and you are applying for funds, consider including a GIS item in your budget. A 319 budget should always include GIS support.

If your team does have access to GIS expertise, you can secure data for GIS from several sources. Federal sources are listed in Table 5-2 in the EPA Handbook. GIS data for Kentucky are available online through the Kentucky Geography Network [38]. The Kentucky Geography Network (also known as "k-y-geonet") houses much of the GIS data from agencies in the state. GIS data are also available in other locations, for example from the online "Geospatial Data Library" of the Kentucky Geological Survey.

Chapter 5 of the EPA Handbook provides a detailed guide on digital and GIS sources of the information described in this chapter.

#### *319 Requirements for Maps*

Use of GIS is required for 319-funded projects.

319-Funded projects must provide maps showing watershed and sub-watershed boundaries, political boundaries (counties, cities), roads, and hydrology, and others features. The complete list of 319-required maps are listed in the Write It Down section and identified throughout this section. Data for these maps are available through kygeonet [39]. Questions about GIS requirement should be directed to the project's Nonpoint Source Program Technical Advisor.

***Maps Without GIS***

If you are not using 319 funds, GIS may not be required. This and other sections of this chapter provide links to many Internet sources of maps and map viewers with watershed-related data.

Regardless of your mapping methods, you will need multiple views because there is too much information to put into one view. Begin with one good map that you can use as your standard, a "base" map that shows your watershed boundary, the waterways, and enough towns and roads to orient the viewer. Once you have this base map, you can make clear overlays, use drawing software, or even ink or colored pencils to add more information to different copies of the base map.

If your team does not have 319 funds, you will still find it helpful to make the maps listed in the Write It Down section. See sections below for sources of the data for these maps.

Internet sources of maps and some data include:

- The Kentucky Watershed Viewer. The viewer has several layers of information that can be displayed and printed [40].
- EPA's Enviromapper. This Website provides state-specific information [41].
- Google Earth offers maps and also aerial photography. The Watershed Academy has a good introduction to using Google Earth in the Wetlands BMP module [42].
- EPA's "Surf Your Watershed." This site provides useful information, but at a scale too large for providing maps for printing [43].
- USGS's Hydrology of Kentucky viewer. This viewer is similar to the Kentucky Watershed Viewer, with additional hydrologic information such as stream flow [44].

## 2.2 Finding Water Resources Data and Information

It will take some effort and perseverance to find water resources information, but these data are crucial to the efficiency of your planning and the quality of your plan. This section provides a lot of links and contacts, but be creative. Enjoy being a data detective, since you may need to track down bits and pieces. Try the reference departments at colleges, universities, and public libraries. Ask around! Sometimes it only takes an e-mail to discover a world of information.

### 2.2.1 Watershed Boundary

Begin by defining the boundaries of your watershed, identifying the Hydrologic Unit Code (see Watershed Basics) and the various jurisdictions within your watershed. One way to identify and document your watershed's boundaries and HUC is by using KDOW's Kentucky Watershed Viewer [45]. You can also find HUCs at USGS' website [46].

The watershed boundary should be shown on your base map and each map your team makes. Sub-watershed boundaries are important, since eventually most of your analysis will be at the sub-watershed level.

GIS coverage of watershed boundaries is in kygeonet [47]. 319-Funded projects must provide a map showing watershed and sub-watershed boundaries.

### 2.2.2 Hydrology

Information on the hydrology, including the network of streams and lakes, can be found in Kentucky's Watershed Viewer [48]. Hydrology is also available from USGS [49]. The Kentucky Geological Survey has data about wells and springs [50].

Find real time stream flow data for Kentucky on the USGS's website [51].

Information about your watershed's rainfall and snowfall can be found at:

- Kentucky Mesonet [52]
- University of Kentucky [53]
- National Weather Service [54]
- The National Oceanic and Atmospheric Administration (NOAA), for a fee [55]
- Kentucky Climate Center at Western Kentucky University [56]

The stream network should be shown on your base map and thus on every map created for your watershed plan.

GIS coverage of hydrology is in kygeonet [57]. 319-Funded projects must provide a map showing streams, lakes, and rivers, and wetlands.

***Wetlands***

The number and conditions of wetlands in the United States were identified in the National Wetlands Inventory. US Fish and Wildlife has information about the Inventory [58].

Wetlands can be found using Google Maps. Instructions are available in the Kentucky Watershed Leadership Academy worksheet on wetlands [59].

Members of your team or other locals may know about specific wetland areas, including some that may have been altered in the past. See also Section 2.4.3 for securing information about permitted activities in wetlands.
GIS coverage of National Wetlands Inventory is available from kygeonet [60].

### 2.2.3 Groundwater-Surface Water Interaction

An excellent resource for identifying karst areas in your watershed and securing groundwater data is the online Kentucky Groundwater Data Repository [61].

Members of your planning team or other locals may know about springs and significant sinkholes in your watershed. There may also be a regional caving society in your area.
GIS coverage of karst is in kygeonet [62]. 319-Funded projects must provide a map showing identified groundwater network features: karst basins, springs, sinkholes dye tracing results.

### 2.2.4 Flooding

Floodplain map(s) show flood-prone areas in the watershed. Access to these maps will vary depending on whether counties and communities in your watershed have local floodplain ordinances administered by a local agency. If so, floodplain maps are available from these local authorities, who you will probably want to contact, in any case.

Floodplain maps are available at FEMA Map Service Center [63].

For the Kentucky Floodplain Management Section and further resources, visit the Kentucky Division of Water website [64].

KDOW's Floodplain Management Section permits some construction in and filling of floodplains. If you have questions about whether activities have been permitted or about permit specifics, contact the Floodplain Management Section at 502-564-3410 or go online [65].

Members of your planning team or other locals may know about specific flooding events and locations, and historical changes that appear to have influenced flooding patterns.

GIS coverage of floodplains is in kygeonet [66]. 319-Funded projects must provide a map showing floodplains.

### 2.2.5 Regulatory Data and Status of Waterways

The key sources of regulatory status of waterways are reports that KDOW submits to Congress every two years, as required by sections 305(b) and 303(d) of the Clean Water Act [67].

To efficiently use the Report(s) to Congress, you'll need to know a couple of key pieces of information. First, detailed analysis is conducted for each major river basin every five years. This information is included on the website, in the description of each year's report. Second, the format of the report changed in 2006.

As of 2006, the Report to Congress is presented in one, two-volume Integrated Report. Volume I of the Integrated Report [305(b) report] compiles data gathered from assessments conducted during the two years prior to the report's release. It provides assessment status, including impairments.

Volume II of the Integrated Reports to Congress [303(d) report] lists segments of waterways that do not meet the regulatory requirements for their designated uses and for which a **TMDL** (Total Maximum Daily Load Analyses) is required. It provides detailed information on what designated uses are not met, and why.

For each of Kentucky's river basins, maps illustrating waterway health for several of Kentucky's designated uses can be viewed online [68].

If your watershed was not included in the detailed studies described in the most recent Integrated Report, you will need to refer to two separate documents for the year in which it was studied: the 305(b) and the 303(d) reports.

If your project has GIS capabilities, you can get detailed information from the Integrated Report from kygeonet 69.

Information about streams that Kentucky has designated as Special Use Waters is available from KDOW 70.


Reference Reach streams are shown on the Kentucky Watershed Viewer 71.

When TMDLs are developed for stream segments, extensive watershed data are collected and pollutants loads, flow, and other factors are analyzed. See Watershed Basics and KDOW for introductory information about TMDLs 72.

- If a TMDL is under development, information will be included in Integrated Report Volume II (see link above).
- Copies of approved TMDLs are no longer part of the Integrated Report, but are available from KDOW. A listing of approved TMDLs is available online 73. Copies of approved plans can be requested from KDOW's Records Custodian: 502-564-3410 or from KDOW's website 74.

Make a map showing the regulatory status, including impairment, Special Use and TMDLs. This may require more than one map, depending on how many stream reaches in your watershed have been addressed by designated usage and regulatory status.
GIS coverage of impairment status, designated and special uses are in kygeonet 75 .
319-Funded projects require a map showing regulatory status: impairment status, Special Use waterways, and TMDL status.

### 2.2.6 Other Water Data

Existing water monitoring data for your watershed may be limited or extensive; it may have been collected over a long period of time, or for a brief period; it may have been gathered on some characteristics, but not others. Some are contained in datasets available on the Internet; others are on scientists' computers, in state records, or in volunteer monitoring newsletters. It's your challenge to find it! Don't forget the reference section of your local library, college or university.

#### *Biological Data*

University biology programs are good sources for data about biological communities in streams. Environmental consulting firms may also have biological data they have gathered doing work on other projects. There may be proprietary issues about some of those data, but it's worth asking. In Kentucky, all agencies and universities use "biological indices" that are approved by KDOW.

Procedure manuals for Kentucky biological indices and other surface water assessment methods are posted on the KDOW website [76].

***Other Water Quality Monitoring Data***

Other sources of monitoring data include:

- Many sanitary sewer authorities, especially larger ones, collect water quality data. See more in the Discharges section, below.
- University or college biology programs often collect water quality data.
- Watershed Watch in Kentucky is a nongovernmental, citizen monitoring program in each of Kentucky's basins. Watershed Watch volunteers have monitored over 1000 stream sites in Kentucky. Not all these data have been collected with an approved quality assurance project plan (QAPP), but data without a QAPP can provide key insights worth verification with additional monitoring [77].
- Kentucky Water Watch, sponsored by KDOW also has a network of citizen monitors who upload their stream information to a database [78].
- The US Forest Service sometimes collects biological data within its property limits [79].
- Kentucky Department of Fish and Wildlife sometimes collects biological data within Wildlife Management Areas [80].
- The USGS collects water data [81].
- The US Army Corps of Engineers collects water data related to reservoirs under its jurisdiction. (Louisville District 502-315-6318; Huntington District 866-502-2570; Nashville District 615-736-7161)
- Discharge monitoring reports (see section 2.4.1)

Make a map showing the locations of monitoring sites for which stream data are available.

### 2.2.7 Geomorphologic Data

Stream geomorphology is introduced in the Erosion section of the Watershed Basics section. It is an emerging science, so not many assessments have been conducted. However, there is a chance that geomorphic and sediment assessments are available for some part of your watershed. These data are important for a number of reasons, including identification of sediment sources, assessing stream stability, and predicting the physical response of the stream channel to future activities.

Local universities may have conducted or may be conducting assessments in your watershed. The Stream Institute at the University of Louisville conducts geomorphic assessments in the Commonwealth [82].

Where geomorphological assessments have not been done, you may find related data that will provide clues. For example, USGS streamflow data, as well suspended sediment data, are useful for flood frequency analysis, identifying historic major flood events and looking at duration of baseflow (or absence during the summer) [83].

The Natural Resources Conservation Service (NRCS, US Department of Agriculture) soil surveys have some very helpful details on soil erosion, landform shape, slope stability etc [84].

You may be able to locate historic aerial photographs or topographic maps, which you can compare to existing aerial photographs and maps to determine if the streams in your watershed have been modified. Historic photos and maps can also provide evidence of channel straightening, old mill dams, historic channel condition, whether sinkholes or old farm ponds have disappeared or appeared, etc.

Sources of historic aerial photography, maps, and photos include:

- Kentucky Transportation Cabinet Division of Highway Design Phototechnic lab [85]
- Kentucky Office of Geographic Information Systems [86]
- USDA Farm Services Agency County Offices: USDA Service Centers in each county in KY
- Kentucky Geological Survey [87]
- The Kentucky Historical Society [88]
- Universities. The University of Louisville has some of their archives historic photos online [89]
- Local libraries may also have useful historical photographs
- Group members or other locals

KDOW uses the EPA's Rapid Bioassessment Protocol (RBP) has detail on physical habitat that, rather than focusing on the total score, could be used to compare geomorphological characteristics between sites. If this habitat assessment has been performed in your watershed, you can use the information from the parameter numbers below. The RBP score sheet is provided in Appendix E. However, it is important to understand that these data are subjective. Results are most useful when comparing observations of one person at different sites.

Data from RBP that are relevant to geomorphologic analyses include the following:

| Habitat parameter number | Parameter (Low Gradient) | Parameter (High Gradient) |
|---|---|---|
| 2 | Pool Substrate | Embeddedness |
| 3 | Pool Variability | Velocity/Depth Regime |
| 4 | Sediment Deposition | Sediment Deposition |
| 6 | Channel Alteration | Channel Alteration |
| 7 | Channel Sinuosity | Frequency of Riffles |
| 8 | Bank Stability | Bank Stability |

Kentucky Department of Fish and Wildlife Resources (KDFWR) Stream and Wetland Restoration Program is running a program to conserve and restore streams and wetlands. They may be conducting a restoration in your watershed. If so, they would have geomorphologic information - in addition to being potential partners, etc [90].

Members of your group or other locals may have observed stream channel and sediment changes in your watershed. While this is subjective information, it's worth collecting. Don't underestimate local knowledge!

> Additional geomorphic assessment resources can be found in Chapter 5, Section 5.8.3 of the EPA Handbook.

## 2.3 Finding Natural Features Data and Information

An inventory of the natural features in your watershed will help you to identify sensitive areas. It will also help you to determine the causes, sources, and impacts of pollutants.

### 2.3.1 Geology and Topography

Topographical maps are widely available. They can be downloaded online (with digital imagery) from the Microsoft Research Maps (MSR Maps) [91]. They are also available through USGS [92].

> Do you wonder why some of this information is relevant? Go back to Watershed Basics and find out.

The Kentucky Geological Survey has a list of agencies and well-informed people to contact on their website [93].

See related information about soils in Section 2.3.2.

GIS coverages of geology and topography are in kygeonet [94]. 319-Funded projects must provide a map showing geology.

### 2.3.2 Soils

The Natural Resources Conservation Service (NRCS) has a wealth of expertise and data. To find your local NRCS office, visit their website [95]. Local staff should be invited to be partners in your planning team. They can provide information on soil surveys, highly erodible lands, hydric soils (indicative of wetlands), and prime farmland. Find your soils and other information at the "Web Soil Survey" site [96].

GIS coverage of soils is in kygeonet [97]. 319-Funded projects must provide a general soils map.

### 2.3.3 Ecoregions

Ecoregion information is available from the US EPA [98].

### 2.3.4 Riparian/Streamside Vegetation

Riparian vegetation is the plant life that grows adjacent to flowing water. It serves many functions: filtering and absorbing sediments and nutrients, providing shade to maintain cooler water temperatures, and regulating the exchange of nutrients and woody residue between land and water. These functions are best performed when the riparian vegetation is native. See the Watershed Basics section for more information.

The level of vegetative cover in the riparian area can be explored using aerial photography. Sources of photos, both historic and current, are listed in Section 2.2.7, Geomorphologic Data. Use current photography or GIS to identify areas with and without vegetative cover. Be sure to use photos that were taken during the growing season! Members of your team or other locals may have information about riparian areas with which they are familiar, both for protection and restoration purposes.

KDOW may also know of restoration projects in your watershed, past and present [99]. Members of your team or other locals may also know about past or current vegetative restoration projects.

You can visually "surf" your watershed and look at riparian areas using a web-based three dimensional mapping program, which requires downloading a program and broadband access, using either of the following:

- Google maps [100]
- Microsoft Virtual Earth [101]

Unique natural areas that may need protection can be identified by consulting with:

- Kentucky State Nature Preserves Commission [102]
- Kentucky Department of Fish and Wildlife [103]

GIS coverage of current aerial photography is available on kygeonet [104].

### 2.3.5 Rare and Exotic/Invasive Plants and Animals

Plants and animals are also referred to as flora and fauna. Information about rare flora and fauna that need protection and are known to live in the area defined by your watershed can be found at the Kentucky State Nature Preserves website [105].

If your watershed includes special areas managed by federal or state agencies, contact them for information.

- US Forest Service (USFS) Daniel Boone Forest District [106]
- USFS Land Between the Lakes Recreational Area [107]
- Kentucky Department for Fish & Wildlife Management and Hunting Areas [108]
- Kentucky State Nature Preserves and State Natural Areas (lists and maps) [109]

Exotic invasive species of plants and animals can wreak havoc with ecological balance, creating trouble for rare and common species alike, and also degrade waterways and interfere with water uses. The sources of rare species information above also provide information about exotic invasive species. More information is available from:

- University of Kentucky Invasives Species Working Group [110]
- Kentucky Exotic Pest Plant Council [111]

## 2.4 Finding Data and Information About Human Influences and Impacts

There are a variety of human activities that influence water quality. You'll need to inventory these to identify human needs and potential impacts as well as to explore sources and causes of pollutants.

Appendix E shows potential sources for common pollutants.

## 2.4.1 Water Use

### *Water Withdrawals*
Some potential water withdrawals include public water suppliers, industries, mines, power plants and agriculture, among others. You can view these water withdrawal locations and specifics regarding their permits on the Kentucky Watershed Viewer 112. You can obtain additional information about water withdrawal permitting by contacting KDOW's Water Quantity Management Section at 502-564-3410 or at the website 113.

The water withdrawal program has information on all withdrawals of water greater than 10,000 gallons per day from any surface, spring or groundwater source, with the exception of:
- Water required for domestic purposes
- Agricultural withdrawals, including irrigation
- Steam-powered electrical generating plants regulated by the Kentucky Public Service Commission
- Withdrawals used for injection underground as part of operations for the production of oil and gas

Members of your team or other locals may know more about water withdrawals, particularly agricultural usage, which can be surprisingly voluminous, especially during droughts.

GIS coverage of water withdrawal sites is in kygeonet 114. 319-Funded projects must provide a map showing water withdrawal sites.

### *Public Water Supply*
Source Water Protection and Wellhead Protection Programs, described in 5.1.2, require the delineation of a protection area which is all or part of the watershed or groundwater recharge area for the source and seek to minimize the risks of pollutants entering into those protection areas.

Information about Source Water Protection and public drinking water sytems is available through the Kentucky Infrastructure Authority (KIA) Water Resource Information System (WRIS) 115. To obtain specific information about Source Water Protection in your area you can contact the Water Management Planner for your Area Development District (ADD) 116. You can also contact KDOW's Water Quantity Management Section 117.

KDOW administers the Wellhead Protection Program, which is designed to assist communities that rely on groundwater as their drinking water source. To obtain additional information about this program contact KDOW's Water Quantity Management Section 118.

GIS coverages of water lines and Source Water and Wellhead Protection areas are in kygeonet 119. 319-Funded projects must provide maps showing public water lines and Source Water and Wellhead Protection Areas.

Do you wonder what some of these programs are and what the terms mean? Go back to Watershed Basics and find out.

***Discharges***

*Municipal, industrial and other wastewater facilities discharges and wastewater networks*

Municipal, industrial, and other wastewater facilities directly discharging from a point source (end of pipe) to surface waters are required to obtain a KPDES permit from KDOW. (KPDES stands for Kentucky Pollutant Discharge Elimination System.) The point of discharge is called an outfall. You can locate KPDES permits in your watershed using KDOWs Watershed Viewer [120]. Once you find the basic facility information, you can get more information from EPA's Surf Your Watershed website [121].

More information about KPDES can be found on the Kentucky Division of Water website [122].

Information that is useful at this stage of planning includes:

- Location of discharge, both major discharges and discharges of local concern
- Size of treatment facility
- Whether or not the facility is operating at or above treatment capacity, the volume and flow it can effectively handle.
- Whether the owner plans to expand and whether expansion plans have already been developed
- Whether the facility is in compliance with regulatory requirements of the permit

If the situation or data indicate the need for closer analysis, you will need to look for specific monitoring data. You can secure those data directly from the discharger or from KDOW [123]. In addition, the discharger may be able to provide you other monitoring data.

If the discharge is related to pollutants of issue in your plan, it will be necessary to secure these data in order to quantify **pollutant loads**, which are described in Chapter 4.

Maps showing the boundaries of wastewater (sewer) services and some pipe network information are available at Kentucky Infrastructure Authority (KIA) Water Resource Information System (WRIS) [124]. Your local wastewater treatment facility may also be able to provide maps of the networks of pipes carrying wastewater to their treatment facility. Pollutants sometimes emerge from leaky pipes, especially when those pipes are old.

GIS coverage of discharge sites, sewer lines and proposed sewer lines are in kygeonet [125]. 319-Funded projects must provide maps showing permitted discharges and sewer lines.

*Stormwater discharges*

Although stormwater begins as runoff over surface areas, more than one hundred Kentucky municipalities are regulated by KDOW as permitted, (multiple) point source discharges. Such permits mandate programs to minimize the pollutants in the permitted stormwater system and to encourage citizens to keep pollutants out. Permits also regulate runoff from construction sites greater than one acre and from industrial facilities with outside material storage that might contribute to polluted runoff.

KDOW's website lists communities holding stormwater permits [126].

To locate stormwater collection systems and outfalls in your watershed, you may need to contact the municipalities and counties in which the systems are located. Some Area Development Districts, who frequently help map these outfalls, may also have this information [127].

All large Kentucky cities and many small ones have **Municipal Separate Storm Sewer System (MS4)** permits. A listing of Kentucky municipalities covered by MS4 and the administering authorities is provided on the KY Division of Water MS4 website [128].

GIS coverages of discharge sites and MS4 area boundaries are in kygeonet [129]. In 2010, pipe networks are being added as well. 319-Funded projects' map of discharges, mentioned above, should include stormwater discharge sites.

*Combined Sewer Overflows*

As a part of inventorying your watershed, your planning team should find out if any of the communities in your watershed are served by **combined sewer systems.** If they are, you'll need to map the location of **combined sewer overflow (CSO)** discharge points. The best sources for this type of information are municipalities, cities and county water departments or public works divisions that manage the systems. Identifying the location of the CSOs on a map will help you to correlate water quality information and accurately determine sources of pollution. Additional information from Kentucky Division of Water is located online [130].

*Sanitary Sewer Overflows*

Sanitary sewer overflows (SSOs) are illicit, but they occur if systems become overloaded or are faulty. The best way to locate them is to ask your local wastewater system, team members or other locals.

### *Unsewered Areas*

There are two ways to identify existing areas serviced by onsite systems. One is to contact your local health department's Environmentalist. He or she may also be able to tell you when systems were built and what types of education residents have or have not received about proper maintenance of them.

The second way to identify areas served by onsite systems is to compare areas served by sewer facilities with areas served by public drinking water. The areas receiving water but not sewer are probably populated and using onsite septic systems. You can ask the water and wastewater/sewer facility for service boundaries or go to Kentucky Infrastructure Authority (KIA) Water Resource Information System (WRIS) [131].

Members of your team or other locals are likely to know whether certain neighborhoods have sewer access or not.

GIS coverages of existing and planned extensions of sewer and water lines are available from kygeonet [132].

### 2.4.2 General Land Use

Examination of land use is one of the most important tools for analyzing your watershed and for setting priorities and selecting monitoring sites as your planning proceeds. Remember: what happens on the land impacts water.

Land use is one type of information that is not easy to separate by sub-watershed. However, if you make an effort to do so, it can significantly help when you begin deeper analysis.

There are several ways to examine land use: maps made from GIS data, aerial photography, and making your own observations. In addition, historic and current photos can reveal details.

No matter how much GIS data or aerial photography you have, it is important to ground-truth the information; in other words, to confirm or amend the information by looking around you. See Section 2.6.1, Windshield Surveys.

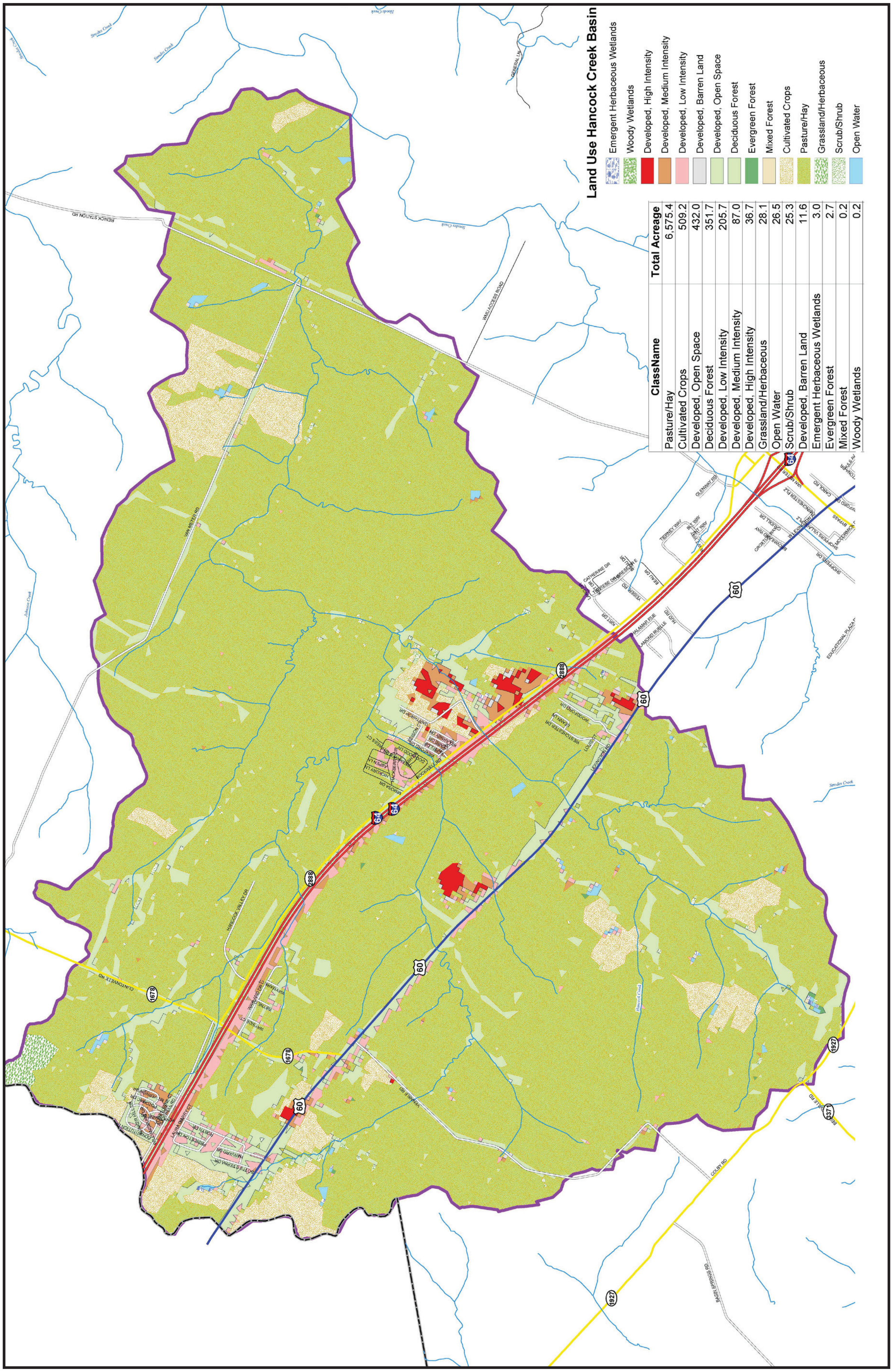
Figure 2.1 is a GIS-created map of the Hancock Creek Watershed that uses the National Land Cover Dataset to show land uses in the watershed.

Aerial imagery offers a bird's eye view of the watershed, giving life to features identified from research described above, and shows additional land features, such as vegetative cover along riparian corridors and presence of natural areas. An aerial image may serve as background to a land use map, or be used separately – in which case it is best to put identifying features on the photograph, such as those on your base map. An aerial image marked with natural areas, nature preserves, scenic rivers, historical or archaeological sites and/or other assets can increase community appreciation of the watershed. The Kentucky Watershed Viewer provides land cover and aerial photography (in the "base imagery" file), but only when zoomed into a small area [133]. Guidance for using Google Earth aerial imagery is available from the Kentucky Watershed Leadership Academy [134].

Some cities and regions in Kentucky have land use databases. You can learn about these from local planning or economic development officials or from your local Area Development District (ADD) [135]. Your partners and local university and college researchers can alert you to mapped sources for land use data.

Land ownership may be a significant factor in your planning if an agency, organization or individual manages a considerable amount of land in your watershed. This might include the US Forest Service, the US Army Corps of Engineers, a Kentucky State Park, a prison, or others. If so, they could be important partners in your planning effort. Some of this information will be in the Watershed Viewer [136]. Some Property Valuation information is readily available:

- A directory of Property Valuation Administrators (PVAs) is available from the Kentucky Department of Revenue [137].
- The Kentucky PVA Association has other related Internet links [138].




# Figure 2.1 - Land Use in Hancock Creek Watershed

Historic photos, maps, and aerial views can provide information about changes in land use. Section 2.2.7 has ideas for finding these items. Members of your team or other locals may know of concerns related to land use. They may also know about historical land uses in your watershed that are not shown on current data. The latter is perhaps most relevant with respect to waste disposal areas.

GIS coverages of land use (National Land Cover Dataset) and aerial photography are in kygeonet [139]. 319-Funded projects must provide a map showing land use.

***Impervious Surfaces***
Since impervious surface has been shown to effect stream degradation, it is important to determine the amount of imperviousness throughout your watershed. See Watershed Basics for more information.

Land use information can be used to predict the percentage of impervious cover. A study by the USDA in 1975 indicated that a one acre residential development may only be twenty percent impervious cover, whereas an industrial or commercial development of the same size may be up to seventy percent impervious cover.

2002 Kentucky GIS land use data identifies impervious surfaces and kygeonet also has an impervious surface coverage [140]. 319-Funded projects must rovide a map showing impervious surfaces.

### 2.4.3 Other Water Disturbances

***Instream Construction or Disturbance (Hydromodification)***
Examples of instream construction or disturbance include moving stream channels, filling in the floodplain, dams, and dredging. See also section 2.2.7, Geomorphologic Data, for sources of information.

Most projects that take place in waterbodies or wetlands, or dump or place dredged or fill material in waterbodies or wetlands, require a **404 permit** from the US Army Corps of Engineers. The Louisville District, which covers most of Kentucky, lists recently issued permits at [141], but if you want information on previous projects in this district, you may need to visit or telephone their office at 502-315-6686 or 502-315-6733. There may be a fee, although you can request a waiver. Louisville District permits are available by county and show only information about the permittee; they do not give the location of the activities.

Parts of southern and eastern Kentucky are covered by other Corps Districts. The Huntington District lists issued permits at [142]. The Nashville District can be reached at 615-369-7500.

Projects that result in significant physical disturbances to wetlands or streams require **Water Quality Certification** (401 WQC) from the Kentucky Division of Water. Impacts in streams or lakes designated as Special Use Waters require an individual WQC. You can find more information regarding this program on the Kentucky Division of Water website [143]. To determine whether a specific site required and obtained 401

Certification, contact KDOW's Water Quality Certification Section at 502-564-3410 or visit their website 144.

In the end, often the best sources of information about hydromofications are aerial photographs, maps, and members of your team or other locals. Small, low-head dams and historical stream channeling will not be identified by databases or permit programs. In almost all of Kentucky, a straight stream is one that has been altered, so look suspiciously at any straight stretch of stream. Ask locals about low-head dams, small stream obstructions built for various purposes.
GIS coverage of dams is available from kygeonet 145.

Low-head dam on South Elkhorn Creek

## 2.4.4 Land Disturbances That Can Impact Waterways

***Mining and Quarries***
Mining operations require KPDES permits when water will be used to wash coal, the operation will pump water from underground seams, or for any discharge of water from the mining site. If mining is active in your watershed, mining operators will be vital stakeholders for your planning team, and the Kentucky Department for Natural Resources will be important partners.

For information on surface mining locations visit the Kentucky Department for Natural Resources website 146.

Members of your planning team or other locals may know about mining sites, including old sites and sites that have been restored as required by permitting.

Quarries are permitted through the Noncoal Review Branch in the Kentucky Division of Mine Reclamation and Enforcement. Call 502-564-2340 to find out if there is a quarry in your watershed. More information about noncoal permits is available at their website 147.

## 2.4.5 Hazardous Materials
Information about sites that store or contain hazardous materials and/or waste is available through a number of programs administered by the Kentucky Division of Waste Management: CERCLA (Superfund), RCRA (Resource Conservation and Recovery Act), Brownfields, Underground Storage Tanks, and landfills. Contact the Division of Waste Management and ask for the program of concern: 502-564-6716.

## 2.5 Finding Data and Information About Demographics and Social Issues

To provide comprehensive context to your analysis and planning for implementation, consider examining trends on the following issues:

- Population (age, size of family, composition, etc)
- Average household income
- Education levels
- Housing (ownership, rental, vacancy rates, etc.)
- Property tax values
- Unemployment rate
- Farming trends (part-time/full time, owner operated/rental, etc.)
- Limited resource landowners
- Major employers, location of facilities
- Regional economic trends

County and zip code level data are available through the US Census Bureau. Local officials and universities maintain census data to a finer grain. A major source of detailed census data available online for Kentucky is the Kentucky State Data Center at the University of Louisville [148].

Local libraries and historical associations may also help with information about demographics and social issues. Members of your planning team or other locals may have information about social issues.

Census data are available from kygeonet [149].

## 2.6 Making Your Own Observations

Besides doing all the detective work described above, it is extremely important for your planning team to get out into the real world and look around and to use your collective knowledge, memory – and brains.

For example, land use data are only collected every few years at best, and changes on the landscape occur continually. Checking land uses throughout the watershed is generally called a Windshield Survey. In addition, data collection isn't always detailed, comprehensive or accurate. Data collected through statewide programs or from satellite data are not going to yield the same results as walking or canoeing along or in a stream provides.

Don't forget to take safety precautions.

### 2.6.1 Visual Surveys

Conduct a visual or "windshield" survey of your watershed using your watershed map and a car or a couple of bicycles. It is preferable to work in pairs, so you can see more and take detailed notes -- and also for safety, because streams have lots of slippery spots, steep slopes, etc.

It's helpful to use a form to stimulate and organize your observations. It's a good idea to do visual surveys twice, once during the growing season and once when leaves are gone and crops have been harvested. Look for changes in land use and land use practices, including construction sites, agricultural operations, etc. Look for erosion, impervious surfaces, and information related to any of the topics listed in this chapter. Be respectful of private property, of course.

EPA's guidebook has guidance for making these observations 150. Forms specific to Kentucky's rural areas are available through Kentucky Waterways Alliance's website 151.

### 2.6.2 Stream Surveys

Walking segments of your stream can be very revealing, and fun, too. Always go in pairs or as a group, to make observations less subjective and for safety reasons. Respect private property. The streams in Kentucky belong to the Commonwealth of Kentucky, and if you are on a boat, you are not trespassing. However, not all landowners know that fact; plus stream banks are not public property. The Natural Resources and Conservation Service has instructions and forms for conducting a stream assessment 152.

The Center for Watershed Protection (cwp.org) has a comprehensive, Unified Stream Assessment manual available for a fee 153.

### Active Options

- Acquaint your team with how information can be organized onto maps using a map-drawing exercise: From Kentucky's Watershed Viewer or another GIS mapping tool, print a map showing only the waterway and the watershed's boundary. Make enough copies for every member of the team. Distribute the copies with markers or crayons, and ask each member to mark things that are personally significant, such as cities, roads, parks, farmlands, and forests, on the map. Ask them to put a big star where they live or work. Then ask members of the team to take turns presenting their maps to the rest of the team. Discuss how individuals view the watershed's characteristics differently.
- When making contacts with other information sources, consider asking if they want to partner with the team. When they provide information but don't get involved, be sure to keep them informed of your team's progress.
- You might invite special speakers to your planning team meetings to present aspects of watershed description:

**How Much To Share?**

The detail provided for each of the topics in this section depends on the subject and the scope of your plan as well as your findings.

If you can, integrate information your team discovered through visual or stream surveys into the related sections.

If you were unable to find information or the category is not relevant to your plan, it is still worthwhile to explain, because otherwise people may wonder why you did not consider that particular factor in your analysis.

If you cannot connect information with a specific location, try to connect it with a sub-watershed, or note where the practice or condition is applicable to a part or to the entire watershed.

Identify sources of information whenever possible.

- Soils and topography: A staff member from the Conservation District
- Land use and cover: A staff member from the county Planning Commission or Area Development District
- Impairment and Protection: A staff member from the Division of Water
- Water Quality Data: A stream scientist from your state university's streams program

• Consider using modules from the Commonwealth Water Education Project, which was created to educate citizens and students about nonpoint source pollution [154].

• Members of your group can do visual assessments of key segments of your waterway using one of the formal survey instruments in Section 6.5.1 of the EPA Handbook. When they're complete, ask the members to share their results (and pictures!) with your group.

• Plan some optional outings, ideally at locations where partners or stakeholders can be hosts. Sites might include:

- Stream restorations
- Innovative stormwater management practices
- A Watershed Watch monitoring site

• Take photos! Develop a brief slide show about what you've learned that can be used for a creek-side news event or short presentations to other local groups. However, avoid the temptation to draw premature conclusions; remember, you have lots of analysis to do first.

## Write It Down

First, revisit and update the information in the first section of your plan. You are likely to have new partners and stakeholders to list as a result of your research process. Also, your team will have learned information that may refine the preliminary concerns.

**Chapter 2: The** *[insert the name of your watershed]* **Watershed**

**Introduction**

Describe your watershed in one or two paragraphs, relating:

- The name of the waterway of concern
- The larger waterway to which it is tributary
- Its location within Kentucky (counties and communities)
- Its area in square miles

Add a paragraph or two to introduce the information you found about water resources, natural features and human influences. This is the part of the plan where you begin to tell the story of your watershed, to integrate existing information.

**Water Resources**

- Describe and provide map(s) of the water resources in your watershed.
- Watershed Boundary
- Hydrology
- Groundwater-Surface Water Interaction
- Flooding
- Regulatory Status of Waterways
- Water Chemistry and Biology
- Geomorphology

**Natural Features**

Describe and provide maps of the natural features of your watershed.

- Geology and Topography
- Soils
- Ecoregion

**Riparian/Streamside Vegetation**

Describe and provide maps of any riparian information you found.

**Rare and Exotic/Invasive Plants and Animals**

Describe and provide any information about rare and exotic/invasive plants and animals you identified in your watershed.

**Human Influences and Impacts**

Describe and provide maps about human activities in your watershed. As much as possible, connect these activities to specific locations or sub-watersheds. Be accurate and respectful.

- Water Use
- Land Use
- Other Water Disturbances
- Land Disturbances
- Hazardous Materials

**Demographics and Social Issues**

Provide any relevant information about demographics or social issues. If feasible, identify differences within sub-watersheds.

**Team Observations**

Describe any visual or stream survey activity of the team, partners, or volunteers. Include any observations that have not been integrated into other sections of this chapter.

**Interim Conclusions**

Consider including a short section that summarizes the information that appears to be most relevant.

**The following information must be included in map form for all 319-funded projects:**

- Watershed and sub-watershed boundaries
- Political boundaries (counties, cities)
- Roads
- Hydrology: streams, lakes, rivers
- Groundwater network: karst basins, springs, sinkholes, dye tracing results
- Floodplains
- Regulatory status: impairment, Special Use, TMDLs
- Geology
- Topography
- Soils
- Water withdrawals
- Water lines
- Source Water Protection Areas
- Wellhead Protection areas
- Permitted discharges
- Sewer lines
- Land Use
- Impervious Surfaces

**Other Records**

Record your team's impressions of watershed issues before, during, and after collecting information. What implications does the team see? These impressions will be helpful as you continue your discoveries. Hopefully, you will either prove the impressions are right or wrong.

Although your plan will summarize much of your research findings, be sure to keep records of your research activities:

- Who you contacted and their contact information, whether or not the contact yielded data. Keeping this information electronically will make it easier to share and update.
- Data inventories
- Calculations
- Dead-end research efforts
- Surveys, if any were conducted, with details about how they were conducted.

# Chapter 3: Learning More
## *Monitoring to Secure New Data*



This chapter will help you:
- Identify monitoring data gaps
- Develop a monitoring program to fill the gaps

As in every chapter, this one also provides:
- Active Options
- Write It Down

Find related information about this stage of watershed planning in Chapters 6, 7, 8 and 9 of EPA's Handbook

## Introduction
There are two major goals of watershed planning: protect good water quality and improve poor water quality. To achieve these goals, efforts must be targeted to protect any areas without problems and to restore areas with problems. To prioritize target areas with problems, it is necessary to identify where pollutants impact waterways. The work conducted for Chapter 2 gave you a better understanding of your watershed, the stream and people systems in it. However, in many cases additional data and more in-depth analysis are needed to identify sources and target implementation projects to places where they will have the most benefit.

For 319-funded watershed plans in Kentucky, a source is considered to be an area, or catchment, of a sub-watershed that is contributing a pollutant. You need a comprehensive understanding of the watershed to identify these pollutant contribution areas, or sources. This understanding can be achieved through the analysis of the watershed data.

Section 3.1 provides instruction to determine additional monitoring data needs and Section 3.2 provides instruction for obtaining additional data through monitoring. If you are developing a watershed plan using 319 funding, then you must fulfill *at least* the monitoring and analysis requirements identified in this Chapter. Section 3.2.1 explains this in detail.

Some watershed planning projects will not have sufficient resources to conduct in-stream monitoring and will have to rely on the data compiled from Chapter 2. Don't let this deter your efforts, because a great deal can be done with existing data. Use the information in this chapter to better understand how to look at your existing data and to identify monitoring that you may want to complete if future resources allow.

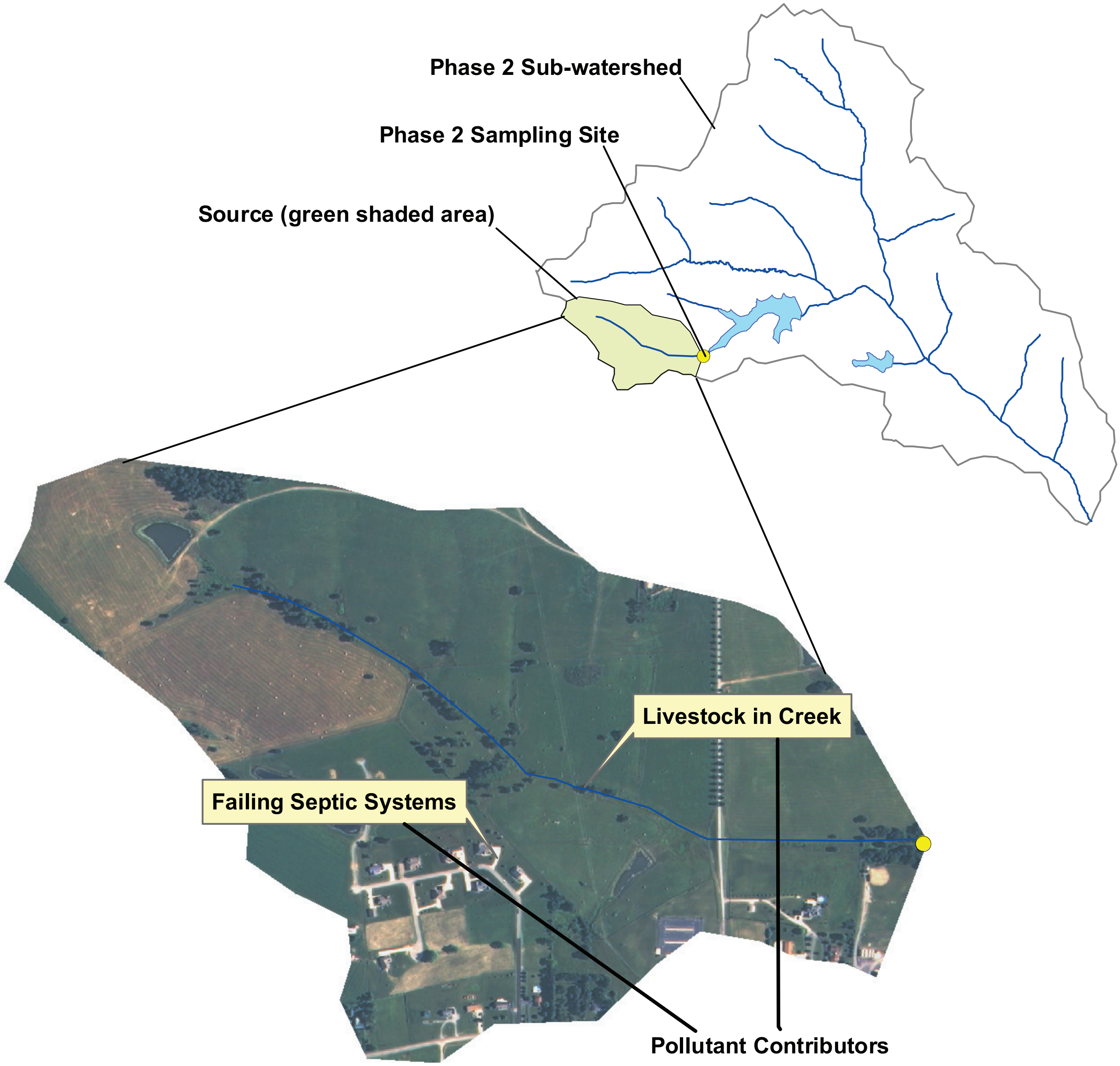



**Figure 3.1 - Source and Pollutant Contributors**

**Source** – There are many different definitions for source. It can be defined as a particular type of land use (e.g. mining), a discharge point (e.g. an outfall from a wastewater treatment plant that is not meeting permit requirements), or in some cases a specific landowner (e.g. Gudmilk Dairy). The KY 319(h) program defines source for the 319-funded watershed plans as the area that contributes a pollutant. Refer to Figure 3.1. In that figure, the source is the small catchment upstream from the Phase 2 monitoring sampling point. This source contains multiple pollutant contributors that are resulting in high levels of *E.coli*.

## 3.1 Determining Additional Monitoring Data Needs

At this stage of the watershed planning process, it's important to determine if you need to collect additional monitoring data to identify sources and target implementation efforts. This can be one of the most difficult challenges in watershed planning. It's often necessary to collect additional monitoring data. Sections 6.2 and 6.3 of the US EPA Handbook provide excellent guidance for identifying monitoring data gaps and should be utilized to identify these gaps.

**Hiring Help.** Your planning team may choose to hire someone to conduct the monitoring and analysis for your plan. Make sure that the person or organization you hire is familiar with the monitoring and analysis requirements in Chapters 3 and 4. It will also benefit you to include the fulfillment of these requirements in their contracts.

Section 3.2 outlines the minimum monitoring requirements for KY 319-funded plans. If you are developing a KY 319-funded watershed plan, then these minimum requirements must be met. You should review the monitoring requirements in Section 3.2 and determine if the existing monitoring data meet these requirements.

Another important factor to consider is the quality of the existing monitoring data. All KY 319-funded watershed plans require that monitoring data used have been collected in a manner that meets the requirements of a **Quality Assurance Project Plan (QAPP).** Additional information regarding QAPPs for 319 projects is available in the Kentucky Nonpoint Source Application Instructions 155.

Many times available resources such as time, money and expertise will limit the monitoring efforts. If you are unable to collect additional data, do not let this prohibit your planning team from moving forward. Use the guidance in this chapter and Chapter 4 to better understand how to analyze your existing data and to identify monitoring that you may want to complete if future resources allow.

**Quality Assurance Project Plan**
A QAPP is a project-specific document that specifies the data quality and quantity requirements of the study, as well as all procedures that will be used to collect, analyze, and report those data. EPA-funded data collection programs must have an EPA-approved QAPP before sample collection begins. However, even programs that do not receive EPA funding should consider developing a QAPP, especially if data might be used in your plan to direct other projects to improve water quality or by state, federal or local resource managers. A QAPP helps monitoring staff follow correct and repeatable procedures and helps data users ensure that the collected data meet their needs and that the necessary quality assurance (QA) and quality control (QC) steps are built into the project from the beginning.

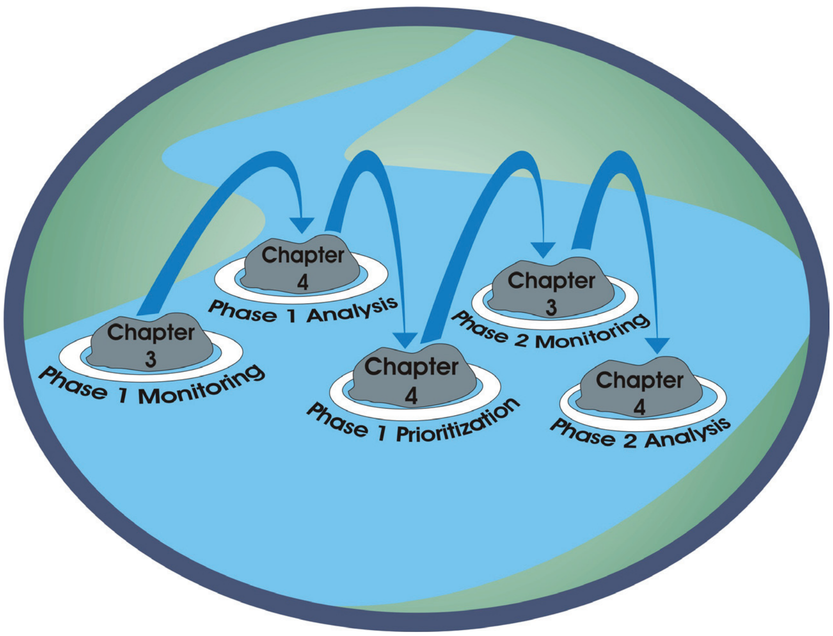
## 3.2 Obtaining Additional Data Through Monitoring

Once you have determined the need for additional monitoring, the next step is to determine where to monitor (scale), what to monitor (parameters), how to monitor (methods) and when to monitor (frequency).

### 3.2.1 Monitoring and Data Analysis for 319-Funded Watershed Plans

A phased approach for monitoring and data analysis must be used for KY 319-funded watershed plan projects. Within a 319 project, the area in which you monitor is dependent on your planning team's progress and the project's geographic scope. The geographic scope is greatly affected by the need for source determination. Source identification should be at a small enough scale to allow for targeting of BMPs with an expectation of water quality improvement. This ultimately determines the monitoring scale requirements for watershed plans.

Section 3.2 describes the phased approach for monitoring, and Chapter 4 describes the phased approach for analysis. For this part of the watershed planning process, you will utilize these chapters together. When you complete the Phase 1 monitoring, you will need to complete the Phase 1 Analysis in Chapter 4, Section 4.2.1. Upon completion of the Phase 1 Analysis, you will need to complete the Phase 1 Prioritization in Chapter 4, Section 4.2.2, then the Phase 2 Monitoring in Chapter 3, Section 3.2.3. Then you will finalize the monitoring and analysis process by completing the Phase 2 Analysis in Chapter 4, Section 4.2.3.




*Monitoring and Analysis Flow Chart*

As discussed in Section 3.1, your planning team may have existing data that fulfill all or part of the monitoring requirements for your plan. If so, it may be appropriate for your planning team to begin at a more advanced point in Phase 1 or possibly with Phase 2. Phase 1 of the monitoring and data analysis begins at a broad scale across your **watershed** and helps to make general assessments to direct the more detailed examination in Phase 2. In Phase 2, your monitoring and analysis will allow you to select **sub-watersheds** in which to implement the most effective management practices for water

> For the 319 phased monitoring and assessment approach the term **watershed** refers to the Phase 1 watershed that measures approximately 50 mi$^2$. This may be a HUC 11, HUC 12 or a group of HUC 14s. The term **sub-watershed** refers to the smaller (approximately 10 mi$^2$ or less) Phase 2 watersheds selected from your Phase 1 watershed. These sub-watersheds may be parts of HUC 12s, HUC 14s, or multiple smaller delineated watersheds. The term **catchment** refers to the even smaller watersheds within the sub-watersheds that drain to the Phase 2 monitoring locations. Refer to Figure 3.2. When a catchment is contributing a pollutant, it becomes a source.

quality improvements. These sub-watersheds will be divided into **catchments**. These catchments are the smaller watersheds that drain to the Phase 2 monitoring locations.

Sections 3.2.2 and 3.2.3 describe the two phases of monitoring for KY 319-funded watershed plans. These are the minimum monitoring requirements for KY 319 watershed plans. It's important to keep in mind that watersheds are different and this monitoring plan may not fit your particular watershed. In the Watershed Basics section, you learned about groundwater and karst basins. If you are planning in an area with karst geology, it will be important to monitor for the entire watershed, including both the surface and groundwater network. This will require sampling at locations such as springs and karst windows throughout the watershed. In some watersheds, it may be necessary to perform more in-depth sediment and/or geomorphic studies. Certain planning teams may choose to conduct biological

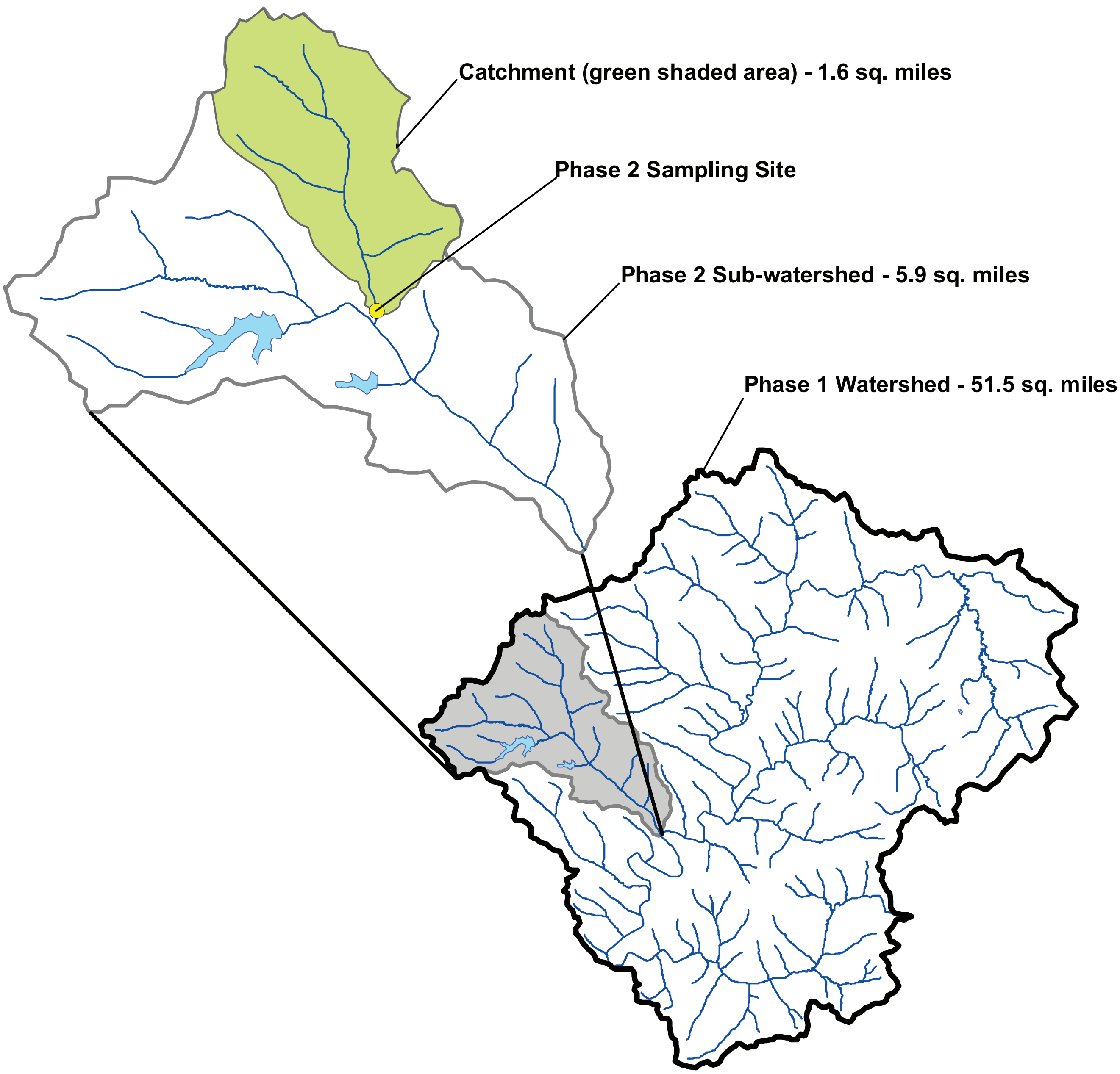



**Figure 3.2 - Watershed, Sub-watershed and Catchment**

assessments. In some cases it may be necessary to conduct Microbial Source Tracking (MST) studies to determine if elevated concentrations of bacteria are from human or animal contributors. You should contact your Nonpoint Source Program Technical Advisor and discuss these monitoring alternatives. It's vitally important that the monitoring strategy you choose will provide the information needed for your specific watershed.

| Group | Parameter | Monthly | 5X/30days May or June | 1X/year May or June | Every Time | Standard Operating Procedure (SOP) |
|---|---|---|---|---|---|---|
| Bacteria | E.coli *(Escherichia coli)* | x | x | | | DOWSOP03017 |
| | $NO_3$/ $NO_2$ (Nitrate/Nitrite) | x | | | | DOWSOP03015 |
| | $NH_3$-N (Ammonia – Nitrogen) | x | | | | DOWSOP03015 |
| | TKN (Total Kjeldahl Nitrogen) | x | | | | DOWSOP03015 |
| | TP (Total Phosphorous) | x | | | | DOWSOP03015 |
| | OP (Orthophosphate) | x | | | | DOWSOP03015 |
| | BOD5* (Biochemical Oxygen Demand) | x | | | | DOWSOP03015 |
| Sediment | TSS (Total Suspended Solids) | x | | | | DOWSOP03015 |
| Flow | Stream Discharge | | | | x | DOWSOP03019 |
| Field Data | Turbidity (actual or estimated) | | | | x | DOWSOP03014/ DOWSOP0315 |
| | pH | | | | x | DOWSOP03014 |
| | DO (Dissolved Oxygen) | | | | x | DOWSOP03014 |
| | Conductivity | | | | x | DOWSOP03014 |
| | % Saturation (Percentage of DO) | | | | x | DOWSOP03014 |
| | Temperature | | | | x | DOWSOP03014 |
| Habitat (required Phase 2 only) | Habitat Assessment (Barbour method) | | | x | | EPA 841-B-99-002 |
| Biology (required Phase 2 only) | Biological Assessment (Watershed Watch method) | | | x | | WWSOP04000 |

* BOD5: The amount of dissolved oxygen consumed in five days by biological processes breaking down organic matter.

**Table 3.1. Watershed Plan Monitoring Table**

### 3.2.2 Phase 1 Monitoring

The purpose of monitoring for watershed planning at the Phase 1 stage is to determine the current water quality conditions of your watershed. The water quality conditions will be determined by monitoring for a variety of parameters. The details below cover the prescribed scale, parameters, methods and frequency for the Phase 1 monitoring effort. Refer to Table 3.1 for details.

***Scale***

Phase 1 monitoring should be conducted in a watershed that measures approximately 50 $mi^2$. This may be a HUC 11, HUC 12, or a group of HUC 14s. This is considered an initial monitoring effort that will help with preliminary identification of sources at a broad scale and prioritize sub-watersheds for further study and targeted implementation. Monitoring should first occur at the mouth of all sub-watersheds with an estimated area of 10 square miles or less (e.g. the mouth of all HUC 14s within the watershed). Additional sampling locations may need to be added based on land use within the watershed. Monitoring above and below major point sources (e.g. wastewater treatment plant) and areas of local concern may also be determined necessary by your planning team. Use the results of the visual survey that was completed in Chapter 2 to help determine these areas of local concern. Kentucky Division of Water (KDOW) monitoring sites or any other long-term monitoring sites must be considered when determining sampling locations. KDOW or other agencies/groups may have already determined the best sampling locations in your watershed. Your data collection efforts could be a continuation of these existing data records. Additionally, you could choose sites in other locations to supplement existing data records and avoid duplication of prior efforts. Figure 3.3 provides an example.

***Parameters***

Required parameters include nutrients, Total Suspended Solids (TSS), *E.coli*, field data (including Turbidity, pH, DO, DO %, Conductivity, and Temperature), and stream discharge. Habitat and biological assessments may be performed as desired. Additional parameters may need to be collected based on 305(b) impairments and parameters of local concern. Refer to Table 3.1. for details.

***Methods***

KDOW Standard Operating Procedures (SOPs) must be utilized for water quality monitoring. SOPs to be referenced include: “Sample Control and Management,” “In-situ Water Quality Measurements and Meter Calibration,” “Sampling Surface Water Quality in Lotic Systems, and the “Bacteriological SOP.” Refer to Table 3.1 for details.

These documents can be found at KDOW’s website 156. If any parameters of local concern were selected for monitoring, and the above specified SOPs do not address those parameters, contact your Nonpoint Source Program Technical Advisor for the appropriate SOP. Alternative procedures can be used with prior approval. For Habitat Assessment, follow “Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers” (EPA 841-B-99-002) 157. For Biological Assessment follow “Kentucky Water Watch Biological Assessment Monitoring Protocol” (KDOW 2010) 158. The

> To understand what these parameters tell you about the quality of water in your waterway, refer to the Watershed Basics Section.

protocols for Habitat and Biological Assessment are intended to provide a minimum baseline condition while minimizing time and resources.

***Frequency***

*E.coli*, nutrients, and TSS must be collected monthly for twelve months. In addition, *E.coli* must be collected five times within thirty days to ensure a sufficient number of samples are obtained during the Primary Contact Recreation (PCR) season. This sampling event should begin in May or June resulting in five grab samples collected within a 30 day period. For example if you collect the first of the five samples on May 12th, then the remaining four samples must be collected by June 10$^{th}$.

Habitat and Biological Assessments must be performed once per year in either May or June during Phase 2. Keep in mind that you will need stream flow for these assessments. For monitoring locations that drain smaller catchments (<5mi$^2$), it will be best to conduct these assessments in May.

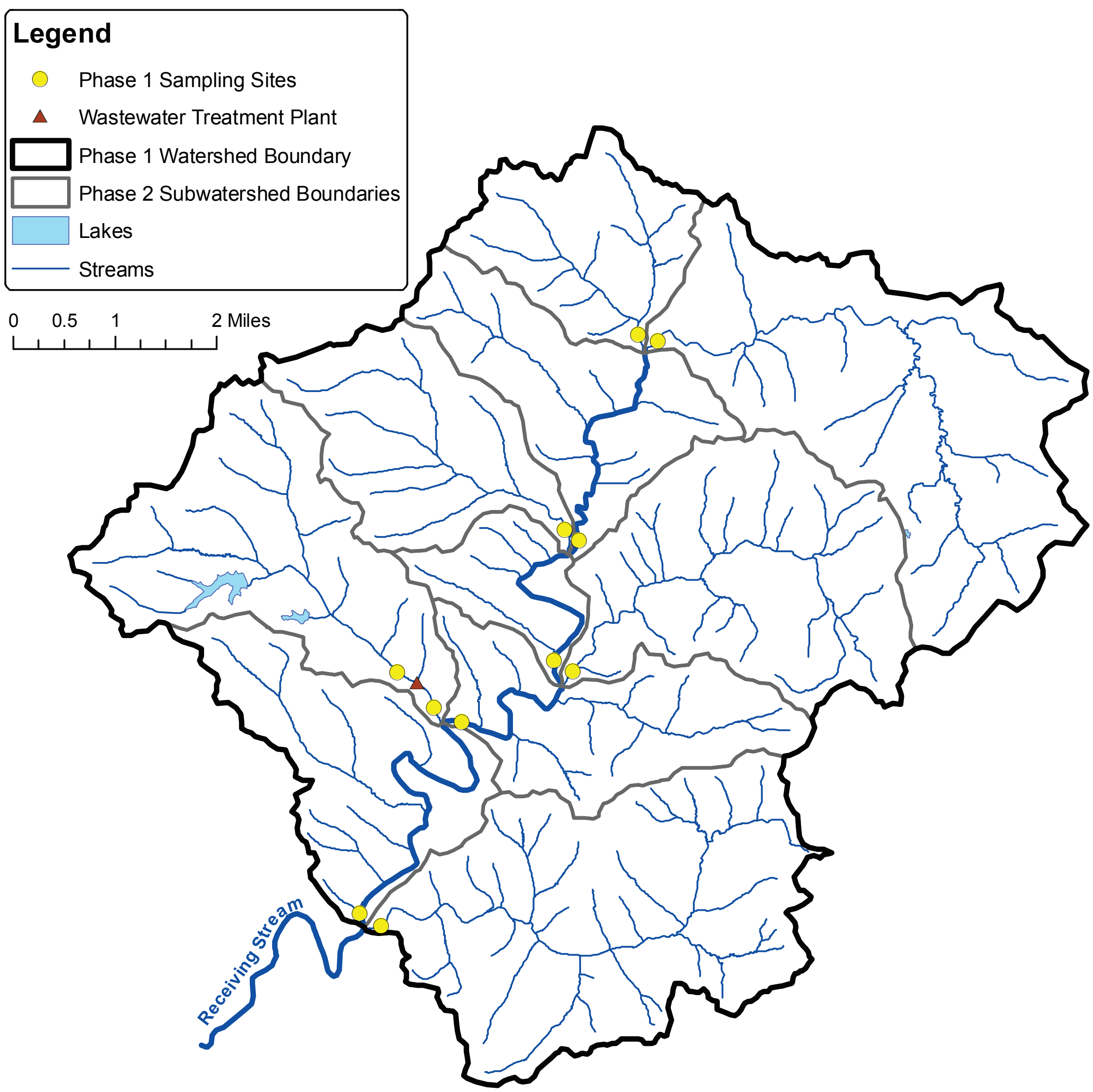



**Figure 3.3 - Example Locations of Phase 1 Sampling Sites**

Stream discharge and field data must be collected at each site for every sampling event. **Stream discharge** is the volume of water flowing past a fixed point in a fixed unit of time. This measurement is needed to analyze the **pollutant load** for each sampling site (see Section 4.2.1). For water flow in streams, the U.S. Geological Survey expresses the discharge value in cubic feet per second (cfs). Refer to Table 3.1 for details.

Samples should only be collected when there is visible flow between the pools of the stream. In dry months you may not be able to collect a sample at certain locations. If this becomes a regular occurrence at particular sites, then you should contact your Nonpoint Source Program Technical Advisor to discuss this issue. Remember, it is important to collect sufficient data to identify sources and target implementation efforts.

At a minimum, you must collect two wet weather samples (to identify nonpoint source pollution) and two dry weather samples (to identify point source pollution) for each of the parameters identified in the "Parameters" section above. It is likely that the wet and dry weather samples will be captured through your regular monthly sampling. It is important to ensure that these events are captured within the sampling year, and this may necessitate collecting samples outside of a regular monthly schedule. A wet weather event is defined as a seven-day antecedent dry period (in which no more than 0.1 inch of precipitation occurs) followed by visible run-off conditions, such as sheet flow on impervious surfaces and visible surface flow in ephemeral channels. A dry weather event is defined as following a seven-day dry period, in which no more than 0.1 inch of precipitation occurs.

**Safety First!** Water Quality monitoring can pose a number of threats. It's always important to ensure that your monitoring locations are safely accessible. This is especially true when you collect wet weather samples. Never go out alone and always carry a cell phone or other communication device in case of an emergency. Also remember to dress appropriately. If you are sampling at a site with high bacteria levels, you do not want the water to come into contact with your mouth, eyes, cuts or any other vulnerable areas. Be sure to wear latex or vinyl gloves.

Ensuring that you collect both **wet weather and dry weather samples** will be helpful for analyzing the data to determine if the water quality issues are related to point or nonpoint sources of pollution. The Watershed Basics section explains the differences between point and nonpoint sources of pollution. Since a large percentage of nonpoint source pollution comes from runoff, wet weather samples that have high levels of pollutants may indicate a nonpoint source. If you see high levels of pollutants in the dry weather samples it may indicate a point source.

### 3.2.3 Phase 2 Monitoring

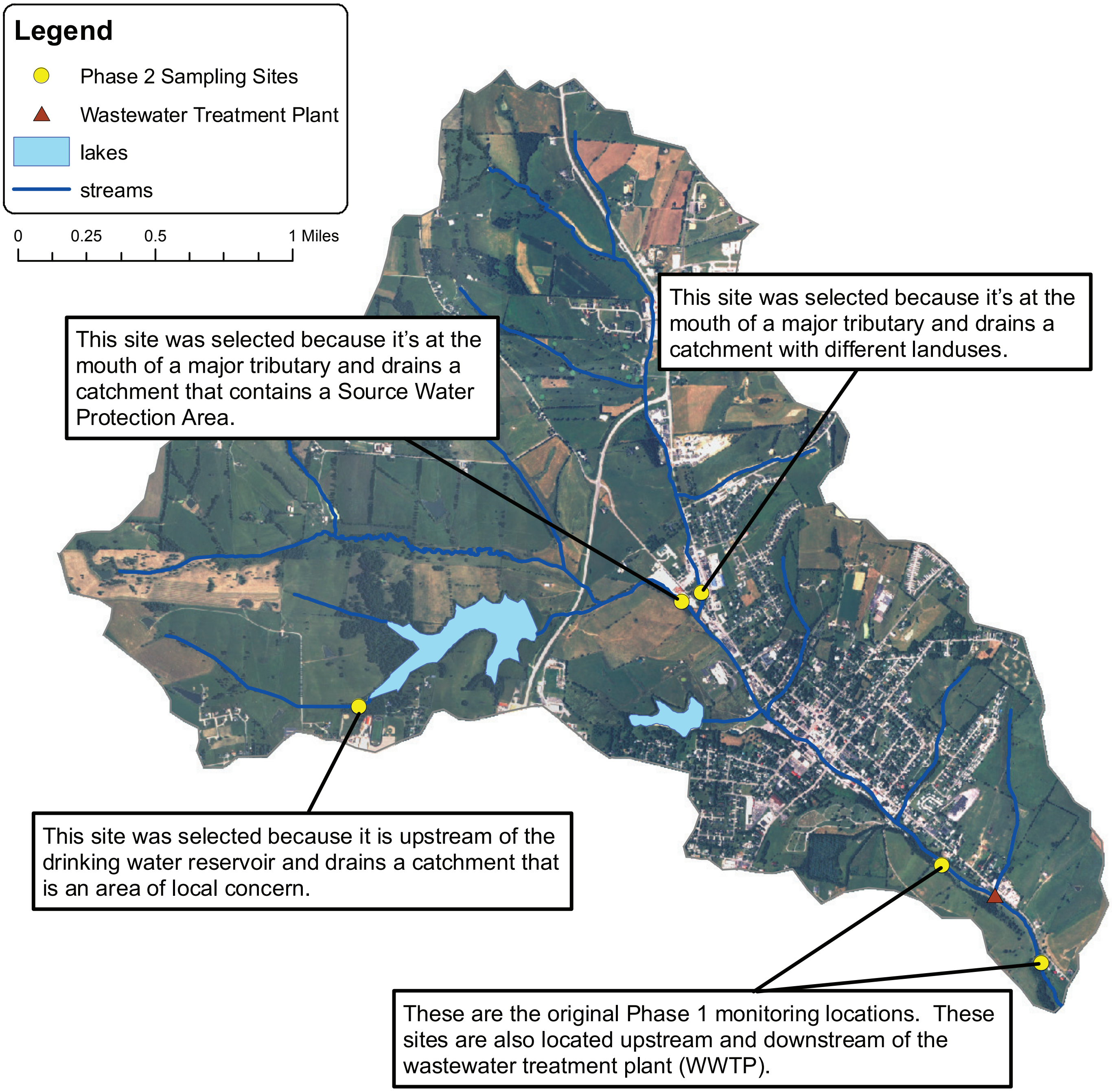
Phase 2 begins upon the selection of three or less prioritized sub-watersheds (e.g. HUC 14s) from the larger watershed you monitored and analyzed in Phase 1. The purpose of monitoring at this scale is to target implementation in the sub-watersheds. The details below cover the prescribed scale, parameters, methods and frequency for the Phase 2 monitoring effort.

### *Scale*

A number of factors can influence the quantity and location of sampling sites within the sub-watersheds. Budget may restrict the number of sites that you are able to sample. Hydrology, topography, and land use will direct the location of sampling sites. A generalized target is four or five sites within the sub-watershed. These sites must be evenly distributed throughout the watershed to help accurately determine sources. You should consider the following factors when selecting the location of monitoring sites:

- Stream flow at Phase 1 sampling site – During Phase 1 you monitored at the mouth of all sub-watersheds. If lack of flow was an issue with the Phase 1 site, it is likely it will be more of an issue for sampling sites located on smaller tributaries within the sub-watershed. It is important that you are able to collect enough samples to determine source and target implementation efforts. If you think obtaining the amount of samples required (detailed in the Frequency section below) will be problematic in your Phase 2 sub-watershed, contact your Nonpoint Source Program Technical Advisor to discuss alternatives.
- Hydrology and Topography – It is important that the monitoring locations subdivide the watershed to better determine the location of the source. In some watersheds this may be accomplished by monitoring the mouth of all major tributaries. In watersheds with steep topography and many small tributaries, you may not have the resources to monitor all of the tributaries. In this case you may have to monitor along the mainstem and target tributaries that are suspected sources.
- Point sources/Areas of local concern – Monitoring locations should also target point sources or areas of local concern. This includes sampling upstream and downstream of major point sources.
- Nonpoint sources – Monitoring locations should be placed in areas that capture the effects of different landuses within the watershed. For example, if your watershed is a mix of urban and agricultural lands, then your monitoring sites should be placed to show the contributions from these different areas.
- Original monitoring location from Phase 1 – Make sure to include the monitoring locations from Phase 1 that are located within your selected sub-watershed. This will provide you with two consecutive years of data for these sites

Figure 3.4 provides an example.




## Figure 3.4 - Example Locations of Phase 2 Sampling Sites

### *Parameters*

The Phase 1 monitoring results will help to determine the parameters that need to be monitored in Phase 2. Remember, the purpose of this monitoring effort is to better determine sources for targeted implementation. The location is important to determine where to implement BMPs, but you also need to know what types of BMPs should be used. The parameters monitored will help you make that decision. Therefore, all parameters that indicate problems or exceedances from Phase 1 must be monitored in Phase 2. Habitat and biological assessments must be performed in Phase 2 as well. Refer to Table 3.1 for details. In addition, Phase 1 may indicate the need for the collection of additional parameters. You should consider the following factors:

- Any parameters of local concern- You may have knowledge of possible problems within the watershed. Parameters should be included that will better determine the source of these issues. For example, in Phase 1, the results may not indicate a problem for the selected watershed, but you know there have been recent complaints about straight pipes in one of the tributaries. Therefore, it may be necessary to collect parameters of local concern in addition to the other parameters.
- Additional parameters based on Phase 1 results – The parameters you collected in Phase 1 may have been limited due to resources. The analysis may have shown a problem that was not explained by the other parameters collected. If this is the case, then it may be necessary to collect additional parameters. For example, the field data may have shown high levels of conductivity. If you suspect that metals are an issue in the watershed, then you may want to collect metals.

***Methods***

The methods discussed in Phase 1 should be used in Phase 2 as well. Refer to Table 3.1 for details. However, based on data collected in Phase 1, you may realize the need for a more in-depth assessment. For example, at this point you may deem it necessary to perform a more detailed sediment or biological assessment that would use different methods than recommended in Phase 1. If this is the case, you should contact your Nonpoint Source Program Technical Advisor for further guidance.

***Frequency***

The frequency discussed in Phase 1 and outlined in the Watershed Plan Monitoring Table should be used for Phase 2. Based on data collected in Phase 1, however, you may realize the need for more frequent sampling. If this is the case, you should contact your Nonpoint Source Program Technical Advisor and discuss these options.

### 3.2.4 Other Monitoring Options for Non-319-Funded Watershed Plans

Monitoring can be a very resource-intensive process. Watershed planning projects that have limited funding will have a hard time conducting the level of monitoring discussed in the previous sections. However, there are other options for collecting additional water quality data. Although you may not require the level of quality assurance described above, you do want to take steps to insure that the data are accurate. One potential source of assistance is the Kentucky Watershed Watch program, which is an excellent volunteer monitoring network and can serve as a resource for this endeavor. 159

## Active Options

The following provides a number of activities your planning team can perform to assist with the monitoring effort and to develop a better understanding of the monitoring program.

- Get your planning team to help with selecting the monitoring sites. Local knowledge is invaluable when you are determining your sampling sites.
- Drive out to your proposed sampling sites to make sure that they are easily accessible and safe. If any of the sites are on private land, schedule time to speak to the landowner about your planning effort and get their permission to sample on

their property. Visit the sites after a rain event to determine how you will safely collect your wet weather samples.
- Involve interested members of your planning team in the monitoring effort. Even if you have hired a contractor to collect the samples, members of your planning team can assist them with the monitoring. Getting people in the stream is a great way to increase their understanding. Your planning team can be a great help, especially for the biological data collection effort in Phase 2.
- Sign up to be a Watershed Watch volunteer for your basin. By doing this you will learn more about proper sampling techniques and your data will be added the large network of volunteer data collected throughout the state.
- Present your sampling results to your planning team throughout the sampling year. You may want to have an outdoor cookout after you've completed your "5 in 30" *E.coli* sampling to present the results to the local public.

## Write It Down

Upon completion of this stage of the watershed planning process you will have selected your monitoring sites, designed your monitoring program and completed a phase of monitoring. You now need to document the following items in your plan.

### Learning More

**Introduction**
Provide a brief overview of the existing monitoring data that you have and the additional monitoring data needs. If you are developing a KY 319-funded watershed plan, be sure to explain the phase of monitoring that you completed at this stage of the planning process.

Provide an overview of your monitoring strategy.
- Include a map with all of the sampling locations clearly labeled.
- Discuss how you selected your monitoring locations.
- Provide a brief overview of the parameters collected, methods used and the sampling frequency. If you are developing a KY 319-funded watershed plan, reference your KDOW approved QAPP for details.

Describe any problems you encountered during the monitoring effort. For example, you should provide an explanation if it was an unseasonably dry year and you were unable to collect a number of samples. This information will be important for Chapter 4.

Include all of the qualified monitoring data results as an appendix. If you are developing a KY 319-funded watershed plan, these results should be thoroughly reviewed and properly flagged to ensure they meet the standards set forth in the KDOW approved QAPP.

**Record Keeping**
Remember you will have a great deal of information upon the completion of this chapter. You will not be including all of this in your watershed plan, but you need to maintain this information and keep it on file.

# Chapter 4 Analyzing Results

***Identifying Sources and Targeting Efforts***



This chapter will help you:
- Understand what the data and information collected tell you about the watershed
- Determine how to utilize the information for source determination
- Target sub-watershed areas for implementation

As in every chapter, this one also provides:
- Active Options
- Write It Down

Find related and additional information about this stage of watershed planning in Chapters 7, 8 and 9 of EPA's Handbook

## Introduction

Once you have collected all of your data, both the existing data compiled in Chapter 2 and the monitoring data Chapter 3, you must determine what the data tell you about the condition of the watershed. This information is vital for determining sources and targeting efforts to protect the areas currently in good condition and restore the areas with problems.

## 4.1 Understanding the Goal of the Analysis

The goal of your watershed analysis is to make a determination of the locations in the watershed in which implementation of BMPs will be most feasible, efficient, and effective. Key factors to consider in the analysis are a detailed examination of monitoring data in relationship to a variety of desired outcomes, how compiled data may be influenced by local conditions, and how readily the goals of your planning team may be accomplished across the watershed. Once you have completed your analysis, you should feel confident that you have selected several sub-watersheds in which you can implement BMPs that will make measureable water quality improvements.

## 4.2 Data Analysis Requirements for 319-Funded Watershed Plans

Chapter 3 explained that a phased approach for both monitoring and data analysis must be used for 319-funded watershed plan projects. It also described the Phase 1 and Phase 2 monitoring requirements. The information below describes the minimum 319 analysis requirements. Subsection 4.2.1 describes the Phase 1 analysis process and subsection 4.2.3 describes the Phase 2 analysis process. The Phase 1 analysis should be performed on the monitoring data collected as part of the Phase 1 monitoring and on the watershed inventory data compiled in Chapter 2. This analysis will result in the selection of the smaller sub-watersheds (e.g. HUC 14) that will be further monitored during the Phase 2 monitoring. The Phase 2 analysis should be performed on the monitoring data collected as part of the Phase 2 monitoring, while again considering the watershed inventory data compiled in Chapter 2. This analysis will allow you to determine sources in the sub-watersheds and target implementation.

### 4.2.1 Phase 1 - Analysis

The purpose of this phase is to analyze the monitoring data collected in the Phase 1 monitoring for prioritization of up to three smaller sub-watersheds for additional assessment and implementation. At a minimum, this analysis should be based on comparisons of parameter concentrations, pollutant loads/yields, and the watershed inventory from Chapter 2 of the watershed plan. Further analysis can be conducted based upon need and local concern.

***Comparisons of Parameter Concentrations***

After you complete the Phase 1 monitoring, you will have results from all of the samples collected. Many of these results will be expressed in concentrations (e.g. 10 mg/L of nitrogen). To determine if these results indicate either good or poor water quality, you need to have a desirable concentration to which you can compare them. The first step in the analysis process is to establish this comparison concentration, which is called a **benchmark**. A benchmark is defined as an acceptable water quality concentration for a healthy stream.

As you make these concentration comparisons for each parameter, keep in mind how precipitation in your watershed and the changes in flow over the watershed that are created by rainfall affect water quality. For example, a wet weather sample can tell you a lot about the types of pollutants that have accumulated across the watershed in the days preceding the sampling event. Conversely, a dry weather sample can tell you a lot about your watershed when pollutants are not being actively collected in runoff from the surface of the land and draining into the stream system. Make sure to consider these precipitation-driven changes in your watershed as you compare pollutant concentrations in your analysis. Additionally, examine how concentrations may vary throughout your sampling period. Consider what duration and frequency of high or low concentrations at different times of the year may suggest about changing conditions or management practices on the landscape.

Some parameter benchmarks have been established through existing Kentucky regulations (refer to Watershed Basics section). These benchmarks are called Water Quality Standards. You will have to establish a benchmark for parameters that do not have Water Quality Standard. This can be determined by using a watershed or regional average for the parameter based on Reference Reach averages in the watershed or ecoregion. The following is the preferred order of benchmark water quality conditions:

**Benchmarks**
Benchmarks should be selected using this hierarchical order of sources (utilizing number 1 if available, if not, then number 2, etc.)

1. Regulatory criteria in 401 KAR 10:031
2. KDOW Reference Reach in Phase 1 watershed (average)
3. KY ecoregional averages (from KDOW Reference Reaches)
4. EPA Nutrient Criteria Database

Once you have established benchmarks, describe the relationship between the actual water quality and the benchmark water quality conditions for the concentrations of all parameters collected for each sampling location.  You may find that the monitoring data are equal to or less than the established benchmarks and, therefore, meet the desired water quality for that location.  Or you may find that they exceed the benchmark and indicate that there is a potential problem with the water quality at that location.

***Comparisons of Pollutant Loads***
The next step in the analysis is to calculate **pollutant loads** for the parameters.  A pollutant load is the amount of a specific pollutant moving through a stream.  The pollutant load is based upon both the concentration of the pollutant and the stream flow.  Loads are generally expressed in terms of a weight (of pollutant) and a period of time, resulting in pounds per day, for example.  Pollutant loads are important in watershed planning because they allow a more balanced comparison of sub-watersheds.  A watershed with a low concentration of a pollutant but with a lot of flow may have a higher load than a watershed that has a high pollutant concentration but only a trickle of flow.  Large loads may have significant impacts on the larger watershed as a whole.

For the water quality parameters you collect, you will likely determine that some concentrations are above your benchmarks and others are below.  Because of the level of involvement required to calculate and evaluate loads, you may decide not to calculate loads for those parameters that are below the benchmarks you have established.  But in some cases, and for

**Modeling**
Another way in which you can achieve estimates of pollutant loads in your watershed is through the use of watershed **models**.  A model is a set of equations that can be used to describe the natural or man-made processes in a watershed system, such as runoff or stream transport.  By building these cause-and-effect relationships, models can be used to forecast or estimate future conditions that might occur under various conditions.  Models can be highly sophisticated, including many specific processes such as detailed descriptions of infiltration and evapotranspiration.  Models can also be very generalized, such as a simple empirical relationship that estimates the amount of runoff based on precipitation.  Some models are available as software packages, whereas simple models or equations can be applied with a calculator or spreadsheet.  For more information on available watershed models, refer to Chapter 8 of the EPA Handbook for Developing Watershed Plans.

**Load Calculation**
To calculate loads, use the monitoring data (parameter results and flow) collected during the Phase 1 monitoring. If you are using existing data with no associated flow data, then use the following historical data for flow in the following order of preference:

1. USGS stream gage [160]
2. WATER Model (when available)
3. Mean Annual Flow (MAF) [161]

To calculate load use the following generalized formula:

- Actual Concentration x Discharge (cfs) x Conversion Factor = Actual Load
- Use the following table for Conversion Factors:

| Conversion Factors | | | |
|---|---|---|---|
| Parameter Unit | Daily Load | Monthly Load | Annual Load |
| CFU/100 mL | 24405408 | 742331160 | 8907973920 |
| | | | |
| mg/L | 5.39 | 164.07 | 1968.80 |

- Conversion Factors result in CFU/time period or pounds/time period
- The generalized formula should be used to calculate an individual load for each sampling event for each site. These individual loads will then be averaged for the overall annual load.
- To calculate the target load use the generalized formula and Conversion Factors above but substitute the benchmark concentration for the actual concentration.
- Compare the actual annual load to the target annual load and calculate the reduction needed to achieve the target load. If actual annual load equals or is less than the target load, make note of this as a potential location for a protection component in your plan.
- For purposes of comparison in the prioritization section below, annual loads must be normalized to account for geographic size differences. This normalized load, the **pollutant yield**, can be determined by dividing each load by a unit of area for each sub-watershed (e.g. acre, square mile).

Note: When calculating annual pollutant loads, you will first be calculating individual daily loads based on concentration and discharge from your sampling events. These individual daily loads will be used to approximate the annual load from the year of sampling data collected. Keep in mind that this is only an estimate of the annual loading that may have actually occurred in your sampling year, as 12 monthly samples are a small sample size to represent 365 days of the year. To more accurately capture the range of conditions, you have collected a minimum of two wet weather and two dry weather samples to include in this analysis.

some parameters, calculated loads may be very useful in helping you compare two or more sub-watersheds.

Because of the importance of several specific water quality parameters to all watershed plans, you will need to calculate loads for these parameters. At a minimum, you must calculate loads for each sampling location for the following parameters: Total Nitrogen, Total Phosphorus, Total Suspended Solids, and *E. coli*. Additional loads must be calculated for parameters where concentrations were found to exceed benchmark water quality conditions and may be calculated for parameters of local concern. In addition, models can be used to supplement these load calculations. Your decision whether to use a model for this part of your analysis will depend on the scope of your watershed plan, the type of water body being studied, the conditions in the drainage area, and the pollutant mix under review.

***Comparison of Watershed Inventory Data to Pollutant Concentrations and Loads/Yields***

The final step in this phase of the analysis is to correlate the pollutant concentrations and loads/yields calculated in the prior step to the watershed inventory information gathered in Chapter 2. This inventory includes information regarding hydrology, karst features, geology, soils, riparian ecosystem, flora, fauna and human impacts, which can have varying levels of influence on water quality based on the watershed location. You will need to examine any potential relationships between this inventory and the effects these may have, either positive or negative, on water quality. This needs to be done for each sub-watershed in which you have monitoring data.

For example, what influence might a karst area have on the water quality you have observed in a particular sub-watershed? You should ask yourself this type of question about each of the categories included in your inventory and consider the wide-ranging and synergistic effects they may have on the specific situation in your watershed. What are the relationships between all of these factors, and what do they mean for your watershed?

### 4.2.2 Phase 1 – Prioritization

Now that you have analyzed all the data collected to this point from your watershed, you can begin to use this new information to help prioritize your sub-watersheds. The goal of prioritization is to select sub-watersheds for additional monitoring to better determine pollutant sources. This will help to target future implementation efforts in your watershed. When utilizing analytical data for prioritization, it is important to consider both protection as well as restoration. Keep in mind that the costs are generally lower for protection activities, and that protection can be more effective than restoration for overall watershed health.

You should be working to prioritize up to three sub-watersheds from your larger watershed for further monitoring and analysis in Phase 2 of your project. There are a number of factors that must be considered in the prioritization process. These factors, summarized below, are detailed in the remainder of section 4.2.2. They include, but are not limited to:

- Organizing Analytical Data
    - Comparisons of parameter concentrations
    - Comparisons of pollutant loads and yields
- Regulatory Status of Waterway
    - Impairment status
    - TMDL status
    - Special Use Waters
- Feasibility Factors
    - Comparison of watershed inventory data to pollutant loads
    - Regulatory matters
    - Stakeholder cooperation
    - Political will
    - Available funding
    - Areas of local concern
    - Existing priority status
    - Watershed management activities
    - Monitoring considerations

***Organizing Analytical Data***

<u>Comparisons of parameter concentrations</u>

In the Analysis section above, you compared parameter concentrations to established benchmarks. Now it is time to use this information to help determine which sub-watersheds need the most change to bring concentrations within an acceptable range. To accomplish this, you will need to categorize the sub-watersheds based on their relationship to the benchmark water quality concentrations. This must include, at a minimum, ranking the sub-watersheds from greatest exceedance to the lowest concentrations for Total Nitrogen, Total Phosphorus, Total Suspended Solids and *E. coli*. These should be considered both in terms of number of exceedances (or non-exceedances) as well as highest maximum (or lowest) concentration.

Once you have compiled your ranked list of sub-watersheds, you should be able to determine which areas are in greatest need of restoration efforts based on exceedances of benchmarks. If the lowest concentrations in your lists fall below your benchmark values, make note of these sub-watersheds as locations that may merit protection efforts.

<u>Comparisons of pollutant loads and yields</u>

In the Analysis section above, you calculated pollutant loads for each sub-watershed. Now it is time to use this information to help determine which sub-watersheds are contributing the most pollution (by weight) within your watershed. You can do this by categorizing the sub-watersheds based on the relationship of their actual annual loads to target annual loads. This must include, at a minimum, ranking the sub-watersheds from the greatest to lowest loading for Total Nitrogen, Total Phosphorus, Total Suspended Solids and *E. coli*. Additionally, utilize your pollutant yields (for geographic size differences) as another comparison.

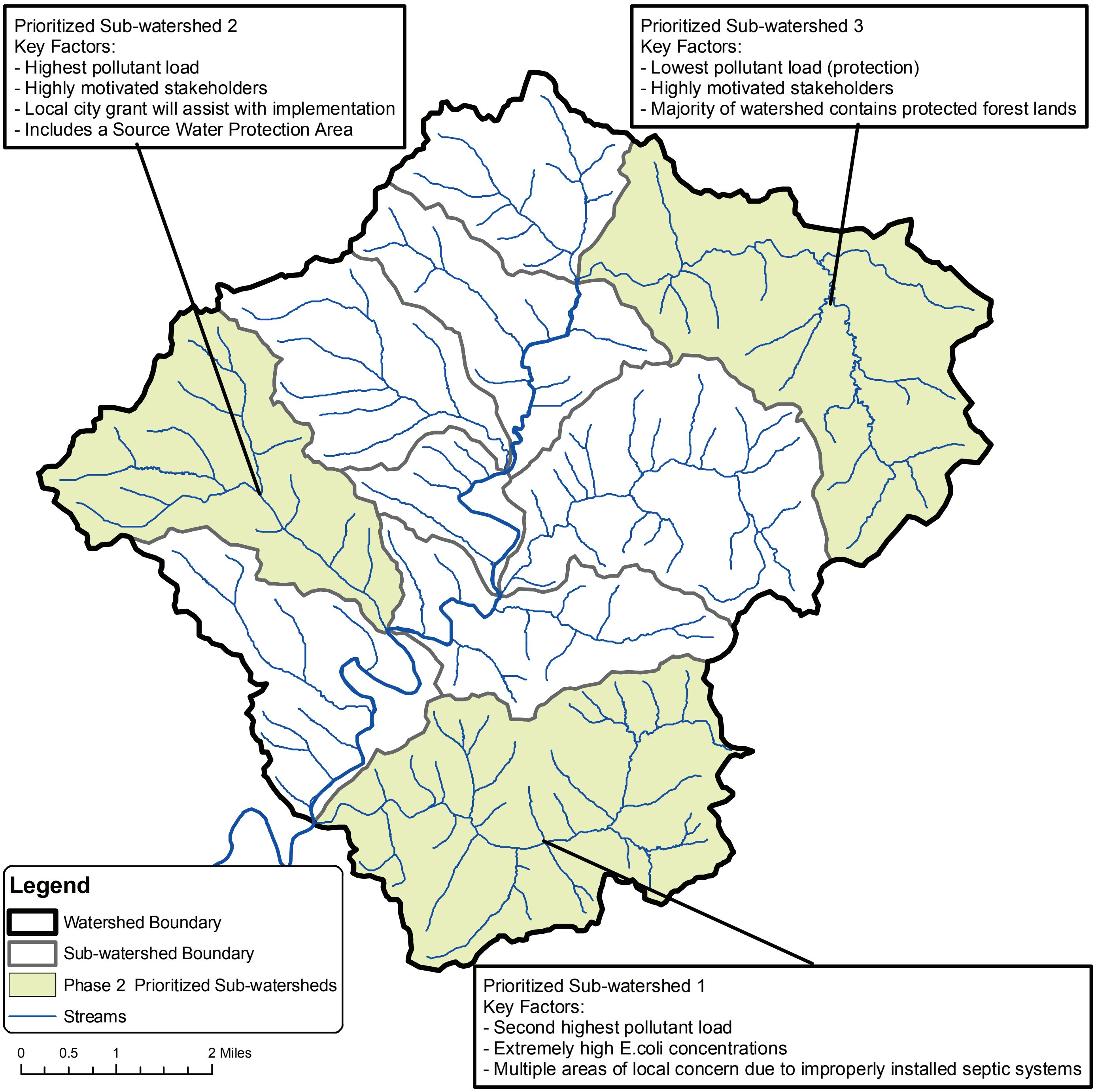



**FIGURE 4.1 - Phase 1 Prioritization of Sub-watersheds**

Once you have compiled your ranked list of sub-watersheds, you should be able to determine which areas are in greatest need of restoration efforts based on the highest pollutant loadings and/or yields. If the lowest loads in your lists fall below your target loads, make note of these sub-watersheds as locations that may merit protection efforts.

### *Regulatory Status of Waterway*

The main goal of watershed planning is to improve waterways to a point that will result in the stream meeting its designated uses, or to protect them so that they continue to meet designated uses. If a stream within your watershed is listed as impaired in the state Integrated Report to Congress on Water Quality [or your monitoring efforts may result in a 303(d) listing or delisting], has an approved TMDL, or contains a Special Use water (401 KAR 10:026 or 401 KAR 10:030), it must receive consideration in your prioritization process.

### *Feasibility Factors*

After looking at the analytical data and regulatory status of your waterway, examine your list and see if your initial priorities for implementation can actually be accomplished. This involves looking at a variety of feasibility factors. The following factors should be considered.

<u>Comparison of the watershed information you collected to pollutant loads</u>

Now that you have calculated pollutants loads for all of the sub-watersheds and compared them to each other, consider the potential influence or effects of the watershed information on the pollutant loads. For example, what is the effect from a wastewater treatment plant point source contribution on the overall loading from a sub-watershed? Even if it seems like an easy fix, it won't do much good if the fix doesn't have an impact on the overall pollutant load reduction. Another example would be a karst-influenced watershed. What impacts could water migration into or out of your watershed have on overall loading from a sub-watershed? These types of questions are important considerations to make when prioritizing sub-watersheds.

<u>Regulatory matters</u>

Some watershed issues may be beyond the scope of what your BMPs can address. Does your planning team have the capacity to address the issue? Is it a regulatory enforcement issue? For example, if data shows that a wastewater treatment plant is the major pollutant contributor, you may choose to eliminate this sub-watershed as potential priority for the focus of your planning team. This could be a regulatory issue, in which case, you should refer to the information on regulatory programs that is discussed in Chapter 5.

<u>Stakeholder cooperation</u>

Successful implementation requires support from local stakeholders. It is important to look at the watershed, along with the watershed information you gathered and pollutant loads, and consider stakeholder support for your goals for protection or restoration. For example, if an implementation goal involved stream restoration, would the local landowners be more supportive in one particular sub-watershed? Sometimes, it is also important to consider local demographics. Will a rain garden be successful over the long run in an area populated mostly by people who rent their homes?

<u>Political will</u>

Successful implementation requires support from local officials. It is important to look at the sub-watershed, along with the watershed information and pollutant loads, and consider the political will for accomplishing your goals for protection or restoration. For example, if an implementation goal involved changing or creating a local ordinance, would your local officials be more supportive if the impetus came from one particular sub-watershed?

Available funding

Financial resources are critical to success in your watershed and must be considered when prioritizing sub-watersheds. For example, are there particular sub-watersheds in which you may be able to garner more funds than the others for continued monitoring and implementation efforts?

Areas of local concern

There may be issues or locations throughout your watershed that are important to local stakeholders. For example, are there areas in the watershed that are special to the community and merit protection, like a swimming hole or a historical location? Is there an area of particular concern for the community even though it may not be an area of significant pollution?

Existing priority status

Past work may have led to additional resources being spent or allocated in your watershed. For example, are there particular sub-watersheds in which partners are already working or have federal, state, or local priority status?

Watershed management activities

The information regarding Source Water Protection Plans, Groundwater Protection Plans, Wellhead Protection Areas, past and current watershed plans, wastewater authorities, Agriculture Water Quality Plans, and special land use planning discussed in Chapter 5 should also be utilized in the prioritization. For example, if there is a particular sub-watershed that is in a Wellhead Protection Area, it may be more likely to secure local support in that watershed.

Monitoring considerations

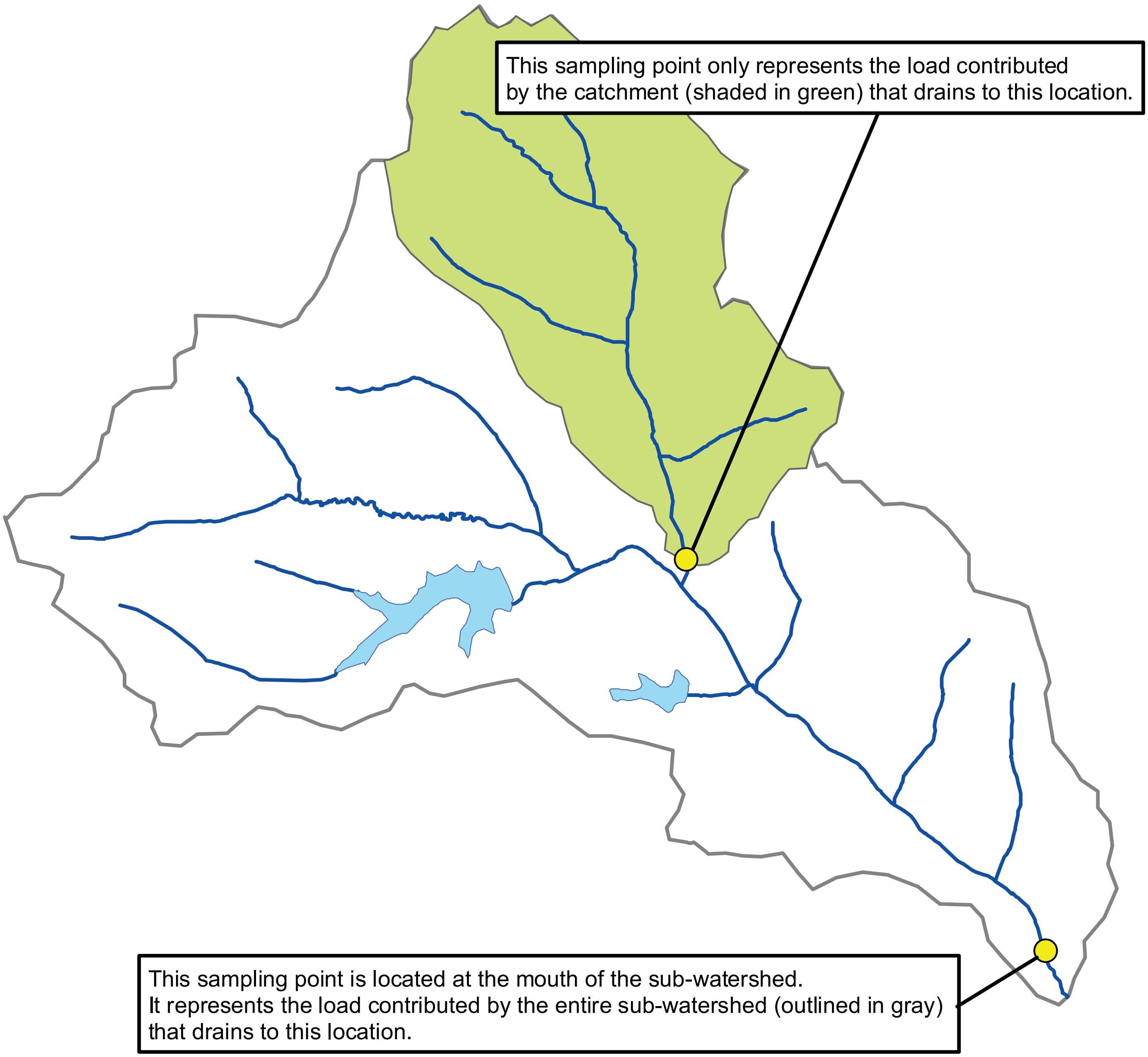
During Phase 1 you monitored at the mouth of all sub-watersheds. If lack of flow was an issue with the Phase 1 site, it is likely it will be more of an issue for sampling sites located on smaller tributaries within the sub-watershed. It is important that you are able to collect enough samples to determine source and target implementation efforts. If you think obtaining the amount of samples required will be problematic in your Phase 2 sub-watershed, you should factor this in to your decision-making when determining your planning team's priorities for Phase 2.

### 4.2.3 Phase 2 – Analysis

The Phase 2 analysis will allow you to focus on the sub-watersheds from your Phase 2 monitoring in which you collected samples for an additional year. Results from this analysis

**Source** – There are many different definitions for source. It can be defined as a particular type of land use (e.g. mining), a discharge point (e.g. an outfall from a wastewater treatment plant that is not meeting permit requirements), or in some cases a specific landowner (e.g. Gudmilk Dairy). The KY 319(h) program defines source for the 319-funded watershed plans as the area that contributes a pollutant. Refer to Figure 3.1. In that figure, the source is the small catchment upstream from the Phase 2 monitoring sampling point. This source contains multiple pollutant contributors that are resulting in high levels of *E.coli*.

should give you the information you need to make determinations of pollutant sources within your prioritized sub-watersheds. You should then begin to determine all of the management practices needed in each of the prioritized sub-watersheds (Chapters 5 and 6).

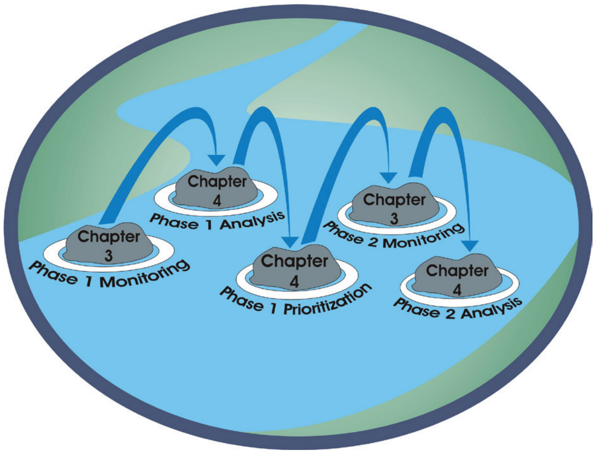



## FIGURE 4.2 - Cummulative Load Contributions

***Comparisons of Parameter Concentrations and Comparisons of Pollutant Loads***

This Phase 2 analysis will rely on many of the same methods that were utilized in your Phase 1 analysis. You will again need to report and make comparisons of all your parameter concentrations to the benchmarks you have set. Also, calculate pollutant loads for all of your sampling locations and determine the target load reductions needed to achieve your target loads. Use the same format and structure to do this that you used in your Phase 1 analysis.

Depending on the sampling strategy within your sub-watersheds, you may need to consider the cumulative impacts of pollutant loading from upstream sampling locations.




*Monitoring and Analysis Flow Chart*

For example, the location at the mouth of the sub-watershed represents the load of the entire watershed and all of the sources. A sampling point upstream only represents the portion of the sub-watershed that contributes to that location. This will be an important consideration when targeting implementation. Figure 4.2 provides an example.

***Comparison of Watershed Inventory Data to Pollutant Concentrations and Loads***

The next step in the analysis is to correlate the pollutant concentrations and loads calculated in the prior step to the watershed inventory information gathered in Chapter 2. This inventory includes information regarding hydrology, karst features, geology, soils, riparian ecosystem, flora, fauna and human impacts, which can have varying levels of influence on water quality based on the watershed location. You will need to examine any potential relationships between the inventory and the effects these may have, either positive or negative, on water quality. Additionally, you need to consider the results of your habitat and biological assessments and what they can tell you about the condition of your watershed. For example, if the data indicate that benchmark water quality concentrations are being met, but your biological assessment scores low, you may need to use the habitat assessment and other information from the inventory to dig deeper to find the problem. This needs to be done for each prioritized sub-watershed in which you have monitored.

In your Phase 1 analysis, this information was considered at a more general level. In your Phase 2 analysis, a more detailed look at this information is required. For example, in Phase 1 you identified areas on sewer and on septic systems above a sampling location. In this phase, you need to examine how many of each exist, and the suitability of the soils and geology to support these types of systems.

Finally, you need to consider what you know about the local concerns within these prioritized sub-watersheds. This could include concerns such as effects of localized flooding within the sub-watersheds.

## 4.3 Other Analysis Options for Non-319-Funded Watershed Plans

Your planning team may not have the budget, resources, or need to perform an analysis as detailed as what has been described in the previous two sections. However, these sections should provide you with some insight into the process of investigating your watershed and analyzing the information you collect. As you proceed with the analysis of your watershed, consider what your planning team is capable of with the resources you have. Pick several pieces of the analysis described above as a start for your planning team, or limit your detailed analysis to a subset of the watersheds in which you have information. You may be surprised at what you can achieve.

## Active Options

- Stream assessments are great ways to involve members of your planning team in the analytical stage of your planning. Members who have limited experience in stream science can be teamed with partners or consultants who have the technical background to take the on-site lead.
- The watershed problems revealed by the analyses will also reveal stakeholders who should participate in the planning process, but have yet to be invited or fail to show up. For example, your planning team may not include farmers, even though agricultural land uses seem to be at the root of some of the stream's problems. Be sure to involve these stakeholders in a positive way that is not misconstrued as finger-pointing or placing blame.
- As the analysis reveals more of the nonpoint source problems of the watershed, it also reveals the potential audience for your education and outreach efforts. You not only need your community's support, but it is also your civic responsibility to let your community know what you are learning.
- Present the results of your analyses to the planning team in a work session where the results of each can be compared with one another. At this point, partners and advisors should be gaining a solid idea of the cleanup and planning issues that you are facing. You might convene another Watershed Roundtable, which is mentioned in Chapter 1.
- This is also a good point in the planning process to consider posting your work on the website of either a sponsor or a partner, and/or to create a Facebook page for the project. These efforts make your work more accessible to members of the planning team and other interested members of the public. You will recruit friends, partners, and influential local support with a policy of sharing and openness.
- A formal presentation to the community may also be appropriate. Depending on what you think may be most beneficial to your project's success, you may choose to present at the end of Phase 1, at the end of Phase 2, or to present both when you are finished. By presenting your findings at a community meeting or in a local newspaper article, what is perhaps unpleasant news can be presented in positive terms and won't take people by surprise. Be accurate but creative; make the most important information the easiest for people to grasp.

## Write It Down

**Phase 1 – Analysis**

Analyze the monitoring data collected in the Phase 1 monitoring for prioritization of up to three smaller sub-watersheds for additional assessment and implementation

- Compare parameter concentrations
  - Establish benchmark concentrations and make comparisons for each parameter
  - Describe the relationship between the actual water quality and the benchmark water quality conditions for the concentrations of all parameters collected for each sampling location
- Compare pollutant loads/yields
  - Calculate pollutant loads/yields

    - Calculate target loads
    - Compare the actual annual load to the target annual load and calculate the reduction needed to achieve the target load
- Compare watershed inventory data to pollutant concentrations and loads/yields
    - Examine any potential relationships between this inventory and the effects these may have, either positive or negative, on water quality for each sub-watershed

**Phase 1 – Prioritization**
Prioritize up to three sub-watersheds from your larger watershed for further monitoring and analysis in Phase 2 of your project

Examine these factors:
- Organizing analytical data
    - Comparisons of parameter concentrations
    - Comparisons of pollutant loads/yields
- Regulatory status of waterway
    - Impairment status
    - TMDL status
    - Special Use Waters
- Feasibility factors
    - Comparison of watershed inventory data to pollutant loads
    - Regulatory matters
    - Stakeholder cooperation
    - Political will
    - Available funding
    - Areas of local concern
    - Existing priority status
    - Watershed management activities
    - Monitoring considerations

**Phase 2 – Analysis**
Analyze the monitoring data collected in the Phase 2 monitoring to make determinations of pollutant sources within your prioritized sub-watersheds
- Compare parameter concentrations and compare pollutant loads
    - Use same methods utilized in your Phase 1 analysis
    - Make comparisons of all your parameter concentrations to benchmarks
    - Calculate pollutant loads for all of your sampling locations
    - Determine load reductions needed to achieve your target loads
- Compare watershed inventory data to pollutant concentrations and loads
    - Examine any potential relationships between this inventory and the effects these may have, either positive or negative, on water quality for each sub-watershed
    - Examine results of habitat and biological assessment
    - Examine local concerns

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# Chapter 5: Finding Solutions
***Exploring BMP Options***



This chapter will help you:
- Learn about Best Management Practices for water quality
- Perform targeted BMP selection

As in every chapter, this one also provides:
- Active Options
- Write It Down

Find related information about this stage of watershed planning in Chapters 9, 10, 11 and 12 of EPA's Handbook

## Introduction
There are limited resources available for watershed protection and restoration. Therefore it is of the utmost importance to use these resources efficiently and effectively. To do this, you need to identify **Best Management Practices** (BMPs) that will address the sources identified through the data analysis. This is the key purpose of watershed planning.

At this point in the planning process, you have collected all of the existing data in the watershed, completed additional monitoring and performed an in-depth analysis of your watershed. Now it's time to put all of these efforts to work and determine your strategy to protect and restore your watershed.

Prior to developing this strategy, you need to have a full understanding of the variety of BMPs that are available. Section 5.1 provides an overview of these BMPs and some of the resources available for these practices. The next step is to begin selecting the BMPs that will allow you to achieve the load reduction needed that you identified for all of the sub-watersheds in the Phase 2 analysis. This is covered in Section 5.2. In Chapter 6 you will take your preliminary list of targeted BMPs and develop your implementation strategy for your watershed.

## 5.1 Overview of Best Management Practices
A variety of management approaches are available to address water quality problems identified by the watershed plan. These include both regulatory and nonregulatory practices for dealing with issues caused by point sources and nonpoint sources of pollution. In this Guidebook all of these management approaches are called

BMPs. BMPs are actions that result in the protection of good water quality and the restoration of poor water quality.

There are many types of BMPs, from agricultural stream buffer setbacks to urban stormwater controls to homeowner education programs for on-site septic system maintenance. BMPs can be categorized in many different ways. In this Guidebook, BMPs are organized under three major categories: subsection 5.1.1 discusses BMPs for specific land uses, 5.1.2 discusses regulatory programs as BMPs, and 5.1.3 discusses the use of education as a BMP.

> A **"best management practice"** or **"BMP"** has traditionally been defined as something built on the ground with guaranteed documentable results in reducing nonpoint source pollution. With paradigms changing to include more expansive management practices, we are using the term "best management practice" or "BMP" to refer to any management practice designed to reduce pollution in the watershed.

***Structural and Non-structural Best Management Practices***

Best management practices are not only built structures, such as a fence to keep cattle out of a creek, but also include other practices. For example: a law that requires all landowners to limit their livestock's access to the stream. Many times these practices are referred to as structural and non-structural BMPs. **Structural BMPs** require construction, installation and maintenance. These are usually BMPs that you can see such as vegetated stream buffers, rain gardens, and silt fences. **Non-structural BMPs** usually involve changes in activities or behavior among people in the watershed. Examples include erosion prevention and sediment control plans for construction sites, ordinances that prohibit building in the floodplain, and education and outreach campaigns.

Both structural and non-structural BMPs are vital parts of a comprehensive watershed plan. In fact, often these practices are most effective when used together. For example, septic tank pump-outs in a neighborhood will have a better chance of long-term success if the homeowners are also educated on how to best maintain their septic systems. The following sections provide information on many types of BMPs, including structural and non-structural practices.

Photo Courtesy of Molly Shireman.

Rain Barrels collect and store stormwater runoff from rooftops. This water can then be used to irrigate gardens and lawns.

Photo Courtesy of Joan Garrison.

Healthy riparian zones help filter sediments and nutrients from runoff, stabilize streamside soils, and provide shade, food, and habitat for the aquatic systems and aquatic life of a waterway.

Photo Courtesy of Phyllis Croce.

Rain Gardens are shallow, depressed gardens that collect stormwater runoff from rooftops or other hard surfaces. These rain gardens help filter pollutants and act as beautiful landscape features.

Photo Courtesy of Steve Higgins

Fencing livestock out of streams and providing alternative water results in pathogen reduction, streambank protection, and provides clean water for livestock.

Seeding or covering bare soil with mulch, blankets, mats, and other erosion prevention products as soon as possible is the cheapest way to prevent erosion. Grass seeding alone can reduce erosion by more than 90%.

### 5.1.1 Best Management Practices for Specific Land Uses

In the Watershed Basics section you learned how land uses can impact water quality. Numerous BMPs have been developed to address these impacts. Table 5.1 provides some examples of structural and non-structural BMPs. Keep in mind that this is only a portion of the actual BMPs available to address water quality issues.

| | Structural Practices | Non-structural Practices |
|---|---|---|
| **Agriculture** | • Contour buffer strips<br>• Grassed waterway<br>• Herbaceous wind barriers<br>• Mulching<br>• Live fascines<br>• Live staking<br>• Livestock exclusion fence (prevents livestock from wading into streams)<br>• Revetments<br>• Sediment basins<br>• Terraces<br>• Waste treatment lagoons | • Brush management<br>• Conservation coverage<br>• Conservation tillage<br>• Educational materials<br>• Erosion and sediment control plan<br>• Nutrient management plan<br>• Pesticide management<br>• Prescribed grazing<br>• Residue management<br>• Requirement for minimum riparian buffer<br>• Rotational grazing<br>• Workshops/training for developing nutrient management plans |
| **Forestry** | • Culverts<br>• Establishment of riparian buffer<br>• Mulch<br>• Revegetation of firelines with adapted herbaceous species<br>• Temporary cover crops<br>• Windrows | • Education campaign on forestry-related nonpoint source controls<br>• Erosion and sediment control plans<br>• Forest chemical management<br>• Fire management<br>• Operation of planting machines along the contour to avoid ditch formation<br>• Planning and proper road layout and design<br>• Preharvest planning<br>• Training loggers and landowners about forest management practices, forest ecology, and silviculture |
| **Urban** | • Bioretention cells<br>• Rain Gardens<br>• Rain Barrels<br>• Infiltration basins<br>• Green roofs<br>• Permeable pavements<br>• Wetland creation/restoration<br>• Establishment of riparian buffers<br>• Stormwater ponds<br>• Sand filters<br>• Sediment basins<br>• Tree revetments<br>• Water quality swales<br>• Clustered wastewater treatment systems | • Planning for reduction of impervious surfaces (e.g., eliminating or reducing curb and gutter)<br>• Management programs for onsite and clustered (decentralized) wastewater treatment systems<br>• Educational materials<br>• Erosion and sediment control plan<br>• Fertilizer management<br>• Ordinances<br>• Pet waste programs<br>• Pollution prevention plans<br>• Setbacks<br>• Storm drain stenciling<br>• Workshops on proper installation of structural practices<br>• Zoning overlay districts<br>• Preservation of open space<br>• Development of greenways in critical areas |

*Note that practices listed under one land use category can be applied in other land use settings as well.

**Table 5.1. Examples of Structural and Non-structural Best Management Practices**

Resources listed below provide information about BMPs based on land use characteristics and their impacts. This is not an exhaustive list of BMP resources, but these sites are good places to start.

> Each website icon refers to a site on that gateway website. In the electronic version of the document, these icons refer to direct links in a list on the gateway website. This gateway website address is **http://water.ky.gov/watershed/Pages/WatershedPlanningGuidebook.aspx**

### *General*

There are numerous resources for BMPs. Two websites that contain information about a wide variety of BMPs are listed below:

- The US EPA has developed several guidance documents on management practices, broken out by type of management measure. The following site provides links to the EPA National Management Measures for Agriculture, Forestry, Hydromodification, Marinas and Boating, Urban, Wetland, and Riparian areas publications on their website [162].
- The website of Kentucky Division of Water's Nonpoint Source Program lists BMP publications for all categories of nonpoint sources [163].

### *Storm Water*

The overall goal of storm water BMPs is to treat, store and infiltrate stormwater runoff before it enters a nearby waterbody. This can be achieved through a variety of structural and nonstructural practices.

- The online International Stormwater Best Management Practice Database provides access to performance data for more than 200 urban management practice studies conducted over the past 15 years [164].
- A number of communities throughout Kentucky have developed stormwater BMP manuals. These documents can be excellent resources for all watersheds throughout the state.
  - Bowling Green [165]
  - Northern Kentucky Sanitation District No. 1 - Stormwater Management Handbook: Implementing Green Infrastructure in Northern Kentucky Communities [166]
  - Lexington [167]
- The EPA provides a "BMP menu" for stormwater on their website [168].
- EPA also has an excellent site for Green Infrastructure [169]
- The Center for Land Use and Environmental Responsibility at the University of Louisville developed the *Kentucky Wet Growth Tools for Sustainable Development* handbook, which provides a variety of tools for cities, counties, multi-stakeholder groups, watershed groups, and other interested members of the public to manage or control growth and development for water resource protection [170].

### *Agricultural*

Agricultural BMPs are practical, cost-effective practices that farmers can implement to reduce the amount of pesticides, fertilizers, animal waste, and other pollutants entering our water resources. These BMPs are designed to benefit water quality while maintaining or even enhancing agricultural production.

- The online NRCS National Handbook of Conservation Practices contains information about agricultural BMPs [171].
- BMPs for farm pesticide applications are listed on the Kentucky Department of Agriculture's website [172].
- Kentucky farmers use BMPs as part of the Agriculture Water Quality Plans that most are required to develop. Farmers receive assistance from Conservation Districts; see their website for more information [173].

***Construction***

Construction site BMPs are designed to prevent erosion and sediment along with other pollutants from leaving a construction site and entering a nearby waterbody. Kentucky has specific BMP guidance documents for construction sites. This information is also available in some of the resources listed under Storm Water above.

- The "Kentucky Erosion Prevention and Sediment Control Field Guide" [174]
- "Best Management Practices (BMPs) for Controlling Erosion, Sediment, and Pollutant Runoff from Construction Sites" [175]

***Forestry***

Forestry BMPs are practices that landowners can implement to protect nearby waterbodies from polluted runoff that can result from forestry activities. These BMPs are also intended to help landowners manage these forestry resources for long term sustainability.

- "The Kentucky Forest Landowner's Handbook" is available online [176].

***Onsite Wastewater Treatment***

Onsite wastewater BMPs are practices that result in the proper installation and maintenance of these systems and prevent malfunctioning systems that can contaminate local water resources.

- The EPA Onsite Wastewater Treatment Systems Manual is available online [177].
- The Kentucky Onsite Wastewater Association Homeowner's Guide is available online [178].
- Information on the National Onsite Demonstration Program is available online [179].
- The EPA Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems is available online [180].

### 5.1.2 Regulatory Programs

A number of regulatory programs exist in Kentucky to manage water quality. It is important to understand the general requirements of these programs and how they can help with implementation. In some cases the implementation needed to address a water quality issue may already be required under a regulatory permit. In this case, you would not want to use your limited resources to implement practices that another entity is required to perform by law, although you may want to put some energy into improving compliance – or even enforcement, if needed.

The following provides an overview of many of these programs, their requirements, how to find out if they apply in your watershed, and how they may be an integral part of the implementation strategy that you develop in Chapter 6.

### *Source Water Protection Plans, Wellhead Protection Program, and Groundwater Protection Plans*

The federal Safe Drinking Water Act Amendments of 1996 requires states to analyze existing and potential threats to each of its public drinking water systems. If there is a permitted water withdrawal in your watershed for a public drinking water supply, Safe Drinking Water Act requirements for either a Source Water Protection Plan or a Wellhead Protection Plan apply. In addition, be sure to check downstream, because your watershed could be part of a protection area for a downstream, surface water intake for public water supply.

For public water systems using surface water, the Safe Water Drinking Act requires that counties develop county or regional water supply plans that assess the quantity of water used by their public water systems and formulate protection plans for the source waters used by those systems. A great deal of information regarding water resource planning is available through the Kentucky Infrastructure Authority (KIA) Water Resource Information System (WRIS) [181]. To obtain specific information about water resource planning and source water protection in your area you can contact the Water Management Planner for your Area Development District (ADD) [182]. You can also contact the Water Quantity Management Section of the Kentucky Division of Water.

Similarly, the Kentucky Division of Water administers the Wellhead Protection Program, which is designed to assist communities that rely on groundwater as their drinking water source. To obtain additional information about this program contact the Water Quantity Management Section of the Kentucky Division of Water [183].

The Groundwater Section of the Kentucky Division of Water also oversees the development of Groundwater Protection Plans, which are required for anyone engaged in activities that have the potential to pollute groundwater. To learn more about these plans for your area, contact the Groundwater Section of the Kentucky Division of Water [184].

These plans can provide a great deal of useful information for your watershed. They can also function as good BMPs. For example, if these plans restrict the types of land use in these designated areas, then they may act as a good protective measure in the watershed. The Drinking Water Utility may also be interested in partnering on an educational campaign to inform local residents how their actions can impact their drinking water source.

### *Agriculture Water Quality Plans*

The Kentucky Agriculture Water Quality Act requires, any farm operation on a tract of land situated on ten or more contiguous acres that engage in agriculture or silviculture activities to develop and implement a water quality plan. The Kentucky Agriculture Water Quality Plan consists of best management practices from six areas: 1) Silviculture, 2) Pesticide & Fertilizer, 3) Farmsteads, 4) Crops, 5) Livestock and 6) Streams and Other Water. Landowners must prepare and implement these plans based on their individual farm operations and keep a record of planning and implementation decisions. Agricultural agencies assist farmers in the simple steps of developing these plans. The Agriculture Water Quality Plan generally gives an overview of each landowner's decisions regarding how they plan to address potential water quality impacts generated by their operation. These plans are maintained on file with the individual farm operator or owner. Your local District Conversationalist or the Division of Conservation (DOC) may be able to provide you an estimate of the number of plans filed in your area or the percentage of farmers that have these plans. You can find more information about these plans on DOC's website [185]. Online guidance is available for developing the plans [186].

***Regulations and Programs for Wetlands and In-stream Construction or Disturbance***

Section 404 of the Clean Water Act regulates the discharges of dredged or fill materials into the waters of the United States, including small streams and wetlands adjacent or connected to regulated waters. These discharges include return water from dredged material disposed of on the upland and generally any fill material (e.g., rock, sand, dirt) used to construct land for site development, roadways, erosion protection, and so on. Guidebook section 2.4.3 includes instructions for obtaining information about 404 permits and 401 Water Quality Certifications. In addition to being aware of these permitted activities in your watershed, it's important to consider these requirements when selecting BMPs. For example, you may have found that sedimentation impacts in your watershed are due in part to in-stream construction or placement of fill material in the floodplain. You may also have found that these activities are occurring without a 404 permit or 401 certification. This would identify the need for BMPs that educate local officials and contractors of these permit requirements and the need to ensure these requirements are properly enforced.

***Regulations for Floodplain Construction***

Anyone performing construction and other activities in the 100-year floodplain are required to apply and obtain a permit from the KDOW Floodplain Management Section. Typical permitted activities are dams, bridges, culverts, residential and commercial buildings, placement of fill, stream alterations or relocations, small impoundments, and water and wastewater treatment plants. More information about the floodplain management program and permit requirements can be found on KDOW's website [187].

***Facility Plans for Wastewater***

Wastewater authorities are required to submit plans for the development of their wastewater facilities to the Kentucky Division of Water under Section 201 of the Clean Water Act. Many times these documents are called facility or wastewater plans, but they are sometimes referred to as 201 plans. If you have a sewer system in your watershed, you should discuss the plan with the responsible authority. The information in the plan and their other operational plans can provide a great deal of information about future efforts such as sewer line extensions, treatment plant up-grades, etc. This information is extremely valuable when developing an implementation strategy to address wastewater impacts. For example, you would not want to implement a large onsite wastewater project for a neighborhood that will be added to the sewer system in the following year. If you do not know whether the communities in your watershed have these plans, then contact your Area Development District (ADD) for a list of these communities [188].

You can also contact the Kentucky Division of Water Wastewater Planning Section and ask if there are any facility plans for your area.
Additional information about these facilities can also be found at the Kentucky Infrastructure Authority (KIA) website [189].

***Programs and Permits for Managing Wastewater Discharges***
The Kentucky Pollutant Discharge Elimination System (KPDES) permit program controls water pollution by regulating point sources that discharge pollutants into Kentucky's waterways. This includes wastewater discharges from multiple human sources such as wastewater treatment plants, package treatment plants, industrial facilities, and mining operations. You can view a full list of these permits on KDOW's website [190].

In addition to managing human wastewater, KPDES also requires permits for Concentrated Animal Feeding Operations (CAFOs). These permits set waste discharge requirements that need to be met by implementing animal waste management practices such as reducing nutrients in feed; improving storage, handling, and treatment of waste; and implementing feedlot runoff controls. You can find more information about these permit requirements on KDOW's website [191].

In Chapter 2, section 2.4.1 you were instructed to obtain information about these permitted discharges in your watershed. In addition to knowing what these facilities are discharging, it is also important to understand their regulatory requirements and how the permit holder ensures these requirements are met. You may find that the wastewater treatment plant is not meeting its permit limits and as a result contributing to the elevated *E.coli* levels in the watershed. This may be due to a number of factors, such as leaking collection pipes or an undersized facility. It is important to know what measures the entity that manages the treatment plant plans to take to comply with their permit. This information is an important part of the implementation strategy for the watershed. By including these measures with other identified BMPs, you may be able to identify funding sources for these activities and ensure future compliance.

***Programs and Permits for Managing Stormwater Discharges***
Another discharge controlled by the Kentucky Division of Water is stormwater. More than 100 Kentucky municipalities are required to have permits that mandate programs to minimize the discharge of pollutants from their Municipal Separate Storm Sewer Systems (MS4s). In Chapter 2 you were instructed to identify any of these designated MS4 permitted communities that exist in your watershed. As part of the permit requirements, these communities must develop and implement a Storm Water Quality Management Plan (SWQMP). These plans must include the following six minimum control measures in their management programs:

- Public education and outreach on stormwater impacts
- Public involvement/participation
- Illicit discharge detection and elimination
- Construction site runoff control
- Post-construction stormwater management in new development and redevelopment
- Pollution prevention/good housekeeping for municipal operations

You can obtain additional information about these permit requirements on KDOW's website [192].

Through your watershed planning efforts, you may have identified a number of impacts caused by stormwater runoff. If a permitted MS4 exists in your watershed, then it is important to know how their SWQMP addresses these identified impacts. Working with the permitted community can help them target their efforts to the stormwater impacts identified in your watershed plan and can also keep both of you from duplicating efforts.

The KPDES stormwater program requires operators of construction sites that are one acre or larger (including smaller sites that are part of a larger common plan of development) to obtain authorization to discharge stormwater under a KPDES construction stormwater permit. Permits are also required for industrial facilities with outside material storage that might contribute to polluted runoff. You can obtain additional information about these permits on KDOW's website [193].

### *Programs and Permits for Managing Combined Sewer Overflow (CSO) and Sanitary Sewer Overflow (SSO)*

Combined Sewer Overflows (CSOs) are permitted overflows of sanitary wastewater and storm water combined in a single conduit (e.g. sewer pipe). Pursuant to the 1994 CSO Control Policy, acceptable Long-Term Control Plans (LTCPs) must be developed by the 17 CSO communities in Kentucky. These LTCP are calculated to allow those communities to achieve water quality standards after the LTCPs are implemented, as documented by post-construction compliance monitoring. Additional information for CSOs can be found on KDOW's website [194].

Sanitary Sewer Overflows (SSOs) are illegal according to the Clean Water Act. However, many communities in Kentucky experience SSOs periodically, and a majority of those communities have one or more recurring wet weather SSOs. The wastewater provider for the area is required to eliminate the overflow. This is usually done through a Sanitary Sewer Overflow Plan (SSOP) or other corrective action orders or agreements.

In Chapter 2 you were instructed to identify these discharges within your watershed. If one of the 17 CSO communities is in your watershed, you should review the LTCP for that area. If there are SSOs in your watershed, then it will be important to know if a SSOP has been developed or if another corrective action has taken place to eliminate the SSO. As with the SWQMPs, it's important to understand the activities identified in these plans so that you do not duplicate efforts. In some cases, your watershed planning efforts may assist the local wastewater provider in addressing these issues.

You can request LTCPs, SSOPs, and information regarding enforcement actions for SSOs from the Wet Weather Section of the Kentucky Division of Water.

***Special Land Use Planning or Existing Watershed Plans***
Local authorities may have ordinances and regulations that restrict how land may be used. Ordinances that directly affect water quality may include Floodplain Construction, Erosion Prevention and Sedimentation Control, riparian setbacks, or sinkhole ordinances. Ordinances for subdivision and other developments frequently impact the amount of impervious surface in the area and other factors, such as vegetative buffers in riparian areas.

Zoning or Development Plans that determine where types of development can be permitted will also have a major influence on water quality because they will determine future land uses. Some cities may have special land use planning districts that establish riparian corridors along special waterways. There may have even been past watershed planning efforts in your watershed.

It's important that you are familiar with these existing local plans and requirements so that your implementation strategy can build on these existing efforts.

### 5.1.3 Education as a Best Management Practice
Education can be the most effective long-term BMP for water quality and is an integral part of the watershed plan. Every watershed plan should include an education and outreach component that involves the watershed community. Because many water quality problems result from individual actions and the solutions are often voluntary practices, effective public involvement and participation promote the adoption of management practices, help to ensure the sustainability of the watershed management plan, and perhaps most important, encourage changes in behavior that will help to achieve your overall watershed goals. They are particularly important when implementation requires broad-based participation by a group of individuals: changed nutrient management practices among local farmers, for example, or the installation of rain gardens by residential landowners.

Outreach can be a part of your plan, giving it a focus for coordinating the various activities. It can also be something coordinated as part of your planning team's continuing work during the implementation phase of the plan (discussed more in the next and final chapter).

> This section is based on EPA's *Getting In Step: A Guide for Conducting Watershed Outreach Campaigns*, which can be downloaded from their website 195.
> EPA's website also has a toolbox of outreach materials that watershed planning teams can use 196

An outreach strategy, whether for the entire plan or within each action item, will have these components:

- **Define the objectives of your outreach strategy**: Are you raising awareness, providing information, or encouraging action?
- **Identify and analyze the target audience**: Who are you trying to reach with your outreach strategy? Be as specific as you can, identifying the most important segments of your community who need to be reached with a particular message. Use the Demographics and Social Issues information collected in Chapter 2 to

assist you in determining who is your target audience, what do they care about, and what is the best way to reach them.

- **Create the message**: What information do you want your target audience to know, or what actions do you want them to take? The message should be clear and tied directly to something the target audience values, such as saving time or money or improving health.
- **Package the message**: What type of communication will you use? Some media will more effectively reach certain audiences, and will target specific messages better than others. Sometimes media is not helpful at all except as reinforcement after one-on-one contacts. Be creative with your approach.
- **Distribute the message**: Especially with printed material, how will you get them to your target audience?

## 5.2 Selecting Best Management Practices for Your Watershed

Now that you are familiar with the types of water quality Best Management practices, it's time to begin selecting BMPs based on the Phase 2 Analysis completed in Chapter 4. As discussed in the introduction, targeted implementation is vital to successful watershed planning. You invested a great deal of resources into the data analysis completed in Chapter 4. Now it's time to utilize the results. Based on the source identification and the calculated load reductions needed from Chapter 4 you can now select the BMPs that will most effectively and efficiently address the identified issues.

Having completed the Phase 2 analysis for the selected sub-watersheds (HUC 14s), you now have a detailed account of all the suspected sources and contributors to the pollutant concentrations and loads calculated for each sampling location. Next, create a list or table of BMPs to address these sources and contributors.

The following are some of the important factors to consider when developing the BMP list/table:

- What types of BMPs are needed to address the pollutant contributors? For example, if your analysis shows the elevated *E. coli* loads are due to livestock and failing septic systems, you should select BMPs for both of these issues.
- Where should the BMPs be implemented to address the source? It's not only important to identify the type of BMPs but they must also be targeted to the source (the area in the watershed that is contributing to the elevated pollutant loads). For example, the Phase 2 analysis may show that the largest *E. coli* load is coming from a small tributary upstream of one of the sampling locations. This area is identified as a source of *E. coli* and therefore the BMPs should be targeted to this area.
- What are the cumulative impacts as you move downstream? The loads calculated for each sampling location represents the impacts of the entire watershed draining to that point. Therefore implementing BMPs in the upper portions of the watershed may decrease the pollutant load at all of the sampling points downstream from the selected implementation area.
- Are there any sampling sites where the water quality did not exceed the in-stream target value for a particular parameter? If so, then this is an area that should be protected. BMPs should be selected for this area that protects the

characteristics (e.g. intact riparian corridor) that contribute to the good water quality.

- Are there any existing programs, regulations or other practices that are currently addressing the identified issues? As discussed in Section 5.1.2, you do not want to use limited resources to duplicate efforts or implement practices that are already required by an existing permit. On the other hand, if you find that a permit requirement is not being met and is contributing to a pollutant load, then you may need to include measures in your management strategy to address this lack of compliance.

### *Active Options*

The following provides a number of activities to help understand the BMPs available and how these practices should be targeted in your watershed.

- Plan a field trip to observe BMPs. It is always helpful to see structural BMPs in action. There are a number of areas throughout Kentucky where you can observe these BMPs.
    - Agricultural BMPs – contact the local NRCS office and ask if there is farm that your planning team can visit to observe agricultural BMPs.
    - Stormwater BMPs – SD1's Public Service Park in Northern Kentucky showcases a wide array of stormwater BMPs including a green roof, permeable pavements, bioswales and cisterns.
    - Onsite Wastewater BMPs – The Kentucky Onsite Wastewater Association's Training Center in Lawrenceburg is an excellent place to see a number of onsite wastewater practices.
    - All BMPs - Contact Kentucky Division of Water's Nonpoint Source and Basin Team Section to find out about examples of BMPs throughout the state.
- Invite an expert for particular types of BMPs to speak to your planning team. This person may be an excellent resource when it's time to implement the practices.
- Invite someone from the local public works department, planning and zoning commission, wastewater or drinking water utility, or Health Department to speak to your Planning team about the regulatory programs outlined in Section 5.1.2.
- Take a driving tour of the watershed to take a closer look at some of the sources identified through you Phase 2 analysis. Note any possible barriers to implementation in these areas. This information will be very helpful in Chapter 6.

### *Write It Down*

Upon completion of this stage of the watershed planning process you will have a large list or table of BMPs that are targeted to address the sources of pollution identified in the Phase 2 analysis. Although it would be ideal to implement all of these BMPs, this is not usually an option due to limited resources and a number of other factors. In Chapter 6 you will take this list of targeted BMPs and apply a number of "feasibility factors" to determine the final BMP Implementation Strategy for your watershed plan.

**Other Records**
Although the list of BMPs is important for the next phase of planning, it is not necessary to include the list at this point in your watershed plan. However, if you are developing a watershed plan with KY 319 funding you should keep a record of this list and be able to provide the list to the Nonpoint Source and Basin Team Section upon request.

# Chapter 6: Strategy for Success
***On the Path to Implementation***



This chapter will help you:
- Understand the critical connection between BMPs and water quality
- Select BMPs based on realistic factors in your watershed
- Organize a detailed plan of action

As in every chapter, this one also provides:
- Active Options
- Write it down

Find related information about this stage of watershed planning in Chapters 11 and 12 of EPA's Handbook

## Introduction
By this point in the planning process, you know a lot about water quality and the Best Management Practices (BMPs) used to address issues with water quality. The overall intent of this chapter is to distill those BMPs down to a realistic plan to improve water quality in your waterway and then calculate pollutant load reductions expected for the selected BMPs. Each BMP needs to be tied to reducing the pollutant loading of your stream. This takes planning and attention to detail, but you have the tools you need. As your planning team goes through the process of selecting BMPs and the action items to get the BMPs done, it will be important to keep stakeholders involved.

## 6.1 BMP Feasibility
In the preceding chapters, you figured out what's happening in your watershed and the BMPs that may be able to address the issues. Now you must look over your list of potential BMPs and decide which ones are realistic for your watershed and your watershed planning team. There are many factors to consider. It may be the case, for example, that a particular BMP would result in the greatest water quality improvement, but it's unlikely the landowners could participate or the cost is too high. In that case, a different BMP would be a better fit. Now is the time to think about all the external forces at play in your community and the feasibility of establishing certain BMPs.

### 6.1.1 Feasibility Factors
In Chapter 5, you developed a list of BMPs to address the sources and pollutant contributors within the Phase 2 sub-watersheds. This list also included BMPs to protect the catchments with good water quality. Now you need to examine your list

and see if your initial priorities for implementation can actually be accomplished. This involves looking at a variety of feasibility factors. The following factors should be considered. These are similar to the feasibility factors that you used in Chapter 4 to select your Phase 2 sub-watersheds, but now you are applying them on a different scale to determine your plan of action.

- Regulatory matters – Some watershed issues may be beyond the scope of what your BMPs can address. Does your planning team have the capacity to address the issue or is it a regulatory enforcement issue? Keep in mind that your BMP strategy should be comprehensive, but you do not want to duplicate efforts. If your issue is being addressed through an existing regulatory action then your planning team may decide to pursue the issue through a different forum. For example, if the Kentucky Division of Water (KDOW) is pushing the local wastewater treatment system to make some improvements that would address your concerns, can you help boost local support for a needed improvement to the wastewater treatment system?

- Stakeholder cooperation – Successful implementation requires support from local stakeholders. It is important to look at the sub-watershed, along with the sub-watershed information you gathered and pollutant loads, and consider stakeholder support for your goals for protection or restoration. For example, if an implementation goal involved stream restoration, would the local landowners be more supportive in one particular catchment within the sub-watershed? Sometimes it is also important to consider local demographics. Will a rain garden be successful over the long run in an area populated mostly by college students?

- Political will – Successful implementation requires support from local officials. It is important to look at the sub-watersheds, along with the watershed information and pollutant loads, and consider the political will of accomplishing your goals for protection or restoration. For example, if an implementation goal involved changing or creating a local ordinance, would local officials be more supportive in one particular catchment within the sub-watershed? If local officials are adamantly against changing or creating an ordinance, your initial goal may need to be a focused plan of outreach and education to the officials and their voting constituency to make them aware of the need for the ordinance. Perhaps this feasibility factor will not be as relevant at this Phase 2 scale, but it should be considered if it applies to your sub-watershed.

- Available funding – Financial resources are critical to success in your watershed and must be considered when prioritizing BMPs. For example, are there particular BMPs in which you may be able to garner more funds than the others? Also, it may be the case that your planning team only has the resources for educational or non-structural BMPs. These BMPs are still valuable and can be your focus as you search for funding for other BMPs!

- Cost-benefit analysis – Often there will be more than one BMP that can address the pollutant of concern. There are several processes that may be used to rank their cost-effectiveness. One approach would be to score each BMP according to the criteria your planning team has established as critical (like some of the factors in this very feasibility factors list) and arrive at a total score by averaging or summing the factor scores. This may be an exercise that your watershed planning team can do together.

- Areas of local concern – There may be issues or locations throughout your sub-watershed that are important to local stakeholders. For example, are there catchments within the sub-watershed that are special to the community and merit protection, like a swimming hole or a historic location? Or is there an area of particular concern for the community even though it may not be an area of significant pollution?

- Existing priority status – Past work may have led to additional resources being spent or allocated in your sub-watershed. For example, are there particular catchments within the sub-watershed in which partners are already working or have federal, state, or local priority status?

- Watershed Management Activities – The information regarding Source Water Protection Plans, Groundwater Protection Plans, Wellhead Protection Areas, past and current watershed plans, wastewater authorities, Agricultural Water Quality Plans, and special land use planning that was discussed in Chapter 5 should also be utilized in the prioritization. For example, if there is a particular catchment within the sub-watershed that is in a Wellhead Protection Area it may be more likely to gain local support in that watershed.

## 6.2 Developing a Plan of Action

Now that you have studied the possible BMPs and selected ones that are most appropriate for your project, in your sub-watershed, you must develop a plan of action. There are many good ways to do this, but certain elements will need to be present regardless of chosen style and organization. For each BMP selected, Action Items should be developed. Action Items will fill in the details of each BMP.

> The process of **prioritizing your BMPs** will benefit from the involvement of your technical team, who should be familiar with the range of practices that are appropriate for your objectives and are likely to help you reach your target values. It will also benefit from the participation of partners who administer BMP programs in Kentucky, such as the NRCS or the Division of Forestry.

### 6.2.1 Developing Action Items

Action items are the real-world steps your planning team will take to get each best management practice up and running. They are the steps needed to encourage, plan, install, maintain, and monitor the success of BMPs and water quality improvements. There may be multiple action items necessary to implement one best management practice. In developing action items, it may be helpful to start with the watershed planning team's initial concerns. Using those concerns and what you have learned, work out long-term goals that ultimately address those concerns in the context of water quality improvements. For each Action Item, it will be necessary to discern the following details:

- Responsible Party – Identify the person or organization responsible for carrying out each action item. This may be one of your partners or someone outside your group.
- Technical Assistance – Identify who will be providing the specialized scientific and technical knowledge to support effective implementation of action item.
- Total Cost – Estimate the cost of the action item.
- Funding Mechanism – Identify the funding mechanism for the action item including concrete amounts already established as well as potential sources and in-kind assistance.
- Location of BMP – Identify the area within the sub-watershed where the BMP will be implemented.
- Pollutant or Measureable Parameter – The pollutant or measurable parameter addressed by the BMP was determined in Chapter 5. Many BMPs will address multiple pollutants or parameters. You should include all of these.
- Target value – The target value is the in-stream benchmark for the pollutant or measureable parameter. This was established in Chapter 4, Section 4.2.3.
- Target load reduction – The target load reduction needed for the pollutant or measureable parameter was also established in Chapter 4, Section 4.2.3. Remember to use the target reduction needed for the catchment where the BMP will be implemented.
- Estimated load reduction – The estimated load reduction expected from the BMP can be determined in a number of ways. Section 11.3 of the EPA Watershed Planning Handbook provides numerous methods for completing this task. Keep in mind that certain BMPs, especially non-structural BMPs, may not have specific load reductions. This does not make these BMPs any less valuable. For example, your Action Plan includes landowner education for septic system maintenance. This Action Item addresses *E. coli*, but you will not have a load reduction estimate for this particular BMP.
- Milestones – short-term (less than one year), mid-term (1-3 years), long-term (3+ years), and extended (20+ years with following-up monitoring).

There may be additional information that your planning team wants to add. The idea is to iron out all the details in advance so that once implementation begins, most of the planning work is finished – until it's time to reevaluate and revise.

The action item details can be cumbersome to organize. One watershed group in Kentucky, the Muddy Creek Watershed Team, took the approach of breaking the information up into a series of tables that illustrate the process the group went through to flesh out all the detail needed. They found the process of making these tables a good way to organize their information and intentions. Look at each table (below) and see what details were added each time. Notice, too, that they started out on a broad, watershed level, but eventually worked their way down to the sub-watershed level for detailed planning. Your planning team will need to decide the best method for your project.

### 6.2.2 Plan Examples

The Muddy Creek Team used this first table to organize their original concerns, the specific water quality issues to be addressed, and target values for indicators (‘indicator’ is used in the tables to mean water quality issue). See Table 6.1.

| Concerns | Source/Cause/Pollutant | Indicators | Priorities |
|---|---|---|---|
| Decrease the sediment loads in Muddy Creek | **Runoff from disturbed land:** sediment input can fill in the creeks causing water to more rapidly overflow banks. Sediment loads also negatively impact water temperature, nutrient concentrations, and aquatic habitat.<br>**Removal of stream bank vegetation:** the removal of vegetation from the bank allows for sediment to easily erode. | • Bank measurements<br>• Visual observations<br>• TSS<br>• Water temperature<br>• Land cover<br>• Nutrient concentrations<br>• Conductivity<br>• pH<br>• Alkalinity | Reduce sediment loss from run-off associated with vegetation disturbances and construction<br><br>Increase stream bank and riparian zone vegetation<br>Stabilize stream banks<br><br>Educate public |
| Decrease bacteria levels to meet Primary Contact standards | **Residential inputs:** failed septic systems increase bacteria entering our waterways.<br>**Runoff from livestock operations:** bacteria levels increase without proper buffer zones and creek fencing. | • Bacteria counts<br>• Nutrients<br>• Visual survey | Reduce bacteria loads from failed/ failing septic systems and livestock operations<br><br>Educate home and land owners |

Table 6.1 Muddy Creek Watershed Concerns and Priorities

The Muddy Creek planning team then narrowed their focus to a sub-watershed (Amanda’s Branch) for the second table. They also created similar tables for each of the other sub-watersheds. This allowed them to address water quality issues more specifically. Table 6.2 follows concerns through to related Indicators and their Target Values. Note that this table does not yet include Action Items. It does include the Target Value. The target value is the level or amount of a particular indicator that is desirable. Depending on the indicator in question, a lower or higher target value would be better. For example, the *E. coli* level would ideally be even lower than the target value of 130 cfu/mL while the Habitat Assessment would ideally be higher than 130.

| Concerns | Priorities | Indicator | Target Value | Basis |
|---|---|---|---|---|
| Decrease the sediment loads in Muddy Creek | Increase stream bank and riparian zone vegetation<br><br>Stabilize stream banks<br><br>Educate public | TSS | 3.39 mg/L | Reference data |
| | | Habitat Assessment | 130 | Literature values |
| | | Biological Assessment (volunteer form) | Score of "Good" | Literature values |
| Decrease bacteria levels to meet Primary Contact standards | Reduce bacteria loads from failed/failing septic systems<br><br>Educate home and land owners | Bacteria Count | Monthly geometric range of 130 cfu/100 mL or 240 cfu/100 mL or greater in no more than 20% of samples | WQ Standards |

Table 6.2 Relationship of Concerns to Target Values in the Amanda's Branch sub-watershed.

For Table 6.3, the Muddy Creek planning team added their Action Items. Action Items are organized here by the associated BMP. To address each of their concerns, there are multiple BMPs, and for each BMP, there are multiple Action Items.

| Concerns | Priorities | BMP | Action Items |
|---|---|---|---|
| Decrease the sediment loads in Muddy Creek | Increase stream bank and riparian zone vegetation<br><br>Stabilize stream banks<br><br>Educate public | Place vegetated buffer strips along the main stream channel<br><br>Enforce current laws and regulations<br><br>Education | 1. Secure local cost share money to do on-ground demonstration.<br>2. Obtain funding for local landowners to implement.<br>3. Develop a workshop to be held for landowners.<br>4. Provide monitoring information with local and state agencies.<br>5. Work with local agencies to provide education opportunities for landowners. |
| Decrease bacteria levels to meet Primary Contact standards | Reduce bacteria loads from failed/failing septic systems<br><br>Educate home and land owners | Upgrade Septic Systems<br><br>Enforce current laws and regulations<br><br>Education | 1. Work with County Health Department to provide assistance.<br>2. Help qualifying homeowners with grant programs.<br>3. Provide monitoring information with local and state agencies.<br>4. Work with local agencies to provide education opportunities for landowners. |

Table 6.3 Summary of Action items for BMPs in Amanda's Branch sub-watershed.

Pollutant Load columns have been added here. Tying pollutant loads to BMPs is a critical step in the watershed planning process and important to map out for each sub-watershed. For example, if the septic systems in Amanda's Branch sub-watershed are upgraded as planned, how much bacteria reduction can be expected? In Table

6.4 below, note that the reduction in bacteria needed is 67%, but the "Upgrade Septic Systems" BMP is only expected to reduce the pollutant load by 50%. In this case, there are additional BMPs that will contribute to the reduction of the load so this one doesn't have to reduce the entire load itself.

| BMP | Action Items | Indicator | Target Value | Target Load Reduction Needed | Estimated Load Reduction Expected |
|---|---|---|---|---|---|
| Upgrade Septic Systems | 1. Work with County Health Department to provide assistance.<br>2. Help qualifying homeowners with grant programs.<br>3. Provide monitoring information with local and state agencies. | Bacteria Count | Monthly geometric range of 130 cfu/100 mL or 240 cfu/100 mL or greater in no more than 20% of samples | 67% | 50% |

Table 6.4 Target Load Reductions and Estimated Load Reductions for the Amanda's Branch sub-watershed.

And finally, Muddy Creek's Table 6.5 gets down to the nitty-gritty planning of each BMP and associated Action Item. You may not know all the details at first, but it is important to take time to figure them out. It would also be helpful to address milestone goals for short-term (less than one year), mid-term (1-3 years), long-term (3+ years), and extended (20+ years with following-up monitoring) items.

| BMP | Responsible Party | Technical Assistance | Cost | Funding Mechanisms |
|---|---|---|---|---|
| Place vegetated buffer strips along the main stream channel | Landowner | NRCS<br><br>Fish and Wildlife<br><br>KY Department of Fish and Wildlife Resources (KDFWR) | $1,500 per mile<br><br>~$9,000 for the entire main stem of Muddy Creek | 319 (h) grant<br><br>NRCS cost share programs<br><br>KDFWR cost share programs |
| Upgrade Septic Systems | Landowner<br><br>Health Department | Health Department | $3,000 - $10,000 per house | East KY PRIDE |

Table 6.5 Summary of Action items details for BMPs in Amanda's Branch sub-watershed.

Another watershed group in Kentucky took a different approach. One way to handle the planning and illustration of that planning is through an interpretive map. The Clarks Run watershed group, created a pollutant load reduction map (see Figure 6.1) that is a great example of a more visually-oriented way of presenting information.

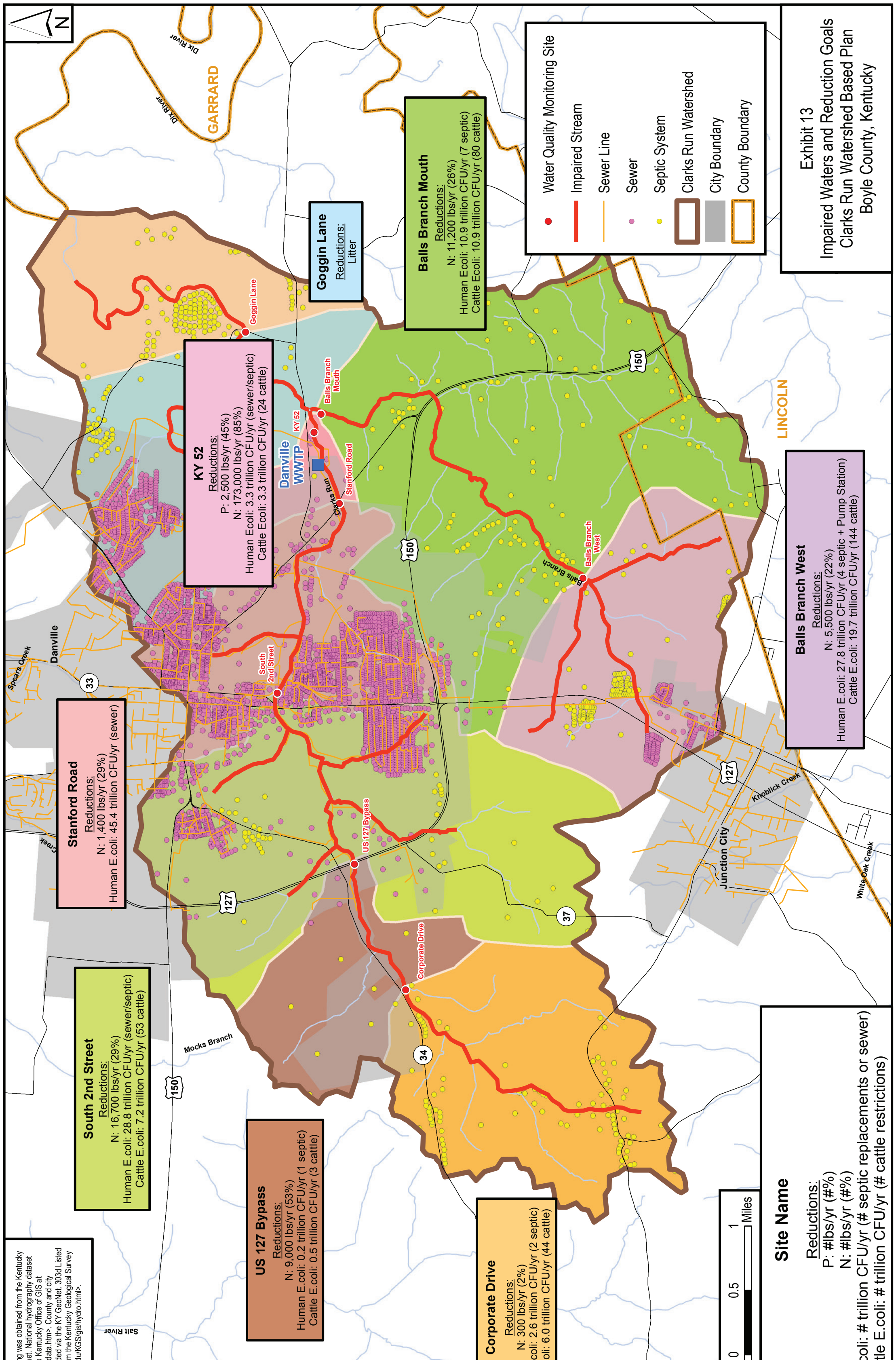


**FIGURE 6.1 - Clarks Run Pollutant Load Reduction Map**

## 6.3 Finding the Resources

Finding a single funding source for your watershed plan would be unusual and probably unwise. Your plan has been developed using a collaborative process that has brought together partners and stakeholders who have significant resources and direct interests in the health of the watershed. Many of them administer programs that influence watershed or waterway health. Others have technical expertise that is within their mission to share in watershed planning activities, and still others have political or moral influence over groups of stakeholders in your community whose changed behavior can positively affect your waterway's health. In many cases, resources will need to be identified for each best management practice in your action items.

### 6.3.1 Potential Resources

***NRCS Resources***

The Natural Resources Conservation Service (NRCS) is a federal agency that provides assistance to local farmers and landowners to help them manage their land, through conservation programs and with technical information.

One such program is the Conservation Reserve Program (CRP), which provides technical and financial assistance to eligible farmers to address soil and water issues on their lands through policies that are cost-effective for the landowner and environmentally friendly. Implementation of the CRP program helps to reduce soil erosion and sedimentation in streams and lakes through native plantings or the establishment of riparian buffers. These practices improve water quality; enhance or create wildlife, forest, and wetland habitat; and encourage farmers to plant vegetative cover, (native grasses, trees, and shrubs) and riparian buffers on highly erodible cropland to decrease sediment erosion. Farmers who sign up for multi-year conservation easement contracts with the NRCS are paid annual rental rates for their contracted acreage, plus cost sharing opportunities for approved vegetative cover practices.

Another NRCS program, Conservation of Private Grazing Land (CPGL), offers technical assistance to farmers and landowners for better land management, preserving water quality, decreasing soil erosion, and providing wildlife habitat. Where runoff of bacteria sources – such as cattle in streams and manure applications – is a main impairment to streams, the NRCS offers technical assistance in many areas. These include manure and feedlot management, nutrient management planning and agricultural programs.

Information regarding these and other NRCS programs can be found on their website [197].

***319 Nonpoint Source Funds***

For other strategies, no funding source may be available. In these cases, the sponsor or an eligible partner may apply to the Kentucky Division of Water for 319 program funds. Chances are if you are preparing this watershed plan, you're very aware of the requirements of the program!

**Don't be daunted!**
The overall goal of this part of the planning process - identifying the needed solutions to your water quality problems - is not to scare you or your stakeholders. From a planning perspective, it's important to know whether or not you'll be able to deal with your problems in one year or five or twenty-five. If you're facing some significant challenges, your group will need to know that an effort is needed over the long haul, and that results might not be evident for several years.

The 319 program requires significant local match of the federal funds that may be awarded. Fortunately, two important resources of your planning team are available as match:

- The value of the time the members of your planning team spend on its activities; and
- The value of the action items undertaken by planning team partners.

***Kentucky EXCEL***

A program of the Kentucky Environmental and Public Protection Cabinet, "Excellence in Environmental Leadership" ("EXCEL"), provides incentives for environmentally-regulated businesses to assist with watershed and other initiatives. In your community, there may be businesses participating in this program, and they are looking for partners just like your watershed planning team. More information is available at the EXCEL program's website 199.

To learn more about the 319 program, call the program staff at 502-564-3410 or visit their website 198.

***In-Lieu Fee Program for Stream and Wetland Mitigation***

The Kentucky Department of Fish and Wildlife administers the In-Lieu Fee Program for Stream and Wetland Mitigation Program. This program uses funds collected from mining or other activities that alter streams to finance stream or wetland restoration and enhancement projects, to compensate for the loss of aquatic habitat. The scope of stream mitigation can vary from something as simple as planting a riparian area along a stream to projects as complicated as full-scale reconstruction of the channel. Contact the Kentucky Dept. of Fish & Wildlife Resource at 502-564-5448 for more information.

***Kentucky Transportation Cabinet***

The Kentucky Transportation Cabinet, Division of Environmental Analysis administers another stream and wetland mitigation program. If there are transportation projects in your area, funds may be available for stream and wetland restoration and enhancement projects. For additional information contact the Bio-engineering branch at 502-564-7250 or visit their website 200.

## *Active Options*

- Conduct a Stream Walk with help from local experts on plants and animals and area history
- Organize a "BMP Dessert Night" to connect with local residents and business people and get their ideas on BMP Feasibility
- Take a field trip to a nearby green infrastructure site to learn more cost, maintenance, and community support
- Invite a guest speaker (for example a green infrastructure company or a Kentucky Onsite Wastewater Association representative) to talk to your planning team
- Host a public awards ceremony to highlight exemplary practices in your target audience, for example a farmer or volunteer tree-planting project.

For more funding ideas for implementing your watershed plan, go to 201 and EPA's website 202.

## *Write It Down*

Implementation Strategy Planning

**BMP Feasibility**

Feasibility - record the factors at play in your watershed and the choices you made about BMPs.

**BMPs and Action Items**

In some manner (a table, chart, narrative, etc.), record all necessary information about the BMPs selected.  If most of the information is going into a table, it may still be helpful to have some explanatory narrative.

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# Chapter 7: Making It Happen

***Staying on Track for Your Watershed's Future***



This chapter will help you:

- Market your plan to those who can make it happen
- Find resources to implement your plan
- Track your progress
- Evaluate and adjust your plan for long-term success

As in every chapter, this one also provides:

- Active Options
- Write It Down

Find related information about this stage of watershed planning in Chapters 12 and 13 of EPA's Handbook.

## Introduction

Now that your team has determined what needs to be done and illumined a path to better waterways, it's time for action. Action is all about people and money, about finding both and keeping them effectively on task. Some of the plan's goals and action items can be met with current partners, but it's likely that other goals will require participation from people, businesses, and/or organizations that have never heard of your plan – or a "watershed" or "BMP," for that matter.

Securing and managing financial resources is a crucial part of implementation and may require new partners or contractors, people with administrative skills.

As you begin action steps, it is crucial to track your progress. Tracking progress is mandated by funders, but also necessary to encourage yourselves. Plus, it helps when you are advocating the plan. In addition, and perhaps most importantly, evaluating progress will help identify changes needed: adjustments to your original plan that will make it be more effective and meet the goals you have set.

## 7.1 Advocating for Your Plan

Convincing people to support and implement action items requires outreach and marketing: advocacy for the plan. Think strategically about whose support you need and who needs to take the actions. You especially need to reach those who you've identified as responsible parties or target audiences. (See also Muddy Creek example in section 6.2.2, Table 6.5.)

Make smart decisions about how you package the news and how you get the word to your audiences. What will they listen to? What will they understand?

Be sure you continue to advocate for your plan as you implement it and begin to see progress. Initial progress is a sure selling point!

### 7.1.1 Reach Out

Although you have made efforts to engage the community, you now must share the plan – and sell it - to anyone who hasn't been involved and has the ability or authority to make the changes it calls for, and to the larger community who may have influence. People need to know about your plan, what needs to happen for it to succeed and how they fit in.

> Resources helpful in developing education and outreach strategies will continue to be helpful during plan implementation, especially *Getting In Step*: 203
> Also, the outreach toolbox: 204

Consider producing one or more outreach events, and invite a local reporter. Videotape an outreach event and post it on the Internet. Seek invitations to existing groups' meetings or events that may include your target audiences, for example Conservation District events, places of worship in the watershed, Boy Scouts, civic clubs, your fiscal court, etc.

Continue reaching out as you implement your plan. Keep in touch with your stakeholders and political leaders. Share your progress with them. These people are keys to the long-term success of your plan.

### 7.1.2 Communication Alternatives

Most people will not want to read the entire plan, so you'll need some other way to communicate what you've done and what needs to be done, without all of the details. One watershed team wrote an executive summary for each chapter of their plan and uses those summaries to share the plan with others.

No matter what format(s) you choose, the purpose of executive summary presentations is to continue to build support, marketing especially the aspects of the plan that require public labor, influence, or funds. Create one or more ways to present your executive summary, a way to get the information to people who don't yet understand what you have done. Consider a variety of communication methods, for example storyboards, Facebook or Website pages, slide presentations, brochures, newsletters, newspaper insert, flyers, age-appropriate school curriculum materials, or others.

An executive summary can be used to highlight the key goals, strategies, partner commitments, and vision for a healthier watershed future. Explain just enough about the work for them to understand the principles they need to grasp the plan and to understand that your team is diverse, thoughtful and committed.

Be ready to tailor your summary presentation to different audiences, and keep it fresh and current. If you have a slide presentation, change it for your audience or as implementation progresses. Sometimes the audience only needs a one-page briefing, while another wants a pared-down version of the complete plan. Make sure you use language your audience will understand! Remember, most people haven't thought about watershed or best management practices.

No matter what your format, your summary information should look professional and be well-organized. Make enough copies for members of your planning team, key stakeholders, and elected officials for the jurisdiction of your watershed. Make some extras to have them available for grant and other funding applications.

Once you have begun making progress and achieving even small amounts of success with your plan, you'll want to share those results. It is especially important to share results with your target audiences, the ones you've identified as responsible parties for action items, but you'll want to share them with the community at large as well and, in particular, with their elected leaders. Again, creatively consider formats and stay professional. How about a report card showing where your waterway has raised its grade from C to A?

## 7.2 Securing and Managing Financial Resources

Whether you have funding for implementation or need to find some, there's work to be done. You'll need at least one person with patience for figures and administration. The more financial resources you have, the more you will need to pay someone to manage them.

Anyone giving money will want to know that you have a good plan for it and that you will efficiently use the funds for the agreed purposes. They will also want to see the results. This means telling them:

- What activity you will do with the funds, as specifically as possible. For example "plant 200 trees along Mill Creek where it passes through the Hanover subdivision" is better than "Mill Creek stream restoration activities."
- How the activities they could fund fit into the big picture. What goal will the activities serve, and how? Provide enough background information that they understand both the goal and the action, based on your understanding of their knowledge of watershed principles, your plan, and the situation in your watershed.
- How much money you need and how you will spend it. Give them a specific budget showing other funds you need or have, and how their funds fit into the overall picture. Be sure that your budget is realistic; do your research to determine costs. As much as possible, build in compensation for the person who

is responsible for managing the funds and implementing the action items. Budget in a little buffer for those things you may overlook, such as the cost of making photocopies of reports, etc.

For any potential funder, you need to know:
- How they want the request packaged. Foundations and government grants provide very specific instructions, so use them.
- Their interests and goals. Which part of your plan coincides with their interests?
- Reporting requirements. What documentation do they expect or require about the activities and the funds used: how often and with what level of detail? See also section 7.5.
- Their needs for credit and publicity. Should their name be on publications or flyers? Do they want photos of the results?

Basically, funders should understand what the team expects to do and what is needed to do it. It is helpful to create a set of bullet points that can be fashioned into a variety of requests for funding, to augment the summary presentation document described above.

It is easier to secure donations or grants if your organization either finds a nonprofit partner who will accept a grant on its behalf or as an associate, or the organization formalizes as a nonprofit. Donations to IRS-approved non-profits are tax-deductible. One of your partners may be able to provide advice about this.

Once you have secured funds, you need protocols for how they are managed. Generally and regardless of the trustworthiness or skills of any one person, no one should have complete power over expenditure decisions and checkbooks. Your organization should require regular reporting on funds and progress. Reports to funders should be prepared in a timely manner and be reviewed by at least one other designated person than the author. If you secure a significant amount of money, you probably need to pay someone to look after it.

## 7.3 Implementation Functions and Roles

The shift from plan design to plan implementation adds responsibility for your team leader(s) or project coordinator(s), who is now accountable to a work plan as well as to the team's ongoing guidance. Your watershed has an established timetable, and sticking to that timetable will require resources, including one or more person(s) who will take responsibility for momentum, for getting things done. In addition, other specialized skills may be required. That level of responsibility almost always requires financial compensation.

An overall coordinator, often termed a **Watershed Project Coordinator**, is a benefit to most plans. This could be a funded part- or full-time position, depending on the scope of the plan. All 319 program grants require and can fund the time of a person who manages the grant, and this person could act as the Watershed Project Coordinator. If this position is not federally or 319-funded, then the Watershed Coordinator's time could be counted as match for the grant.

In addition, a subcommittee (Implementation Team) should be formed to perform the following implementation functions:

- Make sure tasks are implemented as scheduled
- Review monitoring information
- Take advantage of new resource opportunities as they become available
- Share results with the larger team (see section 7.5)

Finally, a subcommittee (Technical Team) will need to monitor water quality data and technical aspects of plan implementation. The Technical Team would include partners as well as any technical consultant.

## 7.4 Adapting to Changes and Challenges

Waterways are not static, and neither are good plans. To achieve your goals, your watershed plan will need adjustment and change. You need to make a commitment... to be flexible!

If you've achieved most of your goals from your first round of watershed planning, you have good reason to celebrate. However, here's the tough part: the watershed and human impacts on it are dynamic, always in a state of change and frequently undergoing unexpected changes. Your action items will create changes in the watershed, and some of these will be unexpected, too – although hopefully in a positive sense. This is another reason to track and monitor your results (see section 7.5).

This dynamic nature of watersheds and planning means that protection and restoration must be regularly re-evaluated. You're going to have to go back and check on it—more than once. In some cases, teams have restored waterways only to discover that years later the situation has regressed. So, you'll need to ensure that your progress is maintained

As you reach the milestones in your plan, you'll need to convene a meeting of your team to ask the hard questions: What is needed to maintain and advance waterway health? Should we expand our vision? Should we set new goals?

Planning in general is an iterative process, one that entails continual review and repetition of the planning process itself. There's a good chance you'll need more monitoring and analysis if you really want your watershed to be improved and protected in the long run. It's a good idea to let people know now that a realistic plan must be updated and amended to remain vigorous.

## 7.5 Measuring Progress and Success

To know if you are moving toward or accomplishing your goals, and in order to help you adapt your plan, you must measure progress. Your action item timetable and the indicators you selected in Chapter 6 will help guide this activity. Remember that your actual success, over time, is indicated by desirable changes in how the land is used and improvements in the waterway's water quality. An array of regularly scheduled water quality and ecological "checkups" should be included in your plan for each.

This section is also discussed in Section 12.6 of the EPA Handbook.

### 7.5.1 Tracking Progress

While it's not a measure of improvement in the waterway, monitoring how reliably the activities in the plan are implemented will indirectly indicate success. The "Action Item Worksheet" developed for each objective will be a good foundation for evaluating implementation, because it identifies the person or organization accountable for each step and sets some interim goals. Reviewing progress against the worksheets can be a regularly-scheduled function of the implementation team or the Watershed Project Coordinator.

### 7.5.2 Improvements in Watershed Health or Practices

The benefits of implementing best management practices in a watershed are difficult to measure, and sometimes the quality of their maintenance defeats their purposes. For example, if a diverse vegetative buffer is added to a riparian area but city maintenance crews mow it regularly, it will revert to lawn. If livestock is fenced away from the creek but a flood tears down part of the fence and it is not repaired, the livestock will return to the creek.

It is challenging to measure improvements that are a result of best management practices with broad-based application, such as riparian corridors or erosion controls on construction sites. Ideally, the process used to implement the practice will include some accountability measure that tracks their appropriate installation and maintenance. For this reason, partnering with an organization for the implementation of a best management practice is important. The organization will often have some process for accountability that it can use for the new function it has been asked to provide.

It is also difficult to measure how much your activities have changed behaviors or attitudes. Opinion surveys can be an effective way to measure behavior change by large groups of people. Universities or public health departments may be valuable partners in devising objective surveys that can be telephoned or mailed to random samples from a target audience for behavior change. You can create a simple, online survey with tools such as Survey Monkey 205.

### 7.5.3 Improvements in Water Quality

Your plan identified key outcome indicators associated with action items and/or goals. A method for sampling for these pollutants or conditions over time should be part of your plan as it is implemented. This is referred to as success monitoring.

Just as you selected your BMPs based on conclusions about conditions and sources, your success monitoring plan should be designed to specifically measure results. The monitoring plan for assessing present conditions that you developed in Chapter 3 may continue to be useful to measure implementation success, but it may not. It may not be sufficiently robust, and/or it may have included parameters that are no longer the concern of the plan. For example, if some sites were below a discharge facility that is no longer operating, cut those monitoring sites. If earlier monitoring measured both bacteria and nutrients but you have since learned that nutrients are not of concern, bacteria monitoring will suffice.

Success monitoring may require new sites, in addition to earlier monitoring sites. Measuring directly below a BMP is recommended, although you will want before-and-after monitoring if possible. Where early monitoring was at the mouth, success monitoring may need to include additional sites in headwater areas.

While it's certainly possible and even desirable to use volunteers to monitor water quality, monitoring for a watershed plan will have certain design constraints that call for expertise in designing water quality monitoring programs:

- The parameters that are monitored should relate directly to the pollutants and concerns of your plan.
- The monitoring plan must collect sufficient data to answer the question you're asking. Streams are dynamic systems and may require sampling a number of times under a variety of conditions to account for all the variables.
- The plan will require statistical analysis.
- A Quality Assurance Program Plan (QAPP) will be required for monitoring funded by the 319 program.

Sometimes, it's possible to avoid a full frontal assault on stream parameters to meet the plan's monitoring needs. A partner may be monitoring the indicator as part of its own regulatory compliance. It may be possible to choose an indicator that is not the pollutant itself. For example, using an example from the EPA Handbook, it may be possible to take a "creel census" from anglers as a cost-effective alternative to calculating a fish index when the concern is aquatic health. Creativity in monitoring outcomes and coordinating the existing work of partners conserves and focuses precious resources and keeps partners involved.

## 7.6 Group Vitality

Your team may have become impatient with exploring the data and making planning decisions, yet sometimes the shift to implementation, the part that sounds productive and exciting, can also be difficult.

Go back to your original list of potential partners, or perhaps partners that did not remain active during the planning stages. Let them know you are moving to action and see if they want to renew their participation.

Maintain the interest and support of your partners and other planning team members. Give them regular progress reports, reports on progress that aren't necessarily the technical reports provided to funding sources. Keep them involved by scheduling trainings offered from time to time by state and national watershed organizations and encouraging their involvement in the evaluation of your plan.

Kentucky Waterways Alliance [206] and River Network [207] provide organizational development assistance to watershed teams.

### *Active Options*

You've done so much hard work. Take a break and go out and enjoy your beautiful watershed:

- Celebrate! Consider holding an event near your waterway (Creek Celebration Day!) that formally recognizes the hard work of the members of your planning team, but also have some informal arts or recreation activities that reflect back to the watershed or to some specific aspect of your plan. This event should be upbeat and optimistic about success, while clarifying that the work has only begun.

- Make a video about your project and put it on local cable and YouTube
- Organize a bicycle ride through the watershed
- Go fishing or kayaking…

## *Write It Down*

**Executive Summary or Summaries**
Whether you create an Executive Summary for each chapter or one for each chapter (or both), add these to your plan.

**Organization**
Briefly describe how you will oversee the implementation phase of your planning. Identify key people, their organizations, and their roles, including (if applicable) Watershed Coordinator, Implementation Team, and Technical Team. Update lists of team members and partners.

**Presentation and Outreach**
Briefly describe how you will share the plan and progress reports with political leaders, stakeholders, important audiences, and the public. Describe plans for outreach events and other marketing methods.

**Fundraising**
Briefly describe your fundraising plans. If you have a budget for the complete project, consider including it - perhaps as an appendix.

**Monitoring Success**
Describe how you plan to monitor progress on action items, watershed health or practices, and improvements in water quality.

For the water quality outcome indicators in the plan, describe how the team's earlier monitoring plan might be revised to better monitor results. If feasible, specify who will provide the monitoring, the monitoring schedule, and the schedule of regular reports on progress toward pollutant load reductions. If the team decides to apply for 319 funds to implement your plan, the application will require an approved Quality Assurance Project Plan for monitoring results.

**Evaluating and Updating Your Plan**
Describe when and how you will evaluate the implementation of your plan, and who will be involved in the evaluation process. Ideally, evaluation will occur soon enough to influence the achievement of short-term, mid-term and long-term goals.

**Specifically, describe:**

- How you will evaluate the implementation of your action items
- How you will evaluate the outcome indicators associated with Load Reduction targets
- How you will evaluate your outreach activities

Briefly discuss how modifications to your plan may occur. Address the role of key partners, stakeholders, and the wider planning team in plan modifications.

**Other Records**

Document the specific responsibilities of any person or committee. If a contract is involved, be very specific. Keep copies of any financial management policies you develop, marked with the date they became effective. This is especially important, of course, if you have or expect to receive significant quantities of funds.

Document your outreach events: how they were announced, efforts to secure press and other coverage, participation, and evaluative information.

Generally track the distribution of any Executive Summary, and specifically list presentations made.

Keep copies of any fundraising letters or proposals and budgets that are not included in the plan.

Update contact lists.

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# APPENDIX A:  Watershed Plan Outline

This appendix includes:

- An outline for your watershed plan, compiled from the Write It Down sections of each chapter and intended to make it easier for you to put your Watershed Plan together
- A list of other records your team should retain
- A list of maps required for 319-funded projects

## Chapter 1: Introduction

**The Watershed**

Identify the waterway and watershed to which this plan pertains.

Explain briefly why this area was chosen.

Provide a summary or details of local concerns about the waterway.

**Partners and stakeholders**

List the partners and stakeholders who are involved in your planning process. Identify their organizations, if any, and roles. This list will grow as your process proceeds, so be sure to update it regularly.  Provide a contact person and contact information.

NOTE: Your planning team should never overstate the commitment of a partner or stakeholder, nor publish a list including a stakeholder without approval of the listing by the stakeholder. However, it may be appropriate to list partners that your team hopes to work with or you have contacted, clearly indicating their prospective status.

**How Much To Share?**

The detail provided for each of the topics in this section depends on the subject and the scope of your plan as well as your findings.

If you can, integrate information your team discovered through visual or stream surveys into the related sections.

If you were unable to find information or the category is not relevant to your plan, it is still worthwhile to explain, because otherwise people may wonder why you did not consider that particular factor in your analysis.

If you cannot connect information with a specific location, try to connect it with a sub-watershed, or note where the practice or condition is applicable to a part or to the entire watershed.

Identify sources of information whenever possible.

## Chapter 2: The *[insert the name of your watershed]*

## Watershed

**Introduction**

Describe your watershed in one or two paragraphs, relating:

- The name of the waterway of concern
- The larger watershed to which it is a tributary
- Its location within Kentucky (counties and communities)
- Its area in square miles

Add a paragraph or two to introduce the information you found about water resources, natural features and human influences. This is the part of the plan where you begin to tell the story of your watershed, to integrate existing information.

**Water Resources**

Describe and provide map(s) of the water resources in your watershed.

- Watershed Boundary
- Hydrology
- Groundwater-Surface Water Interaction
- Flooding
- Regulatory Status of Waterways
- Water Chemistry and Biology
- Geomorphology

**Natural Features**

Describe and provide maps of the natural features of your watershed.

- Geology and Topography
- Soils
- Ecoregion

**Riparian/Streamside Vegetation**

Describe and provide maps of any riparian information you found.

**Rare and Exotic/Invasive Plants and Animals**

Describe and provide any information about rare and exotic/invasive plants and animals you identified in your watershed.

**Human Influences and Impacts**

Describe and provide maps about human activities in your watershed. As much as possible, connect these activities to specific locations or sub-watersheds. Be accurate and respectful.

- Water Use
- Land Use
- Other Water Disturbances
- Land Disturbances
- Hazardous Materials

**Demographics and Social Issues**

Provide any relevant information about demographics or social issues. If feasible, identify differences within sub-watersheds.

**Team Observations**

Describe any visual or stream survey activity of the team, partners, or volunteers. Include any observations that have not been integrated into other sections of this chapter.

**Interim Conclusions**

Consider including a short section that summarizes the information that appears to be most relevant.

## Chapter 3: Monitoring

### Introduction

Provide a brief overview of the existing monitoring data that you have and the additional monitoring data needs. If you are developing a KY 319-funded watershed plan, be sure to explain the phase of monitoring that you completed at this stage of the planning process.

Provide an overview of your monitoring strategy.

- Include a map with all of the sampling locations clearly labeled.
- Discuss how you selected your monitoring locations.
- Provide a brief overview of the parameters collected, methods used and the sampling frequency. If you are developing a KY 319-funded watershed plan, reference your KDOW approved QAPP for details.

Describe any problems you encountered during the monitoring effort. For example, you should provide an explanation if it was an unseasonably dry year and you were unable to collect a number of samples. This information will be important for Chapter 4.

Include all of the qualified monitoring data results as an appendix. If you are developing a KY 319-funded watershed plan, these results should be thoroughly reviewed and properly flagged to ensure they meet the standards set forth in the KDOW approved QAPP.

Remember you will have a great deal of information upon the completion of this chapter. You will not be including all of this in your watershed plan, but you need to maintain this information and keep it on file.

## Chapter 4: Analysis

**Phase 1 – Analysis**

Analyze the monitoring data collected in the Phase 1 monitoring for prioritization of up to three smaller sub-watersheds for additional assessment and implementation

- Compare parameter concentrations
    - Establish benchmark concentrations and make comparisons for each parameter
    - Describe the relationship between the actual water quality and the benchmark water quality conditions for the concentrations of all parameters collected for each sampling location
- Compare pollutant loads/yields
    - Calculate pollutant loads/yields
    - Calculate target loads
    - Compare the actual annual load to the target annual load and calculate the reduction needed to achieve the target load
- Compare watershed inventory data to pollutant concentrations and loads/yields
    - Examine any potential relationships between this inventory and the effects these may have, either positive or negative, on water quality for each sub-watershed

**Phase 1 – Prioritization**

Prioritize up to three sub-watersheds from your larger watershed for further monitoring and analysis in Phase 2 of your project

- Examine these factors:
    - Organizing analytical data
        - Comparisons of parameter concentrations
        - Comparisons of pollutant loads/yields
    - Regulatory status of waterway

        - Impairment status
        - TMDL status
        - Special Use Waters
    - Feasibility factors
        - Comparison of watershed inventory data to pollutant loads
        - Regulatory matters
        - Stakeholder cooperation
        - Political will
        - Available funding
        - Areas of local concern
        - Existing priority status
        - Watershed management activities
        - Monitoring considerations

**Phase 2 – Analysis**
Analyze the monitoring data collected in the Phase 2 monitoring to make determinations of pollutant sources within your prioritized sub-watersheds

- Compare parameter concentrations and compare pollutant loads
    - Use same methods utilized in your Phase 1 analysis
    - Make comparisons of all your parameter concentrations to benchmarks
    - Calculate pollutant loads for all of your sampling locations
    - Determine load reductions needed to achieve your target loads
- Compare watershed inventory data to pollutant concentrations and loads
    - Examine any potential relationships between this inventory and the effects these may have, either positive or negative, on water quality for each sub-watershed
    - Examine results of habitat and biological assessment
    - Examine local concerns

## Chapter 5: *[Optional: included here as a placeholder to avoid confusion]*

Although the list of BMPs is important for the next phase of planning, it is not necessary to include the list at this point in your watershed plan. However, if you are developing a watershed plan with KY 319 funding you should keep a record of this list and be able to provide the list to the Nonpoint Source and Basin Team Section upon request.

## Chapter 6: Strategy for Success

**BMP Feasibility**
Feasibility - record the factors at play in your watershed and the choices you made about BMPs.

**BMPs and Action Items**
In some manner (a table, chart, narrative, etc.), record all necessary information about the BMPs selected. If most of the information is going into a table, it may still be helpful to have some explanatory narrative.

## Chapter 7: Making it Happen

**Organization**

Briefly describe how you will oversee the implementation phase of your planning. Identify key people, their organizations, and their roles, including (if applicable) Watershed Coordinator, Implementation Team, and Technical Team. Update lists of team members and partners.

**Presentation and Outreach**

Briefly describe how you will share the plan and progress reports with political leaders, stakeholders, important audiences, and the public. Describe plans for outreach events and other marketing methods.

**Fundraising**

Briefly describe your fundraising plans. If you have a budget for the complete project, consider including it - perhaps as an appendix.

**Monitoring Success**

Describe how you plan to monitor progress on action items, watershed health or practices, and improvements in water quality.

For the water quality outcome indicators in the plan, describe how the team's earlier monitoring plan might be revised to better monitor results. If feasible, specify who will provide the monitoring, the monitoring schedule, and the schedule of regular reports on progress toward pollutant load reductions. If the team decides to apply for 319 funds to implement your plan, the application will require an approved Quality Assurance Project Plan for monitoring results.

**Evaluating and Updating Your Plan**

Describe when and how you will evaluate the implementation of your plan, and who will be involved in the evaluation process. Ideally, evaluation will occur soon enough to influence the achievement of short-term, mid-term and long-term goals.

Specifically, describe:

- How you will evaluate the implementation of your action items
- How you will evaluate the outcome indicators associated with Load Reduction targets
- How you will evaluate your outreach activities

Briefly discuss how modifications to your plan may occur. Address the role of key partners, stakeholders, and the wider planning team in plan modifications.

## Other Records Your Team Should Retain

**Chapter 1:**

Keep records of the contacts you made while looking for partners and workgroup members, including their contact information, the date(s) of contact, and their responses. Make a note of those who you may want to engage or query further into the planning process.

Keep minutes of all your workgroup meetings.

**Chapter 2:**
Record your team's impressions of watershed issues before, during, and after collecting information. What implications does the team see? These impressions will be helpful as you continue your discoveries. Hopefully, you will either prove the impressions are right or wrong.

Although your plan will summarize much of your research findings, be sure to keep records of your research activities:

- Who you contacted and their contact information, whether or not the contact yielded data. Keeping this information electronically will make it easier to share and update.
- Data inventories
- Calculations

**Chapter 3:**
Remember you will have a great deal of information upon the completion of this chapter. You will not be including all of this in your watershed plan, but you need to maintain this information and keep it on file.

**Chapter 5:**
Although the list of BMPs is important for the next phase of planning, it is not necessary to include the list at this point in your watershed plan. However, if you are developing a watershed plan with 319 funding you should keep a record of this list and be able to provide the list to the Nonpoint Source and Basin Team section upon request.

**Chapter 7:**
Document the specific responsibilities of any person or committee. If a contract is involved, be very specific. Keep copies of any financial management policies you develop, marked with the date they became effective. This is especially important, of course, if you have or expect to receive significant quantities of funds.

Document your outreach events: how they were announced, efforts to secure press and other coverage, participation, and evaluative information.

Generally track the distribution of any Executive Summary, and specifically list presentations made.

Keep copies of any fundraising letters or proposals and budgets that are not included in the plan.

Update contact lists.

# Appendix B: Nine Minimum Elements to Be Included in a Watershed Plan for Impaired Waters Funded Using Incremental Section 319 Funds

Although many different components may be included in a watershed plan, EPA has identified a minimum of nine elements that are critical for achieving improvements in water quality. (Go to 208 for more information on the 319 Program.)

EPA requires that these nine elements be addressed for watershed plans funded using incremental section 319 funds and strongly recommends that they be included in all other watershed plans that are intended to remediate water quality impairments. Once the plan has been developed, plan sponsors can select specific management actions included in the plan to develop work plans for nonpoint source section 319 support and to apply for funding to implement those actions.

The nine elements are provided below, listed in the order in which they appear in the guidelines in the EPA Handbook. Although they are listed as *a* through *i*, they do not necessarily take place sequentially. For example, element *d* asks for a description of the technical and financial assistance that will be needed to implement the watershed plan, but this can be done only after you have addressed elements *e* and *i*. Explanations are provided with each element to show you what to include in your watershed plan. In addition, chapters in the *EPA Handbook for Developing Watershed plans to Restore and Protect Our Waters* where the specific element is discussed in detail are referenced.

***Nine Elements***

***Element a:*** *Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant subcategory level along with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).*

*What does this mean?*
Your watershed plan should include a map of the watershed that locates the major sources and causes of impairment. Based on these impairments, you will set goals that will include (at a minimum) meeting the appropriate water quality standards for pollutants that threaten or impair the physical, chemical, or biological integrity of the watershed covered in the plan.

***Element b:*** *An estimate of the load reductions expected from management measures*.

*What does this mean?*
You will first quantify the pollutant loads for the watershed. Based on these pollutant loads, you'll determine the reductions needed to meet the water quality standards. You will then identify various management measures (see element *c* below) that will help to reduce the pollutant loads and estimate the load reductions expected as a result of these management measures to be implemented, recognizing the difficulty in precisely predicting the performance of management measures over time.

Estimates should be provided at the same level as that required in the scale and scope component in paragraph *a* (e.g., the total load reduction expected for dairy cattle feedlots, row crops, or eroded streambanks). For waters for which EPA has approved or established TMDLs, the plan should identify and incorporate the TMDLs. Applicable loads for downstream waters should be included so that water delivered to a downstream or adjacent segment does not exceed the water quality standards for the pollutant of concern at the water segment boundary. The estimate should account for reductions in pollutant loads from point and nonpoint sources identified in the TMDL as necessary to attain the applicable water quality standards.

***Element c:*** *A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.*

*What does this mean?*
The plan should describe the management measures that need to be implemented to achieve the load reductions estimated under element *b*, as well as to achieve any additional pollution prevention goals called out in the watershed plan. It should also identify the critical areas in which those measures will be needed to implement the plan. This can be done by using a map or a description.

***Element d:*** *Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.*

*What does this mean?*
You should estimate the financial and technical assistance needed to implement the entire plan. This includes implementation and long-term operation and maintenance of management measures, I/E activities, monitoring, and evaluation activities. You should also document which relevant authorities might play a role in implementing the plan. Plan sponsors should consider the use of federal, state, local, and private funds or resources that might be available to assist in implementing the plan. Shortfalls between needs and available resources should be identified and addressed in the plan.

***Element e:*** *An information and education (I/E) component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.*

*What does this mean?*
The plan should include an I/E component that identifies the education and outreach activities or actions that will be used to implement the plan. These I/E activities may support the adoption and long-term operation and maintenance of management practices and support stakeholder involvement efforts.

***Element f:*** *Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.*

*What does this mean?*
You need to include a schedule for implementing the management measures outlined in your watershed plan. The schedule should reflect the milestones you develop in *g*.

***Element g:*** *A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented*.

*What does this mean?*
You'll develop interim, measurable milestones to measure progress in implementing the management measures for your watershed plan. These milestones will measure the implementation of the management measures, such as whether they are being implemented on schedule, whereas element *h* (see below) will measure the effectiveness of the management measures, for example, by documenting improvements in water quality.

***Element h:*** *A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.*

*What does this mean?*
Using the milestones you developed above, you'll develop a set of criteria (or indicators) with interim target values to be used to determine whether progress is being made toward reducing pollutant loads. These interim targets can be direct measurements (e.g., fecal coliform concentrations) or indirect indicators of load reduction (e.g., number of beach closings). You must also indicate how you'll determine whether the watershed plan needs to be revised if interim targets are not met and what process will be used to revise the existing management approach. Where a nonpoint source TMDL has been established, interim targets are also needed to determine whether the TMDL needs to be revised.

***Element i:*** *A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item h immediately above.*

*What does this mean?*
The watershed plan must include a monitoring component to determine whether progress is being made toward attainment or maintenance of the applicable water quality standards. The monitoring program must be fully integrated with the

established schedule and interim milestone criteria identified above. The monitoring component should be designed to determine whether loading reductions are being achieved over time and substantial progress in meeting water quality standards is being made. Watershed-scale monitoring can be used to measure the effects of multiple programs, projects, and trends over time. Instream monitoring does not have to be conducted for individual BMPs unless that type of monitoring is particularly relevant to the project.

# Appendix C: Sample Team Invitation and Brochure

***Example of a Recruitment Letter:***

Date
Name
Address
Dear _________:

Our watershed project, Clean Up the Crawdad, is seeking committed, enthusiastic volunteers to serve on our steering committee and subcommittees, and during project activities. We are looking for community residents who are interested in conserving natural resources, improving water quality, and enhancing the recreational uses of Crawdad Lake and Crawdad River.

Clean Up the Crawdad is a locally-led initiative formed to restore and protect water resources in the Crawdad Lake watershed, in order to provide high-quality recreational opportunities for area residents. Members and supporters include the Hushpuppy and Mudflat County SWCDs, county commissioners, county health departments, county highway departments, the state Fish & Game Commission, the Hoosierville Rotary and Grange, agricultural commodity organizations, the Crawdad Lake Association, and Infinite Bass.

Please review the attached information and pass it along to others. If you or someone you know is interested in participating in Clean Up the Crawdad, please contact the Watershed Project Coordinator, Sally Coordinator, at 555-555-1234 for more information.

Sincerely,

William B. Chairperson

***Example of a Recruitment Attachment:***

**We're looking for concerned citizens in the Crawdad River Watershed and surrounding communities to help us protect and restore Crawdad Lake.**

**Who we are:** Clean Up the Crawdad (CLUC) is a non-profit, volunteer, umbrella group seeking to involve citizens in and around Crawdad Lake. The Riverbank Resource Conservation & Development board and the Mudflat and Hushpuppy County Soil & Water Conservation Districts are our sponsors.

**Our Mission:** To protect and restore water quality in Crawdad Lake through coordinated community & agency efforts. We want to have a beautiful, healthy lake in a thriving community!

**What we're concerned about:**
Algae blooms and weeds in the lake
Unrestricted boating activity
Reduced quality of fishing
Beaches closed due to pollution

## What's your commitment?

- **Steering committee members** serve a two-year term. The 15-member steering committee discusses and formulates decisions for the watershed project and reviews the work of the Planning and Assessment committees who are developing the watershed plan. The committee meets on the first Tuesday of each month at Pete's Fish & Ribs in Hoosierville, from 6:30 to 8:30 PM. The public is welcome to attend and provide input to the committee's decisions. More frequent meetings are occasionally required. Training workshops are available. **We currently need three more steering committee members.**

- **Subcommittee members** work with the committee of their choice (Planning, Assessment, or Outreach) for a year (or more, if they want to). Committees may need to meet frequently during some phases of the project.  Only the committee chair is expected to attend the monthly steering committee meeting, although others are welcome to come.

- **Project volunteers** participate in an activity such as stream assessment, trash pickup, or a canoe trip, on the day of the event. The Coordinator will take your contact information and let you know when events are planned.

## What's in it for you?

As a member of Clean Up the Crawdad, you can: Be a voice for citizens of your community.....Have the satisfaction of helping to restore the lake so everyone can enjoy it.....Be recognized as a community leader.....Learn more about water resource protection and restoration..... Contribute your unique knowledge and skills.....Meet and work with great folks, and have a lot of fun!

## Want more information?

Call Sally Coordinator at 555-555-1234, or drop into the Hushpuppy or Mudflat County SWCD office any weekday from 8:00 to 4:00. We need you now!

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# Appendix D: Resources for Team Development

The following list of websites will help you build your watershed planning team, reach out to stakeholders in your area, give you ideas for keeping your stakeholders active and interested, and will offer other helpful hints for working with groups.

*EPA Getting In Step: Engaging and Involving Stakeholders in Your Watershed*
The Getting in Step watershed outreach guidebook provides some of the tools you will need to develop and implement an effective watershed outreach plan. If you're a watershed practitioner trained in the sciences, this manual will help you address public perceptions, promote management activities, and inform or motivate stakeholders 209.

The Center for Technology Information Center (CTIC) has developed a series of documents to help you know your watershed. This information clearinghouse for watershed coordinators helps to ensure measureable progress towards local goals. The clearinghouse is available at 210.

River Network is a non-profit organization with a mission to "help people understand, protect and restore rivers and their watersheds." Their website is full of helpful information for watershed planning, including information on ordering *Starting Up: A Handbook for New River and Watershed Organizations.* Go to 211.

The EPA has a Capacity Building Website with a full tool kit for watershed and restoration projects. Go to 212.

The Social Sciences Team of the Natural Resources Conservation Services (NRCS) offers helpful factsheets on running meetings, running public meetings, conflict resolution, community listening, focus groups, and any other social skill you might need 213.

The following are helpful printed resources on Consensus Building and Group Facilitation:

Breaking the Impasse: Consensual Approaches to Resolving Public Disputes by Lawrence Suskind and Jeffrey Cruikshank, Basic Books, 1987.

Collaborating: Finding Common Ground For Multiparty Problems by Barbara Gary, Jossey-Bass Publishers, 1989.

Getting to Yes by Roger Fisher and William Ury of the Harvard Negotiation Project, Penguin Books, 1983.

Group Power: A Manager's Guide to Using Meetings by William R. Daniels, University Associates, Inc., 1986.

How to Make Meetings Work: The New Interaction Method by Michael Doyle and David Straus, Berkley Publishing Group, 1976.

Managing Public Disputes: A Practical Guide to Handling Conflict and Reaching Agreements by Susan L. Carpenter and W. J. D. Kennedy, Jossey-Bass Publishers, 1988.

Mining Group Gold: How to Cash In on the Collaborative Brain Power of a Group by Thomas A. Kayser, Serif Publishing, 1990.

Pulling Together: A Land Use and Development Consensus Building Manual by David R. Godschalk, David W. Parham, Douglas R. Porter, William R. Potapchuk, and Steven W. Skulkraft (Washington, D.C.: Program for Community Problem Solving), 1994.

# Appendix E

## *Habitat Assessment (EPA Rapid Bioassessment Protocol Scoring Sheet)*

### HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

| | | |
|---|---|---|
| STREAM NAME | LOCATION | |
| STATION #__________ RIVERMILE__________ | STREAM CLASS | |
| LAT _______________ LONG _______________ | RIVER BASIN | |
| STORET # | AGENCY | |
| INVESTIGATORS | | |
| FORM COMPLETED BY | DATE ________<br>TIME ________ AM PM | REASON FOR SURVEY |

Parameters to be evaluated in sampling reach

| Habitat Parameter | Condition Category: Optimal | Suboptimal | Marginal | Poor |
|---|---|---|---|---|
| **1. Epifaunal Substrate/ Available Cover** | Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient). | 40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **2. Embeddedness** | Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **3. Velocity/Depth Regime** | All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.) | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/ depth regime (usually slow-deep). |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **4. Sediment Deposition** | Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. | Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools. | Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. | Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **5. Channel Flow Status** | Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Water fills >75% of the available channel; or <25% of channel substrate is exposed. | Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Very little water in channel and mostly present as standing pools. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

# HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

**Parameters to be evaluated broader than sampling reach**

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Optimal** | **Suboptimal** | **Marginal** | **Poor** |
| **6. Channel Alteration** | Channelization or dredging absent or minimal; stream with normal pattern. | Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present. | Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted. | Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **7. Frequency of Riffles (or bends)** | Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15. | Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25. | Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **8. Bank Stability (score each bank)**<br><br>Note: determine left or right side by facing downstream. | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars. |
| SCORE ___ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **9. Vegetative Protection** (score each bank) | More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. |
| SCORE ___ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **10. Riparian Vegetative Zone Width** (score each bank riparian zone) | Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Width of riparian zone 12-18 meters; human activities have impacted zone only minimally. | Width of riparian zone 6-12 meters; human activities have impacted zone a great deal. | Width of riparian zone <6 meters: little or no riparian vegetation due to human activities. |
| SCORE ___ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

**Total Score __________**

## HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

| | | |
|---|---|---|
| STREAM NAME | LOCATION | |
| STATION #__________ RIVERMILE__________ | STREAM CLASS | |
| LAT _______________ LONG _______________ | RIVER BASIN | |
| STORET # | AGENCY | |
| INVESTIGATORS | | |
| FORM COMPLETED BY | DATE _________<br>TIME _________ AM PM | REASON FOR SURVEY |

Parameters to be evaluated in sampling reach

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Optimal** | **Suboptimal** | **Marginal** | **Poor** |
| **1. Epifaunal Substrate/ Available Cover** | Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient). | 30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). | 10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **2. Pool Substrate Characterization** | Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common. | Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present. | All mud or clay or sand bottom; little or no root mat; no submerged vegetation. | Hard-pan clay or bedrock; no root mat or vegetation. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **3. Pool Variability** | Even mix of large-shallow, large-deep, small-shallow, small-deep pools present. | Majority of pools large-deep; very few shallow. | Shallow pools much more prevalent than deep pools. | Majority of pools small-shallow or pools absent. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **4. Sediment Deposition** | Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition. | Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools. | Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. | Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **5. Channel Flow Status** | Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Water fills >75% of the available channel; or <25% of channel substrate is exposed. | Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Very little water in channel and mostly present as standing pools. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

## HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| **6. Channel Alteration** | Channelization or dredging absent or minimal; stream with normal pattern. | Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present. | Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted. | Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **7. Channel Sinuosity** | The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.) | The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line. | The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line. | Channel straight; waterway has been channelized for a long distance. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **8. Bank Stability (score each bank)** | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars. |
| SCORE ___ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **9. Vegetative Protection** (score each bank)<br><br>Note: determine left or right side by facing downstream. | More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. |
| SCORE ___ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **10. Riparian Vegetative Zone Width** (score each bank riparian zone) | Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Width of riparian zone 12-18 meters; human activities have impacted zone only minimally. | Width of riparian zone 6-12 meters; human activities have impacted zone a great deal. | Width of riparian zone <6 meters: little or no riparian vegetation due to human activities. |
| SCORE ___ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

**Total Score __________**

# Appendix F: Potential Pollutant Sources

| Causes (Pollutant or Stressor) | Possible Sources | Potential Adverse Impacts |
|---|---|---|
| Sediment/Siltation (sand, silt, clay) | Cropland<br>Forestry activities<br>Pasture<br>Stream banks<br>Construction<br>Roads<br>Mining operations<br>Gullies<br>Livestock operations<br>Other land-disturbing activities | Sediment may destroy fish habitat by: (1) blanketing spawning and feeding areas; (2) eliminating certain food organisms; (3) causing gill abrasion and fin rot; and (4) reducing sunlight penetration, thereby impairing photosynthesis. Suspended sediment decreases recreational values, reduces fishery habitat, adds to mechanical wear of water supply pumps and distribution systems, and adds treatment costs for water supplies. Nutrients and toxic substances attached to sediment particles may enter aquatic food chains, cause fish toxicity problems, impair recreational uses or degrade the water as a drinking water source. |
| Nutrients (phosphorus, nitrogen) | Erosion and runoff from fertilized fields<br>Urban runoff<br>Wastewater treatment plants<br>Industrial discharges<br>Septic systems<br>Animal production operations<br>Cropland or pasture where manure is spread | Nutrient enrichment may cause excessive algae and aquatic plant growth, which may choke open waters and consume oxygen (primarily from decomposition of dead plants and algae). These conditions will adversely affect fish and aquatic organisms, fishing and boating, and the taste and odor of finished drinking water. Nitrogen contaminants in drinking water significantly above the drinking water standard may cause methoglobinemia (blood disease) in infants, and have forced the closure of many water supplies. |
| Pathogens (bacteria and viruses) | Human and animal excreta<br>Animal operations<br>Cropland or pasture where manure is spread<br>Wastewater treatment plants<br>Septic systems<br>Urban runoff<br>Wildlife | Waterborne diseases may be transmitted to humans through drinking or contact with pathogen-laden water. Eating shellfish taken from or uncooked crops irrigated with pathogen-laden waters may also transmit waterborne diseases. The principal concern in both surface and ground waters is the potential degradation of public water supply sources. Pathogens reaching a lake or other surface water body may limit primary contact recreation, such as swimming. |
| Pesticides | All land where pesticides are used (forest, pastures, urban/suburban areas, golf courses, waste disposal sites)<br>Sites of historical usage (chlorinated pesticides)<br>Urban runoff<br>Irrigation return flows | Pesticides may enter surface waters either dissolved in runoff or attached to sediment or organic materials, and may enter ground water through soil infiltration. The principal concerns in surface water are their entry into the food chain, bioaccumulation, toxic effects on fish, wildlife and microorganisms, habitat degradation and potential degradation of public water supply sources. Ground water impacts are primarily related to water supply sources. |

| Causes (Pollutant or Stressor) | Possible Sources | Potential Adverse Impacts |
|---|---|---|
| Toxic Substances (heavy metals, oil and petroleum products) | Urban runoff<br>Wastewater treatment plants<br>Industrial discharges | Toxic substances may enter surface waters either dissolved in runoff or attached to sediment or organic materials and may enter ground waters through soil infiltration. Principal concerns in surface water include entry into the food chain, bioaccumulation, toxic effects on aquatic organisms, other wildlife and microorganisms, habitat degradation and degradation of water supplies. Ground water impacts are primarily related to degradation of water supply sources. |
| Organic Enrichment (depletion of dissolved oxygen) | Human and animal excreta<br>Decaying plant/animal matter<br>Discarded litter and food waste | Organic materials (natural or synthetic) may enter surface waters dissolved or suspended in runoff. Natural decomposition of these materials may deplete oxygen supplies in surface waters. Dissolved oxygen may be reduced to below the threshold necessary to maintain aquatic life. |
| Thermal Stress/ Sunlight | Riparian corridor destruction<br>Bank destruction<br>Urban runoff<br>Hydromodifications<br>Industrial dischargers | Direct exposure of sunlight to streams may elevate stream temperatures, which can exceed fish tolerance limits, reduce dissolved oxygen and promote the growth of nuisance algae. The lack of trees along a stream bank contributes to thermal stress and excessive sunlight. Thermal stress may also be the result of storm water runoff, which is heated as it flows over urban streets. Hydromodifications that create wider, shallower channels create more surface area and allow for quicker temperature changes. Modifications that create pools and increase the storage time of water may also contribute to thermal stress by increasing surface area and not allowing the warmed water to wash out of the watershed. Coldwater fish may be eliminated or only marginally supported in streams affected by thermal stress. |
| pH (acidic and alkaline waters) | Mine drainage<br>Mine tailings runoff<br>Atmospheric deposition<br>Industrial point source discharges | Acidic or alkaline waters will adversely affect many biological processes. Low pH or acidic conditions adversely affect the reproduction and development of fish and amphibians, and can decrease microbial activity important to nutrient cycling. An extremely low pH will kill all aquatic life. Acidic conditions can also cause the release of toxic metals that were adsorbed to sediments into the water column. High pH, or alkaline conditions, can cause ammonia toxicity in aquatic organisms. |

| Causes (Pollutant or Stressor) | Possible Sources | Potential Adverse Impacts |
|---|---|---|
| Salinity (dissolved solids) | Brine from oil extraction<br>Road deicing | High levels of dissolved solids will affect the taste of drinking water. High concentrations of sodium sulfate or magnesium sulfate in drinking water can cause laxative effects, and excess sodium may affect persons restricted to low sodium diets. High concentrations of salts can inhibit aquatic plant growth and have an adverse effect on aquatic life. Lakes receiving runoff with high salt concentrations may form a saline layer near the bottom that will resist mixing, thereby reducing dissolved oxygen in the saline layer. |
| Flow Alterations (hydrologic modifications) | Channelization<br>Dams<br>Dredging<br>Streambank modifications | Hydrologic modifications alter the flow of water through the stream. Structures or activities in the water body that alter stream flow may in turn be the source of stressors, such as habitat modifications, or exacerbate others, such as thermal stress. Dams may also act as a barrier to the upstream migration of aquatic organisms. Stream flow alterations may result from a stressor such as sedimentation, which may change a stream bed from narrow with deep pools to broad and shallow. |
| Habitat Modifications | Channelization<br>Construction<br>Changing land uses in the watershed<br>Stream burial<br>Dredging<br>Removal of riparian vegetation<br>Streambank modifications | Habitat modifications include activities in the landscape or in the water body that alter the physical structure of the aquatic and riparian ecosystem. Some examples include: removal of stream side vegetation that stabilizes the stream bank and provides shade; excavation in the stream and removal of cobbles from the stream bed that provide nesting habitat for fish; stream burial; and development that alters the natural drainage pattern by increasing the intensity, magnitude and energy of runoff waters. |
| Refuse, Litter and Other Debris | Litter<br>Illegal dumping of solid wastes | Refuse and litter in a stream can clog fish spawning areas; stress aquatic organisms; reduce water clarity; impede water treatment plant operations; and impair recreational uses of the water body, such as swimming, fishing and boating. |

Source: A Guide to Developing Local Watershed Action Plans in Ohio State of Ohio Environmental Protection Agency, Division of Surface Water 1997

# Appendix G: Glossary

**303(d):** The section of the Clean Water Act that requires states to develop a list every 2 years of the streams and lakes in the state that are impaired and require a Total Maximum Daily Load (TMDL). The list is a subset of the 305(b) list. The list is called the 303(d) list and since 2006 is submitted along with the 305(b) list to EPA by the Kentucky Division of Water as the Integrated Report to Congress. The 303(d) list in found in Volume II. Before 2006, the two lists were submitted separately.

**305(b):** The section of the Clean Water Act that requires states to develop a list every 2 years of the streams and lakes in the state that have been assessed. The list is called the 305(b) list and since 2006 is submitted along with the 303(d) list to EPA by the Kentucky Division of Water as the Integrated Report to Congress. The 305(b) list is found in Volume I. Before 2006, the two lists were submitted separately.

**319 Nonpoint Source Pollution (NPS) Control Program:** Congress amended the Clean Water Act (CWA) in 1987 to establish the section 319 Nonpoint Source Management Program because it recognized the need for greater federal leadership to help focus State and local nonpoint source pollution efforts. Under section 319, State, Territories, and Indian Tribes receive grant money, or **319(h) funding**, which supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects. Groups apply to the Kentucky Division of Water for 319(h) Funds.

**319(h) watershed planning funds:** The portion of 319(h) funds that are allocated for watershed planning purposes.

**401 program, Water Quality Certification program:** The Clean Water Act Section 401 Water Quality Certification (WQC) program in Kentucky ensures that activities involving a discharge into waters of the state and requiring a federal permit or license, are consistent with Kentucky's water quality standards in Title 401, Chapter 5, of the Kentucky Administrative Regulations. In Kentucky, the Water Quality Certification Section in the Water Quality Branch is responsible for implementing the Section 401 program.

**404 permitting program:** Projects that involve the discharge of dredged or fill materials into waters of the United States, including wetlands, are regulated by the U.S. Army Corps of Engineers under Clean Water Act Section 404 and require Section 401 certification. Examples of activities that may require a Section 404 permit and Section 401 water quality certification are stream relocations, road crossings, stream bank protection, construction of boat ramps, placing fill, grading, dredging, ditching, mechanically clearing a wetland, building in a wetland, constructing a dam or dike, and stream diversions.

**Algae:** (singular form is alga) Simple, single-celled and rootless plants that grow in sunlit waters and provide food for fish and macroinvertebrates; water that contains too many nutrients will have an overgrowth of algae that can lower the dissolved oxygen in a waterbody as they die and decay

**Aquifers:** An underground geological formation, or group of formations, containing water. Aquifers are sources of groundwater for wells and springs.

**Bacteria:** (Singular form is bacterium) Single-celled organisms that can't be seen with the naked eye. Bacteria are found everywhere and perform many valuable functions that support life on the planet, however, some bacteria can cause diseases; they reproduce rapidly.

**Basins:** Area of land where water from rain and melting snow or ice drains downhill into a body of water. There are 12 major river basins in Kentucky.

**Basin coordinators:** Person(s) responsible for facilitating Kentucky Watershed Management Framework activities in one or more of the state's basin management units.

**Basin team:** People from state agencies and other organizations that provide the partnership network for watershed planning within a basin and who serve as planning and implementation resources.

**Best Management Practices (BMPs):** A best management practice or BMP has traditionally been defined as something built on the ground with guaranteed documentable results in reducing nonpoint source pollution. With paradigms changing to include more expansive management practices, the term best management practice or BMP is now often used to refer to any management practice designed to reduce pollution in the watershed as well.

- **Structural BMPs** – These Best Management Practices require construction, installation and maintenance. These are usually BMPs that you can see such as vegetated stream buffers, rain gardens, and silt fences.
- **Nonstructural BMPs** - These Best Management Practices involve changes in activities or behavior among people in the watershed. Examples include erosion prevention and sediment control plans for construction sites, ordinances that prohibit building in the floodplain, and education and outreach campaigns.

**Benchmark:** An acceptable water quality concentration for a healthy stream.

**Benthic macroinvertebrates:** Small animals that can be seen with the naked eye, live on the bottom of streams and lakes, and don't have a backbone. They are often the immature forms of insects that live on land as adults, and they are an important food source for fish and other aquatic animals.

**Biochemical Oxygen Demand (BOD):** A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution found in the system.

**Biological assessment:** Using information about the macroinvertebrates, fish, and/or algae and diatoms found in a waterbody to determine the health of the waterbody.

**Biological indicators:** Organisms, processes, or characteristics found in a waterbody that serve as markers to indicate the status or health of that waterbody.

**Biological survey:** Collecting and identifying macroinvertebrates, fish, and/or algae and diatoms.

**Clean Water Act (CWA):** Federal law enacted by Congress in 1972 to protect surface water in the United States.

**Cold Water Aquatic Habitat (CAH):** Surface streams that will support native aquatic life or self-sustaining or reproducing trout populations on a year-round basis.

**Colony forming unit (cfu):** The reporting unit for laboratory bacterial analysis; based on the number of clusters, or colonies, of bacteria that have grown in laboratory conditions until they can be seen with the naked eye.

**Combined Sewer Overflow (CSO):** Combined Sewer Systems (CSSs) carry both storm water and wastewater (sewage). Normally, the waste all goes to a treatment facility, but when rainfall or snowmelt is heavy, the flow in combined sewer systems can exceed pipe capacity, resulting in discharges to CSOs. CSOs are direct outlets to ditches, lakes, rivers, streams and creeks, which prevent backups in the CSSs. Because the wastes in CSSs are untreated, discharges from CSOs can contain a variety of pollutants, such as pathogens, oxygen-demanding pollutants, suspended solids, nutrients, toxics, and floatable solids.

**Combined Sewer System (CSS):** These systems carry both storm water and wastewater (sewage) in one pipe to a water treatment facility.

**Conductivity:** A measure of the ability of a solution to carry an electrical current.

**Conduits:** Openings and channels formed in bedrock by the infiltration of acidic precipitation.

**Designated uses:** The Clean Water Act directs states to assign "uses" to their waterways that are legally recognized descriptions of the desired use(s) of the waterway. In Kentucky, the designated uses are Warm Water Aquatic Habitat, Cold Water Aquatic Habitat, Primary Contact Recreation, Secondary Contact Recreation, Domestic Water Supply/ Drinking Water, and Outstanding State Resource Water.

**Diatoms:** Single celled plant-like organisms that have rigid structures made of silica in their cell walls.

**Dissolved Oxygen (DO):** The oxygen that is freely available in water, and that is vital to fish and other aquatic life and for the prevention of odors. DO levels are considered an important indicator of a water body's ability to support desirable aquatic life.

**Ecoregions:** Large areas where the environmental conditions and natural features are similar so the plants and animals that live there are similar, too.

**Ecosystem:** The interacting systems of plants and animals and their non-living environmental surroundings.

**Erosion:** The wearing away of land surface by wind or water, intensified by land-clearing practices related to farming, residential or industrial development, road building, or logging.

**Eutrophication:** The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication the water body is choked by abundant plant life due to higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

**Facilitator:** Someone who helps a group of people understand their common objectives and assists them to plan to achieve them without taking a particular position in the discussion.

**Fauna:** All of the animal life in a particular area.

**Fecal Coliform:** Bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

**Fishable, swimmable**, **and drinkable:** The intent of the Clean Water Act is to ensure that the waterways in the United States meet these goals.

**Flora:** All of the plant life in a particular area.

**Geomorphology:** The study of erosion, sediment transport, and sediment deposition and how these processes shape the surface of the earth.

**GIS data layer:** Computer programs linking features commonly seen on maps (such as roads, town boundaries, water bodies) with related information not usually presented on maps, such as type of road surface, population, type of agriculture, type of vegetation, or water quality information. A GIS is a unique information system in which individual observations can be spatially referenced to each other.

**Glide:** Areas in the stream where the water flow is increasing in speed as it flows out of pools and decreasing depth.

**Habitat:** The place where a population (e.g. human, animal, plant, microorganism) lives and its surroundings, both living and non-living.

**High gradient streams:** Steep streams that flow out of hills and mountains and have many riffles and runs.

**Hydrologic Cycle:** A continuous cycle that represents the movement of water from one phase to the next between the atmosphere and Earth; this includes evaporation, precipitation, infiltration and runoff.

**Hydrologic Unit Code (HUC):** A cataloging system developed by the U.S. Geological Survey and the Natural Resource Conservation Service to identify watersheds in the United States. HUCs are typically reported at the large river basin (6-digit HUC) or smaller watershed (11-digit and 14-digit HUC) scale. These codes were developed to standardize hydrological unit delineations for geographic description and data storage purposes.

**Hydromodification:** When undeveloped land is covered with buildings and pavement, it causes more stormwater runoff to flow into creeks at faster rates. This may result in creek channel erosion, as well as flooding, habitat loss, and, in some cases, property damage. These are development-induced changes to the natural hydrological processes.

**Hypoxia:** Waters with dissolved oxygen concentrations of less than 4 parts per million, the level generally accepted as the minimum required for most marine life to survive and reproduce.

**Impaired waters:** These are waterbodies that do not fully support their designated uses.

**Impervious surface:** Any surfaces that are covered by materials that block water infiltration such as asphalt, concrete, etc. These surfaces include roads, sidewalks, driveways, parking lots, and rooftops. Compacted soils (including some lawns) are also highly impervious.

**Infiltration:** The physical process by which water on the ground surface moves into the soil.

**Integrated Report Volume I:** Section 305(b) of the Clean Water Act requires states to submit a report every two years that provides the status of waterways that have been assessed in the state. This list of assessed streams is called the 305(b) list and is submitted to EPA as Volume I of the Integrated Report to Congress.

**Integrated Report Volume II:** Section 303(d) of the Clean Water Act requires states to submit a report every two years that provides the status of waterways that have been assessed in the state. This list of assessed streams is called the 303(d) list and is submitted to EPA as Volume II of the Integrated Report to Congress.

**Intermittent streams:** Streams with a defined channel that only flow during a precipitation event.

**Karst:** A geologic formation of irregular limestone deposits with sinks, underground streams, and caverns.

**Larvae:** (singular form is larva) Immature forms of some insects.

**Low gradient streams:** Streams that flow through flat land and have few, if any, riffles, many glides and pools, and mostly fine sediment bottoms.

**Match**: The percentage of a 319(h) project budget that is not funded by federal dollars. Match can be in-kind goods and/or services or money.

**Model:** A set of equations that can be used to describe the natural or man-made processes in a watershed system, such as runoff or stream transport. By building these cause-and-effect relationships, models can be used to forecast or estimate future conditions that might occur under various conditions.

**Municipal Separated Storm Sewer System (MS4):** A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, man-made channels or storm drains):

- Owned and operated by a state, city, town, borough, county parish, district, association or other public body (created by or pursuant to state law) having jurisdiction over disposal of sewage, industrial wastes, stormwater or other wastes, including special districts under state law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges to waters of the United States; Designed or used for collecting or conveying stormwater;
- Which is not a combined sewer; and
- Which is not part of a publicly owned treatment works.

**Nonpoint source pollution:** Pollution originating from runoff from diffuse areas (land surface or atmosphere) having no well-defined source. The pollutants are generally carried off the land by storm water. Common nonpoint sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

**Nonpoint Source Pollution Control Program:** The Kentucky Nonpoint Source (NPS) Pollution Control Program goals are to protect the quality of Kentucky's surface and groundwater from NPS pollutants, abate NPS threats and restore degraded waters to the extent that water quality standards are met and beneficial uses are supported.

**Nutrients:** Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

**Package treatment plants:** A small-scale wastewater treatment facility.

**Pathogens:** Microorganisms (e.g., bacteria, viruses, or parasites) that can cause disease in humans, animals and plants.

**Perennial streams:** Streams that receive groundwater and normally flow year round.

**Periphyton:** Microscopic underwater plants and animals that are firmly attached to solid surfaces such as rocks, logs, and pilings.

**pH:** An expression of the intensity of the basic or acid condition of a liquid; may range from 0 to 14, where 0 is the most acid and 7 is neutral. Natural, healthy waters usually have a pH between 6 and 9.

**Point bars:** Areas of accumulating sediment in a stream; often called sand bars.

**Point source:** Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or storm water runoff.

**Pollutant load:** The amount of a specific pollutant moving through a stream. The pollutant load is based upon both the concentration of the pollutant and the stream flow. Loads are generally expressed in terms of a weight (of pollutant) and a period of time, resulting in pounds per day, for example.

**Pollutants:** Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

**Pollutant yield:** A pollutant yield is calculated from a pollutant load to account for geographic size differences. This normalized load, the pollutant yield, can be determined by dividing the pollutant load by a unit of area (e.g. acre, square mile).

**Pools:** The deepest areas with the slowest flow in a stream.

**Primary Contact Recreation (PCR):** Recreational activities such as swimming that create contact between the water and the mucus membranes of humans (mouth, eyes, inside nose) that will allow infection by any pathogens that could be in the water.

**Precipitation:** Any form of water that falls from the atmosphere; includes rain, snow, sleet, and hail.

**Quality Assurance Project Plan (QAPP):** A QAPP is a project-specific document that specifies the data quality and quantity requirements of the study, as well as all procedures that will be used to collect, analyze, and report those data. A QAPP helps monitoring staff to follow correct and repeatable procedures and helps data users to ensure that the collected data meet their needs and that the necessary quality assurance (QA) and quality control (QC) steps are built into the project from the beginning.

**Reach:** A selected length of a stream.

**Recharge:** The process by which water is added to the water table, or groundwater, usually by percolation from the soil surface; e.g., the recharge of an aquifer.

**Riffles:** The areas in a stream where there is a drop in elevation that causes the rocks on the bottom of the stream to extend above the surface of the water creating a churning action that causes the surface of the water to look rough and bubbly.

**Riparian areas:** Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

**Runoff:** That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface-water. It can carry pollutants from the air and land into receiving waters.

**Run:** A segment of a stream that flows quickly out of a riffle.

**Sanitary Sewer Overflows (SSOs):** Occasional unintentional discharges of raw sewage from sanitary sewers. These types of discharges are called Sanitary Sewer Overflows (SSOs). SSOs have a variety of causes, including but not limited to severe weather, improper system operation and maintenance, and vandalism.

**Secondary Contact Recreation (SCR):** Recreational activities such as fishing, wading, and boating that create limited human contact with the water in a stream or lake.

**Sediment:** Soil, sand, and minerals washed from land into water, usually after rain. They pile up in reservoirs, rivers and harbors, destroying fish and wildlife habitat, and clouding the water so that sunlight can't penetrate the water.

**Sediment deposition:** The process by which sediments carried by the flow of water in a stream are deposited on the stream bottom as the flow loses energy and slows.

**Sediment transport:** The process by which sediments in a stream are moved by the force of the flow of water.

**Septic systems:** An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent (sludge) that remains after decomposition of the solids by bacteria in the tank and must be pumped out periodically.

**Sinkholes:** Depressions on the land surface formed as precipitation carries soil into the ground through cracks and conduits in limestone.

**Source:** The KY 319(h) program defines source for the 319-funded watershed plans as the area that contributes a pollutant. Refer to the Chapter 3 Introduction for a figure illustrating source.

**Special Use waters:** Rivers, streams, and lakes that are worthy of additional protection and are listed in Kentucky Administrative Regulations or the Federal Register as Cold Water Aquatic Habitat, Exceptional Waters, Reference Reach Waters, Outstanding State Resource Waters, Outstanding National Resource Waters, State Wild Rivers and Federal Wild and Scenic Rivers. Not included as special use waters are water bodies designated by default as Warm Water Aquatic Habitat, Primary Contact Recreation and Secondary Contact Recreation.

**Springs:** Ground water seeping out of the earth where the water table intersects the ground surface.

**Stakeholder:** Anyone who is involved in or affected by watershed planning. Stakeholders include landowners, government agencies, businesses, private individuals, and special interest groups.

**Straightpipes:** Some homes or other buildings are neither on sewers nor have an installed septic system. Instead, wastes are illegally "straight piped" to a creek, ditch or other area outside the structure. In addition to the odor this creates, straight pipes directly contribute pathogenic wastes to streams, posing a health hazard.

**Stream Discharge:** The amount of water (based on the depth, width, and flow speed of the stream) that is flowing past a given point in the stream for a given amount of time. It is usually measured in cubic feet per second (cfs or ft3/sec). An example to demonstrate stream discharge is: Water is flowing past a given point in two 11 feet wide streams at the same flow speed. However, one stream is 10 inches deep and the other is 10 feet deep. A larger amount of water is flowing past the given point in the stream that is 10 feet deep. So, this stream has a greater discharge than the one that is 10 inches deep.

**Total Coliform:** A group of 16 different bacteria that have similar properties and are found in soils, plants, and in the intestines and waste of warm-blooded and cold-blooded animals.

**Total Maximum Daily Loads (TMDLs):** 1. A TMDL is a calculation of the maximum amount of a pollutant (examples are sediment, phosphorus, and bacteria) that a stream or lake can receive and still meet water quality standards. 2. A TMDL may also refer to a written report, which includes detailed assessment information of site-specific impaired waters, watershed information, mathematical modeling and the calculated number of a pollutant load.

**Total Suspended Solids:** A measure of the suspended solids in wastewater, effluent, or water bodies, determined by tests for "total suspended non-filterable solids." Suspended solids are small particles of solid pollutants that float on the surface of, or are suspended in, sewage or other liquids.

**Transpiration:** The process by which water vapor is lost to the atmosphere from living plants. The term can also be applied to the quantity of water thus dissipated

**Tributary:** A stream that flows into another stream or into another waterbody.

**Turbidity:** A cloudy condition in water due to suspended silt or organic matter.

**Warm Water Aquatic Habitat (WAH):** A surface waterbody and associated substrate capable of supporting native warm water aquatic life.

**Wastewater treatment facilities:** A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water. Most treatments include chlorination to attain safe drinking water standards.

**Water cycle:** See hydrologic cycle.

**Watershed:** The area of land that drains to a specific stream; watersheds join together to form larger watersheds; a major river will encompass many smaller watersheds.

**Water table:** The boundary in a geologic formation below which the rock is saturated and groundwater exists.

**Watershed coordinator:** Person responsible for organizing watershed planning, education, and implementation for the protection and restoration of local water resources.

**Watershed roundtable:** A regional government-citizen forum whose purpose is to promote collaboration and cooperation on environmental concerns, especially water quality issues, among the various local governments and stakeholder interest groups residing within a watershed.

**Weathering:** The process where rock is dissolved by the acidity in precipitation and groundwater.

**Wetland:** A natural area that is covered with water or soggy, but may not be wet all year round.