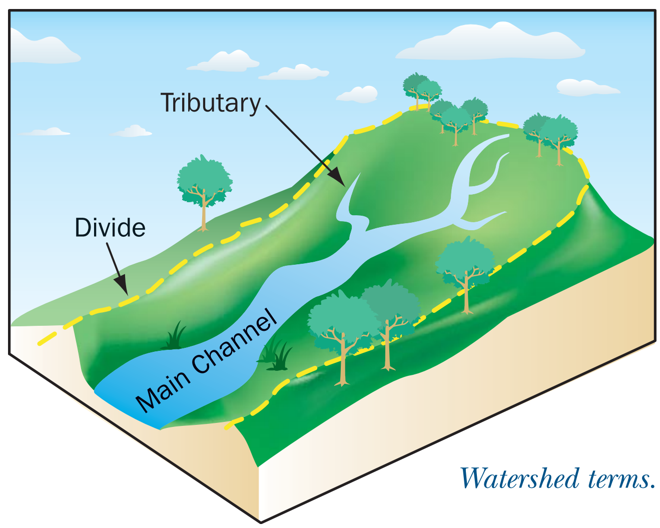
Drainage Improvements

8

Every community has a drainage system, either natural or human-made or, more likely, a combination of both. The drainage system carries surface water from where it falls (or where the snow melts) through channels to a receiving body of water.

This chapter focuses on improvements to local drainage systems. In most cases, these improvements will be applicable to small streams or areas with stormwater drainage problems. The types of drainage projects described here are smaller than flood control projects, and would not be expected to alter a 100-year flow or result in a change in a flood hazard area boundary. However, if communities implement the measures outlined in this chapter, they will see a reduction in overall flooding problems.



Watershed terms.

The Drainage System

Terminology

The setting for the drainage system is the **watershed**.
A watershed is an area that drains into a lake, stream, or other body of water. Other names for a watershed are "basin" or "catchment area." Watersheds vary in size, and larger ones can be divided into sub-watersheds.

The boundary of a watershed is a ridge or a **divide**. Water from rain and snowmelt is collected by the smaller channels, or **tributaries**, which can be natural streams, ditches, or **swales**. Swales are shallow flow areas that may not look like a defined channel. These tributaries collect the surface water and send it to larger channels and eventually to the lowest body of water in the watershed (main channel).

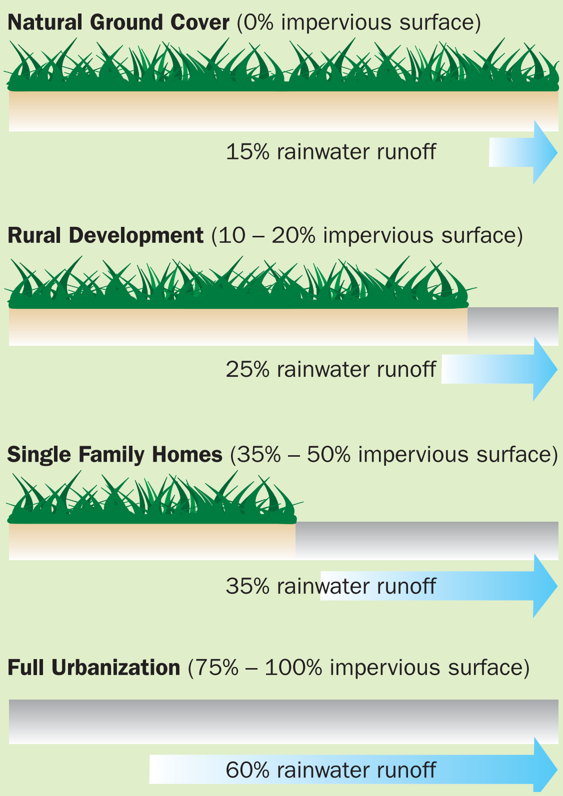
When there is too much surface water, it flows out of the channel and floods the adjacent areas. This scenario can happen along the main channel, where the floodplain may be mapped on the community's Flood Insurance Rate Map (FIRM) as an A Zone. Or, it can happen along the smaller upland tributaries, ditches, and swales, which may not be mapped on the FIRM, but are shown as a B, C, or X Zone.

What happens in a watershed affects events and conditions downstream. In relatively flat areas, shallow, slow-moving flood water may cover large areas of land for days or even weeks. In hilly areas after a heavy rain, a flood may come and go in minutes.

Development and Drainage

If the watershed and its floodplains are undeveloped, water is temporarily stored while the channel is overflowing. This allows excess water to filter into the ground during and after the rain or snowmelt, reducing the amount of water moving downstream.

Stormwater runoff increases as areas are urbanized



Note: These represent findings from land use conversions in the Chicago area. Actual values are site-specific and depend on the initial land use condition, soil type, degree of ground saturation, and the storm's duration.

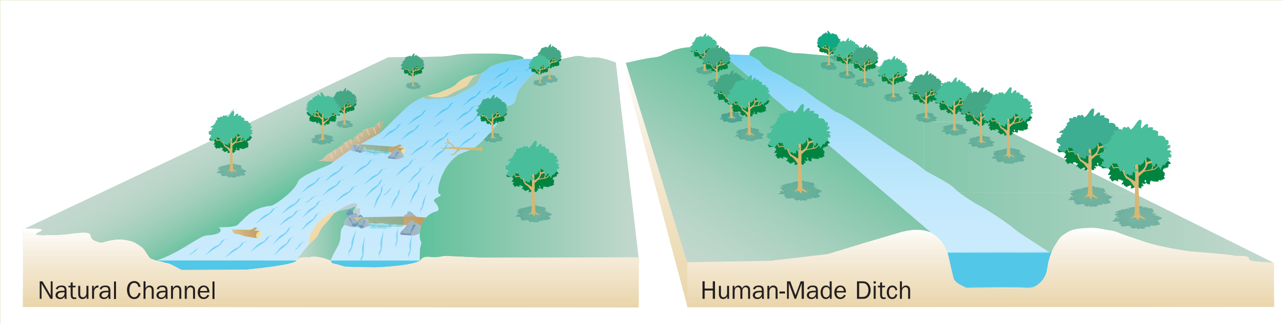
The buildings, streets, and parking lots that accompany human development replace the natural ground cover, which allowed infiltration into the soil, with impervious surfaces, which do not allow water to be absorbed. Storm sewers and ditches collect surface flows and discharge them away from developed sites and into downstream systems.

When rain falls in a natural setting, as much as 85 percent of it will infiltrate into the ground, evaporate, or be absorbed by plants. Human development in the watershed and the floodplains changes the natural conditions of the ground surface. In an urbanized area, as much as 60 percent of it will run off, as illustrated on this page.

The result of urbanization is that there is more runoff in the watershed, which can increase flooding downstream. For example, the amount of runoff from a 5-year rainfall on a developed parcel in the Houston area can be more than the runoff from a 50-year rainfall on the same parcel had it had been left undeveloped; this overloads the drainage system.

Urbanization also changes the timing of flows along the tributaries. After a subwatershed develops, the peak runoff will leave sooner than it used to, possibly arriving at the main channel at the same time as the peak arrives from another tributary, causing increased flooding downstream.

General Channel Types



A community's drainage system is usually a combination of natural and human-made channels and storage basins.

A **natural channel** typically has a wider area in which to flow. Trees and small log or debris jams can be accommodated by minor diversions of flow without causing any problems. In fact, vegetation and minor obstructions that cause riffles and pools are desired in many natural streams because they improve habitat and water quality.

A **human-made drainage ditch** or canal is typically designed to use less surface area to carry more water. These channels need more attention because there is no room to carry overflows caused by blockages. They are not intended to have trees or other vegetation growing in them. In human-made ditches, too much vegetation is considered "debris."

CRS Credit for Drainage System Maintenance, page 9

Conveyance

The drainage system can perform two functions: it carries water away and, during times of high water, it may store water until it can be carried away. The drainage system therefore contains conveyance systems and may contain storage facilities.

Traditionally, human alterations to drainage systems focused on conveyance. People wanted to move water away from a site as quickly as possible. Ditches and storm sewers were built to collect the surface water more quickly and send it to the larger streams. Natural channels were altered to be larger and/or straighter so they could carry more water more efficiently.

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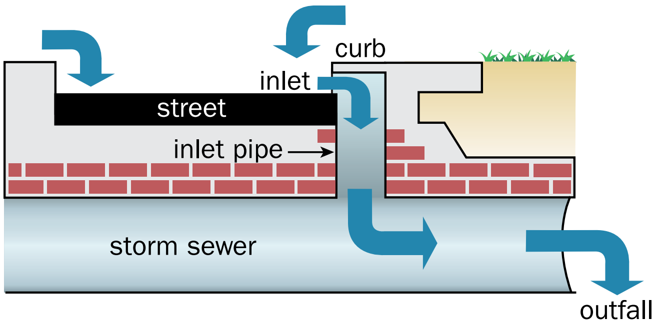
Human-made ditches can carry more water, but they may require more maintenance.

Urban or human-made channels are different from the natural channels. As illustrated here, human-made channels may carry more water, but may need more maintenance to provide proper conveyance. To function properly, it is necessary that they be kept clean and clear.

The urban drainage system also includes storm sewers (i.e., pipes) that carry smaller flows underground. When storm sewers work, the streets and yards are drained quickly. Storm sewers won't work for storms



Storm sewer terminology.

greater than their design specification, or when they are blocked. Typically, neither the storm sewer nor the inlets are designed to handle larger storms, such as the 100-year event; overflow paths should be provided that will protect surrounding buildings from damage.

Blockages can be caused by debris at the inlet, an outlet or outfall that is under water, a broken pipe, or debris or sediment in the pipe (see diagram for terminology).

After a watershed is developed, the natural channels in urban drainage systems have to carry more water for longer periods. As a result, the water scours the channel bottom and banks and increases bank erosion.

In the last 30–40 years, communities have been using storage basins as an alternative approach to addressing the problems created by urban drainage channels.

Storage

Under natural conditions, the floodplain provides storage for the drainage system. When a stream floods, the water is often stored in the floodplain area outside the waterway's banks. The excess water drains back into the river as the water level goes down.

Today's drainage systems typically include human-made storage basins, especially in the newer areas. Storage basins can be dry or wet. Dry basins are intended to drain completely and not to hold any water between storm events. The land may be used for other purposes, such as a park or playing field.

Wet bottom basins have permanent pools of water that function like natural ponds. Excess runoff is stored above the permanent water level in the basin and is discharged at a reduced rate through an outlet. Some communities prefer wet basins because they provide a water amenity, but others may be concerned about the safety hazard of having children playing near a body of water.

Communities have built larger basins to reduce flooding in developed areas and they require new developments to build basins to store their excess runoff on site. As noted in Chapter 4, most communities now require that new developments ensure that the peak flows leaving their sites are no greater than they were before the development.

A third approach is to incorporate natural storage areas into the design of the drainage system. Preserving wetlands and natural depressions has been found to be very effective for storing (and filtering) flood waters. See the example of Butterfield Creek on page 4-15.

Water Quality

Human activity within a watershed affects how and where stormwater runoff flows and also affects the quality of the water. Most stormwater runoff affected by human activity eventually ends up in a stream, river, lake, or other water body. There are many programs to monitor, regulate, and in general protect streams, rivers, and lakes from being polluted by contaminated runoff, discharges of pollutants, and other sources.

One program that affects most communities was established under the Federal Clean Water Act to ensure that only water of a certain quality is discharged into the waters of the United States. The National Pollutant Discharge Elimination System (NPDES) regulates the type and amount of pollutants and sediment that a community can release from its drainage system into a water body (see below).

Water quality is not the subject of this guide, but it is important to keep its principles and goals in mind when considering the drainage system, because many of the techniques for preventing and relieving localized flood problems are the same as those for preventing water pollution.

Local Stormwater—Quality and Quantity Intertwined

Section 402 of the Clean Water Act directed the U.S. Environmental Protection Agency (EPA) to develop and implement a program to prevent harmful pollutants from being released into the nation's surface water from sources such as wastewater treatment plants, agricultural operations, and stormwater drainage. Under the program (the National Pollutant Discharge Elimination System (NPDES), which is administered by most states on behalf of EPA), most communities that operate a storm drainage system must obtain a permit to discharge their stormwater drainage into a local water body. To get the permit, the community must have a local stormwater management program that includes these components, most of which are also fundamental to sound management of flood problems:

1. Public education and outreach on stormwater impacts.
2. Public involvement and participation.
3. Identification and elimination of illicit discharges to storm sewers.
4. Control of construction site runoff.
5. Control of stormwater runoff from development.
6. Reduction of pollutant runoff from local government operations.

The NPDES permit specifies what can be discharged, how the level and type of pollutants in the water are to be monitored and reported, and other provisions.

Under their stormwater programs, communities use best management practices, or "BMPs," that are recognized techniques for improving water quality. Some of these are described in this guide as being central to flood mitigation as well. Some BMPs for stormwater management are:

- Using buffers
- Planning
- Installing riparian (stream-side) zone protection
- Minimizing land disturbance
- Maximizing open space
- Installing wet ponds
- Establishing wetlands
- Using filtering practices
- Building open channels for storage
- Using infiltration measures
- Planting vegetation

The NPDES stormwater regulations now apply to all stormwater systems that serve more than 100,000 people and to smaller ones that are located in urbanized areas or are designated by the state or EPA as being subject to the regulations. Construction sites larger than one acre are also required to have NPDES permits.

For more information, see http://cfpub.epa.gov/npdes/.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This project improved the carrying capacity of the channel and protected some of the banks, but had an adverse effect on the natural functions of the stream and created new maintenance costs for the community.

Modifying the Drainage System

Methods for modifying the drainage system focus on its two main components: conveyance and storage facilities. Because the purpose of drainage ditches and storm sewers is to safely convey water downstream, modifications to conveyance are recommended only where the receiving stream or river has sufficient capacity to receive the increased volume of water. To minimize the cumulative downstream flood impacts that may result from multiple small drainage projects, more detention or runoff reduction techniques should be considered along with the channel or storm sewer improvements.

Remember that the drainage system serves many purposes. Modifying it for one purpose—flood protection—can have adverse impacts on its other purposes. As noted on page 8-4, a natural stream carrying more flow will often result in bank erosion and accompanying sedimentation. Water moving out of the area too quickly can inhibit the natural process of filtering out pollutants. Altering the channel with rock or concrete will damage or destroy habitat and the aesthetic value a stream provides to adjacent property owners.

Channel Modifications

Four types of channel modifications are usually used to reduce localized flooding: channelization, vegetated swales, dredging, and increasing conveyance at stream crossings.

Channelization. Channelization means straightening, deepening, and/or widening a ditch or drainageway. It is important to emphasize some concerns about this approach.

- Channelized streams can cause or worsen flooding problems downstream because more water is transported more efficiently and often at a faster rate.
- Channelization projects destroy habitat (see bottom photo, this page).
- Channelized streams rise and fall faster than natural ones. When the weather is dry, the water level in the channel is often too low, which can diminish water quality and degrade the stream-side and aquatic habitat.


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Channelization project.

- Channelized waterways need more frequent maintenance to ensure that they keep their carrying capacity (see illustrations on page 8-3 and top photo on facing page).

Vegetated swales. A vegetated swale is an open channel that is used to convey stormwater in place of conventional ditches or storm sewers. Swales are also used to treat stormwater runoff by using native vegetation to filter pollutants.

Vegetated swales have advantages over traditional concrete-lined ditches or storm sewers:

- They are less expensive to build (although they may take up more surface area);
- They are less expensive to maintain;
- They more closely preserve the natural hydrologic characteristics of the drainageway; and
- They clean the stormwater by filtering it through the vegetation.

Drainage system modifications can be combined with wetland creation, vegetated swales, infiltration trenches, and other best management practices that increase infiltration (reducing runoff) and improve water quality.

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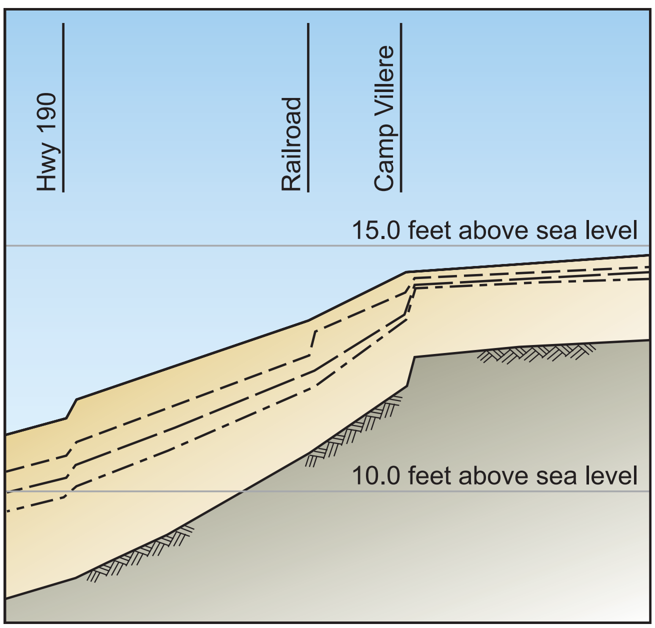
Drainage modifications do not have to be concrete channels. They can include measures to improve infiltration and water quality.

Dredging. Dredging involves the excavation of the channel bottom. It is often requested by residents who believe it will increase channel conveyance, but it poses these problems:

- Given the large volume of water that comes downstream during a flood, removing a foot or two from the bottom of the channel may have little effect on reducing flood heights.

- Dredging is often cost-prohibitive because the dredged material must be disposed of somewhere.
- Steeper side slopes increase bank erosion.
- Unless in-stream and upstream erosion problems are corrected, the dredged areas usually fill back in within a few years, and the process and expense have to be repeated.
- If the channel has not been disturbed for many years, dredging will destroy the habitat that has developed.

To protect the natural values of the stream, there are many places where Federal law requires obtaining a Section 404 permit from the U.S. Army Corps of Engineers before dredging can proceed. This can be a long process requiring advance planning and many safeguards to protect habitat (which adds to the cost of the project). In general, dredging a length of a channel is usually not recommended, although removing siltation at an obstruction, such as a bridge, may be worthwhile.



Adapted from St. Tammany Parish Flood Insurance Study

A profile is a side view of the elevations of a channel bottom and the various flood levels. This profile shows that on this tributary to Bayou Liberty, the Camp Villere Road causes nearly a one-foot increase in flood heights during smaller flows at the place where it crosses the waterway.

Stream crossings. Undersized stream crossings are a frequent problem in stream systems. An undersized culvert or bridge opening constricts flows and causes localized backwater flooding. One way to identify such places is to check the flood profiles, which are graphic portrayals of flood elevations that can be found in the community's Flood Insurance Study or local flood studies. Obstructions that back up water appear as stair steps on the graph (see illustration).

A common solution to these problems is to enlarge the culvert or bridge opening. In some cases, the existing culvert may act as a dam and provide flood storage upstream of the road. Increasing the culvert openings will reduce the flooding upstream; however, it will also allow more water downstream. Project plans need to ensure that the projects do not make flooding worse somewhere else and do not result in scour at the bridge or culvert.

As noted on page 2-6, the Village of Orland Hills was faced with undersized and deteriorating culverts. After a flood in 1996, the Village applied for and received disaster assistance funds to repair them. In the process, the culverts shown in Figure 2-2 (page 2-6) were replaced with larger openings.

Storm Sewers

Storm sewers can be an effective means of conveying local drainage and discharge into a receiving stream or a stormwater management facility. Flow capacity in storm sewers can be increased by installing new sewers, enlarging pipes, and preventing back flows. Storm sewers are commonly designed to handle smaller storms and may not be effective for larger storms, such as the 100-year storm. Therefore, overland flow paths should be provided that will protect surrounding buildings from damage during a large storm.

The advantage of converting an open channel to a storm sewer is that it creates more useable ground surface. It can also reduce maintenance problems, because it is harder for debris to get into the pipes and clog the flow of water.

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Although piping a ditch makes more room for surface use, where will the excess water go? This pipe can carry only a fraction of the water that can be carried by the ditch.

From a flood protection perspective, piping ditches and storm sewers has some drawbacks:

- A big problem is that a pipe cannot expand. What happens to the water from a 10-year storm when a pipe is designed to carry only the 5-year flow? A good system design needs to ensure that overflows can be diverted to the street and not to buildings.
- Pipe openings and storm sewer inlets need to be kept clean so the water can get into the pipes.
- Installing pipe is an expensive activity, although it can save maintenance costs in the long run and reduce the potential for accidents or injuries that can occur in open channels.

Converting an open channel to a storm sewer should be done only if there are arrangements for handling potential overflow, either through a swale over the pipe or through streets.

Storm sewers are designed to carry runoff from an area to a receiving body of water. Sometimes the receiving body of water is at flood stage and the storm sewers back up, flooding the area that they are supposed to drain. If an area analysis concludes that backflow is one of the causes of localized flooding, a gate or valve can be installed to prevent storm sewer backup.

Levees and Floodwalls

Levees and floodwalls protect properties from flooding by keeping high flows within the channel, away from development in the floodplain. While dredging and channelization may make the channel deeper, levees and floodwalls, in effect, make the channel's banks higher.

Levees are barriers built of earth, and a floodwall is usually concrete, masonry, or sheet piling. Floodwalls perform the same function as levees, except they are vertical-sided structures that require less surface area for construction.

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A small floodwall can protect against smaller, more frequent floods.

Both structures must be properly designed to account for large floods, underground seepage, pumping of internal drainage, erosion, and scour. Key considerations when evaluating use of a levee or floodwall include:

- Should fill be removed to compensate for the floodwater storage that will be displaced?
- Will the structure divert flood flows onto other properties? (Because of this hazard, levees and floodwalls are not allowed in the regulatory floodway in the mapped Special Flood Hazard Area.)
- How will the project handle drainage of the surface flows in the area protected by the levee?
- What will it cost to construct?
- What will it cost in the future to maintain?
- Will people object to having their river access and views restricted?
- Will people have a false sense of security? (Although levees may reduce damage for smaller, frequent rains, they may also be overtopped or breached in extreme conditions and then create more flood damage than would have occurred without the levee.)

Levees or floodwalls placed along the edge of a river or stream may degrade the aquatic habitat and water quality. They also are likely to push floodwater onto other properties upstream or downstream.

To reduce environmental impacts and provide multiple benefits, a setback levee is sometimes used. The area between the levee and the channel can provide open space for recreation and provide access sites to the river or stream.

Storage Improvements

Storage improvements should be located upstream of the flood problem area, although there are some limitations on what can be done in the drainage system of an already built-up area. There are two kinds of storage facilities: regional and on-site. Regional basins or reservoirs collect and store the excess runoff from many properties and are typically larger than on-site basins.

On-site storage basins manage the stormwater from the site where it originates. These smaller basins are usually constructed when the development is built and can be designed to address water quality concerns as well. Chapter 4 discusses stormwater management regulations that require such basins. Later in this section, on-site features are discussed that individual property owners can implement to reduce their runoff.

Regional facilities. Larger regional storage basins are often called reservoirs. Reservoirs can be dry and remain idle until a large rain. Or they may be designed so that a lake

The Town of Hilton Head Island, South Carolina, conducted an Island-Wide Drainage Study in 1995 to identify existing drainage improvement needs. The study recommended channelizing the natural freshwater creek upstream of Jarvis Creek and upgrading the stormwater outfall. According to the original drainage plan, the freshwater creek would be enlarged to a bottom width of 35 feet and a depth of 6 feet. This project would destroy approximately 4 acres of freshwater wetlands.

In 1996, the Town negotiated the purchase of the 50-acre Jarvis Creek Tract, which is adjacent to the existing Jarvis Creek ditch and was privately owned. An alternative plan was developed: a 10-acre lake would be capable of storing and conveying the necessary stormwater. A pump station was installed that moved water from the ditch to the lake. From the lake, water would flow through a vegetated spillway that discharged into the headwaters of Jarvis Creek.

By selecting this storage approach over the channelization project, 3.5 acres of freshwater wetlands were protected and upland habitat and tree loss was reduced. In addition to being a drainage improvement project, the Jarvis Creek Project was designed to be a community park.

Town of Hilton Head Island

or pond is created. The lake may provide recreational benefits or water supply.

In urban areas, some reservoirs are simply human-made holes, excavated to store flood waters. Some communities have converted quarries and sand pits to temporary storage basins. If they are built into the ground, there is no dam for these basins and no dam failure hazard. Wet or dry basins can also double as parks or other open spaces.

There are several considerations when evaluating use of reservoirs and storage basins:

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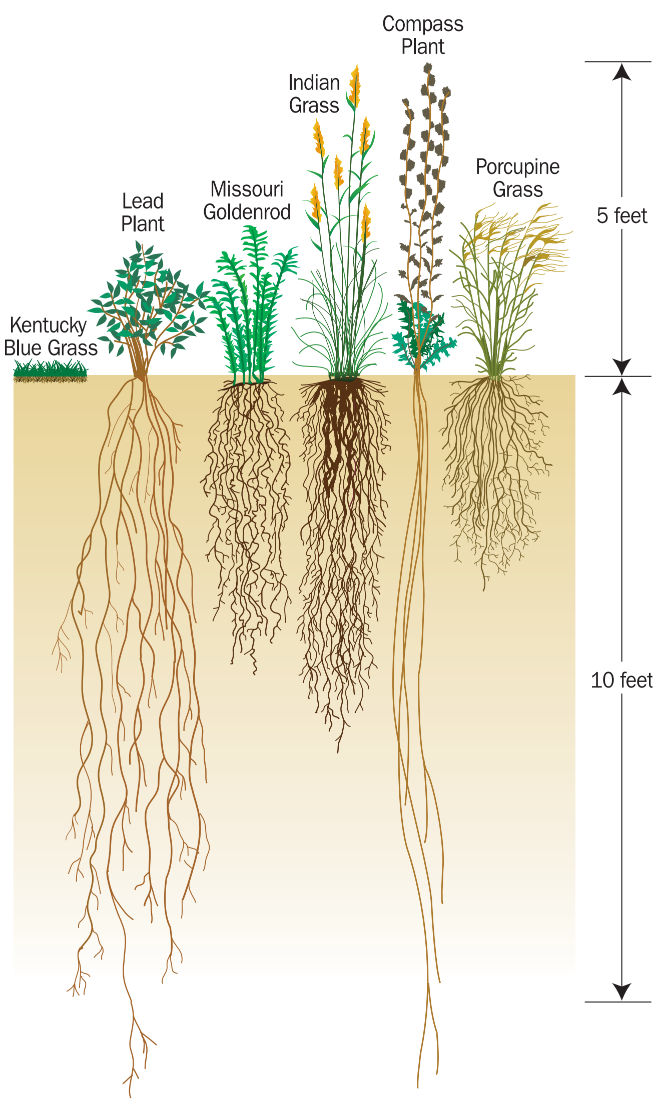
This storage basin adds a water amenity to this office park and protects downstream properties from high flows.

- Floods can threaten the protected area if the reservoir's dam fails;
- The expense for management and maintenance of the facility;
- Reservoirs and basins may fail to prevent floods that exceed their design levels, which are typically less than a 100-year event;
- Sediment deposition may occur and reduce the storage capacity over time;
- Water quality (both positive and negative) can be affected due to altered temperature, dissolved oxygen and nitrogen, and nutrients; and
- If not designed correctly, in-stream reservoirs may cause backwater flooding problems upstream.

On-site storage improvements. Most on-site storage facilities are constructed to meet the community's subdivision or other development regulations. These regulations are covered in Chapter 4.

In areas that are already developed, large basins are not likely to be feasible. However, some improvements can be made when a parcel is redeveloped, and some can be initiated by interested owners that will reduce the amount of runoff leaving an individual residential or commercial property. Although such techniques will not appreciably diminish runoff from a large storm, their cumulative effect may reduce flooding problems for small storm events. They do improve water quality at a local level and have the added advantage of raising neighborhood awareness about water quality and quantity. Some examples include:

- Using open brickwork or porous paving when replacing a driveway or parking lot (although proper construction and maintenance are needed to keep the surface porous);
- Replacing lawns with native plants that have deeper roots that improve filtration;
- Installing rain barrels that collect and hold rainwater in large receptacles for lawn and garden watering. This reduces the owner's water bill and reduces the runoff during and after a storm; and
- Building rain gardens. These are landscaped areas planted with wildflowers and other native vegetation that soak up rainwater, mainly from the roof of a house or other impervious areas. Rain gardens, which incorporate special design features, allow approximately 30 percent more water to soak into the ground than a conventional patch of lawn.



Compare the root system of Kentucky blue grass with native prairie plants. The value of native ecosystems to absorb and hold stormwater can be a useful tool in reducing floods in urbanized areas.

Projects like rain barrels and rain gardens can be a valuable part of the community's effort to reduce stormwater runoff and meet its NPDES goals of improving water quality. Although an individual rain garden may seem insignificant, many collective rain gardens and an active rain garden program can produce substantial neighborhood and community environmental benefits and a constituency interested in, knowledgeable about, and committed to improving the area's drainage system.

Rain gardens yield many benefits:

- They increase the amount of water that filters into the ground, which recharges local and regional aquifers;
- They help protect streams and lakes from pollutants carried by urban stormwater—lawn

fertilizers and pesticides, oil and other fluids that leak from cars, and numerous harmful substances that wash off roofs and paved areas;

- They enhance the beauty of yards and neighborhoods; and
- They provide valuable habitats for birds, butterflies, and many beneficial insects.

Rain gardens take careful planning and won't work everywhere. The design needs to account for soil types, standing water that may breed mosquitoes, potential damage by vehicles or children, and similar concerns that arise when a new technique is introduced.

Prince George's County, Maryland, Stream Teams, a valuable part of the community's stormwater program, includes a citizen volunteer monitoring program and has held several workshops called "Planting a Rain Garden for Community Service Day" and "How to Make a Rain Barrel." Both workshops were free and open to the public. Free native flowering plants were given to all participants for the Rain Garden workshop and a free rain barrel to each participant at the Rain Barrel Workshop.

At a Rain Barrel Workshop, about 15 people met in the West Laurel Civic Building for a 30-minute demonstration. Representatives from the state Department of Environmental Resources showed the participants how to assemble the rain barrel and answered questions.

Maintaining the Drainage System

A community's drainage system covers a large area and includes storage basins, stream channels, backyards, swales, ditches, and culverts. A regular program of drainage system inspections can catch problems in the system before they turn into major obstructions. Such inspections and follow-up work for the whole drainage system can be quite daunting, so this section breaks the work down into four levels of effort:

- Maintaining the public drainage system;
- Involving citizens in the process;
- Regulating against dumping and other actions that will adversely affect the system; and
- Maintaining the yard.

Maintaining the Public System

The public part of a drainage system varies from community to community. Normally, the larger streams, drainage ditches, and channels on public property are maintained by the local government. Storage basins that have been dedicated to the community also are part of it. Some communities do not accept maintenance responsibility for new storage basins, leaving that up to the property owner.

Government agencies usually accept responsibility for maintaining bridge openings and facilities on public property. However, in most areas, the responsibility for drainageway maintenance on private property, where no easements have been granted, is with the individual private property owner. This often results in very little maintenance being accomplished. A community that wants to improve the care of its streams should have a campaign to urge owners to sign easements allowing local staff access for inspections and maintenance.

Dr. Warren Campbell

A regular inspection and maintenance program can remove debris before it becomes an obstruction to stream flows.

As outlined in the CRS, at a minimum, the maintenance program should:

- Inspect the entire drainage system at least once each year;
- Check known problem sites during or immediately after heavy storms;
- Respond to inquiries or complaints from citizens; and
- Remove debris soon after it is found.

In Activity 540 (Drainage System Maintenance), the CRS encourages and provides credit for:

- A formal program that inspects channels and storage basins and removes debris;
- A capital improvements program that provides an annual budget for channel and basin improvements; and
- Stream dumping regulations.

"Debris" refers to a wide range of materials that may obstruct flows so that a small storm will cause an overbank flood. Debris may include tree limbs and branches that accumulate naturally, large items of trash or lawn waste accidentally or intentionally dumped into channels, drainage swales, or storage basins. Maintenance of storage basins may also require revegetation or repairs of the restrictor pipe, berm, or overflow structure.

All communities are encouraged to have formal procedures for maintaining their part of the system. Sometimes it is a very fine line that separates debris that should be removed from natural material that helps form habitat. Therefore, written procedures that are consistent with state laws and environmental concerns (such as the NPDES guidelines) are especially helpful.

Guidelines on designing a program, along with model procedures, can be found in *CRS Credit for Drainage System Maintenance*.

Citizen Involvement

An annual inspection by a public agency means that for most of the year, the inspection or maintenance crew does not see the stream or basin. Involving the citizens can be very helpful. While they may not do any maintenance (especially removing large logs or obstructions), citizens are the eyes and ears of the community and can look out for and report problems before they cause a flood.

Some communities have organized "stream teams" that regularly monitor assigned sections of rivers, streams, and canals and report when problems are found. Some of these team members are trained to know what to remove and what not to touch, so they can do some minor work during their inspections.

Many communities leave storage basin maintenance up to the property owner or homeowners association, people who are often not knowledgeable about the technicalities of basin maintenance and who may not have the resources to properly care for them. To counteract this, some communities have assumed responsibility for inspecting all basins on private property. If a problem is found, the owners are required to correct it.

Mandeville's Drain Team

A group of 38 volunteers formed the **City of Mandeville, Louisiana**, Drain Team. The Drain Team assists the Department of Public Works by monitoring over 150 miles of drainage arteries in their neighborhoods. These citizens clean debris from the ditches and catch basins during wet and dry weather. Members receive yellow rain suits with the City of Mandeville insignia on them to help keep them dry while monitoring the drainage.

Monthly and quarterly meetings are held with these members and with the City staff for regular updates. "You just wouldn't believe what an impact this team has on keeping the water flowing during storms. Their biggest job is keeping the balls and garbage can lids out of the culverts," said Mr. Glenn Craddock, Assistant Superintendent of Streets and Drainage.

FEMA (2002, pp. 25–26)

Other communities have implemented training programs for homeowners associations and other basin owners. Some have published guides for individuals who live along a stream and for owners of stormwater facilities.

Regulating Dumping

An anti-dumping program can reduce drainage problems and the workload of the maintenance crews. Nuisance ordinances in many communities prohibit dumping garbage or other objectionable waste on public or private property, but dumping still occurs.

Non-objectionable materials, such as grass clippings or tree branches that can kill ground cover or obstruct drainage channels, also should be covered by the dumping ordinance. A community can schedule regular inspections to catch violations. Sample language for an ordinance can be found in *CRS Credit for Drainage System Maintenance*.

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Stream dumping notice.

A dumping enforcement program should include public information materials that explain why the rules are in place and what the penalties are. This program is essential because many people do not realize the consequences of their actions. They may fill in the ditch in their front yard, not realizing that it is needed to drain water running off the streets. It may not be clear to them that regrading their yard, filling a wetland, or discarding leaves or branches in a stream or ditch can cause flood problems.

Yard Maintenance

Yards are part of the drainage system. Subdivision and building plans should have the main structure elevated on a building pad. The side and back yards should be preserved as conveyance areas to carry water away from the building and to the storm sewers, streets, or receiving ditches or streams.

Many people do not realize the importance of keeping the yards and swales clear. When people build fences, garages, sheds, and swimming pools or plant trees that disrupt the drainage patterns, surface water will be pushed onto other properties or even flow back and into the owner's house (see the photograph on page 4-20).

A local government can do two things to preserve yard drainage. The first is to inform the public about the importance of yard maintenance, keeping the drainageways open, and reporting problems to the authorities. Most people will not obstruct flows if they understand how obstructions can adversely affect them and their neighbors.

The second action is to enforce the dumping regulations and drainage easements. Most survey plats show easement boundaries, and public information programs can help to educate property owners about the laws against stream dumping and the easement regulations and restrictions.

Where to Get Help

- U.S. Army Corps of Engineers (for larger levee and channel modification projects).
- More information on Corps of Engineers' 404 permits can be found at http://www.nwo.usace.army.mil/html/od-tl/introductionto404.html.
- Natural Resources Conservation Service (for larger levee and channel modification projects).

Additional resources are listed in Appendixes A and B.