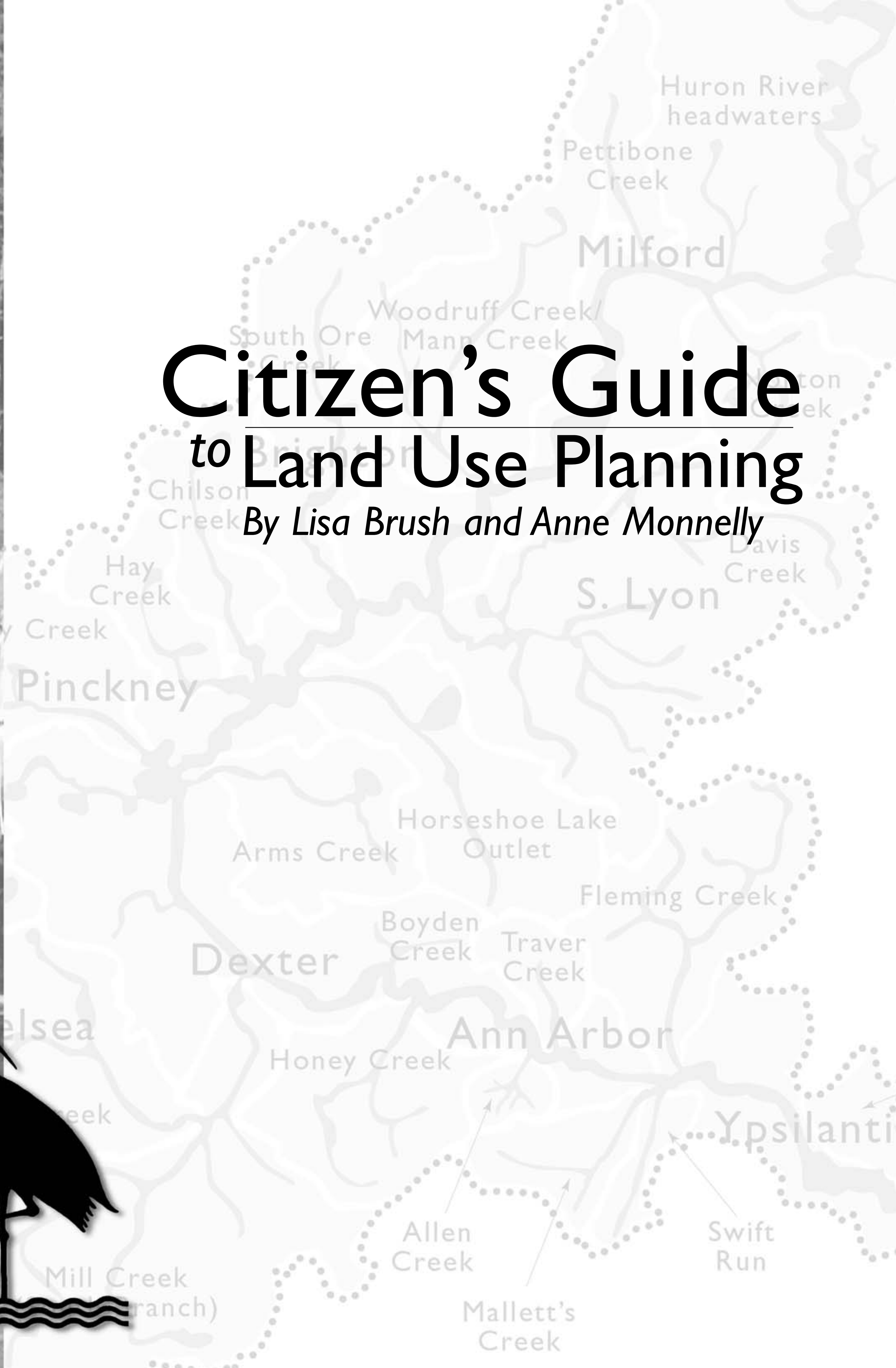
Citizen's Guide *to* Land Use Planning

By Lisa Brush and Anne Monnelly



Citizen's Guide *to* Land Use Planning

By Lisa Brush and Anne Monnelly

Second Printing

This document has been made possible by generous funding from the Huron River Watershed Council, the W.K. Kellogg Foundation, the C.S. Mott Foundation, the Michigan Department of Environmental Quality Willow Run Consent Decree Judgment, the Edna Bailey Sussman Fund, and the University of Michigan.

1100 North Main Street, Suite 210, Ann Arbor, MI 48104 • Phone: 734.769.5123 • Fax: 734.998.0163
www.hrwc.org

Contents

Introduction to the Citizen's Guide to Land Use Planning

In Michigan the most important land use decisions get made at the local level. This document is a hands-on tool for working with your local government to protect water resources by positively affecting land use decisions. It is intended as an introduction to both water resources and land use planning. Anyone who is just learning to work effectively with their local government to protect rivers, lakes, wetlands, and other water resources in their community should find this booklet valuable. Whether it's the role of the land in the water cycle, soil erosion, or zoning issues, we hope you'll learn something new here. We also hope these readings stimulate you to learn more and continue to become more effective in participating in your local land use decisions.

Chapter One gives an overview of different aspects of the water cycle (which we call water cycle jobs) and explains how different land uses and development patterns can impact the water cycle. Chapter Two explains how land use decision making works at the local level, presents ways for you to get involved in the planning process, and explains how to use your local planning documents to protect water.

If we are to preserve our water resources intact for future generations, we must plan for the future. It is your informed voice that can help us all work together to preserve the living legacy we have!

Introduction to the Huron River Watershed

Introduction to the Huron River Watershed

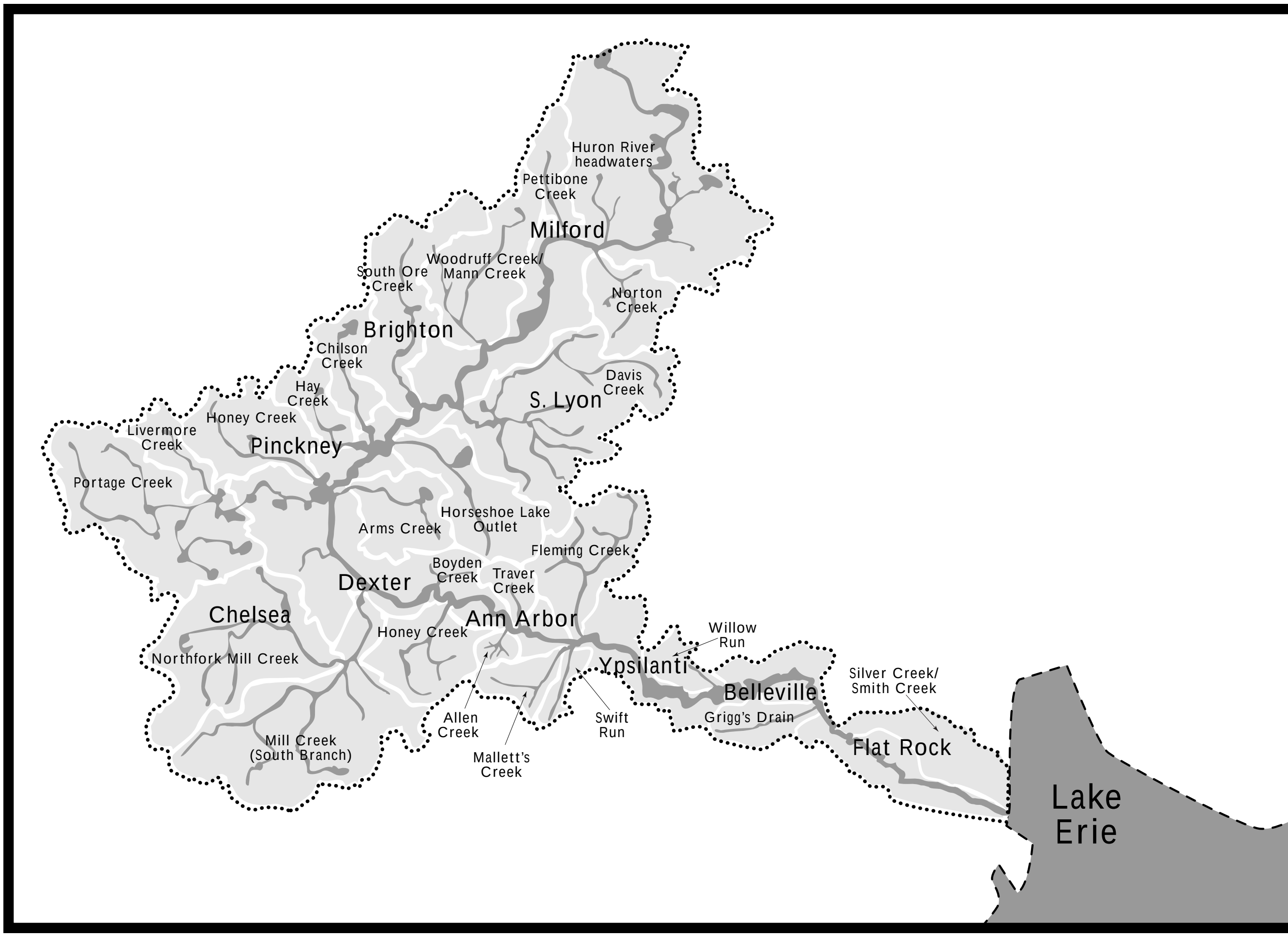


Figure 1: The Huron River Watershed covers 908 square miles of land. This land drains into the Huron River which in turn drains into Lake Erie.

Does the boundary around the map shown in Figure 1 look familiar to you? It's not a political border, and you won't find it on most road maps. It's a naturally formed boundary that marks the edges of the Huron River Watershed, which is the geographical area covered by this workbook. Anyone with an interest in protecting local rivers, lakes, streams, wetlands, and other water resources will most likely become familiar with this boundary and her or his community's location within it.

What is a watershed?

The hills and valleys of the land we live on form basins which catch water and direct it downhill toward a river or lake. These catchment basins are also known as watersheds. A watershed is all the land that drains to any body of water. (See Figure 2.) Watersheds can vary in size from several square miles to thousands of square miles. The small creek in your neighborhood has a watershed, as do the Great Lakes. The boundary separating one watershed from another is marked by high points or ridges on the landscape. Rain that falls on the ridge between two watersheds can contribute to either watershed, depending on which side of the ridge it flows down.

The Huron River Watershed

In Michigan, the difference in elevation between the high and low points on the landscape is relatively modest. You have almost certainly crossed over the Huron River Watershed divide and may not have even noticed. This is because the hills that mark the edges of the watershed are small; the highest point is only 1,018 feet above sea level. From this point, the river falls 446 feet on its journey to Lake Erie at 572 feet above sea level. (This 446 foot drop is about equal to

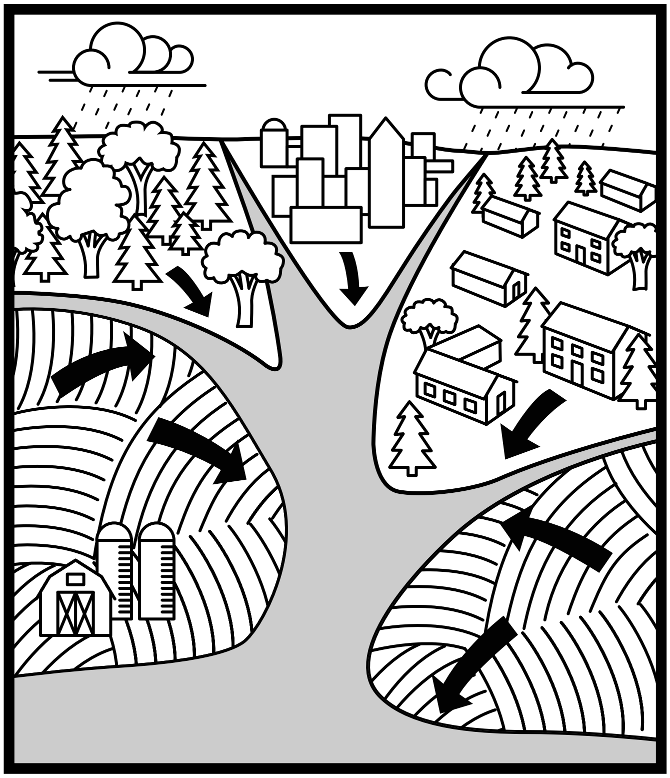


Figure 2: Much of the precipitation that falls within a watershed eventually flows to the river (or other water body). All of this land makes up the watershed.

a 34 story building. The Renaissance Center in Detroit is 39 stories tall.)

The Huron River Watershed covers 908 square miles of land and is home to 525,670 people (as of 2000). It includes parts of seven counties: Oakland, Livingston, Jackson, Ingham, Washtenaw, Wayne, and Monroe; 38 townships; and 19 cities and villages.

The Watershed is bounded by five other watersheds: the Raisin River Watershed to the south, the Grand River Watershed to the west, the Shiawassee and Clinton River Watersheds to the north, and the Rouge River Watershed to the east (Figure 3).

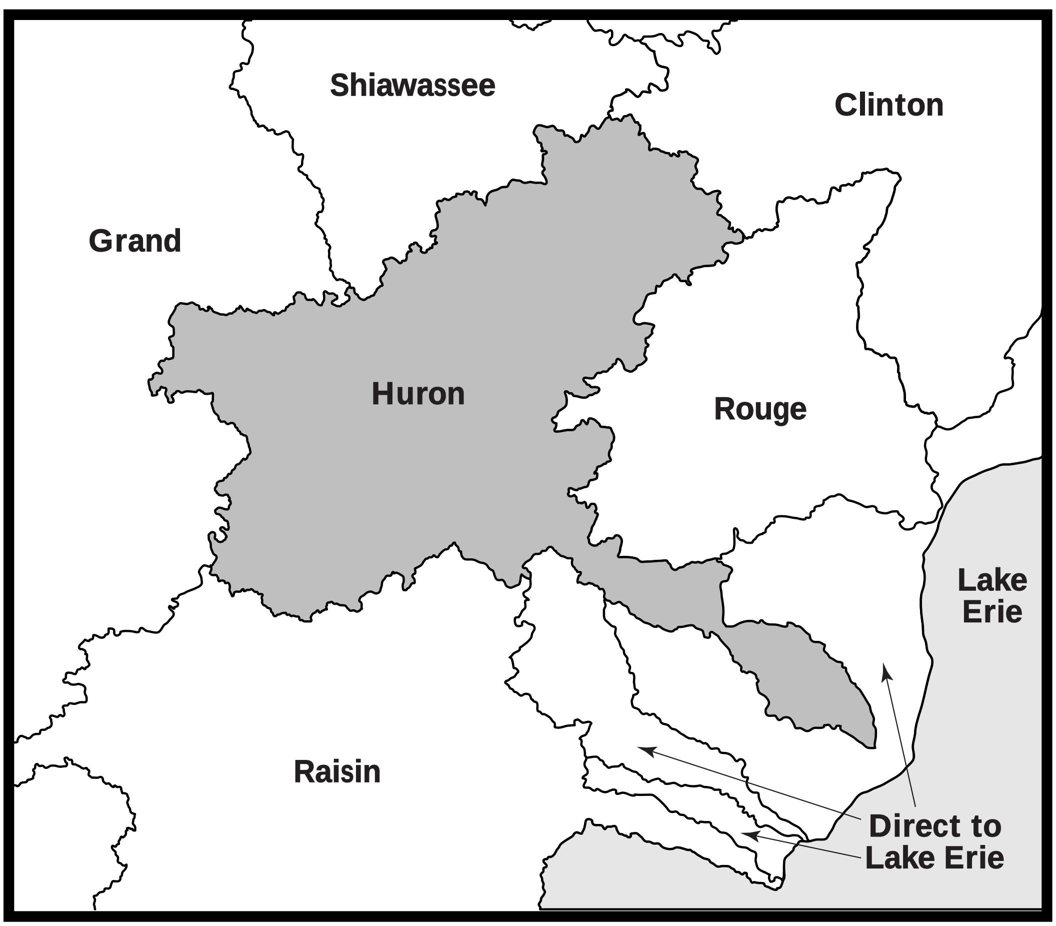


Figure 3: The Huron and its surrounding watersheds

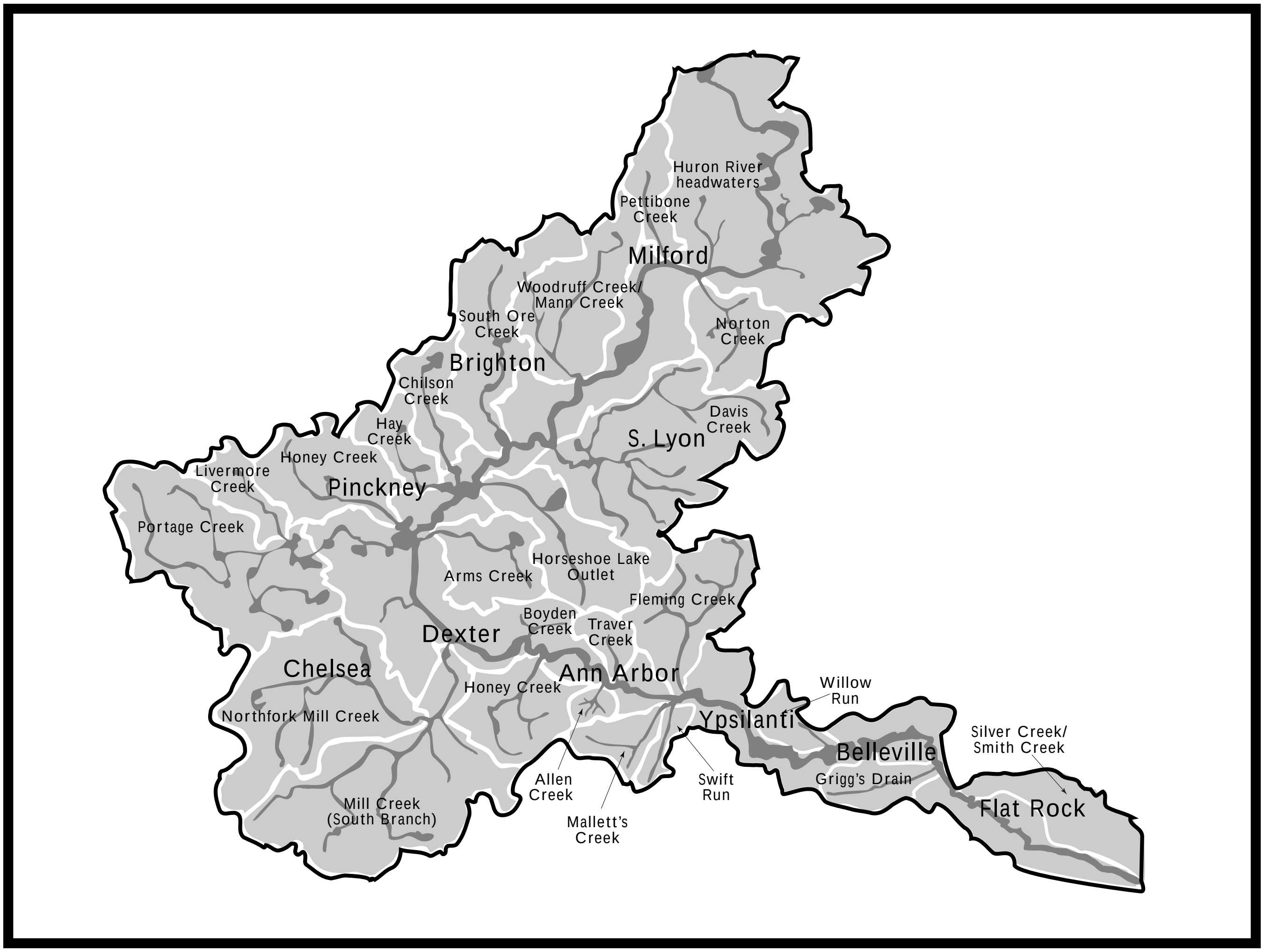


Figure 4: The Huron River Watershed

Tributaries are smaller creeks and streams that feed into a larger river. The Huron River has 34 major tributaries. Like the Huron River and its watershed, each tributary has a smaller area of land that drains water to it. These "mini" watersheds are nested within the Huron River Watershed; they are often called subwatersheds, subbasins, or creeksheds. In this workbook we will use the term creekshed. The Huron River Watershed contains 34 major creeksheds.

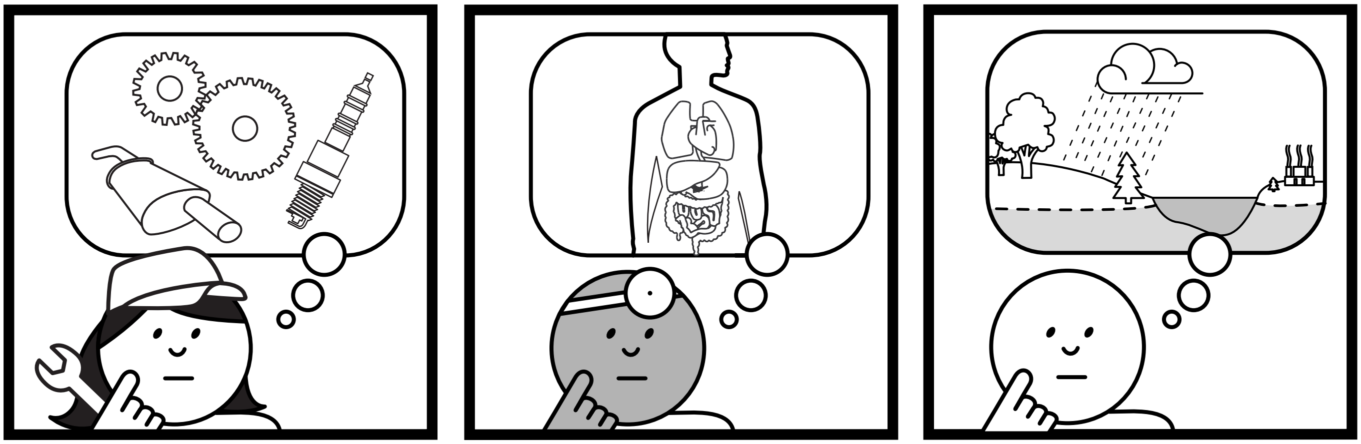
Do you know your watershed address?

Can you locate your community on the map shown in figure 4? Do you know which creekshed you live in? Look at the map above to begin to get an idea of what is your neighborhood creekshed. If you need to, do a little more research—consult a topographic map, explore the area and discover your neighborhood creek! You can call the Huron River Watershed Council's Adopt-A-Stream Program (734/769-5971) to learn more about your creek.

Now that you are oriented, let's begin with the connection between land use and water quality.

Chapter One: The Connection Between Land Use and Water Quality

The Connection Between Land Use and Water Quality



Overview:

Do you know what factor has the greatest impact on the quality of water in the Huron River and all the lakes, streams, wetlands, and other water resources in the Huron River Watershed?

If you answered "land use," you are at least one step on your way to learning how to protect water resources; you have recognized one of the major issues of concern.

The major objective of this chapter is to explain how our use of land affects water resources. We will begin by learning some basics about how water is stored on the land and how water moves from the earth to the atmosphere and back. This process is known as the water cycle (Figure 5). How is water kept clean? How are floods handled? Which parts of the land hold water?

Once we develop a working vocabulary and understanding of important water cycle terms we will bring people into the picture. What kinds of changes do people make to the land? How do these changes affect the quality of our waters?

By the end of this chapter you will understand:

- The many important roles of land in the water cycle
- Why every activity that occurs in a watershed affects the quality and condition of the water that drains from that watershed

The Role of Land in the Water Cycle

Introduction

Just as a mechanic needs to know how an engine works, and a doctor must understand the functioning of the human body, anyone who wants to protect water resources needs to understand the land's role in the water cycle.

The water cycle refers to how water moves or "cycles" from the atmosphere, to the ground, through the landscape, and back to the atmosphere. Our discussion will focus on the parts of the cycle that occur in and on the landscape because this is the place where our actions can make the most difference.

Although we all realize that the land is not really an actor, our discussion will use the metaphor of land as a manager with jobs to do. Our story begins with a rainstorm. What happens to the rainwater once it reaches the land? In other words, how does the land handle its share of the water cycle?

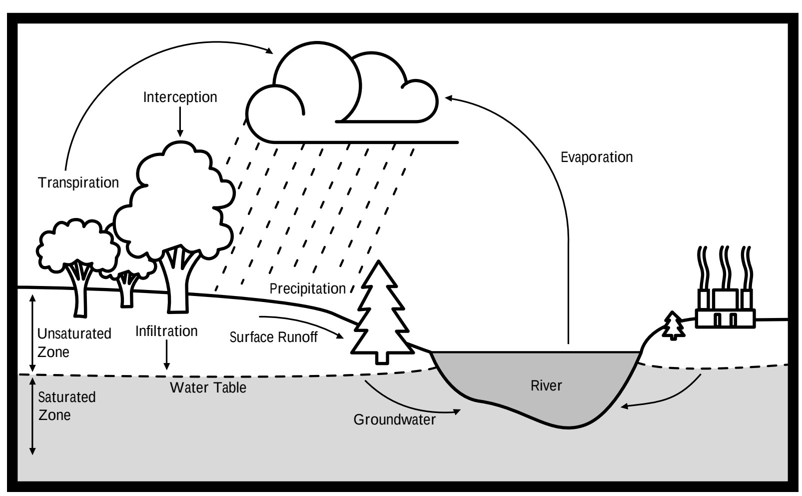


Figure 5: The water cycle

The land receives water from a rainstorm. Some of the water is sent back to the atmosphere through evaporation and plant transpiration (or "breathing"), some is stored in depressions on the surface of the land, some soaks into the ground and is stored in soil, and some runs across the surface of the land. The land naturally balances how much water goes where.

Characteristics of the land such as soil type, vegetation, surface waters, and topography help to determine what will happen to water. These characteristics are often called natural features. Along with helping to determine where water goes, natural features help to keep water clean. We'll refer to the "management jobs" performed by the land and its natural features as the landscape jobs.

The landscape jobs we'll look at are:

- The process of infiltration: how water moves through the soil
- The process of interception: how water is caught by vegetation
- The job of storage: all the ways water is held in and on the land
- The process of transport: all the ways that water moves

Let's take a closer look at how the land and the natural features on it "manage" water.

Landscape Job #1: INFILTRATION

Rain that soaks into the ground filters through the soil in a process called infiltration. Infiltration is the flow or seepage of any fluid (we'll be talking about water) through the soil, sediments, or rocks of the Earth's surface.

Where does infiltration occur?

Well, it's almost easier to talk about where infiltration doesn't occur. There are two situations where it doesn't occur:

- If the surface of the land is covered by a material that doesn't allow water to soak in, infiltration will not occur. Roads and other pavement are examples of surfaces that prohibit infiltration.

- When soil becomes saturated with water (in other words, when all the spaces between soil particles are filled with water), infiltration will not occur because the soil cannot hold any more water.

- When the ground is frozen, infiltration will not occur.

Other than these three situations, infiltration occurs everywhere in a watershed (Figure 6). However, some land areas allow more infiltration than others, and this fact has important consequences. Lands that allow a lot of infiltration can help to replenish underground water supplies. These areas are often called groundwater recharge areas. To learn more about what groundwater recharge areas are and how they work, see the section that follows on saturated soil storage.

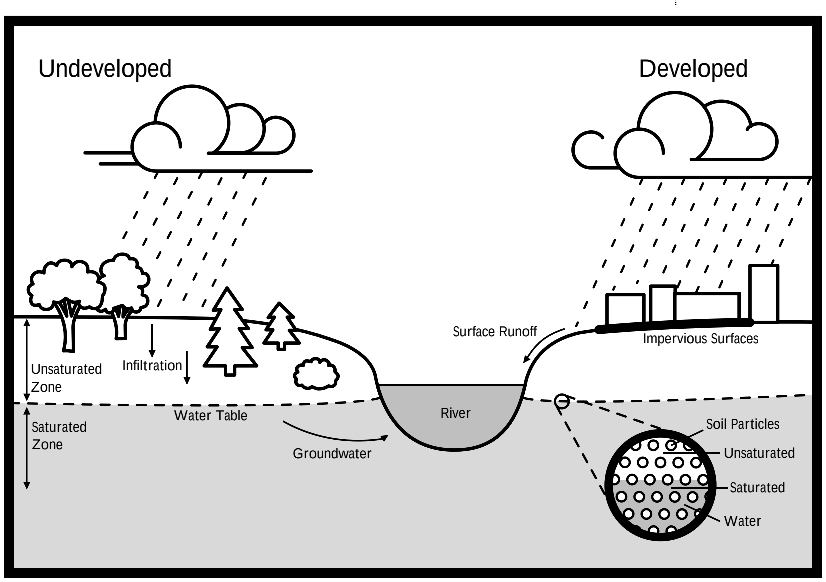


Figure 6: On undeveloped land, rainwater soaks into the ground, or vegetation intercepts it, resulting in very little surface runoff. On developed land, impervious surfaces prevent infiltration and water runs off the surface. Note the groundwater feeding the river, on the left side, providing a stable, cool flow of water. And on the right, the surface runoff provides a rush of water to the river right after a rainstorm.

Why is infiltration important?

- The process of infiltration can help water quality. Many soils can filter out some types of pollutants as water moves through them. The degree of purification depends on the size and type of pollutant in the water and the type of soil it is traveling through. For example, soil can filter out many kinds of bacteria and prevent them from reaching groundwater.

- The process of infiltration can contribute water to underground water supplies. To learn more about how this works, see the Soil Water Storage section on page 10.

- The process of infiltration can provide a stable, cool flow of groundwater to streams and rivers.

Landscape Job #2: INTERCEPTION

Interception is what happens when precipitation (rain, snow, sleet, etc.) is caught (or intercepted) by vegetation (Figure 7). During a rainstorm you've probably seen rain wash down the pavement or carry mud down a dirt road. Have you noticed in the woods how little rain flows across the forest floor? In fact, for a while after the rain begins, you remain quite dry under the trees. The movement of water during a storm is very different before the land is cleared of trees and bushes. Much of the rain is caught by the vegetation, except in very heavy storms. In an undeveloped watershed interception is provided by woods and other areas with lots of vegetation like prairies and shrubby areas.

Why is interception important for water quality?

Interception by vegetation reduces the mechanical power of rain to cause soil erosion. Rain that does get to the forest floor usually trickles down gently. In addition, vegetation has extensive root systems that hold soil in place, helping to prevent erosion.

Did you know?

Soil Erosion and Water Quality

Rain falling on bare soil wears away this precious soil. Did you know that soil erosion leads to one of the biggest pollutants for rivers and streams-mud? Yes, everyday old mud can be a pollutant. Large quantities of mud can be a problem because when they reach water they:

- Increase treatment costs for drinking water
- Clog the gills of fish, insects, and other animals, making it harder for them to breathe
- Cover food supplies on the bottom of water bodies
- Cover eggs laid by fish and other creatures, preventing them from hatching
- Carry with them other pollutants, such as pesticides, making water unsafe for humans and other creatures
- Block light from reaching beneficial plants that live underwater
- Absorb the sun's heat and thereby warm up the water to the point where sensitive and beneficial species can no longer live there

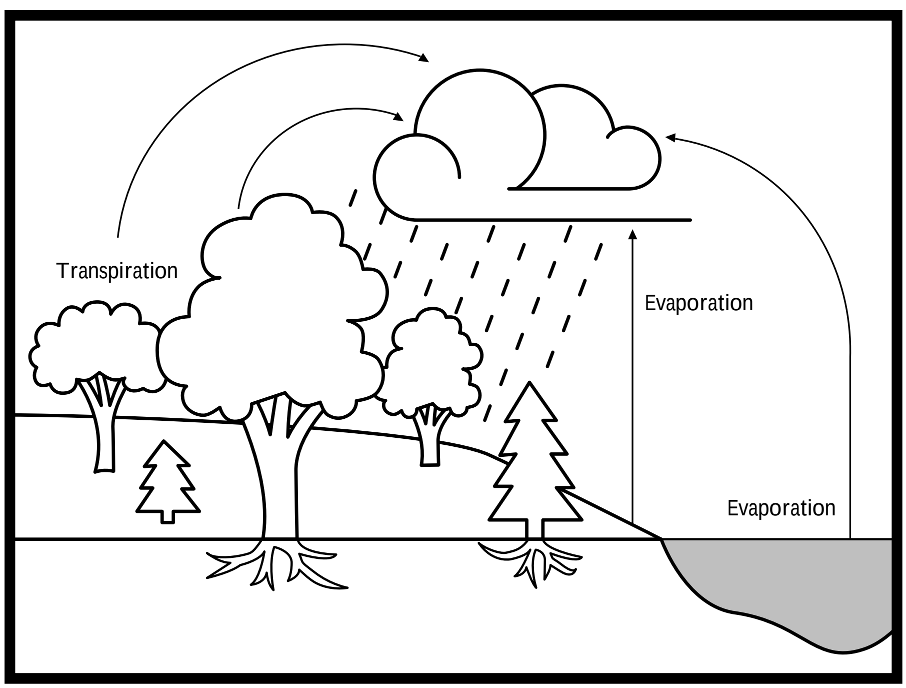


Figure 7: Vegetation intercepts rain and reduces soil erosion.

Landscape Job #3: STORAGE

The landscape has a tremendous capacity for storing water in a variety of ways. Storage provided by the land can take many different forms. Water can be stored in different states—as ice, snow, or liquid—and it can be stored for varying lengths of time—from days to years to decades. There are essentially two ways that land stores water:

• Surface water storage
• Soil water storage

Surface Water Storage

Surface storage is provided by depressions on the surface of the landscape that hold water. Surface storage areas can be as small as puddles or as large as the Great Lakes. Lakes, ponds, puddles, bogs, swamps, reservoirs, and marshes are all surface storage areas (Figure 8). Surface storage areas have storage periods ranging from temporary, to seasonal, to permanent. A puddle may hold rainwater for a day or two until it evaporates, some wetlands may hold water only in the wet season, and a lake or reservoir may hold water for many years.

Surface storage areas are often connected to the groundwater beneath them (see Figure 10). Water can travel out of them and into the ground (see Figures 5 and 6) or water can travel into them from the ground, as in a spring-fed lake.

What services do surface storage areas provide?

- During and after a heavy rainstorm, surface storage areas often hold excess water, which prevents flooding downriver.

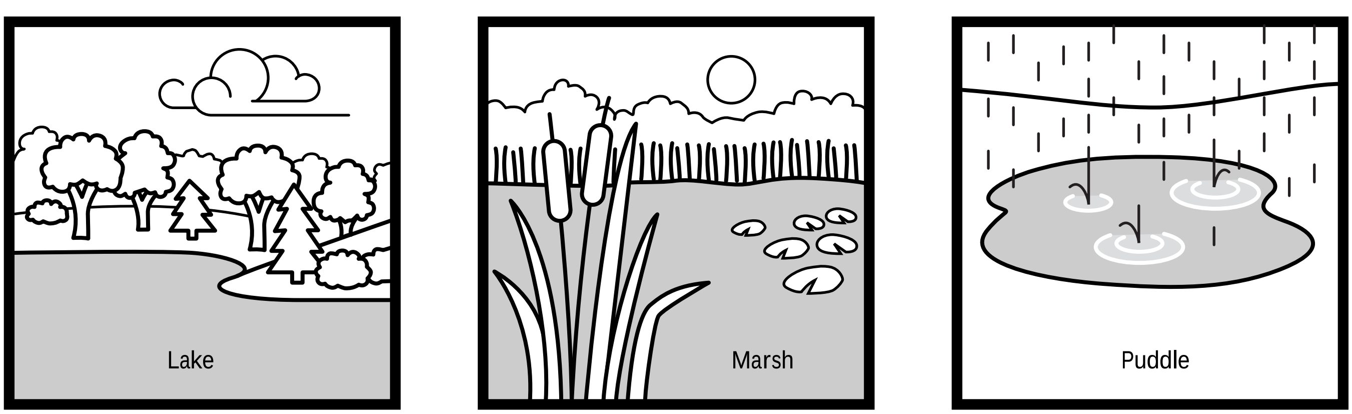
- Many surface storage areas hold water for long periods of time, which allows sediments, like mud, to settle out. See the previous section on soil erosion to learn more about why sediments in water can be a serious problem.

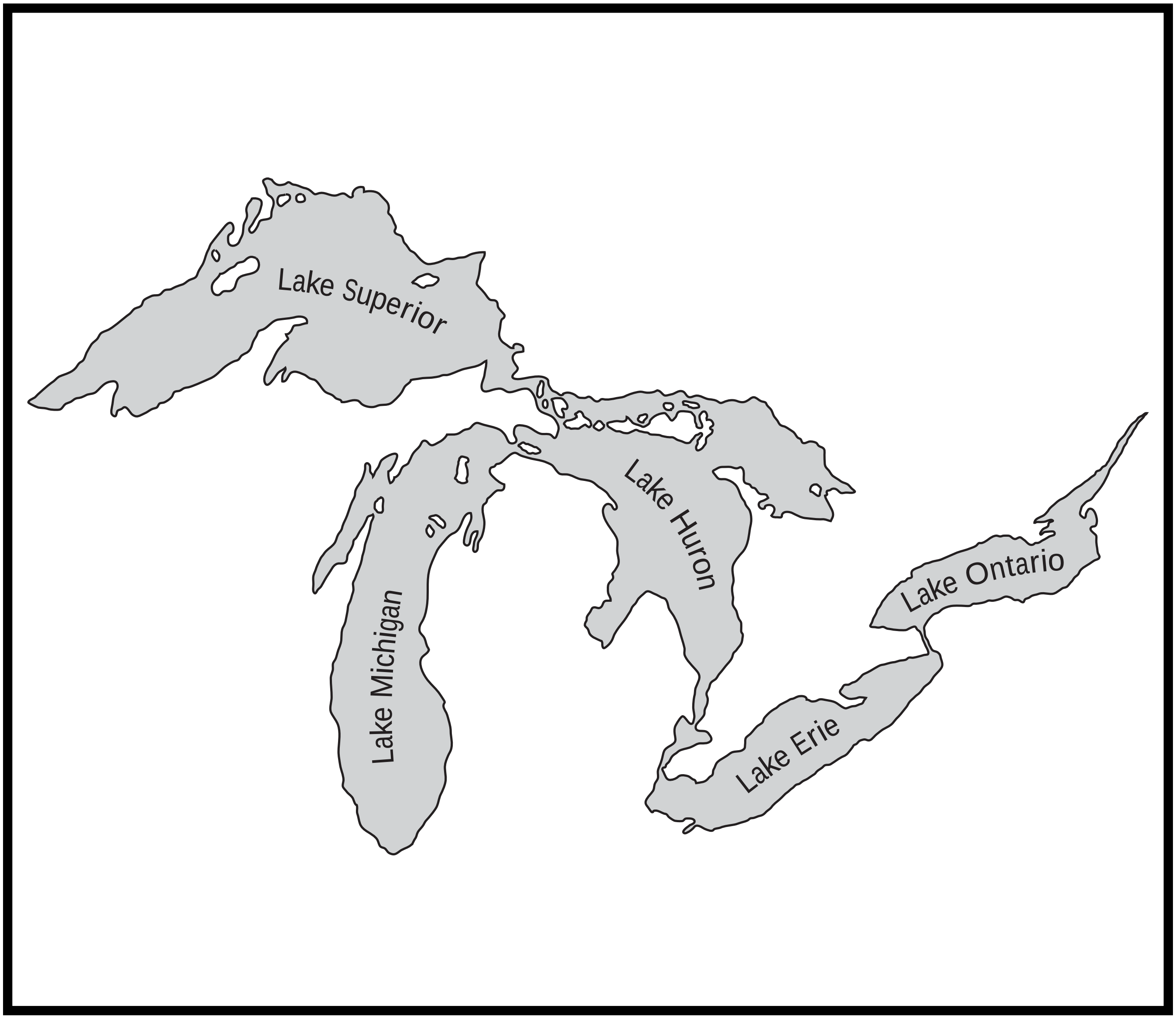
- Some surface storage areas contribute water to underground water supplies.

- Many surface storage areas provide sources of drinking water.

> ## Did you know?
>
> The largest natural surface storage area in the Huron River Watershed is Portage Lake.
>
> Collectively, the Great Lakes basin is the largest fresh-water surface storage area in the world. It holds 20% of the world's fresh surface water.

Figure 8: There are many different forms of surface storage areas. Some hold water for a day, others for a season, and still others hold water for many, many years.





The five lakes that make up the Great Lakes basin: Huron, Ontario, Michigan, Erie, Superior. The Great Lakes basin is the largest freshwater surface storage area in the world.

Soil Water Storage

While some water is stored on the surface of the land, the bulk of the precipitation that falls on the landscape soaks into the ground and is stored in the soil. Water moves into and through the soil by the infiltration process described earlier.

Once water enters the soil two things can occur:

- It may be taken up by the roots of plants
- It may move down further into areas referred to as the unsaturated and saturated zones

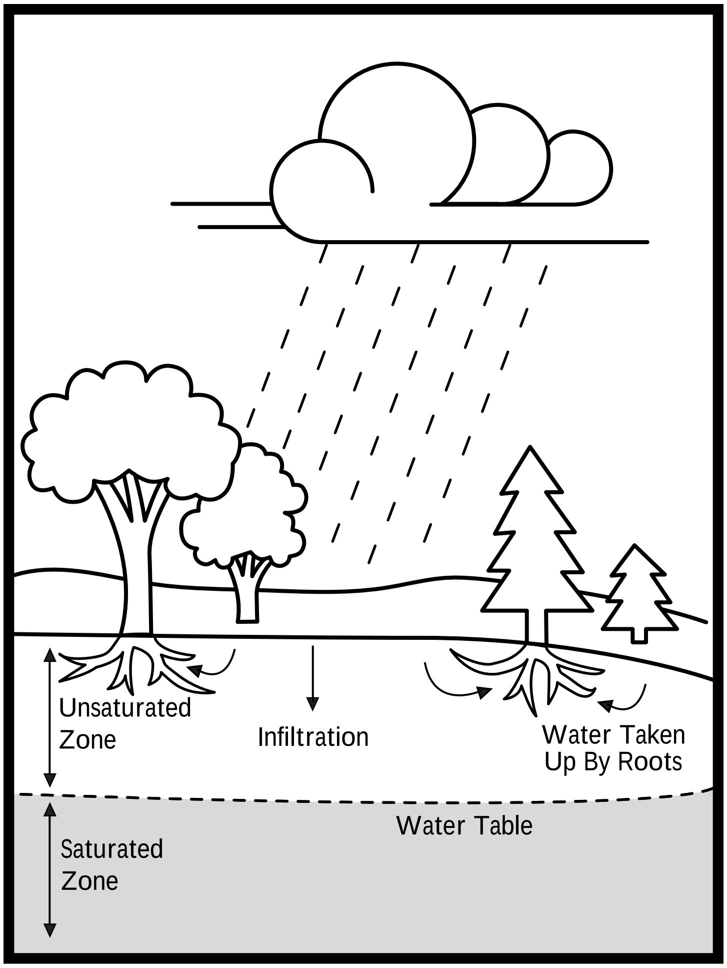


Figure 9: When water enters the soil it is either taken up by the roots of plants or infiltrates down to the saturated zone.

What is the saturated zone?

Soils are said to be saturated when freshwater entirely fills the spaces between clay, sand, gravel, and rock particles underground. Water in the saturated zone is referred to as groundwater.*

Many Huron River Watershed residents use groundwater as their drinking water. Maintaining the quality and quantity of our groundwater is therefore very important. In Chapter Two we will learn about ways to protect groundwater through planning. The information on the next two pages provides a framework to help communities understand groundwater storage so they will be better able to protect it.

**Some people find this terminology confusing. They argue that literally speaking, water in the unsaturated zone is groundwater in the sense that it is water stored in the ground. However, groundwater is actually a technical term and refers only to water in the saturated zone.*

What is the unsaturated zone?

Unsaturated soils have some air in the spaces between the soil particles. Storage of water in the unsaturated zone is usually temporary. Eventually the water is either taken up by plants or it moves down (infiltrates) to the saturated zone (Figure 9). Groundwater recharge is the process whereby water moves from an unsaturated zone to a saturated zone, or directly from a surface storage area to a saturated zone (Figure 10).

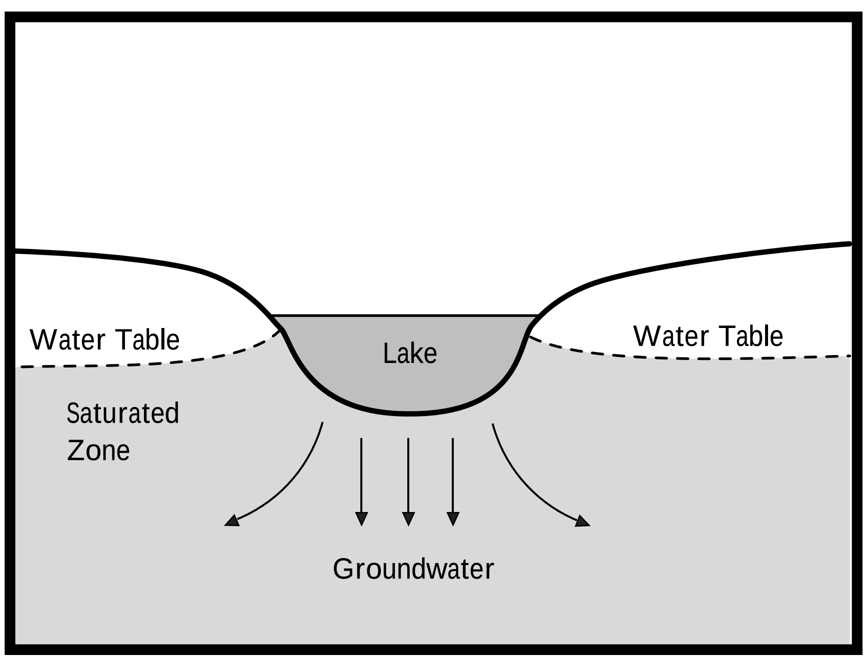


Figure 10: Surface storage areas, like lakes, can recharge groundwater. The opposite is also true: often groundwater migrates to surface storage areas and supplies them with water.

Groundwater Resource Sheet

Depth to Groundwater

The top of the saturated zone is called the water table. (Remember, all the water below this point is groundwater.) The water table line marks the upper surface of groundwater storage. Just as lake levels go up and down with seasons and water availability, so does the water table and hence groundwater availability. The height of the water table (how far down it is from the surface) also varies from place to place. In dry areas such as deserts, the saturated zone may be thousands of feet down. In Michigan, the water table can be at the surface (some of the lakes we see are just surface expressions of the groundwater) or hundreds of feet down, depending on the season and where you are.

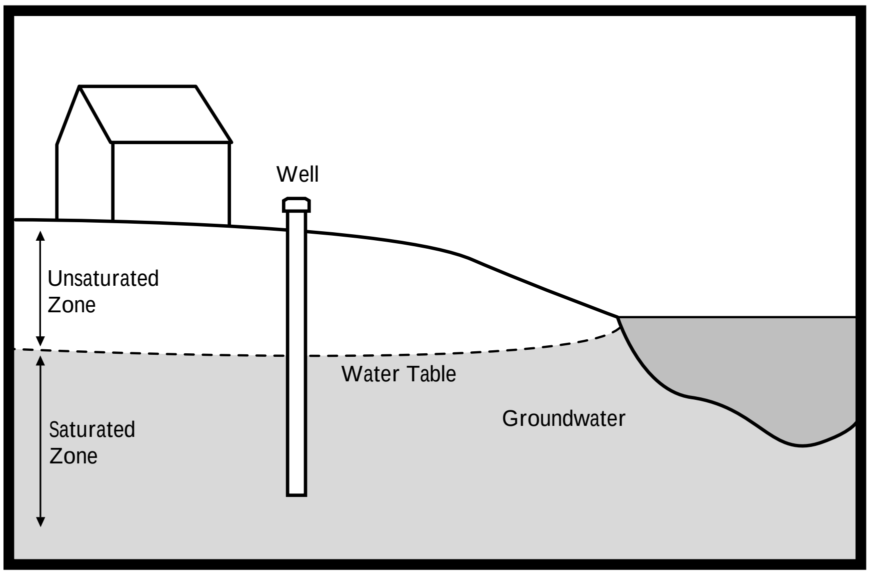


Figure 11: When people drill wells they need to drill down until they find the water table and then drill even further, because the depth of the water table can vary with the seasons.

Quality of Groundwater

Many people use groundwater as their primary source of drinking water (Figure 11). Thanks to the process of infiltration, groundwater is usually high quality water. The process of infiltration can help water quality because many soils can filter out some types of pollutants as water moves through them. The degree of purification depends on the size and type of pollutant in the water and the type of soil it is traveling through.

Movement of Groundwater

Although we refer to groundwater as water that is "stored" in soil, it is actually moving, albeit very slowly. The rate of groundwater flow can range from a foot a day to a foot a decade. Groundwater flows from areas of recharge to areas of discharge. A recharge area contributes water to underground water supplies. A discharge area receives groundwater from springs. Whether an area provides recharge or discharge depends on a variety of factors, including geographic location, soil type, precipitation, and time of year.

Wellhead Protection

If your community supplies drinking water to its residents from municipal wells, you should have a Wellhead Protection Program. Communities in this program are working to protect the groundwater that supplies municipal drinking water. These communities are working to understand the sources of the groundwater that provides drinking water; to learn about the potential sources of contamination of the local water supply; to find ways of managing these sources in order to protect drinking water; to plan for drinking water emergencies; and to educate the public about their drinking water and what they can do to protect it.

Groundwater Resources

- About half of the Huron River Watershed's residents use groundwater as their drinking water.
- Groundwater contributes a significant amount of water to many lakes, rivers, and wetlands in Michigan. During dry summer months, groundwater often provides the only source of water to these surface water bodies.
- Michigan's world famous trout streams are sustained by a plentiful supply of groundwater.

To recap, there are two things that can happen to rainwater once it moves into the soil:

- Water can be taken up by roots of plants
- Water can move into the unsaturated zone or into the saturated zone where it becomes groundwater

Landscape Job #4: TRANSPORT

Transport includes all the ways that water moves over and through the land and how it gets back up to the atmosphere. There are three main types of transport:

- Runoff
- Channel transport
- Transpiration and evaporation

Runoff

Runoff is water that flows downhill across the surface of the land and into rivers, lakes, streams, and other water bodies. Runoff occurs when the land can't store any more water in soil and/or surface storage areas. Actually, in an undeveloped watershed, runoff is rare. It must rain very long and hard before all the storage capacity of the land is filled. Runoff is much more of a problem in a developed watershed; we'll learn why when we talk about the changes people make on the landscape.

> **Did you know?**
>
> 27,200 gallons of water fall on a one-acre area in a one-inch rainfall.

Channel Transport

Channel transport is a fancy name for the job performed by rivers, streams, creeks, drains, and any other water bodies that form channels on the land and move water. These systems form major transportation networks for water movement. They move water and sediments across land from higher to lower elevations.

> **Did you know?**
>
> The Huron River drains 908 square miles of land! This is an area the size of about 581,000 football fields.

Transpiration and Evaporation

We've talked about how water moves across the land and how it is held on the surface of the land and underground. Eventually some of this water must return to the atmosphere where it will become precipitation and eventually fall back down to earth completing the water cycle. How does water get back up to the atmosphere? There are two major ways: transpiration and evaporation (Figure 12).

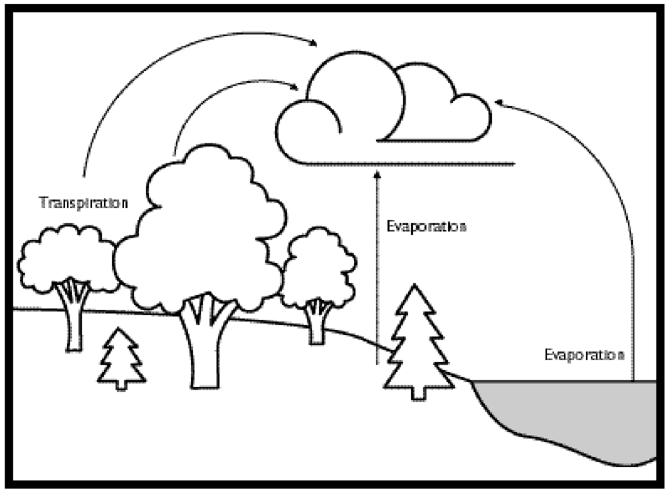


Figure 12: Transpiration and evaporation

- Transpiration is the process by which water leaves a plant. Trees and other plants take up some of the water that is stored in soil. More than 90% of the water they take up is ultimately lost to the atmosphere; most of this loss occurs when water evaporates from the surface of their leaves.

- Evaporation is the process by which water leaves surfaces other than plants, such as the ground, and returns to the atmosphere.

> **Did you know?**
>
> The general process of water leaving natural areas and returning to the atmosphere is often called evapotranspiration.

The Role of Natural Features in the Water Cycle

This next section will explore the natural features that do the landscape jobs we've just described.

What are natural features?

Up to this point we have referred to land simply as "the landscape." However, there are features on the landscape that help it perform its jobs. In this workbook, we will use the term "natural features" to refer to features on the land that play important roles in the water cycle.

A Brief Introduction to the Natural Features in the Huron River Watershed

- Woodlands (one of the vegetated areas) include hardwood forests of deciduous trees such as oak,maple, hickory, ash, birch, etc. and evergreen forests (Figure 13).

- Prairie remnants, meadows, and other areas with substantial vegetative cover (also referred to as vegetated areas) are open sites dominated by grasses and other vegetation, with few shrubs or trees (Figure 14).

- Surface waters include standing water bodies– lakes, ponds, and wetlands**– and flowing water bodies -rivers, creeks, and streams (Figure 15).

***The term "wetlands" is an umbrella term that includes many natural features. Wetlands are commonly defined as areas having:*

- *Soils that are saturated for part of the growing season*
- *Plants that can grow and reproduce in saturated soils*

Michigan's wetland laws clump the many different wetland types into three categories: marsh, swamp, and bog. Marshes have open water areas and usually dry down for part of the year, swamps are wooded wetlands, and bogs have peaty soils and acidic waters. For more information on wetlands see A Homeowner's Guide to Wetlands, Tip of the Mitt Watershed Council, 1997.

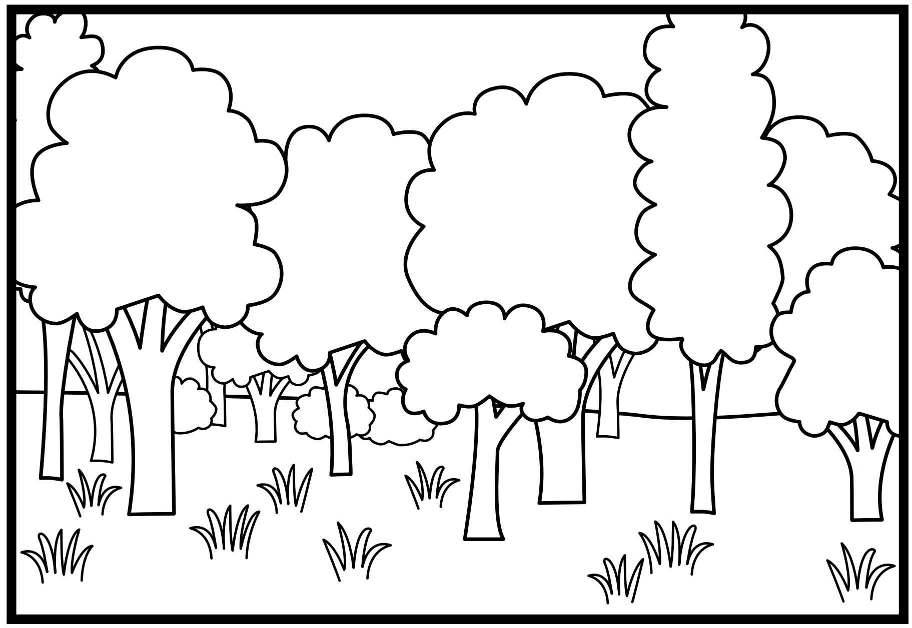


Figure 13: Woodlands

Figure 14: Prairies, meadows

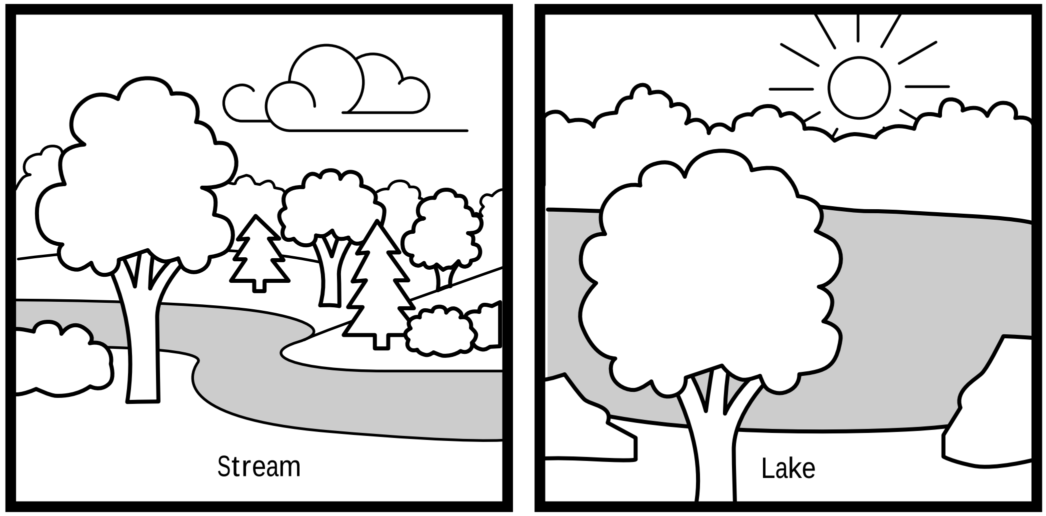
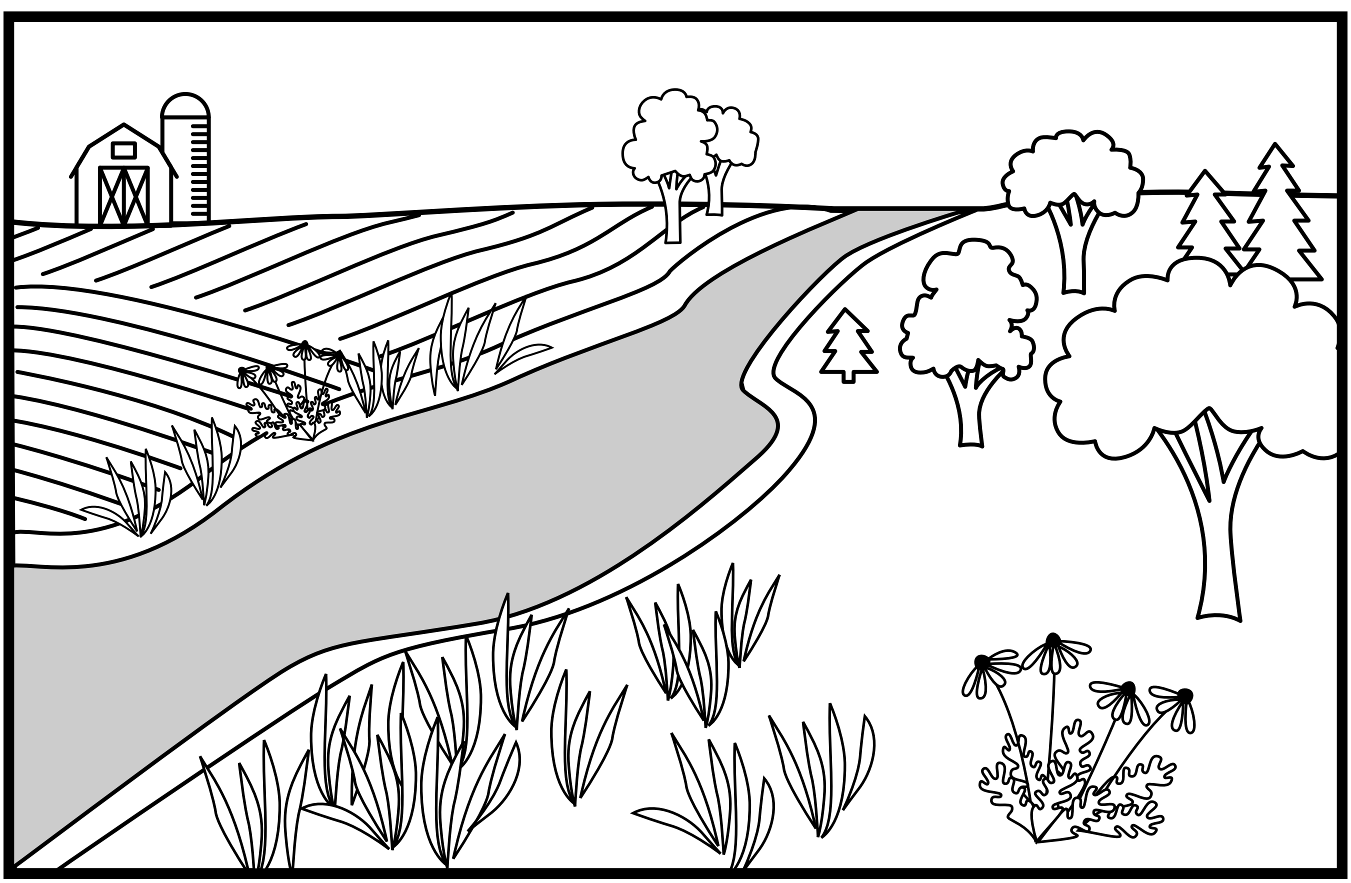


Figure 15: Surface water

- Floodplains are broad, flat lands along a river or stream that normally become inundated during floods, resulting in the deposition of sediments.

Figure 16: Floodplain



The Roles of Vegetated Areas

An important characteristic shared by woodlands, prairie remnants, meadows, and wetlands is the presence of substantial vegetative cover. We'll look at three important roles of vegetated areas in the water cycle, namely reducing erosion, filtering water, and returning water to the atmosphere.

1. *Reducing erosion*
Erosion is a process by which material is worn away from the Earth's surface. It is a naturally occurring process, but sometimes our actions accelerate the amount of erosion that occurs, and this can cause problems for water resources. (Refer to the earlier section on soil erosion and water quality to find out why erosion can cause problems.)

Vegetation helps to reduce erosion by water in several ways:

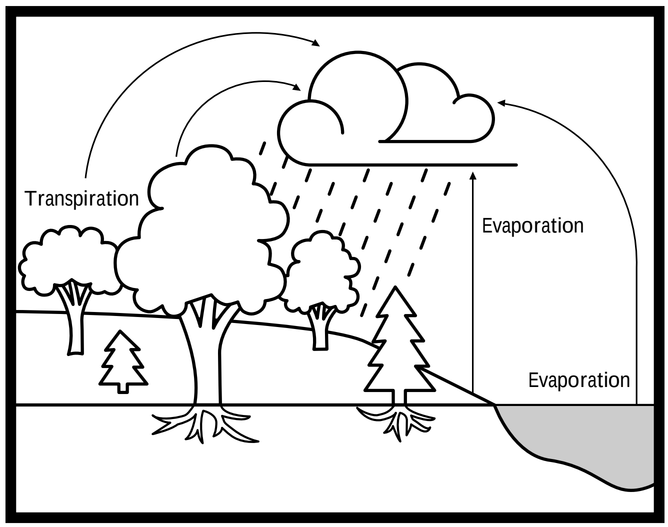
- Interception-Vegetation "catches" precipitation, breaking its fall and thereby reducing its power to erode
- Soil stabilization-The network of roots helps hold soils in place
- Slowing water down-It slows the flow of water across the land, which helps to reduce the power of the water to cause erosion

2. *Filtering water*
Vegetation can filter runoff and clean it by:

- Slowing flow-Slowing down the flow of runoff allows some sediments to settle out or become trapped in the vegetation
- Using nutrients-Vegetation can take up some nutrients in the runoff and prevent them from running into waterways (See "Did you know?" box below.)

3. *Returning water to the atmosphere*
Vegetation can return water to the atmosphere by transpiration, when water evaporates from the surface of trees' and plants' leaves.

Evaporation is the process that happens when water turns from a liquid to a vapor and rises up into the atmosphere. Transpiration is a technical term that refers specifically to evaporation that occurs on the leaves of vegetation. Trees and other plants take up water that is stored in soil. Most of the water they take up is returned to the atmosphere when water evaporates from the surface of their leaves (transpiration).



Vegetation performs several roles including returning water to the atmosphere.

Did you know?

Nutrients and Water Quality

Excess nutrients can cause two main problems:
- Oxygen depletion
- Eutrophication

Oxygen depletion in water occurs because excess nutrients result in an increase in plant growth. With this excess growth comes a corresponding increase in plant decomposition. The decomposition process takes more oxygen than the plants produce (remember plants take in carbon dioxide and release oxygen) and this results in oxygen depleted water. Aquatic life suffers because the animals that live in water need oxygen to live.

Eutrophication is also the result of increased plant growth. As plant growth accelerates as a result of the excess nutrients, plants fill in the banks, open water areas shrink, and gradually the waterway gets filled in.

The Roles of Surface Waters and Floodplains

Surface waters not only store water, but they move it across the landscape. These waters provide valuable services. Surface waters and floodplains:

- Provide a drainage system for the land
  Rivers, streams, creeks, and drains form channels on the land and move water. These systems form major transportation networks for water movement. They move water and sediments across land from higher to lower elevations.

- Store flood waters
  Lakes, wetlands, and floodplains store flood waters in times of excess precipitation. When a river overflows its banks, the floodplain holds the excess water and slowly releases it back into the river system. Sediment is also deposited in floodplains, keeping it out of the river.

- Trap sediments
  Lakes, wetlands, and floodplains also trap sediments carried in water and allow them to settle out.

Here is a little review. See if you can decipher the landscape jobs described below.

WORD SCRAMBLE

Can you decipher what happens to the rain?

Landscape Jobs

1. Some precipitation is caught by vegetation.
   TCEPRIENOINT

   ____

2. Some precipitation is held in soil.
   LOSI TOARSGE

   ____

3. Precipitation that soaks into the ground filters through the soil.
   ATINILRTIONF

   ____

4. Some precipitation fills up water bodies on the surface of the land.
   ESURAFC TOARSGE

   ____

5. Some precipitation flows across the surface of the land.
   ORFUNF

   ____

6. Some precipitation is used by plants and returned to the atmosphere.
   IATANSIRTONRP

   ____

ANSWERS:

1. Interception 2. Soil Storage 3. Infiltration 4. Surface Storage
5. Runoff 6. Transpiration

Summing Up

The landscape jobs you've just learned about and deciphered in the word scramble—infiltration, interception, storage, and transport-are the jobs we need to protect if we want to protect water resources. It is clear that the natural landscape and the natural features on it are very cost-effective water resource managers. They "manage" water by storing it, filtering it, replenishing underground drinking water supplies, and feeding water bodies with runoff and groundwater. In fact, if we keep them intact, they do the job for free!

If the landscape were "managing" water perfectly in the Huron River Watershed there would be no need for this workbook. However, we have not yet discussed the impact of people and their actions on the land. In the next section, we'll talk about the ways people have changed land in the Huron River Watershed and how our changes affect the ability of the land to perform its water cycle jobs.

Our Role in the Water Cycle

Introduction

The landscape description earlier in this chapter doesn't take into account the actions of people on the land. People interact with the landscape and change it in many ways. The development we introduce has many impacts on the way the landscape performs its water cycle jobs. This section is broken up into four parts. We'll talk about how the landscape changes as a watershed becomes developed and what the consequences of these changes are for water resources. We will examine:

- Developing Watersheds: Moving from Natural Features to "Human Features"
- The History of Land Use Change in the Huron River Watershed
- How We Change the Landscape: Development Trends
- What Do the Changes Mean for Water Resources?

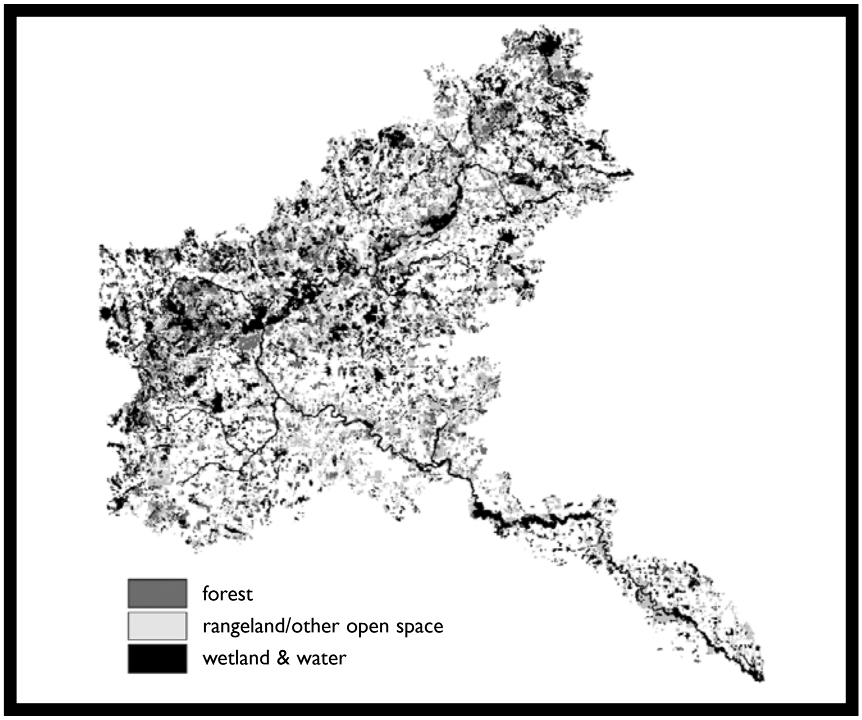


Figure 18: Current land use in the Huron River Watershed

Developing Watersheds: Moving from Natural Features to Human Features

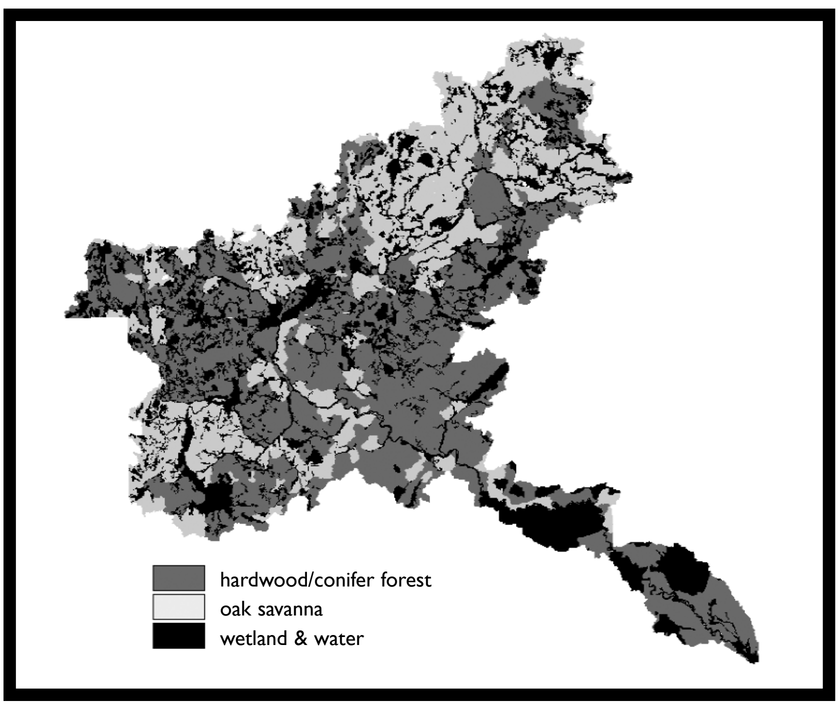


Figure 17: Pre-settlement natural features in the Huron River Watershed

Undeveloped Watershed: Landcovers in the Huron River Watershed

In this map (Figure 17) of the Huron River Watershed you can see what natural features covered the land before European settlers moved into the area.

The map in Figure 18 shows how the land looked in 1995. Think of all the landscape jobs that have been lost!

In comparing these two maps of the Huron River Watershed, notice we have retained some of the natural features that existed before the watershed was settled by Europeans, and we have replaced some of them with "human features" represented by the white areas on the map in Figure 18. Human features are land uses introduced by people. They include residential, commercial, industrial, recreational, and agricultural uses. Local land use laws decide where different land uses will be located. In Chapter Two we will look closely at some of these land use laws.

From here on our discussion will talk about how the water cycle works in watersheds that have these human features as well as natural features.

The History of Land Use Change in the Huron River Watershed

When we talk about pre-European settlement we refer to a time before the early 1800s. The last two centuries have seen dramatic changes to the land. Waterways have been dammed for power and mills, wetlands have been drained to grow crops, and we have paved over large areas of land to build houses, roads, and businesses. In the last thirty years southeast Michigan has experienced major growth and development and these pressures continue. In comparing figures 17 and 18 you can see the changes in land use over the last 200 or so years.

Land Cover/Land Use in the Huron River Watershed

	early 1800s	**1978**	**1995**
Natural Features (as a percentage of total land cover)			
Deciduous forest	45%	12%	11%
Prairies/grassland	29%	1%	1%
Non-forested herbaceous			17.5%
Lakes and streams	3%	2%	4.6%
Wetlands	23%	11%	12.5%
Land Use			
Urban and suburban	0%	8%	26.7%
Agricultural	0%	66%	26.7%

Note- The urban and suburban land use category includes residential, commercial, and industrial lands. Also, the non-forested herbaceous category may include some prairie remnants and grasslands, but also includes fallow agricultural fields.

Do you know what the natural feature/land use mix is in your community?

Land Use
  Urban and suburban _____%
  Agricultural _____%

Land Cover
  Deciduous Forest _____%
  Lakes and Streams _____%
  Wetlands _____%
  Barren _____%
  other _____%

If you're not sure, go ahead and guess. You will learn how to find out in Chapter Two.

How We Change the Landscape: Development Trends

How do we alter the landscape with residential, commercial, industrial, and agricultural development? How do these changes impact the landscape's ability to perform its water cycle jobs? A closer look at some common development trends should help to answer this question.

In this section we'll look at two traditional development trends that are occurring in the Huron River Watershed. We refer to these development practices as "traditional" only in the sense that they represent the most common ways development has occurred in recent years. There are alternatives to these trends. They will be discussed in some detail in Chapter Two. The trends we will discuss here are:

- Losing Natural Features
- Paving Paradise

Development Trend 1: Losing Natural Features

There are a number of landscape changes that are associated with residential, commercial, industrial, and agricultural land uses. We will focus on two of the most common alterations of land:

- Clearing land of vegetation
- Draining and/or filling surface storage areas

Clearing Land of Vegetation

Whether the proposed land use is a residential subdivision, industrial park, retail area, or cornfield, the first step of development is almost always the same. Most or all of the land area is cleared of vegetation. Woodlands, meadows, and shrubby areas are all removed.

If your community is currently experiencing development you may have noticed this trend. Often the natural features we lose when we clear land are replaced with lawns.

Development also often builds right to the edge of water bodies. When this happens the natural buffers for the water are gone.

How does clearing the land of vegetation affect water cycle jobs?

In a nutshell, we lose the functions that vegetated areas provide. The water cycle jobs we lose are:

- Erosion control
- Water filtration
- Water return

Draining and/or Filling Surface Storage Areas

During development, surface storage areas like wetlands and floodplains are often drained or filled. In order to make Michigan more hospitable to settlers, the Michigan Drain Code was enacted and provided a means for wetlands and other areas to be drained so they could be settled and farmed. Development has also often resulted in filling wetlands to provide suitable conditions for building.

What are the results of draining and filling?

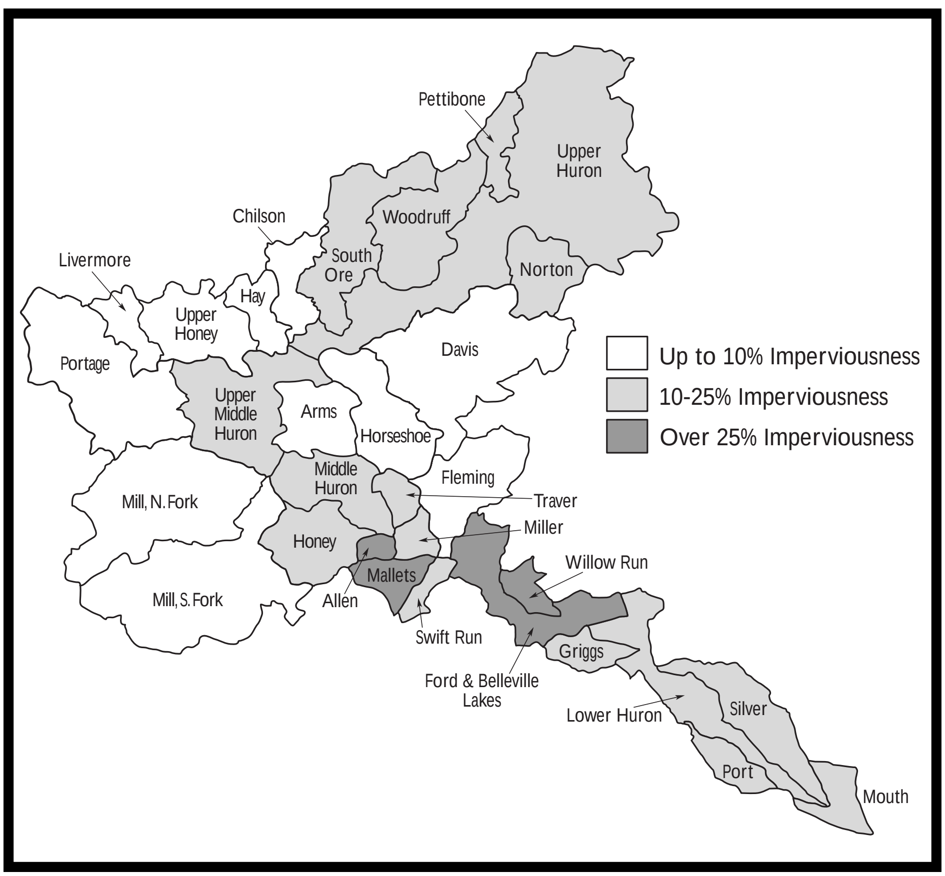
With these actions many landscape jobs are lost in one fell swoop. Draining and filling both reduce the land's capacity to store water. Water that would have been held will now become runoff.

Development Trend 2: Paving Paradise

An impervious surface is any surface that stops rainfall from soaking into the ground. Roads, parking lots, sidewalks and rooftops are impervious surfaces. Even soils can become compacted and impervious. General trends indicate that more people in a watershed almost always leads to more impervious surfaces because we build more roads, houses, and parking lots.

Do you know how much of the land in your community is covered with impervious surfaces? The map in figure 19 shows impervious surfaces in the Huron River Watershed in 1995. It illustrates the trend we just described. The dark areas are the most populated areas in the watershed and they have the greatest amount of impervious surfaces.

Figure 19: Imperviousness in the Huron River Watershed



How does paving affect the landscape jobs?

Figure 20 shows that as we develop watersheds we decrease the amount of infiltration that can occur. Water that falls on the land is

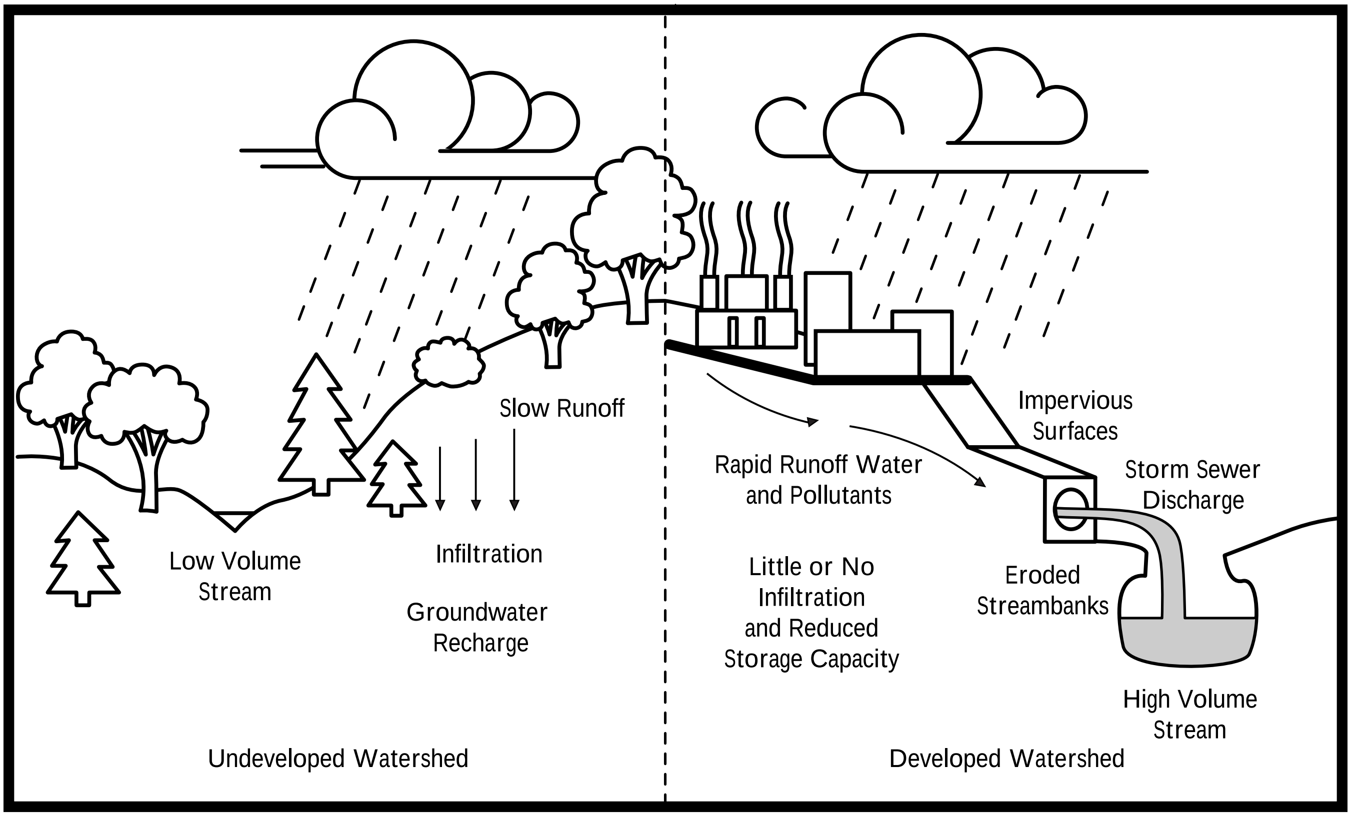


Figure 20: Less infiltration results in less soil storage and more runoff.

blocked by impervious surfaces. Reduction in infiltration leads to less storage. Reduction in infiltration and storage capacity results in a large increase in the amount of runoff that occurs every time it rains. This is because all the water that is not allowed to infiltrate becomes runoff.

> **But what can I do about it?**
> At this point you may be wondering whether you have any control over the loss of natural features and the amount of impervious surface in your community. The answer is yes! Chapter Two will show you how.

What Do the Changes Mean for Water Resources?

By now you've probably gotten the point: The water cycle changes when we include the actions of people on the landscape. We've talked a lot about the changes that occur but we still need to discuss what the changes mean for the health of our water resources.

Let's revisit the ability of land to manage rain. Remember we learned that in a less developed watershed, land and the natural features on it manage water very efficiently.

- Some stormwater is intercepted and taken up by forested areas. These areas reduce the power of rain to cause erosion.
- Some stormwater soaks into the ground and may eventually replenish underground drinking water supplies, and some is held in surface storage areas such as wetlands.
- When all these storage areas become full, the remaining water, which is usually a small percentage of the original rainfall, flows over the land as runoff. The land it flows across is covered with vegetation and so the runoff remains clean.

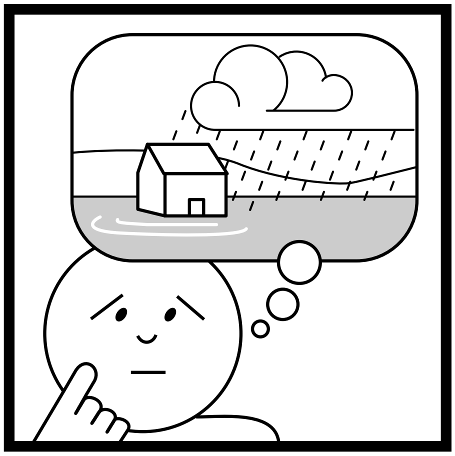
In a developed watershed the natural landscape is often significantly altered.

- Impervious surfaces prevent water from soaking into the ground.
- Important vegetation areas, such as woodlands, are cleared for new development.
- Surface storage areas, such as wetlands, are commonly filled or drained.

• Surface storage areas, such as rivers, lakes, and streams, are overtaxed and cannot store all the water that is flowing into them.

The overall ability of land to manage water from storms is changed as a result of these alterations. The water cycle jobs are not being done well because the natural features that help to perform the jobs have been impacted by human alteration of the landscape. There are several major consequences for water resources. Let's take a look around the Huron River Watershed to see how water resources are being impacted when it rains.

"The river hardly ever used to get this high. What has changed?"



Why are there more floods?

Scientific studies of recently developed watersheds have reported some startling results. Some studies found areas that in the past experienced one flood every five years and are now facing five floods in one year. The average number of precipitation events per year has not changed. Many urban and suburban areas are also experiencing higher and more intense flows each time it rains. What is causing these changes?

In developed watersheds, flows are higher because more water is running off each time it rains. Instead of soaking into the ground and reaching water bodies slowly (as a mix of groundwater and a little runoff), most stormwater now reaches water bodies as runoff. Runoff travels across the land rapidly and enters water bodies shortly after a storm event.

Thus:

- Water bodies receive a greater volume of water at one time.
- Channels aren't shaped to hold the new larger amounts and banks flood.
- Runoff water also has greater velocity, because it is not slowed by vegetation, and therefore more power to scour and erode as it moves.

What are the costs of increased flooding?

- Loss of life
- Expensive flood damage to property, including loss of property and loss of frontage
- Damage to stream banks, bridges, and road crossings
- Stream channels scoured by powerful floodwaters, increasing erosion and destroying habitat for many fish species
- Loss of valuable topsoil, often resulting in increased fertilizer use

"I thought rainwater was clean. Runoff is just rainwater so why is everyone saying that it's a source of pollution?"

Why is runoff a concern?

In developed areas runoff is often a serious source of pollution. The water quality of runoff is determined by the condition of the landscape it flows over. Impervious surfaces in urban and suburban areas tend to collect many different pollutants, including soil, nutrients, pesticides, herbicides, animal wastes, oil from cars, and metals. Runoff flows over these impervious surfaces, picks up the pollutants that accumulate there, and delivers them to nearby water bodies.

Often, stormwater is collected from parking lots, rooftops, and roads, and piped directly, without any treatment, into water bodies.

As water flows over these impervious surfaces, it also heats up quickly. As a result, water that is warmer than it would be if it were slowly filtered is delivered to water bodies. Many of the plants and animals living in the water depend on cool, oxygen rich water.

What are the costs of lost water quality?

- Increased costs to treat community drinking water
- Public health concerns
- Lost recreational potential
- Lost fisheries
- Increased levels of contaminants that harm aquatic life
- More nuisance algae blooms

THESE TRENDS ARE NOT INEVITABLE.
YOU CAN HELP TO CHANGE THEM.
CHAPTER TWO WILL SHOW YOU HOW!

What can we do to reduce our impact on the water cycle?

One of the most important tools we have to change land use trends is LAND USE PLANNING. The rest of this workbook will present ways for communities and individuals to reverse these trends using land use planning that considers watersheds and the importance of maintaining a landscape that can perform its water cycle jobs.

What could this type of land use planning look like?

The ABC's of Water Resource Protection

We can protect the water cycle by protecting all the parts. We can start to protect our lakes, rivers, and wetlands by establishing goals for changing the development trends we talked about. The goals could include:

A) Protecting natural features

Identify areas and protect them, guide development elsewhere.

B) Reducing impervious surfaces

Reduce hard surfaces that don't allow water to soak into the ground or have vegetation to slow the flow of the runoff.

C) Where development is to occur, minimizing impacts on the water cycle functions with best management practices

Best management practices are tools that can help minimize our impact on natural features. Most of the best management practices we will discuss enhance the land's ability to manage stormwater. For example, if a development will destroy a surface storage area, it could be replaced by another that performs the same water cycle jobs.

The ABC's represent land use planning that considers watersheds and the importance of maintaining a landscape that can perform its water cycle jobs. Chapter Two will discuss ways to incorporate the ABC's into our growth and development plans.