CHEMUNG COUNTY SOIL & WATER CONSERVATION DISTRICT

Stream Processes

A Guide to Living In Harmony with Streams

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August 2006

Chemung County Soil and Water Conservation District
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Preparation of this manual was funded in part by a grant from:
Water Resources Board
Of the Finger Lakes – Lake Ontario Watershed Protection Alliance

Additional funding was provided by:
Chemung County Soil and Water Conservation District
Upper Susquehanna Coalition
Southern Tier Central Regional Planning and Development Board
NYS Department of Environmental Conservation
NYS Coastal Management Program
National Oceanic and Atmospheric Administration

CHEMUNG COUNTY SOIL & WATER
CONSERVATION
DISTRICT

Prepared by:
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Southern Tier Central Regional Planning and Development Board

ACKNOWLEDGMENTS

The knowledge and expertise of many professional individuals and organizations are reflected in this guidebook. It is a collaborative project of the Chemung County Soil and Water Conservation District, Upper Susquehanna Coalition, and Southern Tier Central Regional Planning and Development Board. Additional input and assistance was provided by the Hydrologic and Habitat Modifications Workgroup of the NYS Nonpoint Source Coordinating Committee, the NYS Department of Environmental Conservation, the NYS Department of Transportation, the Bradford County (PA) Conservation District, and others. Special thanks go to the many individuals who contributed information, suggestions, photographs, and graphics to this project.

Funding for development and printing of this guide was provided by the Finger Lakes-Lake Ontario Watershed Protection Alliance, the New York State Department of Environmental Conservation, Appalachian Regional Commission, and the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration in conjunction with the New York State Coastal Management Program.

Chemung County Soil and Water Conservation District

The mission of the Chemung County Soil and Water Conservation District is to protect and enhance the natural resources of Chemung County by "developing partnerships and networks and by implementing innovative solutions to our natural resource concerns."

851 Chemung Street
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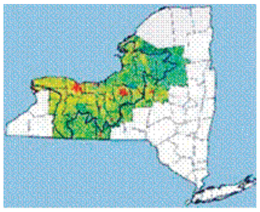
Finger Lakes-Lake Ontario Watershed Protection Alliance-FL-LOWPA

FL-LOWPA is an alliance of 25 counties whose goal is to take the best information and techniques available and adapt them to our local situation-understanding that local problems, resources, and relationships vary from watershed to watershed and county to county. We believe the best way to protect water resources from non-point source pollution is to develop solutions with partners who will ultimately be responsible for carrying them out. In essence, we are working to develop stewards, in our town governments, on our farms, along our shorelines, and in our schools through our FL-LOWPA programs.



Upper Susquehanna Coalition

The Upper Susquehanna Coalition (USC), established in 1992, is a network of county natural resource professionals who develop strategies, partnerships, programs, and projects to protect the headwaters of the Susquehanna River and Chesapeake Bay watersheds. The USC is comprised of representatives from 12 counties in New York and three in Pennsylvania.

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Southern Tier Central Regional Planning and Development Board

The Southern Tier Central Regional Planning and Development Board provides a variety of services to units of government, agencies, and the private sector in Chemung, Schuyler, and Steuben Counties of New York State. The primary objective of STC is to participate in projects that benefit local government and the business and industrial community while improving the quality of life in the region.

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DISCLAIMER

"Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land" Luna Leopold

We intend for the contents of this document to both entice and challenge the reader. We encourage users of this document to supplement it with new literature, and regionally or locally specific information. The comments, issues and examples set forth should not be interpreted as specific advice nor are they the official policy of any organization. Our intent for the information contained will hopefully educate the reader on the complexity of streams.

The Chemung County Soil and Water Conservation District would like to thank the following individuals for helping us make this guide a reality.

First would be Greg McKurth from Wyoming Co. SWCD, Jeff Parker of Steuben Co. SWCD, and Brian Davis from Cattaraugus SWCD who brought up the idea for a stream guide numerous times.

Second, is Jim Curatolo of the Upper Susquehanna Coalition, who assisted the District in writing a grant proposal to develop a stream guide. Third, the Finger Lakes- Lake Ontario- Watershed Protection Alliance Special Project fund for supplying the initial funding.

The District would also like to thank all of the individuals who supplied information, as well as reviewing of the guide.

Last, but certainly not least, Janet Thigpen for agreeing to develop the guide. I can only imagine the countless hours and sleepless nights she had in preparing this document.

Our charge to Janet was to write a short and concise guide on the stream process. It soon became apparent this would be an impossible task. Stream processes are very complex systems and so there was a need to do the best we could to describe them. This is the reason for the length of this guide.

Please take the time to review the information in this guide. This was prepared for the municipal planning board members who can utilize the information, along with code enforcement officers, when reviewing plans for developments next to streams.

The highway department will find a great deal of information about dealing with streams around their highway systems, as well as stream crossings.

Landowners can utilize the booklet so to have the facts where they can make an informed decision before building the home next to the babbling brook or installing a bridge or culvert on their property.

The District hopes this guide will be utilized by many so that the pain and frustration of flooding and erosion problems can be reduced.

Please sit back and enjoy the information in the guide.
Sincerely,
Mark Watts
District Manager

SECTION 1: INTRODUCTION

We love our streams. We value streams and rivers for a host of reasons. As symbols of purity, renewal, timelessness, and healing, rivers and streams have shaped human spirituality like few other features of the natural world. The scenic beauty and recreational benefits of flowing water increase the value of streamside real estate. Streams and stream corridors provide vital breeding, resting and feeding areas for fish, birds, and wildlife. In addition, healthy stream systems provide practical benefits by moderating floods and droughts. In short, streams enhance both the beauty of our landscapes and the quality of our lives. *(Photographs clockwise from top: courtesy of NYC Department of Environmental Protection; by Tim McCabe, USDA Natural Resources Conservation Service; by Janet Thigpen, Southern Tier Central Regional Planning and Development Board.)*

We hate our streams. When a stream or river floods, washes out a bridge, or erodes its banks, it can become the bane of your existence. *(Photographs by Jennifer Fais, Southern Tier Central Regional Planning and Development Board; Mark Watts, Chemung County Soil and Water Conservation District; and Steuben County Department of Public Works.)*

Many well-meaning attempts to address stream problems have resulted in the creation of even more problems. This guide will help you to avoid those mistakes. It includes basic information about how streams work and guidelines for living in harmony with them. It is not a training manual for managing streams, but should enable local governments and property owners to understand stream processes – and why streams don't always behave how we would like them to. It focuses on the common characteristics of streams and how human endeavors can disrupt and alter these complex systems. With this understanding, you will be better equipped to protect, improve, and restore the waters that flow across your land or through your jurisdiction.

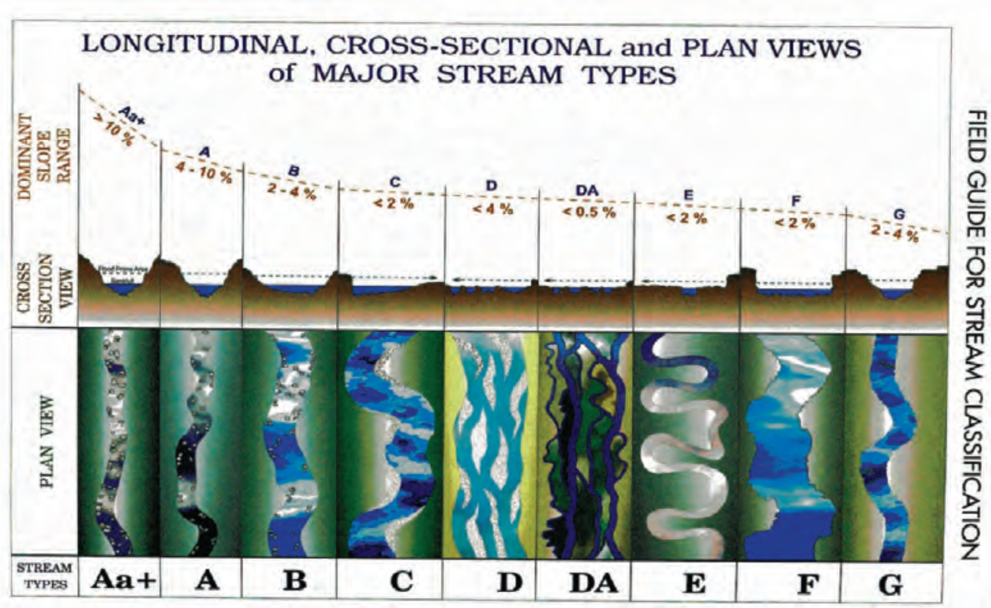
SECTION 2: HOW DO STREAMS WORK?

Streams are more than conduits for water. They are complex systems that do complicated work. In their natural state, healthy streams perform many functions—such as purifying water, moderating floods and droughts, and maintaining habitat for fisheries, birds and wildlife. Stream and river systems gather, store, and move snowmelt and rainwater in synchrony with nature's cycles. In the process they move sediment and alter landscapes.

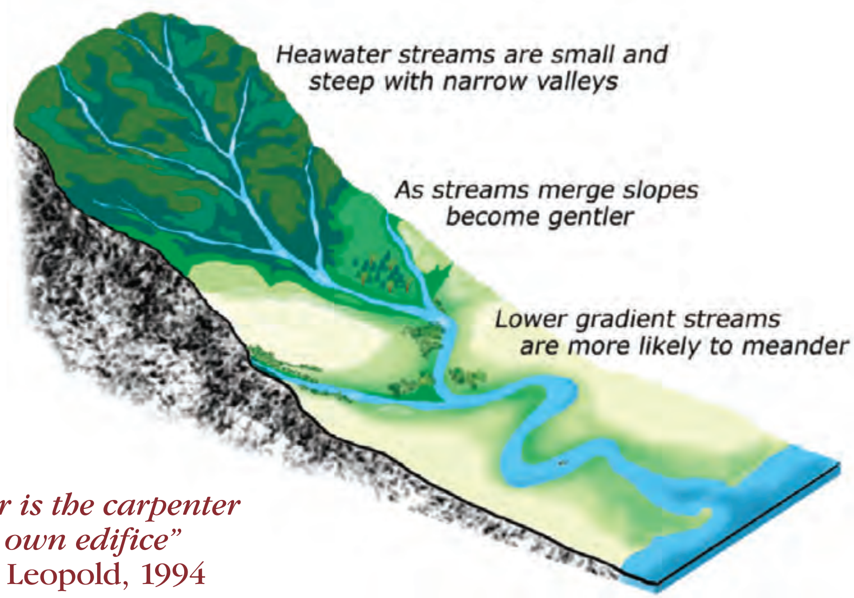
STREAM CHARACTER

Streams come in many shapes and sizes. They range in character from steep, swift-flowing mountain streams to flat, slow-flowing pasture streams. The nature of a stream is influenced by the amount of water the stream carries, the geology and soils it flows through, and the shape and slope of the valley that confines it. Each stream channel is formed, maintained and altered by the stream itself through the processes of erosion and deposition of sediment. Over time the stream will establish a channel shape that accommodates its spring thaws and summer droughts. If something happens to change the conditions that have shaped the stream, then the stream will change its channel to adapt to different conditions.

Slope: The slope of a streambed contributes to how water moves and how much sediment it can carry. The steeper the slope, the faster the water moves and the more bedload (i.e. sediments, silt, sand, gravel, boulders, and organic materials) can be carried through the channel. In flatter areas, where the stream has less slope, it will tend to deposit gravel or sediment. The stream determines its own slope by erosion, deposition, and adjusting its channel length by meandering.



The general stream classification system developed by Dave Rosgen illustrates some of the diversity of stream characteristics. Classification of a stream as one of these types enables prediction of that stream's behavior based on experience with other streams that have similar characteristics. *(From "A Classification of Natural Rivers," by D. L. Rosgen, 1994.)*



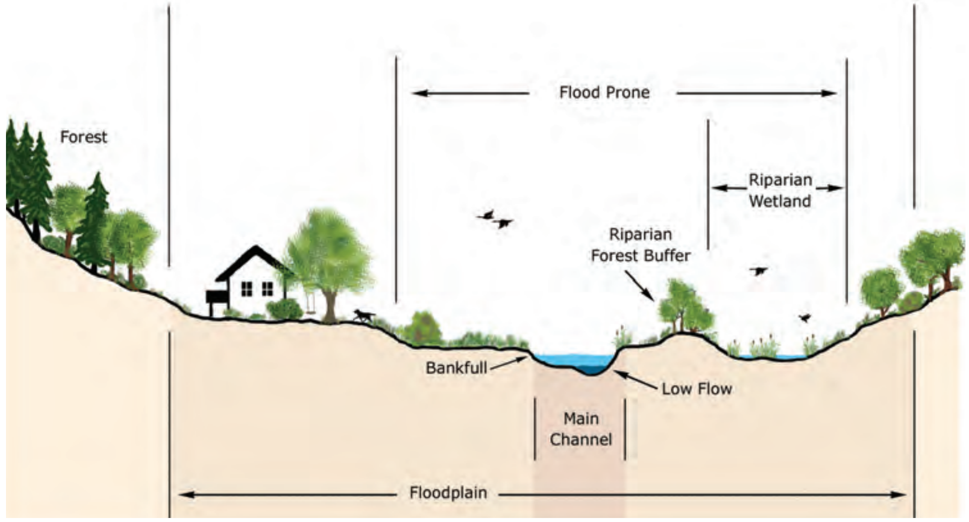
"The river is the carpenter of its own edifice"
-- Luna Leopold, 1994

The channel and behavior of a stream can vary considerably along its length. Mountain headwater streams flow swiftly down steep slopes. At lower elevations, the slope is generally gentler and the stream is more likely to meander across its valley. *(Illustration courtesy of Amy Reges, Upper Susquehanna Coalition.)*

Channel: The banks within which low and moderate flows occur define a stream's channel. The deepest areas are generally connected, forming a low flow channel. The streambed is the foundation of a stream that supports the banks. Streambeds are composed of a variety of materials, which can range in size from large boulders and rocks, to gravel, sand, silt, and clay particles. The scouring and deposition of this sediment shapes the stream channel and its floodplain. Some channels are relatively stable, with little change in the channel shape over time. Other channels are actively adjusting and changing their shape, usually in response to changed conditions, such as increased flow or a modification along the stream. This change can occur quite rapidly – which may cause problems for nearby development – or can occur slowly over time.

Floodplain: Well-established rivers and streams usually have flat valley floors, called floodplains that are periodically inundated by high water. The floodplain is an important part of the stream system, because it provides a place for water to go when it cannot be contained in the channel. When water fans out across the floodplain, the flow velocities are dramatically decreased and the energy of the stream is dissipated. This relieves the pressure on streambanks and allows the water to be stored, thereby reducing the amount of flooding that occurs downstream.

The floodplain is formed by the stream itself through the natural processes of erosion and deposition. Over time, the stream channel can and will move across the floodplain, eroding and re-depositing material. People who live on floodplains can attest to the volumes of mud that a single flood can leave on their yards or in their houses. Some have also witnessed the erosion that occurs when the stream channel adjusts its location on the floodplain. This erosion and deposition of bank material is another mechanism by which energy is dissipated in the floodplain.



A stream's channel and floodplain must accommodate a range of flow conditions, from low flow to extreme flood conditions. *(Illustration courtesy of Amy Reges, Upper Susquehanna Coalition.)*

Streams are meant to flood. If no human development is located in the floodplain, then this area can perform its natural functions of storing and conveying floodwater. Excess energy associated with high flow events is dissipated when water spreads out across the floodplain. Vegetation slows the water's velocity and the roots hold the soil in place, reducing erosion. A stream that is no longer able to overflow onto its floodplain is often a stream with erosion problems. *(Photo courtesy of Green County Soil & Water Conservation District.)*

Some floodplains contain old stream channels that carry water during high flow events. These old channels can relieve some of the pressure from the banks by spreading out the stream flow into multiple channels. *(Photograph courtesy of Steuben County Soil and Water Conservation District.)*

Pools and Riffles: Some streams have alternating deep and shallow areas called pools and riffles. The deep, slow water in pools provides shelter and resting areas for fish. Shallow, swift water in the riffles provides fish with spawning and feeding areas. In addition to their value to fish and aquatic life, pools and riffles help to maintain channel stability. Water leaving a deep pool needs to flow upward into the shallow beyond. This upward flow of water slows it down and dissipates energy.

Meanders: Many streams naturally meander. These curves slow down the water and absorb energy, which helps to reduce the potential for erosion. The velocity of a stream is greater on the outside of a bend. The increased force of this water frequently results in erosion along this bank, extending a short distance downstream. On the inside of the bend, the stream velocity decreases, which results in the deposition of sediment, usually sand and gravel, along this bank. If you could look at the long-term history of a valley over hundreds or thousands of years, you would see that the stream has moved back and forth across the valley bottom. In fact, this lateral migration of the channel, accompanied by down cutting, is what has formed the valley.

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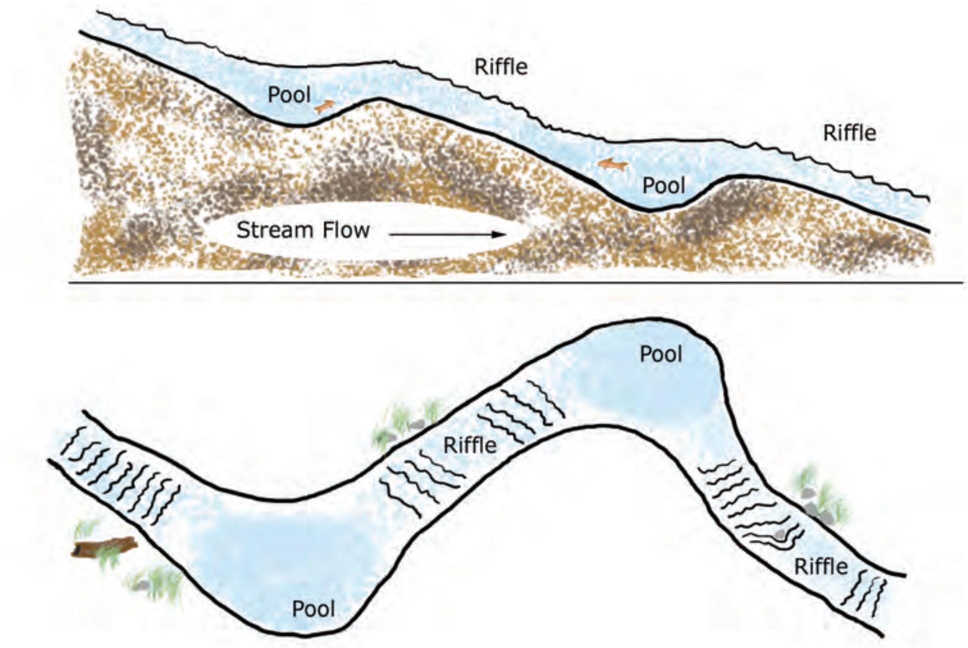

A sequence of riffles and pools serve as speed bumps for the stream, slowing the water and absorbing energy. *(Illustration courtesy of Amy Reges, Upper Susquehanna Coalition.)*

The looping pattern of a river or stream is called a meander. These bends result in a longer channel with a lower slope. *(Aerial photograph by NYS Office of Technology and Cortland County.)*

Braided Channel: Although most streams have a single channel, this is not always the case. Multiple-thread or braided streams can occur when the stream receives more sediment than it can transport. The excess load is deposited within the channel area, with the channel and island locations shifting from year to year. Factors that contribute to channel braiding include high sediment supply, extensive streambank erosion, backwater effects (which reduce a stream's velocity), and flashy runoff conditions that result in rapidly changing flows.

This braided channel formed as a result of backwater from the receiving stream (Susquehanna River) where the stream has deposited large amounts of sediment. *(Photograph courtesy of Bradford County Conservation District.)*

Erosion often occurs at the bends in a stream channel. This does not suggest that straightening a channel will eliminate erosion problems—quite the contrary. Straightening a stream will result in a shorter, steeper channel, in which water moves faster and has more energy. This change may upset the balance of the stream, causing erosion, loss of land, increased sediment supply, loss of aquatic habitat, or other problems.

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As part of the water cycle, the ultimate source of all water in streams is precipitation.

- The average precipitation in New York State is 44 inches per year or 90 billion gallons per day. This varies across the state from 30 to 64 inches per year.
- One half of this (45 billion gallons per day) is returned to the air by evaporation from land and water and transpiration by plants.
- Approximately 16 to 20% (14-18 billion gallons per day) seeps into the ground and recharges the groundwater supply.
- Approximately 30 to 34% (27-31 billion gallons per day) runs off into surface waters.

STREAM PROCESSES

WHAT DO STREAMS DO?

- Collect water from the watershed
- Convey varying amounts of water
- Dissipate energy
- Transport and redistribute sediment
- Seek dynamic equilibrium
- Change in response to changing conditions

In the process of moving water downhill, a stream also dissipates energy and moves sediment. These processes lead to the formation of a stream channel that equalizes the stream's energy and achieves a dynamic equilibrium. Changes in the watershed and the stream channel can disrupt this equilibrium and cause the stream to adapt by changing its channel.

Watershed Drainage: Streams collect water from the surrounding landscape. The land area that contributes water to a stream is called the watershed. Falling rain or melting snow soaks into the ground and fills depressions. The excess water flows downhill into streams as surface runoff and subsurface flow.

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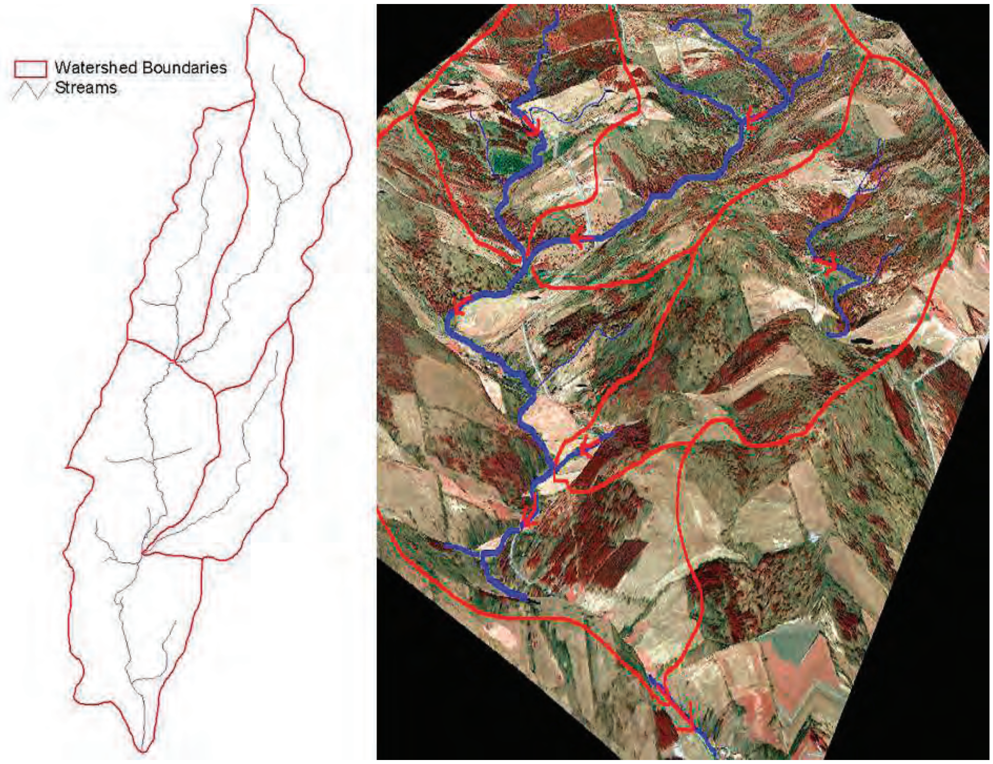


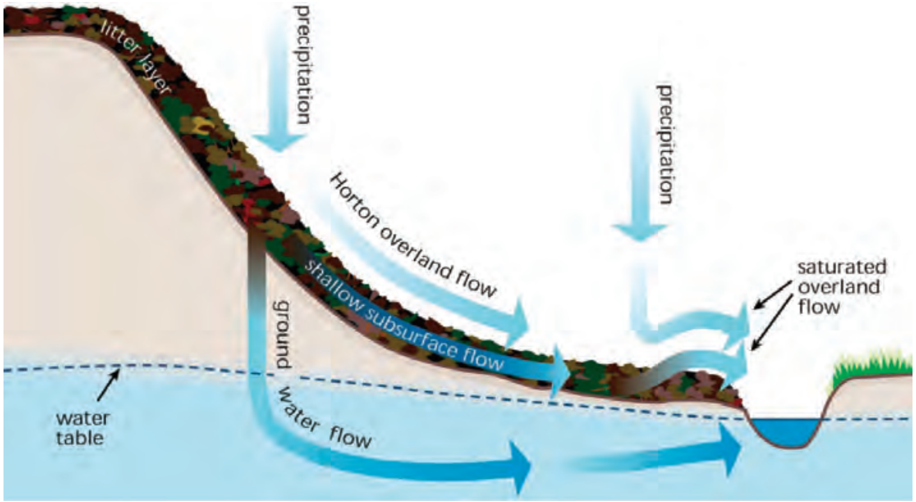
A watershed is an area of land from which surface and subsurface waters drain to a common receiving body or outlet. *(Watershed representation prepared by Michael Jura, Upper Susquehanna Coalition.)*

Hydrologic cycle: The transfer of water from precipitation to surface water and groundwater, to storage and runoff, and eventually back to the atmosphere is an ongoing cycle. *(Image from "Stream Corridor Restoration: Principles, Processes, and Practices," 10/98, by the Federal Interagency Stream Restoration Working Group.)*

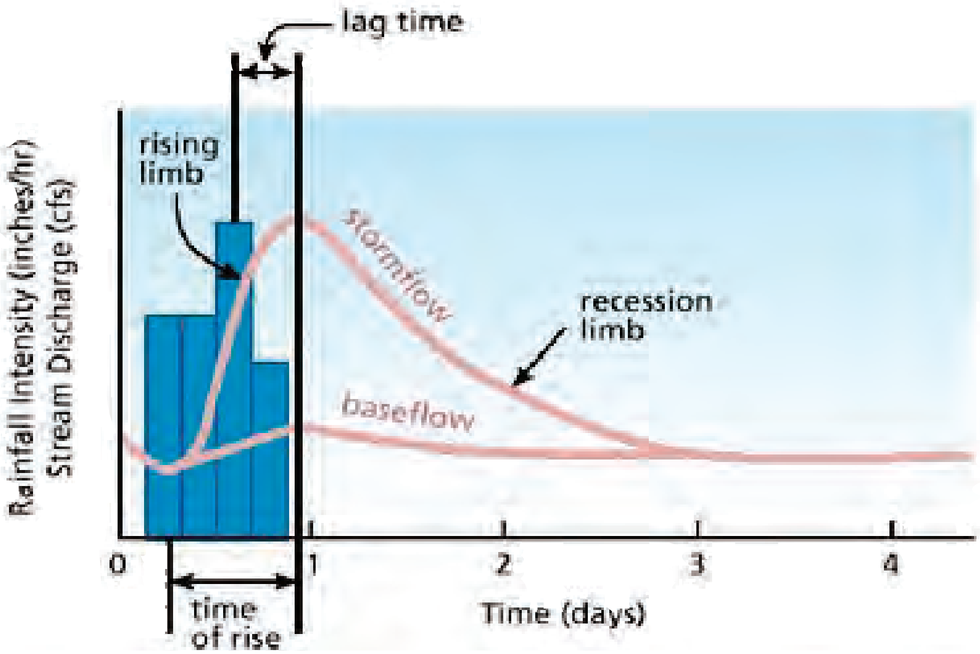
Stream Flow: The amount of water carried by a stream can vary from none, in the case of streams that are dry part of the year, to extreme flood conditions. Precipitation reaches the stream by two different pathways that affect the quantity, quality, and timing of stream flow:

- **Storm flow:** Some of the rainfall and snowmelt within a watershed flows quickly into the stream by flowing over the surface or through near-surface soil. This water is the main component of high stream flows during rainy weather and is called storm flow.
- **Base flow:** The rainwater and snowmelt that soak into the ground recharge the groundwater, which moves slowly through the soil and bedrock before reaching the stream. The regular, continuous discharge of groundwater provides a steady supply of water to many streams and rivers, which is called base flow. Since water moves slowly through the soil, the base flow in streams can represent rainwater that fell days, weeks, months or even years ago.

Stream flow at any one time might consist of water from one or both sources. A stream that receives storm flow, but is not fed by groundwater only flows for a short period after precipitation events. It is base flow that enables many streams to run year-round – even when there has been no recent rainfall. The amount of base flow varies with groundwater levels, so some streams will have continuous flow part of the year, but dry up during dry periods and droughts. Excessive gravel in a stream can also result in a dry channel when water flows unnoticed through gravel under the streambed.



Precipitation reaches the stream as surface runoff and by infiltration into the ground where it contributes to groundwater flow. The amount of water following each flow path depends on the capacity of the soil to absorb water, the amount of storage in surface depressions, and the amount, intensity, and duration of precipitation. *(Image from "Stream Corridor Restoration: Principles, Processes, and Practices," 10/98, by the Federal Interagency Stream Restoration Working Group.)*



A storm hydrograph is used to show how the flow in a stream changes with time for a single storm event. The blue bars on this hydrograph indicate the amount and timing of rainfall. The lower curve shows the change in base flow over time, which increases slightly as a result of the rainfall event. The upper curve includes the more significant rise in storm flow due to runoff from the rain event. *(Image from "Stream Corridor Restoration: Principles, Processes, and Practices," 10/98, by the Federal Interagency Stream Restoration Working Group.)*

Energy Dissipation: It is important to consider streams in terms of their energy. Streams start in headwater areas where there is tremendous potential energy because of the elevation. This potential energy is dissipated or used in the following order:

- **Kinetic energy:** As the water begins flowing downhill, potential energy is converted to kinetic energy, or energy of motion.
- **Friction:** As much as 95% of a stream's energy is used to overcome friction with its bed and banks. Woody debris or vegetation in the channel and on the floodplain break up the flow and increase roughness (friction), thus dissipating energy. Streams also expend energy flowing around curves.
- **Sediment transport:** Stream energy not dissipated by kinetic motion or friction is available to transport sediment. This sediment has been delivered into the channel from the surrounding landscape and erosion of the bed and banks.
- **Erosion:** Additional stream energy is expended by eroding material from the channel. This erosion typically occurs during high flow conditions, when large amounts of water result in more energy than the stream can dissipate by other mechanisms. Material eroded from the stream channel normally constitutes a minor component of the stream's sediment load.

NOTES

If you stand near a river or stream during a flood event, you may feel the ground beneath your feet vibrate as gravel, cobbles, and boulders tumble against each other as the force of the water pushes them down the streambed. *(Photograph courtesy of New York City Department of Environmental Protection.)*

The erosion, transport, and re-deposition of sediment are essential natural processes for any stream system. Over geologic time, these processes cut valleys and shape the landscape. In the short term, the sediment supply and valley shape are major factors in determining the channel characteristics of a stream. *(Photograph courtesy of USDA Natural Resources Conservation Service.)*

Sediment Transport: Sediment transport depends on the interaction between the topography and geology of upland areas, which represent the principle source of sediment, and the stream system, which supplies the energy for sediment transport. A stream develops over time to handle a certain sediment load. When either the energy or the sediment inputs are changed, the energy balance is altered and the stream system will adjust to the new conditions. If a stream does not have enough energy to transport the sediment load, deposition occurs. Conversely, if the stream has more energy than is required to transport the available sediment, it will acquire additional sediment by eroding its bed or banks.

Change: Streams are dynamic systems. Even when completely undisturbed by man, a stream will not remain static over time. This change may be very slow compared to a human lifetime or it may occur quickly. This natural tendency of streams to adjust and move causes problems when development is located close to a stream. To make matters worse, human activities often result in larger or more rapid changes than those that would have occurred naturally.

Dynamic Equilibrium: Despite frequent change, streams exhibit a dynamic form of stability. The changes and adjustments in the stream system occur when there is an imbalance in the system's energy. As long as the conditions that influence the stream's energy are relatively constant, then the stream for the most part stays in equilibrium. If those conditions change, then the stream adjusts to find a new equilibrium. This process of establishing and maintaining a balanced condition is called dynamic equilibrium.

It is not unusual for human actions to disturb the balance between a stream's energy and its sediment load, resulting in increased erosion and/or increased deposition. *(Photograph by Chris Yearick, Upper Susquehanna Coalition.)*

Because the water and energy levels in streams vary with time, so does the ability to carry sediment. When the stream does not have enough energy to transport its sediment load, material is temporarily stored within the stream system. When high flows return, this sediment is re-mobilized and transported farther downstream. Point bars that form on the inside edge of bends are classic examples of sediment in temporary storage between high flow events. These are natural and necessary parts of the stream system. If a point bar is removed, the stream's energy may cause it to erode gravel from the streambed or banks to replace the gravel in the bar. Those who have removed point bars can attest that these features almost always return, supplied by fresh sediment during the next high flow event. *(Photograph by Gary Kramer, USDA Natural Resources Conservation Service.)*

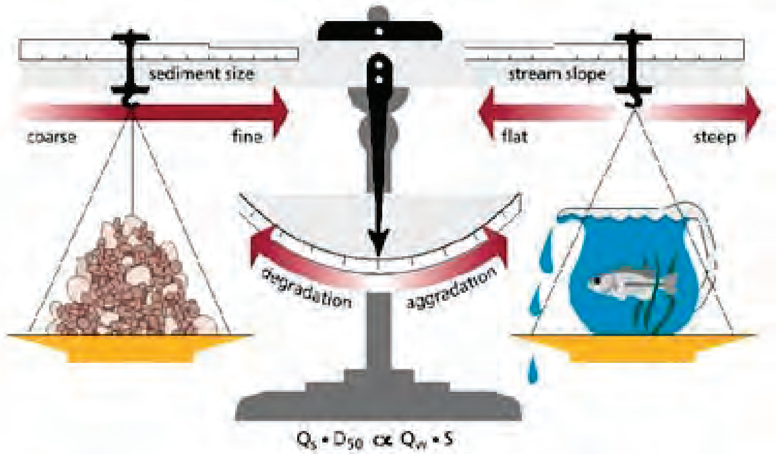
Dynamic equilibrium means that the stream moves and adjusts in such a way as to minimize the energy of the system. The change is what makes the equilibrium dynamic.

HYDROLOGY + HYDRAULICS = CHANNEL SHAPE

Hydrology – The amount of water available to a stream

Hydraulics – How water moves through the watershed and channel

Hydrology and Hydraulics: Each stream has developed in response to the amount of water it carries and the way that water moves in the channel. The volume and timing of runoff into a stream is called its hydrology and is dependent on precipitation patterns and watershed characteristics. The flow processes within a stream channel are called hydraulics and are influenced by channel characteristics, such as slope, cross sectional shape, and roughness (friction due to channel shape, sediment size, vegetation, etc.). The size and shape of a stream



This diagram illustrates the relationship between the water in a stream and the system's ability to transport sediment. This relationship is shown as a balance with sediment load on one weighing pan and stream flow on the other. The hook holding the sediment pan can slide along the horizontal arm to adjust according to sediment size. The hook holding the stream flow side can adjust according to stream slope. When any of these variables changes, then the system is no longer in balance. If the stream is free to adjust, then one or more of the other variables is likely to change until equilibrium is restored. Streams flowing over bedrock or in concrete channels are unable to follow this relationship because of their inability to adjust the sediment size and quantity variables. *(From "Applied River Morphology," by D. L. Rosgen, 1996.)*

People change things in a stream system and then blame the stream for readjusting.

Many human activities alter either the hydrology of a watershed or the hydraulics of a stream channel. When this occurs, it should come as no surprise when the stream channel adapts. Unfortunately, the stream's adaptations frequently impact roads, bridges, and other stream corridor development. Changes in hydrology can result from development, drainage ditches, land use changes, or other activities in a watershed that alter the amount and timing of runoff into the stream. Hydraulic changes can be caused by projects that alter either the channel or its floodplain. These include: channel straightening, bridge construction, channel maintenance, filling of the floodplain, dam construction, etc. Later sections of this booklet will focus on the specific impacts of common watershed and stream system changes.

NOTES

SECTION 3: ASSESSING THE CONDITION OF A STREAM

When dealing with a stream problem, the first step is to work with stream professionals to understand the cause of the problem. Is this change part of the natural life cycle of the stream? Is the stream responding to a change caused by human activity? Although no solution we devise is guaranteed to succeed in correcting the problem, the chances of success are greatly improved if the proposed project is based on an understanding of the local stream and watershed conditions.

NOTES

Many common actions unwittingly contribute to stream instability. The following scenarios illustrate situations in which a stream is thrown out of balance:

- A dead tree topples into a small stream and diverts much of the water flow against the opposite bank. Water still moving near the tree slows down and deposits sediment. As sediment builds up around the tree, the velocity of diverted water increases. Eventually the opposite bank begins to seriously erode and a bar builds up over the fallen tree. Thus, the response of the stream to the fallen tree was realignment of its channel around the tree and erosion of the opposite bank. This is a natural and very common occurrence, in which the stream flow is altered along a small segment of stream. The fallen tree is beneficial in that it improves the physical habitat within the stream.
- To increase his planted acreage, a farmer clears the brushy vegetation adjacent to a stream. He is then able to plow to the edge of the streambank. This results in channeling of rainfall runoff down the bank face and the removal of plant root systems that held the soil together. As the soil holding the shrubs and grasses in place on the bank is slowly eroded away, this natural vegetation is lost, leaving a relatively smooth slope. The stream responds to this smooth, unprotected surface by seriously eroding the bank during the next flood. After several floods the farmer not only loses the land originally covered by brush, but he also loses many valuable acres that he had farmed productively for years.
- A real estate developer is clearing land near a stream. Although many of the large trees are harvested and taken to a sawmill, much of the brush and scrub timber is pushed by bulldozers into the stream channel to be carried away by the next high water. During the next flood, the refuse is indeed carried downstream. This debris, in combination with some dead trees that have fallen into the stream, forms several very large brush and timber piles. A few of these piles are positioned such that the stream flow is deflected against the banks. As the lower banks are eroded away, the upper banks collapse. Thus, downstream landowners begin losing land along the stream as a consequence of improper land clearing techniques upstream.
- Rapid urbanization of a watershed's upstream area has resulted in paving and roofing much of the ground surface area originally available for rainfall infiltration. No provisions were made to protect sensitive features (e.g., wetlands, streams, forests) or to control the rate of runoff from this development. As a result, the downstream flow during storms is greatly increased. The response of the stream is to enlarge its channel by bank erosion and bed scour to accommodate the increased flow. As a result, downstream landowners lose acreage along the stream because developers did not properly mitigate the impact of their project on downstream flow conditions.

STREA VE T RY A D EVA UAT F R

Watershed:		County:		Date:
Stream:			Assessor:	
Site #	Photo#:	WP Start:	WP End:	Time:
alley Type:	Length of site:		Structure Type:	Distance to:
☐ Left nk	☐ oth nks		☐ Right nk	☐ Gr vel r

Erodibility Variables

Bank Height (ft)	Bankfull Height (ft)	Root Depth (ft)	% Root Density	Bank Angle

% Surface Protection	Materials Adjustment (-)	Stratification Adjustment (-)

Depositio al Features

☐ Point rs ☐ Point rs with few Mid- h nnel rs
☐ Numerous Mid- h nnel rs ☐ Side rs
☐ Di gon l rs ☐ h nnel r nching/numerous mid b rs
☐ Side b rs & ch nnel b rs L 2/3 widths ☐ Delt rs

Estimated ear Ba k Stress Predictio

☐ Very Low ☐ Low ☐ Moder te
☐ High ☐ Very High ☐ Extreme

Cause of stability

☐ Entrenched____________# ☐ Incised____________#
☐ Poor Veget tion ☐ R dius of urv ture too tight
☐ Too Str ight ☐ Hum n Influences ☐ High nk
☐ High W/D ☐ Low W/D ☐ High Velocity ☐ M teri l to Sm ll
☐ Other Expl in

Visual Stream Classificatio evel

Current Type ____________Potential________________
Bed Materials ☐ Fl t & Pl tey ☐ Rounded-Sub Rounded
☐ locky ☐ Other________________

Riparia Vegetatio

Deciduous Overstory_____% Evergreen Overstory_____%
Bare % High Brush % Low Brush %
Deciduous w Brush & Grass % Grass & Brush %
Forbs % Perennial Grass %
Wetland egetation % Annuals w Forbs %
Perennial Overstory % Rhizomatous Grasses %

Flow Regime

☐ Perenni l ☐ Subterr ne n ☐ Intermittent ☐ Ehpemer l

Debris a d Blockage

☐ None ☐ Numerous ☐ e ver D ms Few
☐ Infrequent ☐ Extensive ☐ e ver D ms Frequent
☐ Moder te ☐ Domin ting
☐ Hum n Influences

a duse

☐ P sture ☐ H y/F llow ☐ Residenti l ☐ Woods
☐ ultiv ted g. ☐ ommerci l/Industri l ☐ rush
☐ F rmste d ☐ Woods w/ gr ss ☐ onstruction

ea der Patter

☐ Regul r ☐ Tortuous ☐ Irregul r
☐ Trunc ted ☐ Unconfined Scrolls ☐ onfined Scrolls
☐ Distorted Loops ☐ Irregular / Oxbows

Remediaiton Approach	Permit	Access

Comments:

When the "triage" team visits the stream, they use a worksheet to help with observing and describing the stream conditions. Measurements are taken to determine the length of the impacted area at each site or impaired reach. Sites are photographed and locations recorded.

"TRIAGE" APPROACH

"TRIAGE"

- Physically inspect the condition of the stream and its tributaries
- Identify sources of instability
- Develop and prioritize ap propriate remediation strategies

"Triage" is a process for moving from the recognition of a stream problem to selection of an appropriate intervention. The idea is to make a relatively quick assessment of the problem, the causes, and the urgency of the situation before proceeding. Some conditions pose an immediate threat to a house, road, or other development and thus warrant prompt action. Others require additional time to collect information and devise an appropriate solution. Yet others can be handled with a wait and see approach. The first step toward addressing the problem is physical inspection of a stream and its tributaries to assess the existing conditions, not only at the sites with problems, but upstream and downstream as well. Hopefully this inspection will enable an understanding of the sources of the stream's problems. Keep in mind that the instability may result from a combination of sources, which may make resolution of the problem more complex. Only after the sources of instability have been identified can you develop and prioritize appropriate strategies for addressing the situation at each problem site.

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Before trying to "fix" a stream problem, you are encouraged to consult local stream professionals to assess the situation and recommend appropriate management strategies. The first stop for local consultation is the county Soil and Water Conservation District. *(To find the local office, go to http://www.nys-soilandwater.org; select "contacts" and then "county offices.")*

Inspection: The conditions observed in problem streams commonly include:

- Lack of riparian (streamside) vegetation
- Signs that the stream has been altered (straightened, deepened, etc.)
- Inability of the stream to utilize its floodplain
- Constriction at a bridge or culvert
- Road/structure encroachment
- Culvert outlets
- Bank erosion
- Sediment deposition
- Woody debris
- Appliances, tires, or other garbage
- Rock riprap

Observation of any of these conditions may or may not be related to an instability problem in the stream. Some may be natural features of a stream in dynamic equilibrium. Others may be human-induced changes to which the stream has previously adjusted. In order to understand how these observations may relate to the stream's problems, we need to integrate our understanding of how the streambed and streambanks respond to change.

STREAMBEDS

One of the characteristics of a well-balanced stream is that the elevation of its bed remains relatively constant over a time span of several decades. If an imbalanced condition results in excess energy, the stream could scour out its bed or cut downward in the existing channel (thus disconnecting the stream from the floodplain). If an imbalanced condition results in insufficient energy to transport the sediment load, a stream can deposit excess sediment onto the bed. If the bed of a stream is rising or falling, this can cause the banks to erode or the channel to move. It is important to know if a streambank erosion problem is caused by instability of the streambed before any time or money is invested in a streambank protection project that might not work.

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Degradation: A stream that is deg
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ate a deep channel that is disc
nected from its former floodpl
The high streambanks will be sub
to erosion because they no lon
have sufficient support. Degra
tion may result in undercutting
bridge abutments. When high fl
occur, the water is no longer abl
spread out on the floodplain wh
it slows down and dissipates ene
The stream will instead dissipate
ergy by cutting its banks until it
reestablished a floodplain at the n
lower elevation. This in turn cre
excessive amounts of sediment.
erosion and sediment loads are lo
symptoms of an energy imbalan
which might have been triggered
increased flow, increased chan
slope, or some other change to
system.

Aggradation: When a stream is not able to carry its sediment load, material will be deposited on the streambed. As a result, the elevation of the bed will rise, thus reducing the size of the channel. When the next flood comes, the stream may enlarge the channel to its original size in order to carry the flood flow. This enlargement may result in erosion of the streambanks, producing in a wider, shallower channel. The deposition associated with a rising, or aggrading, stream channel may also be indicated by the formation of sediment bars or islands within the channel. Aggradation is a natural feature of streams with high sediment inputs, but may also be triggered by a change to the stream system, such as increased upland erosion or alteration of the channel shape.

Braided multiple channels with excess deposition of loose gravel are characteristic of a stream channel that cannot transport its sediment load. *(Photograph courtesy of Greene County Soil and Water Conservation District.)*

NOTES

STREAMBANKS

Width is the stream characteristic most easily altered by flowing water. A major alteration in the sediment supply or a change in water-sediment relation will frequently result in bank erosion. Before time and money is invested to "fix" an eroding streambank, it is important to understand whether it is the result of a system-wide instability or a localized condition.

Bentley Creek washed out 4 ½ acres of cornfield in a single storm event. *(Photograph by Mike Lovegreen, Bradford County Conservation District.)*

Localized stream adjustments occur when a fallen tree or other obstruction alters the local flow pattern. This can result in sediment deposition (as seen in this photograph) or erosion or both. The situation can generally be left alone, unless development is threatened. *(Photograph from "Stream Corridor Restoration: Principles, Processes, and Practices," 10/98, by the Federal Interagency Stream Restoration Working Group.)*

NOTES

REMEDIATION STRATEGIES

Only when the causes of stream problems are understood, are you ready to evaluate strategies for addressing the problems. Keep in mind that streams constantly change, adjust, and move – there is no such thing as a truly "stable" stream. Unfortunately, the natural movement of streams is often incompatible with development (such as roads, bridges, buildings, and agriculture). It is also important to remember that any change to one part of a stream may cause further disequilibrium that actually creates new problems. "Fixing" one section of a stream may be pushing the problem downstream. Stream professionals can provide the technical assistance needed to address the "source" of the problem. Seek their assistance and try to avoid temporary "band aide" measures that may lead to additional "headaches."

REMEDIATION STRATEGIES

- No action
- Remove development from the stream corridor
- Debris removal
- Planting
- Energy dissipation
- Streambank protection (such as riprap)
- In-stream structures (such as stream barbs)
- Natural stream channel design
- Watershed solutions

No Action: All streams are trying to re-establish or maintain a dynamic equilibrium within their floodplains. If left alone, they will recover naturally. Unfortunately, this may take longer than we are willing to wait. Or development may be damaged by the natural evolution of the stream system. But in many cases, the no action alternative is the best—and least costly—strategy.

change and additional adjustments will occur. The stream in this photograph has been undergoing active adjustments for an extended period of time, as indicated by the abandoned channel in the top center. *(Photograph courtesy of Greene County Soil and Water Conservation District.)*

A debris jam caused floodwaters to backup under the bridge and deposit gravel. Partial removal of the debris enabled the stream to re-establish normal flow conditions. *(Photograph courtesy of Melissa Yearick, Upper Susquehanna Coalition.)*

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Remove Development: Another solution may be to remove the threatened development from the stream corridor. Removal of a structure or relocation of infrastructure is sometimes a cheaper and more permanent solution than trying to protect that development from an unstable stream.

Watershed Solutions: Because watersheds influence the behavior of streams, some solutions to stream problems are located outside of the stream channel. For example, if stream problems developed because logging operations increased the sediment load, then it may be necessary to stabilize the disturbed area before any in-stream solutions can be effective. If the problems were caused by increased runoff from new development (causing erosion of a larger channel), the stream problems can be addressed by capturing and managing the runoff before it reaches the stream.

Cost Effectiveness: Once the potential restoration strategies are identified, the expected effectiveness must be evaluated against the anticipated cost of the project and the risk of doing nothing. A streambank erosion problem that threatens a house or road may warrant a more expensive intervention than a similar erosion problem in an undeveloped area.

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Volunteers are planting willows to stabilize a problem site in Steuben County. Once established, plants on the streambank and floodplain will dissipate energy and their roots will help stabilize the soil. *(Photograph by Jeff DeMeritt, Meads Creek Watershed Citizens' Committee.)*

In addition to natural energy dissipaters, such as meanders and vegetation, extra resistance in the stream can be added by placing rock or wood in the channel to break up the flow. *(Photograph by Gary Wilson, USDA Natural Resources Conservation Service.)*

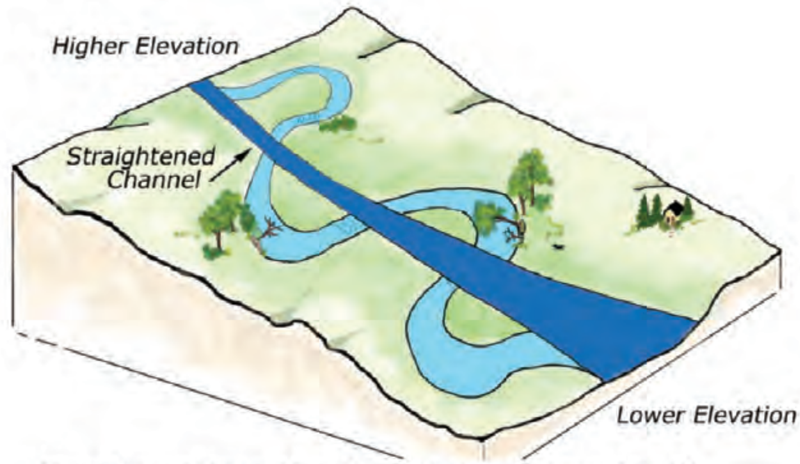
The most common technique for preventing streambank erosion is to protect the bank with rock riprap, but other streambank protection measures can be used as well. In this photograph, a retaining wall has also been used to protect a road. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

The shape and location of this stream channel has been re-built based on "natural stream design" principles. The objective is to create a stream channel in which the energy is balanced. *(Photograph courtesy of Greene County Soil and Water Conservation District.)*

Rock structures have been placed in this stream to stabilize flow patterns and the channel. *(Photograph by Mike Lovegreen, Bradford County Conservation District.)*

Flooding of this stream caused a washout extending 100 feet into the adjacent field. The site was restored by filling in the washed out area, stabilizing the bank with rock riprap, construction of two in-stream rock structures, and planting willows along the edge of the field. *(Photographs courtesy of Steuben County Soil and Water Conservation District.)*

"…ten thousand river commissions, with the mines of the world at their back, cannot tame that lawless stream, cannot curb it or define it, cannot say to it 'Go here,' or 'Go there,' and make it obey; cannot save a shore which it has sentenced, cannot bar its path with an obstruction which it will not tear down, dance over, and laugh at."
– Mark Twain, Life on the Mississippi



Straightened channel length = 1/2 stream channel length
Straightened channel slope = 2 times stream channel slope

ight streams tend to shoot water like a fire hose. When the bends and ves are eliminated, the stream continues to drop the same elevation, but horter linear distance. This increases the slope of the channel, which i am's velocity. Remember that the meanders, riffles, a natural stream channel provide resistance that dis- Without th se features, the stream has more en- gy to *stration courtesy of Amy Reges, Upp r Susq*

Stream channels are altered for a variety of purposes: bridge construction, road building, valley development, flood control, erosion control, fishery improvement, etc. Unfortunately, many of th ff t t manage and rol st d i l

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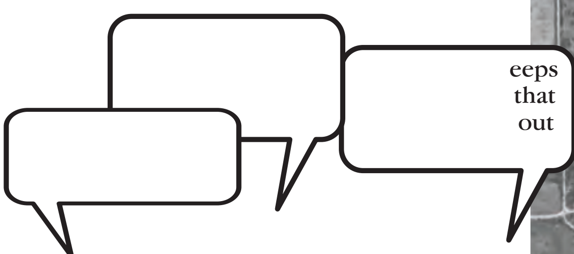

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Air photos taken in 1944 and 1954 he stream was straight- two road crossings. 2004), high water to the old chan- el location and oods the roadway. *hotographs co tesy of Schuyler ounty Soil and Water Conservation District.)*

downstream of the project site. This is because the channel-straightening project tends to focus on one stream function—water transport—without adequately accounting for other functions, such as energy dissipation and sediment transport.

Flat valleys are often the easiest places to build roads—except for the streams that meander from one valley wall to the other. Over the years, many streams have been moved or straightened to accommodate road construction and minimize the need for bridges. This tends to increase the speed and energy of the water within each section that has been straightened. Years later, the stream may still be eroding its bed and/or banks in an effort to restore a stable channel length and slope.

One solution to the increased erosion potential of a straightened stream is to protect the bed and banks with rock or concrete. This smooth, hard channel enables the water to speed through even faster, taking its energy with it. Downstream areas will have higher peak flows, because the water gets there faster, which may increase flooding problems. In addition, downstream areas will be subject to increased erosion, unless the project incorporates sufficient energy dissipation structures. Be a good neighbor – don't solve one stream problem by moving it downstream onto someone else's property or into someone else's jurisdiction.

Confining flow to a paved channel may have flood conveyance benefits to the immediate area. However, habitat is lost and downstream areas will be impacted. *(Photograph from "Stream Corridor Restoration: Principles, Processes, and Practices," 10/98, by the Federal Interagency Stream Restoration Working Group.)*

This channel was designed to carry a stream safely through a residential neighborhood. Unfortunately, the narrow channel and a low bridge clearance restrict the flow of ice, causing ice jams at this location. *(Photographs courtesy of Herkimer-Oneida Counties Comprehensive Planning Program.)*

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The design of some idges and culvert imply not large enough to low for the high flow a ociated d event. Wh fast moving floodwater i hrough cture, the bri e or ulvert may be overtopped, d maged by washed out. *oto-g aph rtesy of Herkimer-Oneida Cou sive Planni g Pro-g*

Narrow

f a bri
spa e for w roug ring a flood event, the shape of this spa e is often quite different than the shape nel and loodplain up-tream of the bridge. a bridge or culvert dth of the stream, ing high flow condi- This constriction may cause water to back up above the structure. The slowe -moving water that is ponded upstream of the bridge has less energy to carry its sediment load, which can result in the accumulation of sediment upstream of a bridge. In order for water to pass through a constricting culvert or bridge, the water approaching the upstream end of the structure must move faster, which raises the potential for streambank erosion near the entrance and under the bridge. As the faster-moving water leaves the bridge or culvert, it is no longer constricted and spreads out. If the spreading water or main flow cannot follow the bank line, a rotating current, called an eddy will be set up next to the bank. The eddy can cause severe erosion if the bank is not properly protected. Further downstream from the bridge, the main flow will contact the bank, causing additional erosion.

A narrow bridge or culvert restricts the stream channel and blocks flow on the floodplain. Improperly sized stream crossing structures can be a disaster waiting to happen and a money hole for maintenance. *(Photographs by Mark Watts, Chemung County Soil and Water Conservation District.)*

The constricted channel at a bridge may contribute to the formation of ice jams or debris piles. This ice jam was extensive enough to block flow in the river and flood surrounding areas. *(Photograph courtesy of the Binghamton Forecast Office of the National Weather Service.)*

NOTES

Floodplain flow was funneled under this narrow bridge, contributing to its collapse. *(Photograph courtesy of Schuyler County Soil and Water Conservation District.)*

Water shooting out of this culvert has blown out the banks of the downstream channel. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

old bridge

NOTES

new bridge

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new bridge during a major flood

When this bridge was replaced in 1991, the existing structure had a 35-foot span and had passed the flood of record in 1955. Because engineering analysis indicated that the flood of record was only a 25-year event, the bridge was replaced with a larger structure having a 160-foot span. Four years later, the watershed experienced a 100-year flood, with flows almost twice that of the previous flood of record. Because the bridge had been designed to accommodate a major flood event, this is a success story of a bridge that was not overtopped or damaged. *(Photographs courtesy of NYS Department of Transportation.)*

Bridge Piers: Placement of a bridge pier in a river or stream can cause significant changes in stream flow characteristics as well as changes in the amount of erosion or sediment deposition. If the geometry of the pier deflects flow against one of the banks or if eddy currents develop, then serious erosion can occur. When trees and other debris become caught on the structure, the effective size of the bridge opening is decreased. This restriction may cause flooding. Increased velocity may also result in streambed scour below and adjacent to the debris piles.

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Because most bridges only span the main channel, the flow occurring in the floodplain is blocked by elevated bridge approaches. In this location, water backed up at the bridge and contributed to flooding problems. Rather than replacing the historic bridge with a larger structure, the problem was resolved by installing a culvert that allows water to flow directly from the floodplain upstream of the bridge to the downstream floodplain. *(Photograph courtesy of Steuben County Soil and Water Conservation District.)*

Debris can threaten any bridge or culvert, but if a bridge pier or multiple culvert design splits the stream flow, the risk of debris damage is increased. *(Photographs by Gary M. Patelunas, Town of Elmira Stormwater Department and Scott Rodabaugh, NYS Department of Environmental Conservation.)*

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Stream Changes: Bridges are relatively permanent structures. When we build a bridge, we would like for the stream to continue to flow in the same place. But streams are dynamic systems that tend to move and change—even if the stream system is well balanced. And unfortunately, most of our streams are not balanced and stable, meaning that they are likely to change more quickly. So even a perfectly designed bridge that does not alter the local energy balance of the stream may wind up having problems when the stream adjusts to other changes in the watershed. If a streambed is rising, or aggrading, then space under the bridge will be reduced. Conversely, a stream that is down cutting may erode down to the level of the bridge supports and threaten the stability of the structure.

Some bridges are not properly aligned with the stream due to original design miscalculations and/or subsequent migration of the stream. If a bridge opening or culvert is not aligned to the centerline of the stream, the stream's energy will be directed at the embankment, increasing the risk of erosion and consequent damage to the bridge or culvert. *(Photograph of Steuben County Bridge over Meads Creek by Janet Thigpen, Southern Tier Central Regional Planning and Development Board.)*

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Aggradation of the stream has significantly reduced the capacity of this bridge, which now causes flooding of surrounding areas. *(Photograph courtesy of Herkimer-Oneida Counties Comprehensive Planning Program.)*

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They used to come
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Dredge the channel!

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continuing costs.

W s on a private drive, all risks, expenses, and liability a ure belong to the property owner. Public funding a available to assist with maintenance, repair, or re- p ges. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

Gravel accumulates in particular locations in the stream because the conditions are appropriate for sediment deposition and not sediment transport. If the gravel is removed without addressing the underlying reasons for deposition at that site, then the gravel will return – again and again and again. *(Photograph by Mike Lovegreen, Bradford County Conservation District.)*

NOTES

Gravel Bars: Gravel bars are normal components of some types of streams. Gravel accumulates on the inside of stream meanders or mid-channel because the water velocity in that location is not sufficient to carry the sediment load delivered by the stream. Some locations are naturally subject to gravel deposition (such as where the slope of a tributary stream changes at the edge of a larger valley). If a new gravel bar forms, it may be due to an increase in the sediment that is washed into the stream or it may be due to a local reduction in the stream's energy, and hence its ability to transport sediment. A gravel bar that is removed will almost always reform in the same place during the next high flow event. Removing a gravel bar may temporarily treat a symptom, but it doesn't solve the problem and may cause bank erosion as the stream finds an alternate supply of sediment to replace what was removed.

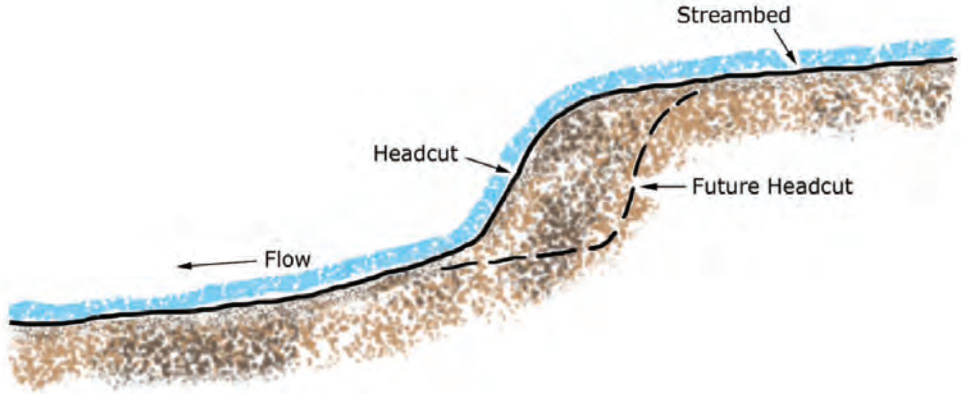
Loss of Riffles and Pools: Removing sediment from the streambed also removes the riffles, pools, and vegetation that provide channel roughness and energy dissipation. These natural features had served as speed bumps for the stream. Dredging removes this natural structure, replacing it with a uniform stream bottom that does not slow down the water. This causes the stream's velocity to increase, which may have the beneficial effect of reducing flooding by moving water through the area faster. However, the unspent energy in the stream enables it to pick up additional sediment, resulting in increased potential for erosion.

Loss of Floodplain: If a dredged channel is made deeper, the stream may no longer be able to overflow onto the floodplain during high flow events. If the floodplain contains houses or other development, this may be done deliberately to provide flood protection. However, when the stream loses access to its floodplain it also loses the functions of that floodplain. During high flows, the stream will no longer dissipate energy by spreading out across the floodplain. The energy of the confined stream will instead be directed at the banks and can cause significant erosion. Eventually, the stream will form a new floodplain at a lower level. This process can take many years, causing significant erosion damage and large volumes of excess sediment.

Many of New York's rivers and streams carry massive amounts of water during flood flows. Gravel bars accumulate quickly when the flood begins to drop, but they generally move out the next time water rises and do not necessarily cause increased flooding. Because gravel provides excellent habitat for fish and other animals, its removal is generally discouraged. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

Routine removal of gravel has destroyed the natural structure of this channel and disconnected the stream from its floodplain. The wide shallow channel lacks the concentrated flow needed to transport sediment through the system. *(Photograph by Chris Yearick, Upper Susquehanna Coalition.)*

Altered Slope: The slope of a stream influences the velocity of the water and consequently the amount of sediment the stream can carry. Unfortunately, many small-scale dredging projects pay little attention to slope—even though the projects are intended to resolve sediment problems. The area with gravel buildup is generally deepened, creating a flattened streambed, which is an ideal location for sediment deposition. So the bottom fills up and pretty soon it's time to bring the bulldozers back to do it again.



Headcut: The resulting problems become more serious if a dredging project causes a headcut This occurs when a section of the
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Clean out this stream!

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Fish love to hide under that fallen tree.

Don't clean this stream!

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m looding d scour. Often, limited stream cleaning is necessary to rotect the piers of bridges and other structures. How ver, stream cleaning should be very selective to cause the least damage and to get the most benefits. If it is clear that a potential hazard exists, consider options other than total removal. For example, a tree that will likely fall and damage a structure or take out part of the bank can often be trimmed to remove only the top part leaving the lower portion of the tree and the roots to bind the soil together. The use of heavy equipment in a stream can damage its bed and banks and should be avoided as much as possible.

a natural stem. Woody debris deposits ofte - locations wh ict with development and are thus t a problem. If trees and other natural debris in the stream do not pose an m-minent threat to stream corridor development, it is generally best to leave em alone and let nature take her course *(Photograph by Mark Watts, Ch mung County Soil and Water Conservation Di trict)*

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DAMS

We need dams to stop all this flooding.

Let's create a lake for recreation.

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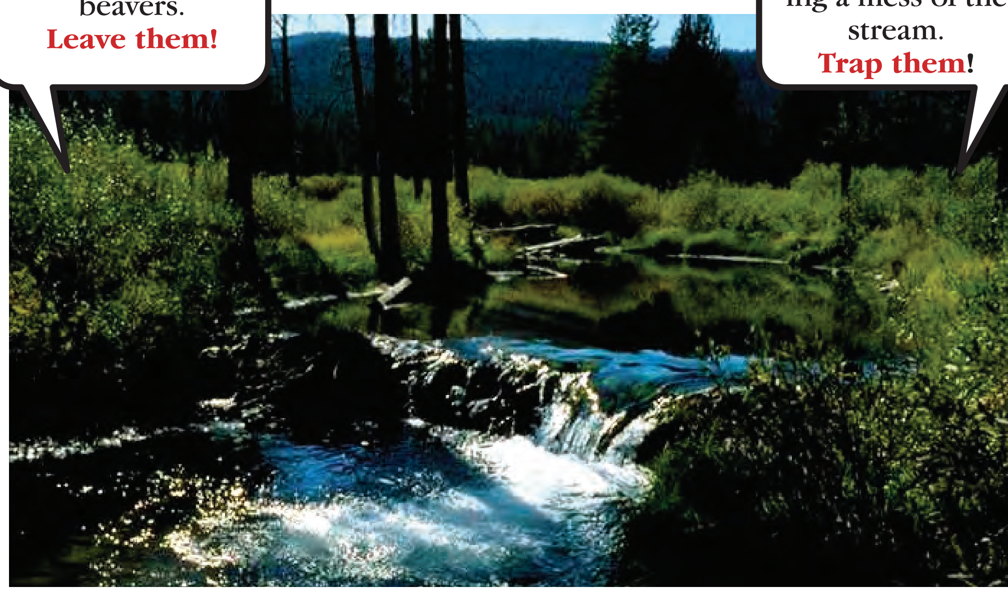
Downstr ecause dam all larger sedim t moving down stream chann the water releas i carrying ess sediment than t am system can handle. This "sed- nt starved" water has excess en- gy that will be used to i k move materials. The r river or stream often d/or wider channel to replace the lost sedim



Bea ose ve bot ega- tive impacts on adw e sedimen ore water, and reduce peak flows. Beaver c n incising st eam by building the streambe back up and eam to its floo plain. On the he hand, the water impounded by beave often floods low lying roads, ot er development. *(Photograph from "Stream Corridor Restora- , Processes, and ctice " 0/98, by the Federal Interagency ration Wo*

Check dams are a common way of controlling stream grade. A check da is a structure placed across the ream to control the upstream bed n. Steel sheet pile, rock or check dams extending be- level of the bed are used to arrest (check) headcutting. If a check dam is built to extend above the bed of a stream carrying significant bed-load, it will trap sediment and build up the streambed to the top of the dam. Check dams can be extremely are not without problems. One of the most common is that they mall waterfalls that disrupt natural stream processes and prevent the fish. If check dams are used, it is better to use many small dams, or two big dam he impact on the stream pro- re pro e and accomplishes the tab *M. Patelunas, Town of* *er Depar*

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GRADE STABILIZATION

much the same way as check *aph by Gary Wilson, USDA*

- rock structures can be used e the bed of a stream. This e consists of large rocks the stream with a "V" shape n the upstream direction. cture focuses the current he center of the channel from the banks. Spacing ulders enables fish passage ment transport through the *(Photograph courtesy of ounty Soil and Water Conservation District.)*

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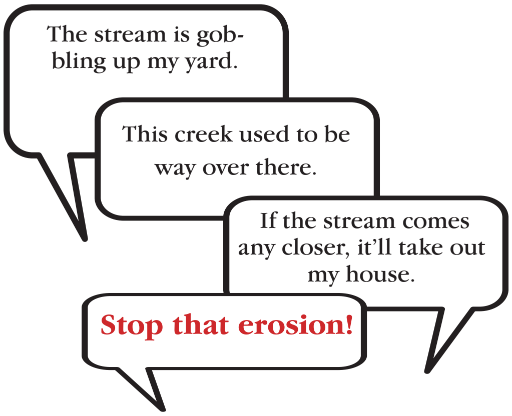

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or even past th big storm. If the underlying ca se of the eros - lem is not und rstood and add n bank protective measures may ffective. If a stream has ex ss ou prevent erosi the ene in erosi A bank protect even increase the amo by inc sing the velocity

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Rock Riprap: Riprap is large angular rock dumped or hand pl d on a streambank to protect it from the erosive power of a stream. While extremely effective in many situations, it has some drawbacks. Water flowing near the riprap generally moves fast and there is often turbulence near the bank. Since the water is moving rapidly, it is more likely to erode unprotected areas adjacent to the riprap and, in some instances, may undermine the riprap. This process of downstream effects can set up an endless process of placing riprap along the entire stream.

Retaining walls are commonly used for streambank protection, particularly when there is not sufficient space for a sloping bank. Because the wall limits the stream's access to its floodplain, high velocities and erosion damage may occur. This newly stabilized streambank (left) was in need of repair after one high flow event (right). Vertical walls also create barriers to the movement of wildlife (like turtles, frogs, and salamanders) and are generally recommended only when other options are not available. *(Photographs by Mark Watts, Chemung County Soil and Water Conservation District.)*

Sheet piling stabilization is a very expensive method of streambank protection and is sometimes only a temporary measure. Proper design is necessary to protect against erosion. *(Photographs by Mark Watts, Chemung County Soil and Water Conservation District.)*

1973

1996

Streamside junk piles are ugly and ineffective bank protectors. They seldom stay in place during floods and frequently contain substances that cause water pollution. Even such massive items as automobiles and cement sidewalk slabs can be dislodged by the power of flowing water. Automobiles that were used to stabilize this stream in 1973 now wind up in the creek when the banks erode. *(Photographs by Donald Lake, NYS Soil and Water Conservation Committee; and Mark Watts, Chemung County Soil and Water Conservation District.)*

In-Stream Rock Structures: Various type in in-stream rock structures are used to control the direction of flow within a stream. One or more structure can be used to direct a stream's energy toward the center of the channel and relieve pressure on an eroding streambank. In-stream structure are almost always less expensive than riprap because they use less rock For these structure to perform properly they must be sized, located and constructed properly.

Vegetation: Well-established vegetation is one of the best long-term protections against bank erosion and channel migration. One study showed tha bare banks are **10,000 times** mor susceptible to erosion than their vegetated counterparts. Vegetation can be used independently or in combination with other streambank protection measures (rock riprap, in-stream structures, etc.). Protecting existing vegetation or planting new material can be a cost-effective and easily maintained method for protecting a streambank.

Vegetation is the only streambank protection method that can repair itself when damaged. Below a stream's waterline, vegetation can effectively protect a bank in two ways. First the root system helps to hold the soil together and increases overall bank stability by forming a binding network. Second, the exposed stalks, stems, branches and foliage provide resistance to the stream flow, causing the flow to lose energy by bending the plants rather than by removing soil particles. Above the waterline, vegetation prevents surface erosion by absorbing the impact of falling raindrops and reducing the velocity of and surface runoff. Further more, vegetation takes water from the soil providing additional capacity of infiltration and may improve bank stability by water withdrawal. However, even a mature forest cannot hold against a stream channel that has become unstable due to other influences.

Rock vanes are carefully placed rock structures built below the water level to control the direction of flow within a stream. This vane reduced the velocity adjacent to the streambank, resulting in sediment deposition near the bank on the upstream side of the structure. Vegetation can be planted on this newly deposited material to provide additional protection. *(Photograph courtesy of Greene County Soil and Water Conservation District.)*

Planting trees along a stream is often effective in restoring and maintaining bank stability. *(Photograph courtesy of USDA Natural Resources Conservation Service.)*

ST BANK

You can't fight Mother Nature.

Can we re-establish this stream's equilibrium?

Work with the natural dynamics of the stream!

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retained or restored include: channel sl e (or gradient), bankfull c nnel width, bankfull channel depth, pool-riffle sequence, meander pattern, and hydraulic roughness. Once a stream is returned to a "functioning" condition, it should adequately transport sediment through the system. This approach focuses on the geometry and physics of the stream in order to establish a channel shape that will not be subject to the rapid adjustments. The resulting stream channel should cause fewer problems for bridges and streamside development, while also providing better habitat for fish and other wildlife.

Dynamic Equilibrium: The objective of a natural stream design project is to establish a stream channel that is in dynamic equilibrium. This does not mean that the stream will be fixed and unmov-

e b en buried and anchored
streambank so that the root
wads provide erosion protection.
(Photograph by Gary Krame U DA
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watershed or i the tream channel. A meandering stream that is in equilibrium **will** exhibit meander migration. When such movements are incompatible with development, then the project should incorporate additional techniques to ensure that the stream continues to flow under bridges and does not undermine buildings.

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The shape and location o this chan-
nel were re onstructed u ing natural
st eam design techniques and in-
structures. *(Photograph*
Greene County Soil and
District.)

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In designing a stream restoration project, special consideration is given to managing causes as opposed to treating symptoms.

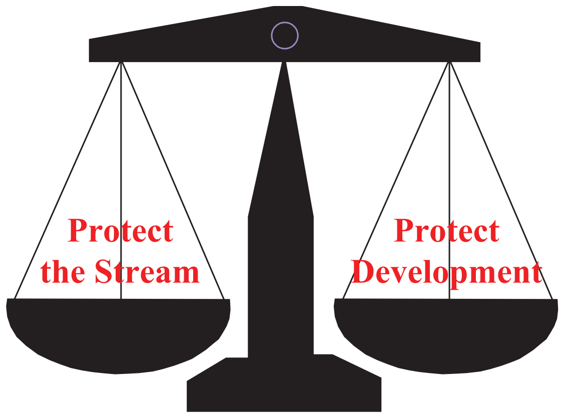
SECTION 5: UTILIZING STREAM CORRIDORS

STREAM CORRIDOR MANAGEMENT

Many stream corridors already have roads, buildings, utility lines, fields, and other development located along the streams. There are also an untold number of bridges and culverts that enable roads and private drives to cross the streams. This development frequently leads to conflicts between human use of the land and natural stream processes. Large rainfall events **will** result in huge volumes of water with tremendous energy that will flood and erode. It is natural for streams to flood. And it is natural for stream channels to change course over time. It is also natural for property owners and municipalities to try to protect streamside development from flooding and erosion. This may lead to efforts to force a stream to stay where it is – which is against its natural tendencies. The disruption caused by stream corridor development and efforts to protect that development often leads to unstable stream systems with escalating flooding and erosion problems.

It is important that streamside activities allow for the physical behavior of the stream and maintain the integrity of the stream system. If human encroachment disrupts a stream's dynamic equilibrium, the stream will adjust and may become a greater threat to nearby development.

By allowing a stream to utilize its floodplain and its tendency to meander as much as practical, we can effectively reduce many of the flooding and erosion problems associated with streams.



The objective of stream corridor management is to strike a balance in which the stream's natural functions are protected as much as possible, while at the same time protecting existing structures and land as much as possible.

This house was constructed so that a portion of the structure extended over the stream. The builder apparently did not anticipate that the stream would erode its channel ten feet deep and undermine the building foundation (left photo). In order to protect the house, the creek bed was raised, lined with rock, and stabilized with a drop structure – at a cost of $36,000 (right photo). *(Photographs by Gary M. Patelunas, Town of Elmira Stormwater Department.)*

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Understand the Hazards: Prior to buying or developing streamside property, take time to honestly evaluate both the opportunities and the natural hazards of the site. Find out if there is a history of flooding, streambank erosion, or drainage problems. Contact neighbors and municipal officials (not just the person selling you the house). Keep in mind that many flood prone areas are not in mapped floodplains. Whenever development is located in a stream corridor, there is a potential for problems.

Alluvial Fans: When a high gradient stream enters the level floodplain of a river, the slope of the stream may decrease sharply. When this occurs, water tumbling down the steep valley slows down and loses its ability to transport sediment. Over a period of many decades, deposition will build up the land at this location, forming what is called an alluvial fan. This forms a fan shaped elevated area that slopes downward from the mouth of the steep side valley. It is tempting to locate development on an alluvial fan because it is elevated above the floodplain of the river. However, the stream on an alluvial fan is highly unstable, filling its channel with sediment and then shifting to a new location.

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This car was licensed and on the road. The owner stopped at parents' house to get them out during a storm event. Fifteen minutes after arriving, the driveway washed out and took the car approximately 300 feet downstream. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

Flash flooding of a small stream piled gravel up to four feet deep on the floodplain. The best protection against this damage would have been to locate development away from the stream on high ground. *(Photograph courtesy of Steuben County Emergency Management Office.)*

Maintain Streambank Vegetation: If there is vegetation along the streambank, these plants may be a key factor contributing to the stream's stability. Existing trees and bushes should be retained. The site layout can protect streambank vegetation by minimizing the use of streambank slopes by livestock, vehicles, and people. If the site contains wetlands, these valuable flood storage areas should also be retained and protected. If the streamside area is currently cleared, consider establishing a buffer of vegetation to protect the stream.

Protect Development: New construction (roads, buildings, septic systems, etc.) should be located away from the stream to minimize the risk of flooding or erosion damage. Additional protection can be provided by elevation above flood levels, scour protection, and other design features.

Relocation—A Win-Win Solution: Sometimes the sensible solution to a stream problem is to relocate endangered assets away from the problem area. This solution meets the duel objectives of protecting development from the stream and protecting the stream from development.

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Local zoning with setbacks from the road caused this house to sit right on the streambank. The owner does not sleep well during heavy rainstorms. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

This house was completely undercut by streambank erosion and toppled into the stream. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

FUNCTIONS OF VEGETATED STREAM BUFFERS

- Slow water
- Stabilize banks
- Reduce erosion
- Deposit sediment
- Filter nutrients/pollutants
- Moderate water temperature
- Provide wildlife habitat/corridors
- Enhance the scenic beauty

RIPARIAN BUFFERS

Vegetation along a stream acts as a buffer between the water and the adjacent land. The benefits are greatest when the riparian buffer contains a variety of types of plants – trees, shrubs, grasses, and forbs. Different types and species of plants provide a variety of root depths and strength to help stabilize streambanks. A diverse mix of native plants also has the ability to resist or recover from the disturbance caused by repeated flooding.

Well-established vegetation on streambanks and in adjacent riparian areas is generally the best and least expensive long-term protection for a stream system. A vegetated buffer should be maintained or established in the swath of land adjacent to the river or stream. It may be a small corridor of vegetation hugging the stream or a large network of wetlands stretching far into the floodplain. *(Photograph from "Stream Corridor Restoration: Principles, Processes, and Practices," 10/98, by the Federal Interagency Stream Restoration Working Group.)*

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The easiest, most effective way to protect a stream is to maintain a strip of plants along the bank. This is known as a riparian buffer.

Some people like grass, but not trees and shrubs, along their creeks. It makes for easier mowing and nicer picnics. However, replacing a native plant community with residential lawns or agricultural crops may significantly impact the stream's stability. Without bushes and trees to slow the floodwaters, more energy is available to wash away the soil. And without the extensive root systems to hold the soil in place, it is more susceptible to erosion. This frequently contributes to scouring of the banks and may result in significant loss of land along the stream. *(Photographs by Mark Watts, Chemung County Soil and Water Conservation District; and Mike Lovegreen, Bradford County Conservation District.)*

In addition to protecting the integrity of the stream system, riparian buffers preclude the siting of development in the highest risk areas adjacent to a stream. Serious problems occur when streambank erosion or flooding threatens a house, septic system, or garage. However, the same condition would not pose a problem if a forested riparian buffer had been preserved and development had been located a safe distance from the creek. *(Photographs courtesy of Greene County Soil and Water Conservation District and Steuben County Department of Public Works.)*

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When livestock are allowed access to a stream, they can cause significant damage. Livestock move to riparian areas to get water and shade. In doing so, they trample important stabilizing vegetation and damage streambanks. Livestock wastes contaminate the waters with harmful nutrients and disease-causing fecal bacteria and viruses. Standing in water is also not good for the cow's health. These problems can be avoided by fencing farm animals away from streams. If stream watering or crossing sites are necessary, choose sites where streambank damage can be minimized and restrict upstream and downstream animal movement. *(Photograph courtesy of Steuben County Soil and Water Conservation District.)*

DIKES AND BERMS

Many cities and villages with developed floodplains are protected by flood control dikes (or levees) that keep water in the channel and prevent the channel from changing course. These structures have prevented billions of dollars in flood damages. But levees and floodwalls also alter the dynamics of river systems by cutting off the river's access to its floodplain. This can increase the height and velocity of water downstream of the protected area, thus increasing the flood hazards at downstream locations.

Gravel Berms Are Not Flood Control Structures: In order to provide flood protection, a levee must be designed, constructed, and maintained in such a manner that it is able to withstand the hydraulic pressure from high water on one side and the lack of water on the protected side. In addition, the structure must be able to withstand the scour of high velocity water—if the stream is confined to its channel, then so is its power. Inability to withstand these stresses or overtopping of the levee can result in failure of the structure. A berm created by building up the streambank with gravel or soil is much more likely to fail than an engineered levee. When this occurs, high velocity water shoots through the breach, rapidly flooding and eroding the land behind the dike. The resulting damage may be more catastrophic than that caused by the gradual rise of floodwater, which would have occurred if the structure were not there.

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The vegetation along this streambank is dominated by Japanese knotweed, an invasive plant species that has displaced the native plant community. In addition to the adverse impacts on plant and animal communities, knotweed appears to be less effective at stabilizing streambanks than deeper-rooted shrubs and trees, possibly resulting in more rapid bank erosion. The best defense against this and other invasive plant species is to prevent its spread into new areas. *(Photograph courtesy of Delaware County Soil and Water Conservation District.)*

Some flood control dikes are set back from the stream. This allows the stream to function naturally while still protecting nearby land from flooding. Setback dikes maintain a portion of a natural floodplain and provide a floodway where high velocity water can spread out and slow down. *(Photograph by Scott Rodabaugh, NYS Department of Environmental Conservation.)*

FLOODPLAIN MANAGEMENT

The history of floodplain management is marked by efforts, largely federal, to reduce flood losses by controlling floods. Billions of dollars have been spent on structural projects such as dams, levees, and channel modifications. In recent years, there has been a shift away from the philosophy of preventing flood damage by controlling nature. Although we still rely on flood control structures, the emphasis is now on policies that change the behavior of people instead of rivers. Efforts are made to prevent the location of new development in areas with known flooding and erosion hazards. And development that is already located in harms way is being protected or moved to safer areas. Owners of flood-prone structures are encouraged to purchase flood insurance in order to reduce the financial impact of a major flood. Improved flood warnings and emergency response enable protection of lives and property. And better understanding of the value of natural floodplains has led to increased efforts to preserve and restore beneficial floodplain functions.

In rural areas and along small streams, the expense of building engineered flood control levees to protect floodplain development is generally not cost effective (project costs would greatly exceed the value of the development to be protected). Property owners in these areas may support the less expensive alternative of bulldozing sediment from the stream onto the bank to create a berm. Once vegetated, these structures look like flood control levees and give residents the secure feeling that they are protected from flooding—but it is a false security. *(Photograph courtesy of Steuben County Emergency Management Office.)*

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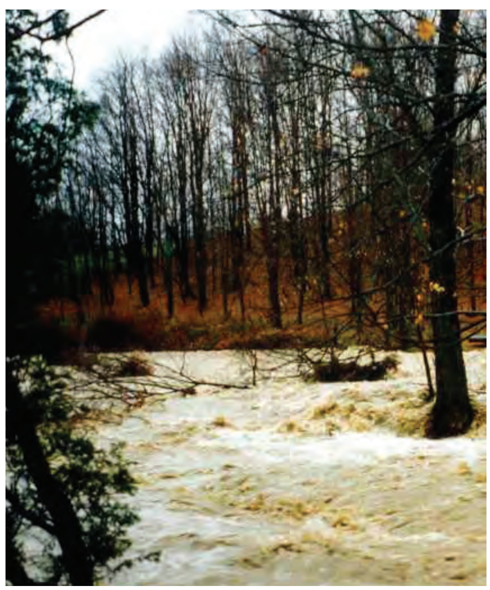
The land in floodplains is generally flat, with deep, fertile soil. We have a history of taking advantage of these features by building on the floodplain. This can be a great place to live—except when it floods. *(Photographs by Melissa Yearick, Upper Susquehanna Coalition, and the Binghamton Forecast Office of the National Weather Service.)*

"Rivers were here long before man, and for untold ages every stream has periodically exercised its right to expand when carrying more than normal flow. Man's error has not been the neglect of flood-control measures, but his refusal to recognize the right of rivers to their floodplain…"
–Engineering News-Record, 1937

Inexpensive land in floodplains seems to attract mobile homes. If not properly anchored, a house can float off its foundation. Some have been swept far downstream. *(Photograph courtesy of Steuben County Emergency Management Office.)*

Most local governments regulate new development within areas mapped as the 100-year floodplain. The National Flood Insurance Program standards require that new buildings be elevated or otherwise protected from flood damage. In addition, the proposed development should not result in physical damage to any other property (e.g., streambank erosion or increased flood velocities). These regulations are intended to restrict inappropriate new development in the floodplain, but do not protect existing floodplain development that is already at risk of flooding. In addition, they do not apply to those flood prone areas that are not identified on floodplain maps.



The best way to protect development from flooding is to locate it out of the floodplain. Both of these streams overflow their banks, but the one on the right doesn't cause any problems. *(Photographs by Mark Watts, Chemung County Soil and Water Conservation District.)*

STRATEGIES FOR FLOODPLAIN MANAGEMENT

- Modify flooding
- Modify susceptibility to flood damage and disruption
- Modify the impact of flooding on individuals and the community
- Preserve and restore the natural resources and functions of floodplains

(From A Unified National Program for Floodplain Management, 1994, by the Federal Interagency Floodplain Management Task Force.)

One strategy for floodplain development is to elevate buildings above the height of floodwaters. This protects the new structure and is permitted by most local floodplain development regulations. Although the elevated building may be inaccessible when the surrounding area floods, the building itself is protected from flood damage. The area under this elevated structure is used for parking. *(Photograph courtesy of Steuben County Emergency Management Office.)*

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Because this house was elevated, the building did not flood. However, the occupants failed to evacuate soon enough and required assistance by emergency personnel. *(Photograph courtesy of Steuben County Emergency Management Office.)*

When existing development is threatened by streambank erosion and/or flooding, a permanent solution is to relocate the endangered assets away from the problem area. This can be accomplished by relocating or demolishing buildings and moving or abandoning infrastructure. When federal grant funding is used for a "buyout" project, the site must be retained as open space so that any future use of the site will be compatible with the flood risk. *(Photographs by Mark Watts, Chemung County Soil and Water Conservation District.)*

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This bridge was in need of costly repairs and the homes that it served were subject to repeated flooding. The win-win solution involved purchase and demolition of the houses and removal of the bridge. The restored site now provides public access for fishing. *(Photographs by Mark Watts, Chemung County Soil and Water Conservation District.)*

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Protect Streamside Wetlands: The ability of a floodplain to store water, and thus reduce downstream flooding, is enhanced in areas with streamside wetlands (marshes and swamps). These low areas serve as natural sponges, temporarily holding and storing floodwaters. Streams and their associated wetlands are interrelated. When wetlands are filled, the stream has to carry more water during storm event, resulting in more frequent flooding. In addition, the stream channel will enlarge to accommodate the additional water, which may result in streambank erosion. Conserving wetlands and other floodplain storage areas is essential to protecting stream stability.

When complete removal of at-risk development is cost-prohibitive or not desirable, various techniques can be used to reduce damages. An effective retrofitting technique in flood-prone areas is to raise an entire existing structure above the flood hazard, as has been done with this home. Sometimes adequate protection can be achieved by elevating or protecting utilities. Other floodproofing techniques include sewer backup protection, protective anchoring of fuel tanks, erosion protection, and elimination/protection of building openings. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

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In addition to their flood control benefits, streamside wetlands can also provide wildlife habitat and/or water quality benefits. The swampy area in this picture protects water quality by filtering nutrients, sediment, and other pollutants from barnyard runoff before it flows into the river. *(Photograph by Lauren Johnson, USDA Natural Resources Conservation Service.)*

We have a tendency to view flooding or erosion problems as local issues related to the stream characteristics or adjacent land use. But these issues occur within the context of the watershed that drains into that stream and should thus be considered on a watershed basis. As an example:

- An upland landowner subdivides a forested hillside and sells lots for residential construction. The process of replacing trees with buildings, mowed lawns, and driveways can significantly increase the amount of water flowing into a nearby roadside ditch.
- In order to protect the road, the town highway department's typical response is to deepen the ditch. The increased flow in the ditch could increase erosion and possibly cause a downstream culvert to wash out.
- The town then replaces the culvert with a larger one, allowing more water to move through more quickly. This in turn could erode denuded road banks and wash additional sediment into a stream where the sediment obstructs flow and may cause flooding of nearby property.
- The town then excavates this sediment and may remove more than was deposited to avoid the need to re-excavate in the near future.

Unfortunately, these local responses led to increased flow, a higher sediment load, and over excavation of the stream. These changes can trigger stream adjustments that may spread both upstream and downstream. In this hypothetical example, each individual response benefits the local situation, but the cumulative effect alters stream conditions in the watershed and can significantly alter the natural processes of erosion and deposition. As problems compound, the stream may become an expensive long term "headache" for the town and local property owners.

Watershed Influences: A stream is the product of the surrounding land, or watershed, which supplies both water and sediment to the stream system. Topography, soil characteristics, and vegetation control how water reaches the stream. These features also influence the potential for soil erosion and the delivery of sediment into the stream channel.

Slope: In hilly or mountainous watersheds, water flows quickly down the steep slopes, producing "flashy" streams, in which the water levels rise rapidly. The steep slopes also facilitate the transport of sediment into the stream. In areas with gentler slopes, the storm flow reaches the streams over a longer period and will thus produce lower peak flows.

Soils: Different types of soil have significantly different abilities to absorb water. If the soil allows large amounts of rainfall to infiltrate into the ground, then less water will runoff as storm flow and more will enter the stream later as base flow. Conversely, soils with high clay content and frozen soils have a limited ability to absorb water and thus result in more rapid runoff into the streams.

Vegetation: Plants play a vital role in moderating the flow of water into streams and protecting against soil erosion. Vegetation prevents erosion by providing a protective cover that moderates the force of raindrops and traps water. A rainstorm or heavy shower drops millions of tons of water on the land. When soil is exposed, the force of raindrops beats away at the surface, loosening soil particles and moving them downhill. When vegetation is present, leaves and stems intercept and reduce the impact of both falling and running water. This allows the water to either soak into the soil or to safely runoff in a controlled manner. Some of the water that infiltrates into the soil is drawn up by plant roots and transpired, or given off through the leaves, as water vapor, renewing the soil's ability to absorb water.

Land Use: If the stability and health of a watershed's streams are to be maintained, activities throughout the watershed must be conducted in a manner that will minimize any changes to existing drainage patterns or else mitigate the impacts. Changes in land use often alter the pattern of water and sediment delivery to a stream and disrupt the dynamic equilibrium. If the disturbance (natural or man-made) is large enough, the watershed can be impacted well beyond the initially affected area, and can take a decade or more to reach a new equilibrium.

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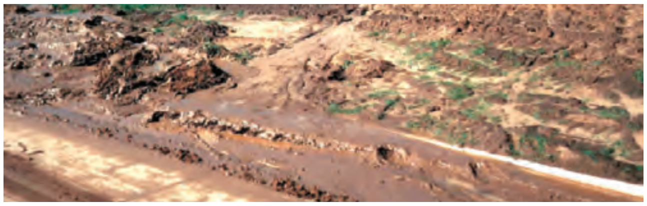

Erosion takes place anywhere there is bare soil that can be dislodged by raindrops and carried away with the runoff. Land use changes that expose soil or increase the intensity of surface runoff often result in higher sediment loads delivered to the stream, which disrupt the stream's equilibrium. *(Photographs by Lynn Betts, USDA Natural Resources Conservation Service; Mark Watts, Chemung County Soil and Water Conservation District; and Jack Dykinga, USDA Agricultural Research Service.)*

TIMBER HARVESTING

A forested landscape is very good at intercepting and storing precipitation. Leaves and twigs on the forest floor soak up and store water, allowing it to infiltrate into the ground. During the growing season, plants use large amounts of water, returning it to the atmosphere. When trees are removed, more rainwater is available to wash into the streams and it generally gets there faster. Because soils are exposed during logging, this runoff may also carry a good deal of mud into roadside ditches and streams. This effect is compounded by construction of logging roads and skid paths, which may concentrate flow and produce eroded gullies on the slopes. Soil erosion from logging operations can contribute large amounts of sediment to nearby streams and rivers. Increased storm flows following timber harvesting, along with fewer trees for bank stabilization, may cause increased erosion within the stream as well.

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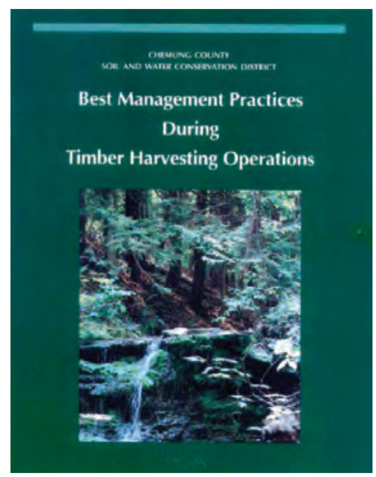
In 1871, Verplanck Colvin argued for creation of the Adirondack Park to protect the region's water resources: "The Adirondack Wilderness contains the springs which are the sources of our principal rivers, and the feeders of the canals. Each summer the water supply for these rivers and canals is lessened, and commerce has suffered ... The immediate cause has been the chopping and burning off of vast tracts of forest in the wilderness, which have hitherto sheltered from the sun's heat and evaporation the deep and lingering snows, [and] the brooks and rivulets ... Now the winter snows that accumulate on the mountains, unprotected from the sun, melt suddenly and rush down laden with disaster..." *(Photographs courtesy of the Adirondack Museum at Blue Mountain Lake, New York.)*



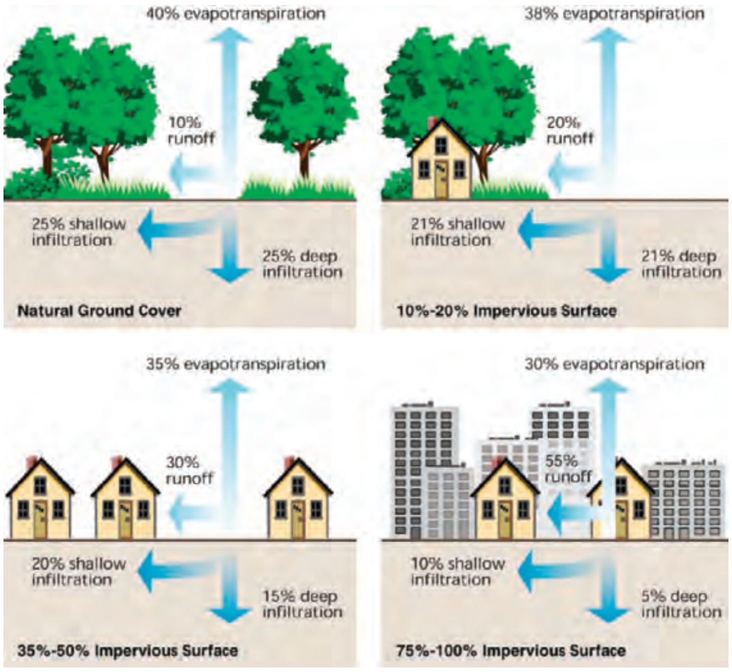
Although the removal of trees does alter the hydrology of a watershed, management techniques can be used to minimize this impact. The layout of roads and skid trails can be designed so that they do not funnel water down the hillside. Water bars (shallow diversion ditches) can be located along sloped roadways to disperse runoff. Damage to streams and drainage channels is avoided by not skidding logs in the channel, keeping heavy equipment out of streamside areas, and maintaining streambank vegetation. Temporary culverts or bridges can be used to cross streams without damaging the bed and banks. When logging is complete, disturbed areas should be stabilized and restored with vegetation. *(Photograph courtesy of Watershed Agricultural Council.)*

AGRICULTURE

Clearing forests for crops and pastureland has often resulted in degraded water quality and changes to natural flow regimes. Cultivation exposes soils to erosion and may eliminate small depressions that allow for ponding of runoff. Livestock and heavy machinery can compact soil, reducing its ability to soak up water. Because crops generally represent sparser ground cover than indigenous vegetation, farmland often has higher runoff rates and greater erosion than undisturbed open space. If drain tiles have been installed to remove water from the fields, runoff quickly reaches downhill ditches and streams. When vegetated waterways and stream buffers are converted to production, these areas no longer provide water quality, flow moderation, and bank stabilization benefits. In short, many agricultural practices can contribute to increased runoff, erosion, and sedimentation.

However, with proper agricultural practices, farmland can provide many watershed benefits, including infiltration of precipitation, food production, and wildlife habitat. When farmland goes out of production, there is often pressure to convert the land to more intensive uses, such as new housing with associated water, sewer, drainage, and highway infrastructure. This development can have a much greater impact on streams and stream corridors than would have occurred if the land had been retained as well-managed farmland.

Improved agricultural management practices can be used to increase infiltration and to keep soil on the land and out of streams. The key to saving soil and improving water quality is to shield the soil and to help rainfall soak into the soil rather than runoff the land. One strategy is to maintain a protective ground cover of crop residues, mulch, or cover crops that prevents falling raindrops from splashing and dislodging the soil. In addition, cropping patterns and water management practices can be used to hold water on the soil to allow infiltration. Terraces on sloping farmland work like rain gutters on a house, intercepting rainfall runoff and guiding it slowly to a grassed waterway. Likewise, improved livestock management techniques can reduce the impacts that farm operations have on streams. *(Art by Scott Patton, USDA Natural Resources Conservation Service.)*



Impervious surfaces associated with development block the infiltration of water into the ground. In addition, urbanized areas have fewer plants to use water and return it to the atmosphere. This can change flood peaks and low flow conditions by orders of magnitude. *(Image from "Stream Corridor Restoration: Principles, Processes, and Practices," 10/98, by the Federal Interagency Stream Restoration Working Group.)*

DEVELOPMENT AND URBANIZATION

Development often changes the way that water flows off the land and into the stream. This can alter the flow regime in the stream and may trigger stream channel adjustments.

Increased Storm Flow: Rainwater cannot infiltrate into the ground when it falls on impervious surfaces such as rooftops, roadways, parking lots, sidewalks, and driveways. In addition, the compacted soil on unpaved roads, driveways, and parking areas has a very low infiltration capacity. One consequence of development is that more water enters the stream as stormwater runoff. As little as 10% impervious cover in a watershed can double the amount of surface runoff and cause stream degradation. A watershed with 25% impervious cover cannot support most aquatic life due to the increased water temperature and the destabilizing effects of increased runoff.

Decreased Base Flow: Another consequence of development is a reduction in base flow because less water soaks into the ground to recharge groundwater. In some cases, a stream that once had year-round flow changes to an intermittent stream with seasonal flow.

In an undeveloped watershed, plants and uneven surfaces provide friction that slows the downhill flow of water. This increases the time over which water reaches the stream, thus reducing the peak storm flow. After development, smooth surfaces and storm drains generally enable water to reach the streams much more quickly. When an area is developed, the combined effect of more runoff and faster runoff is that the peak flows in streams will increase. *(Photographs by Lynn Betts, USDA Natural Resources Conservation Service and Gary Wilson, USDA Natural Resources Conservation Service.)*

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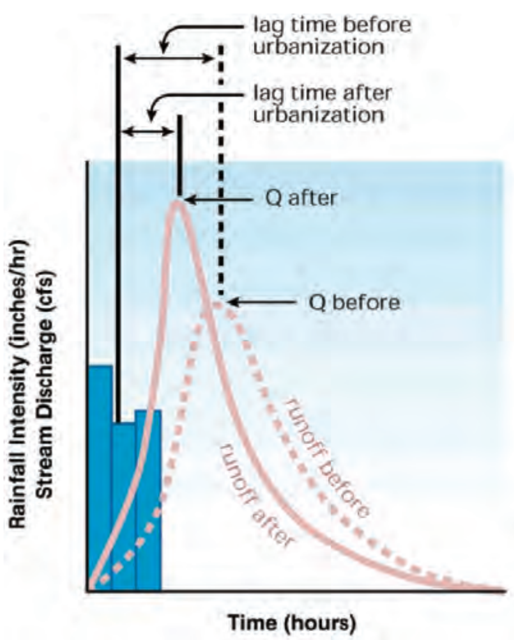

These storm hydrographs illustrate how urbanization changes the hydrology of the stream (with blue bars showing the rate and timing of rainfall). After urbanization, the peak flow is greater and the flow rate rises and drops much more quickly. *(Image from "Stream Corridor Restoration: Principles, Processes, and Practices," 10/98, by the Federal Interagency Stream Restoration Working Group.)*

When watershed development causes increased peak stream flows, the frequency of out-of-bank flooding increases. In addition, the stream generally responds by enlarging its channel and floodplain. Many residents in developing watersheds report that they could once step across the stream that is now eating away at their yards, and perhaps threatening their homes. Little do they realize that runoff from their own houses, driveways, and yards may be contributing to the problem. *(Photograph by Paul Kingsbury, Town of Elmira Stormwater Department.)*

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Even in areas that are primarily rural, the increased runoff that results from construction of a few houses, with graded lawns and long driveways, can be enough to wash out roadside ditches and alter stream flow characteristics. *(Photograph courtesy of Town of Campbell Highway Department.)*

Stormwater Management: Stormwater management is the implementation of water management practices that reduce the impact of development on the local hydrology. A common technique is to build a pond that retains the increased runoff from a developed area so that it does not contribute to increased peak flows on neighboring properties and in the streams. Other practices decrease stormwater impacts by reducing impervious surfaces and/or increasing infiltration. Another way to reduce stormwater impacts is to preserve or plant trees and other vegetation in developed areas. Tokyo has a law requiring skyscrapers to install rooftop gardens, so that plants use the rainfall that would otherwise run off the impervious roofs. In New York State, efforts to reduce the impacts of stormwater runoff include permit requirements, reference materials, educational programs, and an executive order regarding state buildings.

State and federal regulations now require the utilization of stormwater management and erosion control practices for any construction project that disturbs one or more acre of land. Because of the detrimental impact that development can have on roadside drainage systems and streams, some municipalities include additional stormwater management requirements in their local land use regulations. *(Photographs courtesy of the Center for Watershed Protection.)*

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STORM DRAINS AND ROADSIDE DITCHES

The effects of urbanization are compounded by the use of storm sewers and drainage ditches designed for rapid downstream transport of drainage waters. Each storm drain or roadside ditch acts like a small stream channel, carrying water much more quickly than the overland route that it replaces. These drainage systems are intended to control flooding by conveying runoff away from developed areas and roadways. However, the efficiency with which they collect and deliver water can cause increased peak flows and flooding downstream.

The existing network of roadside drainage ditches is quite extensive. It is not uncommon for a watershed to have many more miles of roadside drainage than miles of stream channel. These ditches are necessary because roads block the natural flow patterns of surface runoff and subsurface flow. Ditches or drains intercept this flow and carry it directly into streams. The result is increased storm flow peaks and reduced base flow. *(Photographs by Mark Watts, Chemung County Soil and Water Conservation District.)*

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WETLANDS

Water storage areas throughout the watershed slow down the rate at which water reaches the streams. The best storage is provided by wetlands. These natural sumps hold water and slowly release the stored water downstream. Because of this process, wetlands both reduce flooding and provide a source of water during dry periods. Some wetlands release water slowly into the ground, which recharges groundwater supplies. In addition, wetlands improve water quality and provide crucial habitat for a variety of wildlife.

WATERSHED STEWARDSHIP

Hydrologic Functions: Watershed restoration is the process of protecting and re-establishing the hydrologic functions of a watershed. Land use regulations may be used to protect existing functions. Various management practices can be used to mitigate the impacts that arise from existing land uses as well as proposed activities. A key recommendation is often to retain or restore forests or other vegetation, which helps reduce erosion and increase infiltration. Other practices include wetland construction or enhancement, establishment of groundwater recharge areas, stormwater management structures, and improved forestry and agricultural practices.

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Current stormwater management regulations require that runoff management techniques for new roads and development be designed to minimize the hydrologic impacts. Various practices are used to slow down the water, increase infiltration, or disperse the flow. These techniques can also be used to reduce the damage caused by concentrating flow in existing ditches or storm sewer systems. (Photographs by Mark Watts, Chemung County Soil and Water Conservation District; and Washington State Department of Transportation.)

New York State has lost over 60% of its original wetlands. Numerous watershed benefits can be achieved by preserving the remaining wetlands and restoring or replacing those that have been lost. Whether they are located in floodplains or in upland areas, wetlands can enhance the stability and functions of stream systems. *(Photograph courtesy of USDA Natural Resources Conservation Service.)*

Watershed Planning: The health of our streams and rivers depends on the stewardship of landowners and users throughout the watershed. A local community can facilitate positive changes in the way people conserve, protect, and use land by developing and implementing a watershed management plan. The planning process provides a forum for evaluating problems, identifying opportunities, and prioritizing recommendations. Public education helps residents and businesses take voluntarily steps to protect stream health. Financial incentives can be used to purchase conservation easements or enable improved agricultural practices. Local governments can implement policies and regulations to encourage and/or require improved land use practices, such as:

- restricting activity in stream corridors (through setback provisions or overlay zoning districts),
- developing site plans that minimize the need for bridges,
- designing cluster development to leave streams and their buffer areas undisturbed,
- using low impact development techniques, such as grassed swales and rain gardens, to reduce surface runoff,
- designating sensitive areas as Critical Environmental Areas, which require additional review under the state environmental review process,
- using ponds, wetlands and water storage areas to delay the flow of runoff into streams.

Upland management is necessary for effective long-term management of stream systems. *(Photograph courtesy of USDA Natural Resources Conservation Service.)*

Watershed restoration efforts may include construction of ponds and wetlands to compensate for the hydrologic impact of land use changes. *(Photograph by Mark Watts, Chemung County Soil and Water Conservation District.)*

We all benefit when private landowners take care of the land and water.

"Human activity has profoundly affected rivers and streams in all parts of the world, to such an extent that it is now extremely difficult to find any stream which has not been in some way altered, and probably quite impossible to find any such river."
– H. B. N. Haynes, 1970

The government won't let me do anything with my stream.

Although i t enti- ties h wor in str no preve com- plish t dis- turbs d, o flood Th purpose of a permit is to allow agency staff to review the project for any potential adverse impacts on the stream, the aquatic life that it supports, and floodplain development. Remember that disturbance to on section of a stream may have damaging results to other upstream and down ential for har rity gov tivit tha pote - tial fo egal obli- gation to t landowners from damages that might arise from your activities.

PERMIT REQUI EMENTS

If you plan to alter a stream or floodplain, it is important to understand the applicable and what per- mits, if sed pr n- v y b . Ra k the cou va- tion Dist evelop a project that ur stream management objectives without an adverse impact on the stream system. Once you've got a good design he SWCD can assist with obtaining an necessary permits. A stream projec may require approval by one or more of the following agencies:

ment of Envi- (NYSDEC) is and protect- and wetlands ities that may require a permit in de:

- Disturbance of t e bed or banks of a 'protected stream' or other watercourse.
- Construction and maintenance of

or both in 'navi-

r adjacent to nd.'

e per - ended contact the SW r the NYS - ly in the plan g process.

U.S. Army Corps of Engineers: Under the Clean Water Act, the Corps of Engineers is responsible for ensuring that pr j i 'the waters of the United sely affect such wa- tivities 'in, under, ater or wetlands e waters of the gulated under the ors Act. Examples of lated activities include but are not ited to: dredging, filling, excavating, land learing using mechanized equipme ditching, stream channelization and rel ation, shore protection, and dock construction. It is recommended that you consult with the SWCD or the Corps of Engineers regarding federal permit requirements for any project in or near a river, stream, or wetland. If the project also requires a permit from NYSDEC, a joint application process can be used to obtain the state and federal permits.

NYS Adirondack Park Agency: Activities within the boundaries of the Adirondack Park may require a review by th Adirondack Park Agency and in some instances may require ssuance of a permit.

U.S. Coast Guard: A C ast Guard Bridge permit is required to construct a new bridge or causeway or reconstruct or modify an existing bridge or causeway across the 'navigable waters of the United States' (which includes some that may not appear to be navigable). Projects must meet the navigation requirements of the stream or waterway.

Floodplain development permit: Most municipalities regulate development within the area mapped as the 100-year floodplain according to the standards established by the National Flood Insurance Program. These regulations apply to - am activities, as well as those floodplains. The require- dplain development are nsure that new devel- od-prone areas is ade- cted from flood damages not cause damage to properties. This permit may r engineering analysis to determ a project will result in an incre height of flooding during a 1 - year flood event. Regulated floodplain eas are delineated on federally prepared floodplain maps. Permits for development activities within the designated floodplain are obtained from the city, village, or town.

Local land use regulations: In order to prevent the problems that inevitably arise when development interferes with streams, some municipalities have d- opted additional land use regulation for stream corridors. These may t k the form of steam setback provision for buildings, site plan review requ - ments, or additional development standards within a stream corridor overlay district.

Property owner: Unless you are operating under n em rgency authorization, land wn p mission is required for y that you do not

- - y a proposed cated within an eas en r hway right-of-way, ad- dit onal p rmissi n may be required to insure that the proposed project does not interfere with highway safety or

the purpose of the easement. Agencies that build or maintain flood control projects (U.S. Army Corps of Engineers or NYSDEC) generally hold easements requiring that any project on flood control lands obtain prior approval. The NYSDEC also holds easements for fishing access along some streams. Some property is protected by conservation easements.

Although the overlapping jurisdictions of various government agencies may be confusing and frustrating, keep in mind that the underlying regulations were enacted to protect public safety and the quality of the environment. A project that is consistent with these objectives should be granted the necessary permits. The county Soil and Water Conservation District is a valuable resource in helping you to navigate the regulatory waters and obtain permit coverage.

Even if no permit is required, you may still be responsible for any water quality violations that result from a stream project. It is always a good idea to talk with your county Soil and Water Conservation District if you are unsure of how to proceed.

OWNERSHIP

The river belongs to the Nation,
The levee, they say, to the State;
The government runs navigation,
The commonwealth, though, pays the freight.
Now, here is the problem that's heavy
Please, which is the right or the wrong
When the water runs over the levee,
To whom does the river belong?
– Douglas Malloch,
Uncle Sam's River, Stanza 1

Who owns the streambed?

New York State is the sovereign owner of the beds of "navigable waters" in the state. This ownership gives the state the right to control the bed and to ensure that navigable waterways shall forever remain public highways. A stream and any contiguous wetlands may be classified as "navigable" if it is large enough for operation of a canoe or larger boat. For a information about state ownership of a waterway and the activities for which state approval is required, contact the Lands Underwater program of the NYS Office of General Services *(http://www.ogs.state.ny.us/realEstate/permits/luwfaq.html).*

As a general rule, the ownership and therefore control of the bed of non-navigable streams or other non-navigable bodies of water is vested in the proprietors of the adjoining uplands, unless their deed provides otherwise. In other words, if you own the bank of a non-navigable stream, you probably own the streambed and are referred to as a riparian owner.

Regardless of who owns a stream, various government entities retain police power over activities that may impact navigation, public safety, the environment, or the rights of other property owners. **Owning a stream does not give you the right to do whatever you please with it.**

Who owns the water in a stream?

In New York State, water in a stream is not "owned" by anyone. The relevant question is:

Who has the right to use water in a stream?

Water rights and water laws vary from state to state. New York follows the riparian rights doctrine developed under common law. Common law means that the rules were not enacted by the legislature, but were developed by the courts through the decisions they hand down. Riparian rights doctrine allows the owners of land bordering on a watercourse to withdraw a "reasonable" amount of water. The courts have generally held that domestic use or use on the land is "reasonable," while removal of water from the riparian property is "unreasonable." Because all landowners along a stream have "riparian rights," none can use the water so as to deprive the others of their rights. If a water use interferes with the "reasonable" use of another riparian owner, the aggrieved party must go to court to protect his/her rights.

Do river basin commissions grant water rights?

In some New York watersheds (such as the Susquehanna, Delaware, and Great Lakes Basins), multi-state commissions may have the authority to regulate water use. These agencies can protect other water users and the environment by reviewing and approving a proposed water withdrawal. Although there may be fees associated with water withdrawal permits, this approval is a police power function and does not confer a property right or "ownership."

Who is responsible for the stream?

Restoration of stream problems is generally the responsibility of the private landowner. Although various government agencies have regulatory jurisdiction over how a stream is managed, it is not their job to come and "fix" your stream. Government highway departments generally limit their stream work to that needed for protection of roads, bridges, and culverts. Other government resources are more likely to be available to assist with a project that restores a degraded stream system, rather than one designed for localized protection of private property. For information about stream maintenance and restoration assistance, contact the county Soil and Water Conservation District.

Responsibility for a stream does not give you the right to do whatever you consider necessary to "fix" its problems. Assume that every stream is regulated unless you determine otherwise.

LIABILITY

Common Law is that body of law developed from judicial decisions, based on custom and precedent. As such, it is constantly changing by extension or by interpretation. The central point of common law is damage. The owner of a bridge, hydraulic structure, or other stream project has a legal obligation to protect adjacent landowners from damages due to changes in natural drainage that result from that project. Anyone claiming such damage may file suit in court.

If flooding occurs or gets worse after a stream has been modified (by diverting flow, modifying the channel, constructing a bridge, etc.), is the person who made the modification liable for damages?

Yes, quite possibly. Courts have, according to common law, followed the adage "use your own property in such a manner as not to injure that of another." This means that no landowner, public or private, has a right to use his/her land in a way that substantially increases flood or erosion damages on adjacent lands. A municipality or property owner may thus be liable for construction, improvements, or modifications that they should reasonably have anticipated to cause property damage to adjacent property. The lack of proper planning, design, and execution thereof, may be considered a clear indication of the lack of good faith and hence negligence with regard to damanges that subsequently occurred.

May someone be held liable for failing to remedy a natural hazard that damages adjacent property?

Sometimes. Courts have generally not held governmental units and private individuals responsible for naturally occurring hazards such as stream flooding or bank erosion that damage adjacent lands. In keeping with this principle, a municipality would not be liable for failure to restrain waters between banks of a stream or failure to keep a channel free from obstruction that it did not cause. However, a small number of courts have held that government entities may need to remedy hazards on public lands that threaten adjacent lands. In addition, land owners and governments are liable if they take actions that increase the hazards.

Can liability arise from failure to reasonably operate and maintain a bridge, drainage structure, dam, or flood control structure?

Possibly. The owner of a dam or other water control structure is responsible for inspecting and maintaining it. Where there is a duty to act and the risk of not acting is reasonably perceived, then failure to take appropriate actions may be considered negligent conduct.

May a regulatory agency be liable for issuing a regulatory permit for an activity that damages other private property?

Yes, quite possibly. In fact a careful analysis of hundreds of cases in which the lawsuit involved permitting indicates that a municipality is vastly more likely to be sued for issuing a permit for development that causes harm than for denying a permit based on hazard prevention regulations. The likelihood of a successful lawsuit against a municipality for issuing a permit increases if the permitted activity results in substantial flood, erosion or physical damage to other private property owners.

How safe is safe enough? Municipalities regularly issue permits for activities that are in compliance with existing laws, but might still be at risk of damage. For example, floodplain development regulations generally apply only to areas mapped as the 100-year floodplain. Yet significant flooding and erosion damages can and do occur outside of these regulated flood-prone areas. Some municipalities address this additional risk by attaching conditions to their approvals for those projects with identified risks. These conditions can clearly state that the municipality is **not obligated** to fix personal property in the event of damage. One Town granted approval for a driveway bridge that met all applicable standards, but attached material clearly warning the applicant about the hazards of driving through floodwaters, the risk that emergency vehicles may be unable to reach the house during floods, the potentially high maintenance costs, and the potential liability for the owner if the project results in damage to other property.

May governmental units be held liable for refusing to issue permits in floodways or high-risk erosion areas because the proposed activities could damage other lands?

No. In general, landowners have no right to make a "nuisance" of themselves. Courts have broadly and consistently upheld regulations that prevent one landowner from causing a nuisance or threatening public safety.

What precautions can be taken to avoid liability?

Be "reasonable." The overall issue, in most instances, is the "reasonableness" of an action by the community or property owner. Due to advances in technology and products, there is an increasingly high standard of care for "reasonable conduct." The "act of God" defense is seldom successful because even rare flood events are now predictable. As a precaution, technical assistance from stream professionals should be obtained prior to implementing any stream project. Because a well-designed project is less likely to damage other lands, this reduces the potential basis for legal action. And if you are sued, the best defense is a well-documented record showing "due diligence." That is, that you have done sufficient analysis and design to demonstrate the adequacy of the project with "a reasonable degree of certainty."

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SECTION 8: SELF-ASSESSMENT

After carefully looking through this stream guide, the reader may be prepared to manage a stream problem…or to understand why he/she should seek professional assistance. Although the preceding pages have been filled with explanations, suggestions, and warnings, the most important consideration is still that streams are complex systems. Many well-meaning attempts to address stream problems have resulted in the creation of even more problems. So what should the studious reader have gained from this booklet? The following quiz will help you to assess your understanding of stream processes.

Q: "That gravel bar takes up most of the stream channel—that's why the stream floods. If we could only remove that gravel bar, then this stream would stay in its banks."

(a) All of the gravel deposited above the low water level should be removed to solve the flooding problem.
(b) The gravel should be removed to a level below the low water level so that the stream channel is deeper and wider.
(c) Although gravel bar removal may provide temporary relief in some situations, the gravel bar is likely to return during the next high flow event.
(d) The gravel bar is part of the stream system and should be planted with vegetation to stabilize it.

A: (c) In many streams, gravel bars are an integral part of the stream and floodplain system. They are comprised of sediment that will be carried farther downstream during the next high flow event and replaced by a fresh supply of gravel. If the gravel is stabilized, as recommended in answer (d), then the stream is likely to erode somewhere else to obtain the necessary sediment load and flooding at the site will continue.

Q: "If they would dredge this stream, it would be deeper and we wouldn't have all of these problems with flooding and erosion."

(a) A larger stream channel would hold all of the water and solve the flooding problems.
(b) Dredging results in increased erosion.
(c) Dredging results in increased sediment build up, which may make flooding problems even worse.
(d) Dredging can result in increased erosion and/or increased sediment deposition, so both (b) and (c) may be correct.

A: (d) Because dredging alters the shape and slope of the channel and disconnects the stream from its floodplain, it destroys those features that naturally dissipate the stream's energy. This frequently results in severe erosion problems. In addition, the shape of the dredged channel is generally not conducive to sediment transport, resulting in a buildup of eroded sediment within the channel. Past disturbance of stream channels has resulted in some of the stream problems we see today.

Q: "We need to straighten the stream to keep it from washing out that bank. And if the water flows through here faster, it won't flood my neighbor's house."

(a) Straightening a channel may temporarily solve a localized bank erosion or flooding problem.
(b) When a stream is straightened, it becomes steeper and faster, which results in a greater potential for erosion of streambanks and streambeds.
(c) After a channel is straightened, water will get to downstream areas faster and increase the risk of flooding.
(d) All of the above.

A: (d) Stream straightening or "channelization" can have adverse impacts and is not generally recommended. Because the bends in a stream channel dissipate energy, a straightened stream has more energy available to erode its channel. In addition, channelization may increase the downstream flood risks.

Q: "You should use a bulldozer to build up that streambank for flood protection."

(a) Floodplain soil in usually poorly suited for levee construction.
(b) Floodplain soil is usually ideal for levee construction.
(c) By cutting of the stream's access to its floodplain, an elevated streambank will increase the stream's energy and thus the potential for erosion.
(d) Both (a) and (c).

A: (d) A berm made of local materials pushed up on a streambank is not true flood protection. Although it may withstand the forces of small flood events, these structures are prone to failure during major floods.

Q: "I've owned this land for 10 years and it's never been flooded. But they say it's floodplain, so I can't build the house I'd planned."

(a) No building is allowed in the mapped 100-year floodplain.
(b) Floodplain development may be allowed if rules are followed to minimize the flood risk.
(c) If the last flood didn't touch the building site, it's probably safe to build there.
(d) Government has no authority to restrict what can be done on private property—whether it's in the floodplain or not.

A: (b) Courts at all levels have upheld the validity of floodplain regulations that prevent damage from hazardous development in locations where flooding is an-

ticipated. Most municipalities have enacted standards that allow some development in the floodplain if it meets flood protection criteria and will not cause damage to adjacent properties. However, it is safer to locate new development outside of the floodplain.

Q: "I remember when you could step across this creek. Nobody has done anything to it, but now trees are falling in and the banks are over my head. What happened?"

(a) The speaker's memory is faulty—the stream hasn't changed.
(b) The speaker forgot about the time that his neighbor bulldozed the creek to make it deeper.
(c) It is likely that development or other changes in the watershed have increased stream flow, which triggered erosion of a larger channel.
(d) It is natural for all streams to get bigger and deeper with time.

A: (c) Although it is possible that the creek is adjusting to a channel disturbance, the reason for increased flooding or erosion can often be found in the watershed that drains into a stream. The general hydrologic symptoms of forest clearing, agriculture, and urbanization are increased peak flows and decreased base flows, resulting in more frequent flooding, increased bank erosion, sediment buildup, and other effects. Sometimes it only takes a few new houses or a new access road to cause problems in a stream.

Q: "This !*$!#*! creek is eating away my property. I pay taxes. Who is going to fix it?"

(a) New York State regulates streams, so they are responsible for maintenance.
(b) The County Soil and Water Conservation District takes care of the streams.
(c) In New York, our home rule laws make municipalities responsible for stream maintenance.
(d) The landowner is ultimately responsible for stream and water problems.

A: (d) The land along a stream belongs to the landowner and any necessary work, such as erosion or flood control, is therefore their responsibility. Landowners that have chosen to own land along a stream have assumed stream maintenance responsibilities, much the same as mowing the lawn or fixing the roof. However, responsibility for the stream does not allow a property owner to work in the stream without a permit. Nor does it protect them from liability if they cause damage to another property.

Q: "This is my property. I own the creek. Nobody can tell me what I can or can't do with it."

(a) A permit from New York State is required for any disturbance within 50 feet of some streams.
(b) A U.S. Army Corps of Engineers permit may be required for disturbance of "waters of the United States."
(c) A floodplain development permit must be obtained from the municipality for any development, including fill or grading, within the mapped floodplain.
(d) All of the above.

A: (d) Although the riparian property owner does own the stream, various government agencies have police powers regulating what can be done within and adjacent to the stream channel. This regulatory authority is based on public health and safety concerns, the potential for adverse impacts to other property, and potential impacts to aquatic habitat. In addition, irresponsible alteration of natural drainage patterns can result in a lawsuit if it results in damage to neighboring property.

Q: "My driveway bridge washed out. Who is going to pay for it?"

(a) Federal disaster assistance is available to pay for all flood damages, including washed out driveways.
(b) Flood insurance on the house will cover bridge damage.
(c) The Town or County will help me out.
(d) All maintenance and repair costs for private stream crossings are the responsibility of the landowner.

A: (d) Federal disaster assistance is not available unless the flood is declared a federal disaster, doesn't cover all damages, and may be limited to a low interest loan. The National Flood Insurance Program only offers policies for buildings and building contents. Damage to bridges, culverts, driveways, lawns, etc. is not covered by flood insurance. While local governments may be helpful, your private property is not their responsibility.

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SECTION 9: ADDITIONAL RESOURCES

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SECTION 10: GLOSSARY

100-year flood – A large, but infrequent, flood event that has a 1% chance of occurring in any given year (occurs, on average, once every 100 years).

100-year floodplain – Areas adjacent to a stream or river that are subject to flooding during a storm event that has a 1% likelihood of occurrence in any given year (occurs, on average, once every 100 years). Most municipalities require a floodplain development permit for new development within areas mapped as the 100-year floodplain.

aggradation (aggrading) – The general and progressive buildup of a streambed due to sediment deposition. Aggradation occurs when the channel is supplied with more sediment load than it is capable of transporting.

alluvial fan – A fan-shaped deposit of material at the place where a stream issues from a steep valley onto a plain or broad valley with a low slope.

bankfull – The full capacity of the stream channel to the top of the bank on either side. The bankfull discharge is the flow at which water first overtops the banks onto the floodplain, which occurs, on average, every 1.2 to 2.0 years. Bankfull flow is largely responsible for the shape of the stream channel and is sometimes called the channel-forming flow.

base flow – The portion of stream flow that comes from groundwater seepage into the channel; constitutes the natural dry weather flow in the stream.

bedload – Sediment that is transported in a stream by rolling, sliding, or jumping on or near the streambed.

berm – A mound of earth or other materials, usually linear, constructed along a stream, road or other area. Berms are often constructed to protect land from flooding or eroding, or to control water drainage. Some berms are constructed as a byproduct of a stream management practice whereby streambed sediment is pushed out of the channel and mounded on (and along the length of) the streambank – these berms are frequently breached by the stream and should not be relied on for flood control. Streamside berms often interfere with other stream processes such as floodplain function, and can exacerbate flood-related erosion or stream instability.

braided channel (braided stream) – A stream that has flow in several channels, which successively meet and divide. Braiding occurs when sediment is deposited within the channel area.

buffer – See riparian buffer.

channel – A natural or artificial watercourse with a definite bed and banks that conveys continuously or periodically flowing water.

channelization – Straightening or deepening of a natural stream channel.

check dam – A low dam constructed across a channel to decrease the stream flow velocity (by reducing the channel gradient), minimize channel scour, and promote sediment deposition.

cluster development – The use of a site design that incorporates open space into a development site. The open space can be used for recreation or preserved as naturally vegetated land.

culvert – A pipe or closed conduit for the free passage of surface drainage water. Culverts are typically used by highway departments to control water running along and under the road, and to provide a crossing point for water from roadside drainage ditches to the stream, as well as for routing tributary streams under the roads. Landowners also use culverts to route roadside drainage ditch water under their driveways.

debris – Floating or submerged material, such as logs, vegetation, or trash, transported by a stream.

degradation (degrading or down cutting) – The general and progressive lowering of a channel due to downward erosion of the streambed over a relatively long channel length. A degrading stream may have high, unstable banks and be disconnected from its floodplain.

dike (levee) – An embankment to confine or control water, often built along the banks of a river or stream to contain over bank flow and prevent inundation of floodplain development.

discharge (stream flow) – The rate of flow passing a fixed point in a stream, expressed as a volume of water per unit time, usually cubic feet per second (cfs).

dynamic equilibrium – A stream system that has achieved a balance in transporting its water and sediment loads over time without aggrading (building up), degrading (cutting down), or migrating laterally (eroding its banks and changing course). A stream in dynamic equilibrium resists flood damage, resists erosion, and provides beneficial aquatic habitat.

erosion – The detachment and movement of soil or rock fragments by water, wind, ice, or other geological agents. In streams, erosion is a natural process that can be accelerated by poor stream management practices.

floodplain (see also 100-year floodplain) – Any flat or nearly flat lowland bordering a stream that is periodically inundated by water during floods. The floodplain acts to reduce the velocity of floodwaters, increase infiltration, reduce streambank erosion, and encourage deposition of sediment. Vegetation on floodplains greatly improves these functions.

floodway – That portion of the floodplain required to store and discharge floodwaters without causing potentially damaging increases in flood heights and velocities.

grade (gradient) – The slope of a stream, measured along the length of the stream channel.

grade stabilization (grade control) – The use of hard structures in a channel to prevent headcutting or degradation (lowering of the channel grade).

gravel bar (see also point bar) – An elevated deposit of gravel located within a stream channel and lacking permanent vegetation.

groundwater – Water beneath the earth's surface, found at varying depths, where every space between soil or rock particles is filled with water.

headcut – A marked change in the slope of a streambed, as in a "step" or waterfall, that is unprotected or of greater height than the stream can maintain. Increased potential for erosion at this location causes the headcut to move upstream, eventually reaching an equilibrium slope.

hydraulics – The applied science that deals with the behavior and flow of liquids. When used in reference to a stream, hydraulics refers to the processes by which water flows within the channel.

hydrologic cycle – The global circulation of water in the air, on land, and in the sea.

hydrology – The science that deals with the occurrence and movement of water in the atmosphere, upon the surface, and beneath the land areas of the earth. In reference to a particular stream, the hydrology is the amount and timing of water flow into the stream.

impervious – Those surfaces that cannot effectively infiltrate rainfall and snow melt (e.g. rooftops, pavement, sidewalks, driveways, etc.). Impervious cover causes an increase in the volume of surface runoff.

incised stream – A stream in which degradation (erosion of the streambed) has caused deepening of the channel to a point where the stream is no longer connected to its floodplain.

infiltration – The process of water percolating into the soil.

instability (unstable) – An imbalance in a stream's capacity to transport sediment and maintain its channel shape, pattern, and profile.

intermittent stream – A stream or portion of a stream that flows in a well-defined channel during the wet seasons of the year, but not the entire year.

invasive plant – A species of plant that is not native to a region and has the ability to compete with and replace native species in natural habitats. Invasive plants present a threat when they alter the ecology of a native plant community.

kinetic energy – Energy of motion. The kinetic energy of a stream is equal to one-half the mass of water, times the square of the velocity at which the water is moving.

levee – See dike.

meander – Refers to both the winding pattern of a stream ("meander bends") and to the process by which a stream curves as it passes through the landscape (a "meandering stream"). A meandering stream channel generally exhibits a characteristic process of bank erosion and point bar deposition associated with systematically shifting meanders.

National Flood Insurance Program – Federal program that makes available subsidized flood insurance in those jurisdictions within which the local government regulates development in identified flood hazard areas. Local regulations must be at least as stringent as federal standards.

natural stream design – A stream restoration method that uses data collection, modeling techniques, and stable or reference channels in the design of ideal channel configurations.

nutrients – Essential chemicals, including nitrogen and phosphorous, that are needed by plants and animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and algal blooms.

pattern (of a stream channel) – The shape of a stream as seen from above or on a map.

peak flow – The maximum stream flow from a given storm condition at a specific location.

point bar – A stream deposition feature usually found on the inside of a bend; consists of sand, gravel, or other sediment and lacks permanent vegetation.

pool – A stream feature in which water is deeper and slower than in adjacent areas. Pools typically alternate with riffles along the length of a stream channel.

potential energy – Energy that results from gravitational pull on an object. The potential energy in a stream is equal to the weight of water times the elevation of a specified point relative to the mouth of the stream.

profile – The shape of a stream drawn along the length of its channel to show both the streambed and the water surface.

riffle – A stream feature in which water flow is shallow and rapid compared to adjacent areas. Riffles typically alternate with pools along the length of a stream channel.

riparian – The area of land along a stream channel and within the valley walls where vegetation and other land uses directly influence stream processes.

riparian buffer (or stream buffer) – Zone of variable width along the banks a stream that provides a protective natural area along the stream corridor.

riparian rights – The rights of an owner whose land abuts water.

riprap – Broken rock placed on a streambank or other surface to protect against scouring and erosion.

rock vanes – Rock structures built below the water level to control the direction of flow within a stream.

root wad – Streambank stabilization technique in which a one or more tree trunk is embedded in the streambank with the root mass facing the flow to dissipate energy.

roughness (hydraulic roughness) – In a stream, roughness refers to the frictional resistance to flow.

runoff – See surface runoff.

scour – The process by which the erosive action of flowing water removes material from the bed or banks of a stream.

sediment – Solid material, both mineral and organic, that is being transported or has been moved by air, water, gravity, or ice from its site of origin (streambank or hillside) to the place of deposition (in the stream channel or on the floodplain).

skidding – Short-distance dragging of logs or felled trees from the stump to a point of loading or processing.

skid trail – Rough travel ways for logging machinery. Logs are often dragged over the skid trail surface.

stable (see also dynamic equilibrium) – Although no stream is truly stable in the sense that it doesn't change over time, a stream may be described as stable if it is in dynamic equilibrium, with no appreciable change from year to year.

storm flow – The portion of stream flow that comes from surface runoff and constitutes the main component of high stream flows during rainy weather.

storm hydrograph – A graph of stream discharge against time for a single storm event.

stormwater – Surface runoff; generally referred to as stormwater when the surface runoff is from developed areas.

stormwater management – The use of structural or non-structural practices that are designed to reduce stormwater runoff and mitigate its adverse impacts on property, natural resources, and the environment. Structural practices involve construction of systems that provide short-term storage and treatment of stormwater runoff. Non-structural techniques use natural measures to reduce pollution levels, do not require extensive construction efforts, and/or promote pollutant reduction by eliminating the pollutant source.

stream – A natural watercourse with a definite bed and banks that conducts continuously or periodically flowing water.

streambed (bed) – The bottom of a stream channel bounded by banks.

streambank (bank) – The sides of a stream channel between which the flow is normally confined.

stream restoration – The process of converting an unstable, altered, or degraded stream corridor, including the adjacent riparian zone and flood-prone areas to its natural stable condition considering recent and future watershed conditions.

stream stabilization – The in-place stabilization of a severely eroding streambank and/or streambed. Although stabilization techniques address the immediate problem, they may not restore the system's dynamic equilibrium.

surface runoff (see also stormwater) – The portion of precipitation or snow melt that reaches the stream channel by flowing over the land surface.

transpiration – The process by which water taken up by plants is returned to the atmosphere by evaporation from leaves.

"triage"(approach to stream assessment) – A process for moving from recognition of a stream problem to selection of an appropriate intervention, based on a relatively quick assessment of the problem, the causes, and the urgency of the situation.

tributary – A stream that feeds into another stream; usually the tributary is smaller in size than the main stream.

velocity – In streams, the speed at which water is flowing, usually measured in feet per second.

water bar – A shallow trench or diversion ditch that diverts surface runoff from roads, fire breaks, or skid trails into a dispersion area. Water bars are used to disperse flow, minimize erosion, and enhance conditions for re-vegetation.

watershed – A unit of land on which all the water that falls (or emanates from springs) collects by gravity and runs off via a common outlet (stream).

wetland – An area that is permanently or periodically saturated by water with vegetation adapted for life under those soil conditions, such as swamps, bogs, fens, and marshes.

NOTES

Things to Remember

“Water is the most critical resource issue of our lifetime and our children’s lifetime. The health of our waters is the principal measure of how we live on the land” Luna Leopold

“Rivers were here long before man, and for untold ages every stream has periodically exercised its right to expand when carrying more than normal flow. Man’s error has not been the neglect of flood-control measures, but his refusal to recognize the right of rivers to their floodplain…”
–Engineering News-Record, 1937

By allowing a stream to utilize its floodplain and its tendency to meander as much as practical, we can effectively reduce many of the flooding and erosion problems associated with streams.

We all benefit when private landowners take care of the land and water.

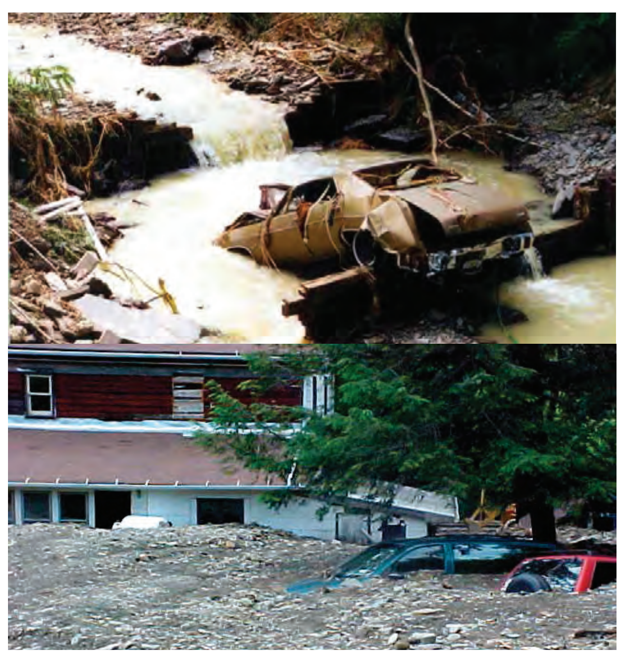
“Human activity has profoundly affected rivers and streams in all parts of the world, to such an extent that it is now extremely difficult to find any stream which has not been in some way altered, and probably quite impossible to find any such river.”
– H. B. N. Haynes, 1970

People change things in a stream system and then blame the stream for readjusting.

Remember

Sometimes we love our streams

Sometimes we hate our streams



"…ten thousand river commissions, with the mines of the world at their back, cannot tame that lawless stream, cannot curb it or define it, cannot say to it 'Go here,' or 'Go there,' and make it obey; cannot save a shore which it has sentenced, cannot bar its path with an obstruction which it will not tear down, dance over, and laugh at."

- Mark Twain

Chemung County Soil & Water Conservation District

Southern Tier Central Regional Planning & Development Board

Upper Susquehanna Coalition

Finger Lakes - Lake Ontario Watershed Protection Alliance

NYS Department of Environmental Conservation

National Oceanic and Atmospheric Administration, U.S. Department of Commerce — NOAA

Your coast, your future — NYSCoasts — NYS Department of State