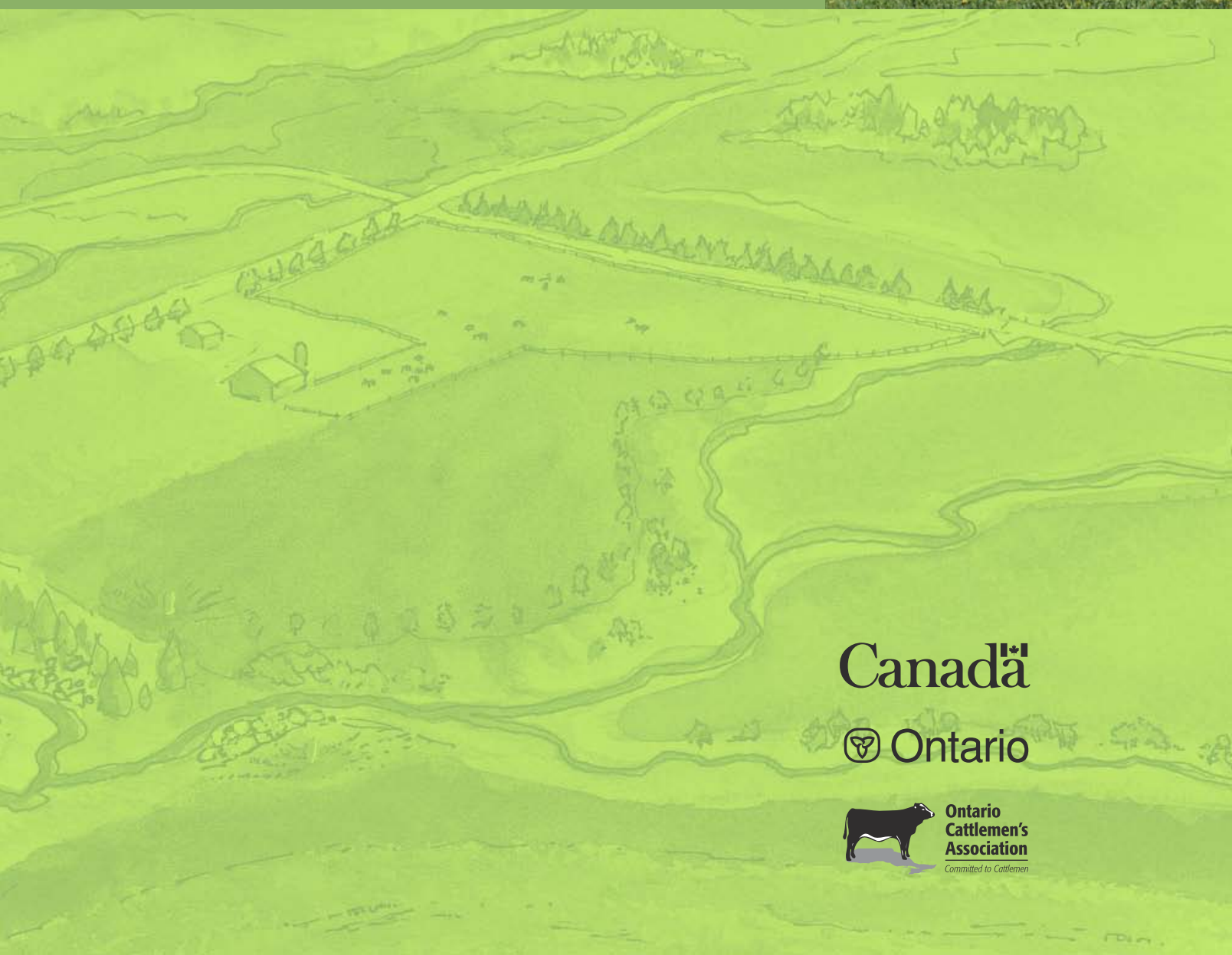
BEST MANAGEMENT PRACTICES

Buffer Strips



Canada

Ontario

Ontario Cattlemen's Association

Committed to Cattlemen

What is a Best Management Practice or "BMP"?

- a proven, practical and affordable approach to conserving soil, water and other natural resources in rural areas

Who decides what qualifies as a BMP?

- a team that represents many facets of agriculture and rural land ownership in Ontario, including farmers, researchers, natural resource managers, regulatory agency staff, extension staff and agribusiness professionals

What is the BMP Series?

- innovative, award-winning books presenting many options that can be tailored to meet your particular environmental concern and circumstances
- current BMP titles are:

Buffer Strips
Farm Forestry and Habitat Management
Field Crop Production
Fish and Wildlife Habitat Management
Horticultural Crops
Integrated Pest Management
Irrigation Management
Livestock and Poultry Waste Management
No-Till: Making It Work
Nutrient Management
Nutrient Management Planning
Pesticide Storage, Handling and Application
Soil Management
Water Management
Water Wells

How do I obtain a BMP book?

- if you're an Ontario farmer, single copies of each title are available at no cost at your local office of the Ontario Ministry of Agriculture and Food
- to purchase single copies or bulk orders of all other titles, and to order complete sets of BMP books, please contact: Ontario Federation of Agriculture, Attn: Manager, BMP, 40 Eglinton Ave. E., 5th flr., Toronto, Ontario M4P 3B1. Phone: 416.485.3333
- for an on-line order form, go to: http://www.gov.on.ca/OMAF/english/products/best.html
- please note that prices vary per title and with quantity ordered

CONTENTS

▶ When you see this symbol  , it means that a recommended practice or approach being discussed may be in violation of the *Fisheries Act* (see pg. 6 for more information).

▶ Need help with terminology? Please refer to the Glossary, which begins on page 138.

▶ In these pages, most measures are in metric with imperial equivalents in parentheses. Occasionally, where common use or common sense dictates, only one system of measurement appears.

INTRODUCTION

THE BENEFITS OF BUFFERS

In years gone by, the naturally scrubby areas alongside streams or other water bodies were often dismissed as wasted, unproductive land.

These days we understand much more about these buffer strips and the greater riparian zone of which they are a part. Many landowners are now establishing, enhancing or retaining buffer areas with the care usually reserved for cropland and livestock.

Around Ontario, crop producers have established buffer strips to protect water from runoff. Beef and dairy producers have fenced cattle out of heavily grazed lands alongside streams and other water bodies. Local fish and wildlife conservation groups have volunteered time and resources to plant trees and make other habitat improvements in buffer areas on private land. And all levels of governments have collaborated with farm and environmental groups to help establish buffer strips in rural Ontario.

The reasons are many. Properly functioning buffer strips and healthy riparian zones:

- act as living filters, trapping and treating sediments and other materials from upland activities
- stabilize streambanks, helping to prevent erosion
- increase soil's water-holding capacity, reducing the impacts of flooding and drought
- provide fish and wildlife habitat through added shade, cleaner and cooler water, and greater plant diversity
- decrease costs associated with drain cleanouts
- decrease the occurrence of water-related health issues (such as foot rot) in livestock.

Need some help with terminology?

- **a BUFFER STRIP is a strip of vegetation – usually a mix of trees, shrubs and grasses – planted alongside natural areas (e.g., watercourses), to protect them from surrounding land uses**
- **a RIPARIAN ZONE has no definite boundaries, but is the larger transitional area between water surface and uplands**
  - **immediately adjacent to water bodies, it includes streambanks, plant and animal communities, and the floodplain**
  - **under natural conditions, riparian vegetation is usually quite diverse and water-loving plants are more abundant than in upland areas**
  - **for an illustration, please see page 8.**

We all share responsibility for the protection of natural resources – particularly water, the very essence of life. Farmers have a good track record of environmental protection and we must continue to do our part.

This BMP book will be helpful to anyone considering how best to protect water that moves through their farm. I encourage any farmer with surface water on their farm to look at their situation with an eye to protecting water quality. In particular, any beef farmer with surface water on their farm should assess their own situation and determine what best management practices they need to incorporate to ensure minimal impact on water quality and to demonstrate due diligence on their part.

Rod Wooddisse, Wellington County Beef Producer and President of Ontario Cattlemen's Association

Well-planned, healthy buffers demonstrate a landowner's due diligence and civic-mindedness.

Some buffers may need additional measures such as fencing to protect the riparian area and comply with legislation.

Healthy buffer strips and riparian zones also give strong testimony to a landowner's due diligence and civic-mindedness. Unprotected water bodies and damaged streambanks suggest otherwise, and may even be in violation of legislation.

For more information about potential benefits, please see the next chapter.

Buffers come in all shapes and sizes. Narrow buffers protect banks and keep management activities away from surface waters.

Wide buffers with complex designs perform more functions than narrow buffers.

Buffer strips come in many forms. Narrow, simple buffer strips protect banks and shorelines from the stresses of vehicle traffic and erosion. Wider, complex buffers offer more of the benefits mentioned earlier. But wider and more complex is not always possible. The right buffer strip is one that can perform the desired function and one that's appropriate for local site conditions.

BUFFERS CAN'T DO IT ALL

Buffer strips are not complete solutions by themselves. They are literally the **last line of defence** before land meets water. You'll get the best results if you approach buffer strip management in the context of a comprehensive environmental farm plan.

By integrating your work on buffers with other soil and water best management practices ("BMPs"), you'll see significant long-term improvements to soil, water, air, plant and habitat quality. You can also profit by way of forage and tree crops and property beautification. This book will show you how.

A best management practice or BMP is a proven, practical, productive and affordable approach to conserving soil, water and other natural resources.

Field buffer strips are one part of a cropland soil and water conservation system.

Fish and wildlife also benefit from riparian buffer strips, which offer more complex ecosystems. These systems provide habitat and improve the aquatic communities they protect.

Use cropland buffer strips in concert with other BMPs. Read on for help with developing an integrated approach.

Livestock access to riparian areas should be closely managed. With outdoor confinement areas (more than 1 nutrient unit or NU per acre per year) or exercise yards, livestock should be kept out entirely.

If you have areas with extensive grazing (less than 1 NU per acre per year), assess the impact of livestock on the riparian area and look for opportunities for improvements. In some cases, win–win scenarios can be developed.

It may be that livestock can have some access, while impact is minimized. Switching to rotational grazing, establishing a forage–pasture buffer, and delaying grazing until mid-summer (when lands near water are drier and less likely to be disturbed) will reduce livestock's impact on riparian areas.

As stated in the *Ontario Environmental Farm Plan* (1996), grazing is either:

- **extensive/low-density – livestock grazing will result in less than 1 NU per acre per year**

or

- **intensive/high-density – livestock grazing will result in an average of more than 1 NU per acre per year. (A grazier may have more than 1 NU/ac/yr for a given period, provided the average does not exceed 1 NU/ac/yr.)**

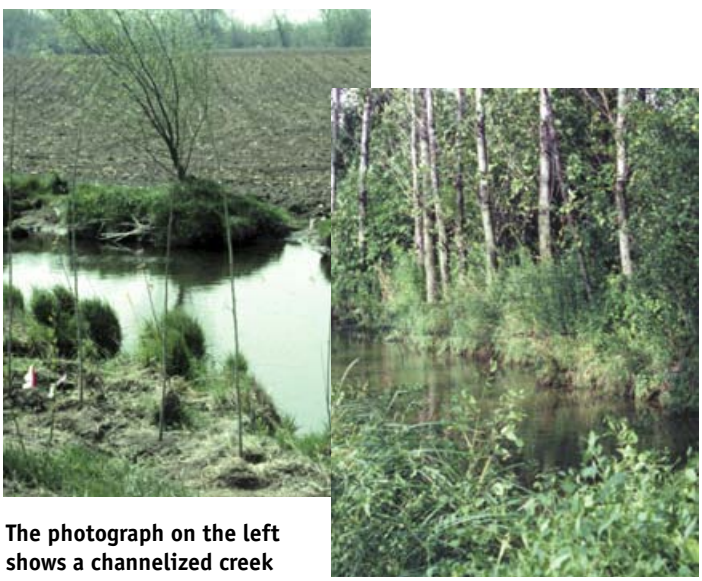
USING THIS BOOK

Buffer Strips has been created with the needs of farm operators and other rural landowners in mind. In subsequent chapters, we'll:

- explore the functions and roles of buffer strips and riparian zones adjacent to flowing water, wetlands, ponds and lakes
- distinguish between healthy and unhealthy buffer strips and riparian zones to help you assess your site
- show how to establish and maintain buffer strips
- identify potential agricultural impacts on these areas
- look at a range of BMPs to consider as part of a comprehensive plan to reduce impacts on surface water.

There are several other related titles in the Best Management Practices series. Look to them for more detailed information on cropland conservation, nutrient management, fish and wildlife habitat management, water management, and much more. Sources for additional information appear on the back cover.

Natural riparian areas are important and they must be protected. The riparian area bordering this watercourse would benefit greatly from a more substantial buffer strip.



The photograph on the left shows a channelized creek (Washington Creek in Oxford County) before the establishment of a treed buffer strip. Note the areas of cropland runoff and bank erosion. The photograph on the right is the same site 12 years after planting. This portion of Washington Creek has been transformed from degraded to prime cool-water habitat.

Neglected riparian areas can be interpreted by neighbours to mean that the landowner's right to make money is more important than everyone's right to enjoy a public resource.

There's also a partial list of relevant legislation on page 140. When it comes to working around water, i.e., fish habitat, the federal *Fisheries Act* is of particular significance, and you should familiarize yourself with it. Please read a summary of its relevant sections provided in the following textbox.

Also, occasionally you'll see this symbol  in these pages. This is a cautionary reminder that a recommended practice may violate the *Fisheries Act*.

When it comes to protecting surface water on your property, always be proactive. Where there's a problem, taking no corrective action leaves you vulnerable to punitive measures. Evidence of improvement efforts, on the other hand, puts you in a more favourable light.

SPOTLIGHT ON THE *FISHERIES ACT*

The *Fisheries Act* has been a federal statute of Canada since 1868. The Department of Fisheries and Oceans and Environment Canada jointly administer the Act.

The Department of Fisheries and Oceans has primary responsibility for the *Fisheries Act* and is responsible for administering the habitat provisions. Subsection 35(1) of the Act is a straightforward prohibition. It states that "no person shall carry on any work or undertakings that results in the harmful alteration, disruption or destruction of fish habitat." Subsection 35(2) qualifies that prohibition and allows for the alteration, disruption or destruction of fish habitat if it is authorized by the Minister or a delegate.

Environment Canada administers subsection 36(3) of the Act, commonly called the pollution prevention provisions. The subsection states that "no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water." The only way a deposit can be authorized is through the creation of a regulation under the Act.

- **deposit** – any discharging, spraying, releasing, spilling, leaking, seeping, pouring, emitting, emptying, throwing, dumping or placing (ref. Ss34(1)(e))
- **deleterious substance** – as applicable to livestock operations, means any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man or fish that frequent that water (ref. Ss34(1)(a))
- **water frequented by fish** – means Canadian fisheries, which essentially is water, which, at some time, has fish in it (ref. Ss34(1)(e))
- **fish habitat** – spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes (ref. Ss34(1)(e))

WHY IS LIVESTOCK ACCESS A CONCERN?

One of the concerns with allowing livestock access to watercourses is the potential for manure to be deposited in a stream. Manure is a deleterious substance. The high levels of nutrients in manure can poison fish and cause excessive plant and algae growth, which upon decay can reduce oxygen levels to levels that cannot sustain fish. Livestock access to watercourses can also result in physical impacts to fish habitat at the crossing site.

HOW CAN YOU ENSURE THAT YOU COMPLY WITH THE *FISHERIES ACT*?

The short answer is: use "all due diligence." The defence of due diligence or "reasonable care" is used in a court of law for most regulatory offences, including subsection 36(3). The defence of due diligence is available to anyone to show that they did everything reasonably within their power to prevent the offence from occurring. A lack of due diligence could include: failure to take remedial steps regarding a potential problem, failure to control discharges to the maximum extent possible, failure to act quickly to correct a problem, and failure to follow standard practices that are recognized by industry associations (e.g., the Ontario Cattlemen's Association) and comply with the *Fisheries Act.*

The best approach, however, is to be proactive. Do everything you can to prevent a deposit of manure, sediment, etc. to avoid causing a complaint or an offence.

ASK YOURSELF:

- Do my livestock have access to water frequented by fish? A *Fisheries Act* violation may exist wherever animals are able to deposit manure in a watercourse.
- Have I, in some manner, discouraged my livestock from accessing streams, rivers and lakes?
- Have I provided an alternative water source for my livestock?
- Have I constructed stream crossings that prevent animals and manure from contacting the water where livestock frequently cross watercourses?
- Are manure piles located so that they will not provide a source of contamination to nearby waters?
- Is contaminated runoff (deleterious substances of any kind) captured and controlled so that it cannot enter water frequent by fish?
- Where work in and around watercourses is required, have I obtained the necessary approvals?

For a complete copy of the *Fisheries Act*, go to: http://laws.justice.gc.ca/en/F-14/index.html

In this before-and-after buffer strip story, an intensively grazed pasture along a creek (Hall's Creek in Oxford County) was taken out of grazing production and planted to grasses, trees and shrubs. By taking this course of action, the landowner ensured that livestock were no longer contributing deleterious substances to fish habitat.

RIPARIAN ZONES AND THE ROLE OF BUFFER STRIPS

In this chapter we'll look at all kinds of riparian zones. We'll explore how riparian zones function, their environmental impact (and what, in turn, impacts them), and the role of buffer strips within zones.

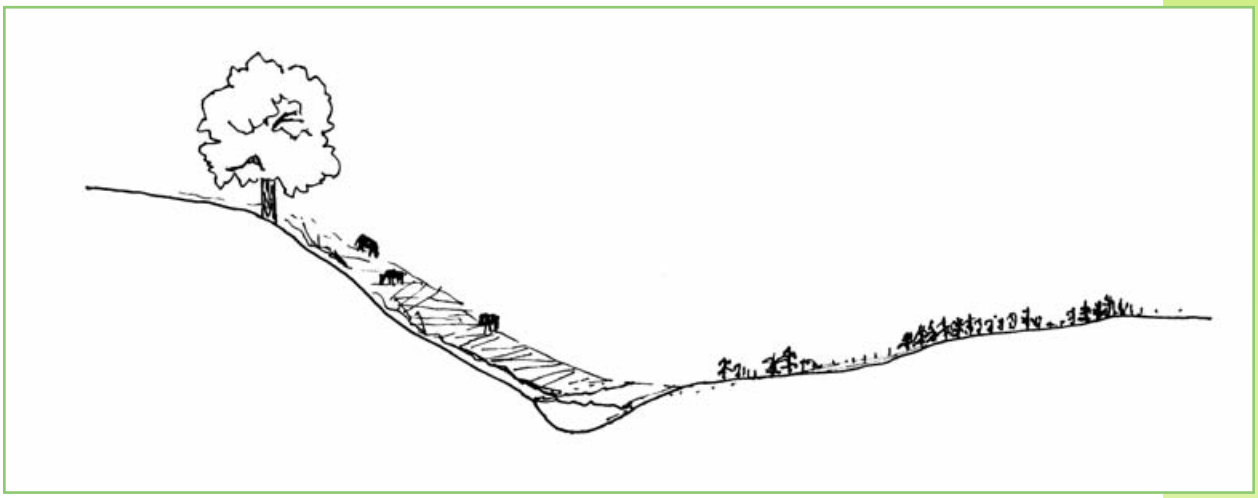
It's not just theory! Gaining a good understanding of how riparian zones "work" is crucial preparation for planning effective improvements on your property.

CROSS-SECTIONAL VIEW OF A RIPARIAN ZONE

NATURAL RIPARIAN ZONE

A riparian zone lies between upland and surface water. It includes components such as the floodplain, shoreline or streambank, and usually a diverse mix of trees and shrubs that border the shoreline and form a buffer strip. Typically there is greater plant diversity here than upland. The zone helps protect water quality and provides habitat for wildlife. For fish, the zone provides food and moderates water quality.

DEGRADED RIPARIAN ZONE



This riparian area reveals a pattern of mismanagement, including intensive grazing and poor cropping practices near sensitive shore areas. Neglect has degraded the functioning of the area and the quality of its features, such as the floodplain, streambank, and the buffer strip.

FORMERLY DEGRADED RIPARIAN ZONE RESTORED WITH BMPS

Complete with a network of trees, shrubs and plants, this zone is functioning optimally. Surface and sub-surface water is being filtered before reaching the water body. Streambanks are being stabilized through reduced erosion and the slow, meandering stream. Where there's a risk of sediments and agricultural chemicals moving off adjacent cropland, they're being trapped and modified before entering the stream. The soil's water-holding capacity is increasing, thereby moderating the effects of flooding and drought while recharging groundwater supplies. Vegetation is shading the water, keeping it cool for fish and offering habitat for amphibians, cover for wildlife, and food for fish.

HOW WATER MOVES

Moving water operates under certain "laws". To be long-lasting and effective, any remedial action you take must work within these laws.

All water, whether in a stream or temporarily remaining in low-lying areas and wetlands, is always seeking to move to lower elevation – through side channels, inlets and outlets, and underground through spaces in soil and rock. Water is always on the move, ultimately "seeking" sea level.

Water moves in a downslope direction with gravity, from high elevation to low elevation. The speed at which it flows downslope depends on the gradient (or slope), the shape of the channel, and the resistance to flow.

As water flows, it erodes soil materials from its beds and banks. The more resistance it encounters – such as rocks in banks and vegetation – the slower the rate of flow.

When water meets resistance, it will change course or meander. As it turns, water will erode sediment from the outside of the bend and deposit it on the inside of the bend.

Flowing water will strive for a dynamic equilibrium or balance between flow rates, sediment load and slope. This means that meandering is more natural than fast-moving straight channels, and less prone to flooding and shoreline erosion.

Natural watercourses will form meanders, or bends, as they strive for a balance of flow, sediment and gradient.

When we tamper with watercourse shape (e.g., with channeling) or resistance (e.g., by removing vegetation), we increase the impacts of bank erosion and flooding.

Stream-flow over fine soils results in channels that are relatively deep and narrow, as it's easier for the stream to cut through soil. Stream-flow over coarse-textured materials, such as sands, cobbles and stones, makes channels that are naturally broader and meander more.

Tree vegetation helps channels to maintain a preferred shape and dynamic equilibrium, and streambanks to hold their ground.

Buffer tree vegetation plays key roles in helping the channel maintain an ideal shape and in stabilizing streambanks – particularly in coarse-textured soils.

Removal of vegetation for grazing, cropping or development will accelerate the rate of bank and bed erosion, make the channel wider and shallower, and could lead to widespread flooding.

VALUE OF RIPARIAN AREAS

In agricultural regions, riparian areas – without extra help from planted buffer strips – offer the following benefits.

WATER STORAGE

In the past 20 years, Ontario has experienced more than its share of both floods and low water conditions. A healthy riparian area is a sound insurance policy against both. Such an area will store rain, runoff, floodwaters and discharging groundwater, then release water to the surface slowly. This keeps water levels and flow rates steady, and maintains wildlife habitat.

To increase their storage capacity, riparian areas must have soils with low densities and high organic matter, and be vegetated with plants with extensive root systems. These soils have high water-holding capacities.

Degraded riparian areas have less vegetation and therefore less storage capacity. The soils here have been compacted from livestock access and farm vehicle traffic. They have lower levels of organic matter and fewer roots to bind them, and are prone to runoff and erosion.

FISH AND WILDLIFE HABITAT

Properly functioning riparian areas protect fish habitat.

Riparian areas are important habitat. For **fish and other aquatic life**, they provide:

- clean water – riparian areas filter, absorb and transform nutrients, sediment and other contaminants
- shade – trees in planted buffers and natural riparian areas keep water temperatures cool
- cover – natural channels, woody debris overhanging banks or shores, stones, cobbles and tree limbs help to form cover for aquatic life
- food – leaves and other plant debris feed aquatic and other insects, which supports the aquatic food cycle.

The red-sided dace is an example of a fish species that experts have determined is at risk due to habitat loss.

Mature trees in riparian areas can provide perch sites for raptors such as this kestrel, keeping rodent populations in check.

For **birds, game and other wildlife**, riparian areas provide:

- space – relatively undisturbed and connected riparian habitats act as corridors for wildlife movement
- cover – all riparian vegetation and some of the diverse features (e.g., gullies, ponds) provide some degree of cover for birds, mammals, reptiles and insects
- water – in surface waters or in the small ponds, pools and wetlands contained therein, riparian areas are important sources of water
- food – natural vegetation can provide a wide variety of seasonal foods (e.g., winter browse, herbs in spring and summer, insects, fruits, seeds and nuts).

Riparian areas can serve as travel corridors for wildlife.

ECONOMIC BENEFITS

An innovative landowner can make money from a riparian area through woodland products. Firewood, timber, nuts, orchard and alternative products can be a welcome source of revenue. Veneer and other high value timber can be obtained from walnut, oak, ash, cherry, maple and white pine.

Landowners can also save money indirectly by using buffer strips to keep their soil in place. Among other things, this reduces the frequency of drain cleanouts.

AGRICULTURAL PRACTICES THAT DEGRADE RIPARIAN AREAS

GRAZING

The riparian functions (and benefits) we've just described assume that the riparian area is in good condition!

Livestock access can impair riparian functions. The degree of livestock's impact varies with the sensitivity of the grazed riparian area, the intensity of access (i.e., number of livestock in a given space), and the duration and timing of the access.

Here are some livestock activities that can adversely affect riparian areas:

- livestock will eat accessible and palatable vegetation, and with time and intensity they'll graze most existing vegetation, damage what can't be eaten, and trample the roots of trees and shrubs

  net effect – the area's filtering ability and wildlife value are diminished

- hooves can compact soils, especially when conditions are wet, to a degree that puts soils beyond short-term rehabilitation

  net effect – infiltration rates are reduced and runoff increases

- hoof pressure above banks (and shores) can cause bank failure and slumping

  net effect – more erosion, hazards to livestock, diminished water quality

- livestock access to the streambed can stir up silt and also lead to deposition of livestock waste directly in the stream

  net effect – contamination of water, risk to human health, degradation of habitat

- overgrazing

  net effect – riparian's productive capacity for intensive, short-duration grazing is diminished.

The impact of livestock access is related to livestock intensity, duration of access, grazing season and the sensitivity of the area accessed.

Allowing livestock free access to small headwater streams can be particularly damaging to sensitive, cold-water trout habitats.

CROPPING ADJACENT TO RIPARIAN AREAS

Intensive production of field and horticulture crops can also negate the positive effects of riparian areas. Here are some examples:

- ▸ farm equipment used too close to banks and shores

  net effect – failure, slumping and erosion of streambanks, and risk of personal injury

- ▸ poor rotation, intensive cultivation, no crop residue management, no use of cover crops, and minimal organic matter additions

  net effect – poor soil quality, accelerated rates of soil erosion, sediment in runoff, contaminated runoff, and frequent drain maintenance

- ▸ poor management of surface-applied materials such as liquid manure, biosolids, fertilizers and pesticides

  net effect – contaminated surface water and tile effluent.

Runoff and tile effluent can contain surface-applied crop inputs such as nutrients and pesticides.

Cropland with poor infiltration rates is prone to runoff. Included in the runoff can be materials at or near the soil surface, such as soil-bound nutrients, applied manure, pathogens, pesticides attached to soil particles, and other materials. Buffer strips can help reduce the impact of contaminated runoff.

Sediment loads from cropland to adjacent riparian areas can be excessive – unless you deploy BMPs in the field, erosion control structures where appropriate, and buffer strips.

Fruit trees are planted right to the edge of this streambank, compromising the watercourse. A wider buffer, combined with the addition of conifers and taller shrubs, would improve the protection of this stream from nutrient applications and orchard spray drift.

All spray applications should be directed away from protective stream buffers.

Excessively dense vegetation in a buffer should be thinned to ensure air circulation is not blocked. In spring, too little air movement can lead to formation of frost pockets and freezing injury to sensitive adjacent crops. Good air movement will lead to faster drying of horticultural crops after rain, reducing crop disease problems.

WHAT BUFFER STRIPS DO IN AND ADJACENT TO RIPARIAN AREAS

We've looked at the benefits of riparian areas, and some of the agricultural activities that can impair them. Let's focus in on buffer strips within riparian areas, and how they can cushion the effects of agricultural activities.

The following chart offers a complete list of what buffer strips and related BMPs can do.

PROCESS	DESCRIPTION	EXAMPLES
WATER QUALITY FOR HABITAT AND RECREATIONAL USE		
SEPARATION	• buffers can keep farm practices away from sensitive natural areas • the greater the distance from "source" to "sink", the greater the reduction of pollution potential	• reduced or restricted livestock access access • no-spray zones in fields
BANK PROTECTION	• buffers can provide protection simply by separating land use from streambanks and shorelines • they protect bank structures, crossings and stabilization plantings	• setbacks for crop management • root masses from planted trees and shrubs along banks
ENTRAPPING AND DEPOSITING	• dense, upright vegetation slows runoff velocity • some sediment is removed during flow • slowed flow can lead to ponding • suspended sediment can drop out and settle in buffer area or in adjacent fields	• strips as narrow as 4–5 metres (13–16 ft.) can trap at least 70% of the sediment and attached contaminants
FILTRATION	• buffer vegetation creates obstacles • suspended material is filtered out by standing vegetation as runoff flows through	• canary grass forms a dense obstacle course for runoff
ADSORPTION (i.e., trapping of nutrients and other chemicals by soil particles)	• sediment and other contaminants in runoff waters "stick" to vegetation and to soil particles	• clay and humus can stick to surface vegetation during storm events • phosphates and ammonium can be adsorbed by clay and humus particles in buffer strip soils
ABSORPTION	• plant roots and soil microbes can uptake inorganic and organic forms of nutrients, salts, metals, pesticides, pathogens • some plant stems and leaves can directly uptake nutrients, metals and salts	• nutrients (e.g., nitrates) in baseflow and runoff are captured and taken up by buffer vegetation – this also reduces greenhouse gas production • soils with high levels of organic matter absorb best

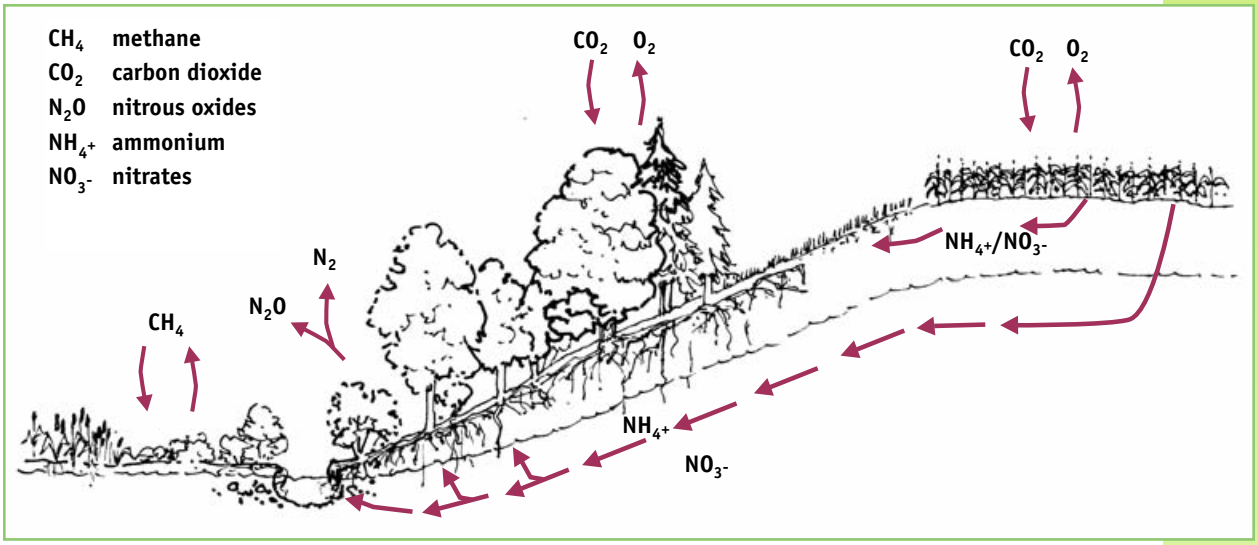
PROCESS	DESCRIPTION	EXAMPLES
TRANSFORMATION	• inorganic and organic compounds can be converted to other chemicals (e.g., manure to organic matter) or other forms (organic matter to carbon dioxide gas) • other chemicals and biological organisms (e.g., pathogens) can be destroyed by exposure to heat, cold, dry conditions and sunlight	• nitrate–nitrogen (NO_3-) to N_2O (nitrous oxide) and N_2 gas (inert nitrogen gas) • pesticides to less toxic compounds (e.g., glyphosate to CO_2 [carbon dioxide] and H_2O [water])
CLIMATE CHANGE		
SEQUESTERING	• planted buffer strips can, through photosynthesis, remove carbon dioxide from the atmosphere • carbon dioxide is a greenhouse gas	• trees are more effective than shrubs, grasses and crops at CO_2 sequestering • fast-growing dense trees, such as oaks, ashes, hickories, and walnut are the most efficient for carbon sequestration, as their valuable wood products remain out of the carbon cycle longer than other woody plants
FISH AND WILDLIFE HABITAT		
COVER	• buffer strips can increase the diversity of vegetation to provide a range of cover functions for fish and wildlife habitat • well-planned buffer strips (plus connected adjacent natural areas) can help form excellent wildlife corridors • conifers provide important winter shelter	• grassed buffers provide some nesting cover for waterfowl – wider buffers are better • trees in planted buffer strips provide habitat for many species of birds and animals (including some nuisance species) • wetlands, woodlands, abandoned areas and treed fencerows can be "connected" by buffer strips to form a corridor
SHADE	• trees adjacent to watercourses provide shade • shade helps keep baseflow surface waters cool • taller trees and wider strips provide more shade	• fast-growing trees planted along watercourses will provide shade sooner • a wide, treed buffer strip is more effective than a single row of trees
FOOD	• buffer strips planted to food crops (e.g., fruit and nut trees, cereals, catkin trees and shrubs, etc.) provide a wide range of food sources for wildlife • woody plants provide leaves and twigs to streams to feed aquatic insects	• smaller wetter areas in the buffer strip design are excellent food sources – waterfowl, other birds, reptiles, amphibians and fish eat insects and their larvae

PROCESS	DESCRIPTION	EXAMPLES
AGRICULTURE		
LIVESTOCK HEALTH, PRODUCTIVITY AND FOOD SAFETY	• grassed buffer strips may provide rich pasture, shade and access to water – however, when grazing density is high or access is continual, muddy conditions prevail in wetter areas, which can be a source of disease organisms for livestock and humans, and a cause of injury to livestock	• exclusion from muddy areas, ponds and wetlands can prevent problems in dairy cattle such as environmental mastitis or injury – consider restricting access or limiting access to short intervals, but only during the drier periods of summer
ECONOMIC BENEFITS	• products such as firewood, orchard fruit and alternative woodland products can be a welcome source of revenue for innovative buffer strip owners	• nuts from nut orchards, walnuts, butternuts • tree species should be matched to site conditions

This cross-section through the riparian zone shows how tree roots hold bank soils in place and help the channel to form a cup shape.

Riparian buffers improve soil and water quality. Roots stabilize the soil. Plant materials add organic matter to the soil to improve its structure, chemistry and biological diversity. Vegetated buffers help to entrap and filter out sediment and debris from floodwaters and runoff. Within the soil profile, nutrients are adsorbed to soil particles, absorbed by plants and transformed into less harmful chemicals.

Channels are deemed healthy when erosion and deposition are balanced throughout a watercourse or along a shoreline.



Treed buffers are important BMPs to reduce agriculture's impact on climate change. Plants and soils sequester some key greenhouse gases, such as carbon dioxide. Methane can also be fixed by riparian soils. Emissions of nitrous oxides can be reduced when riparian vegetation intercepts cropland nitrates and ammonium as they move with groundwater to watercourses.

TYPES OF RIPARIAN AREAS

Riparian areas are often categorized according to the water body they're directly connected to, such as a watercourse, a lake or a wetland. While these types seem obvious, it's helpful to know more specific characteristics of each one, like soil conditions, riparian vegetation, functions, and real-life examples from around Ontario.

Bear in mind too that many of these riparian types – as seen in the following two-page illustration – are connected. For example, wetlands, ponds and small creeks and streams feed ever-larger watercourses as water flows to its destination – a lake, in this case.

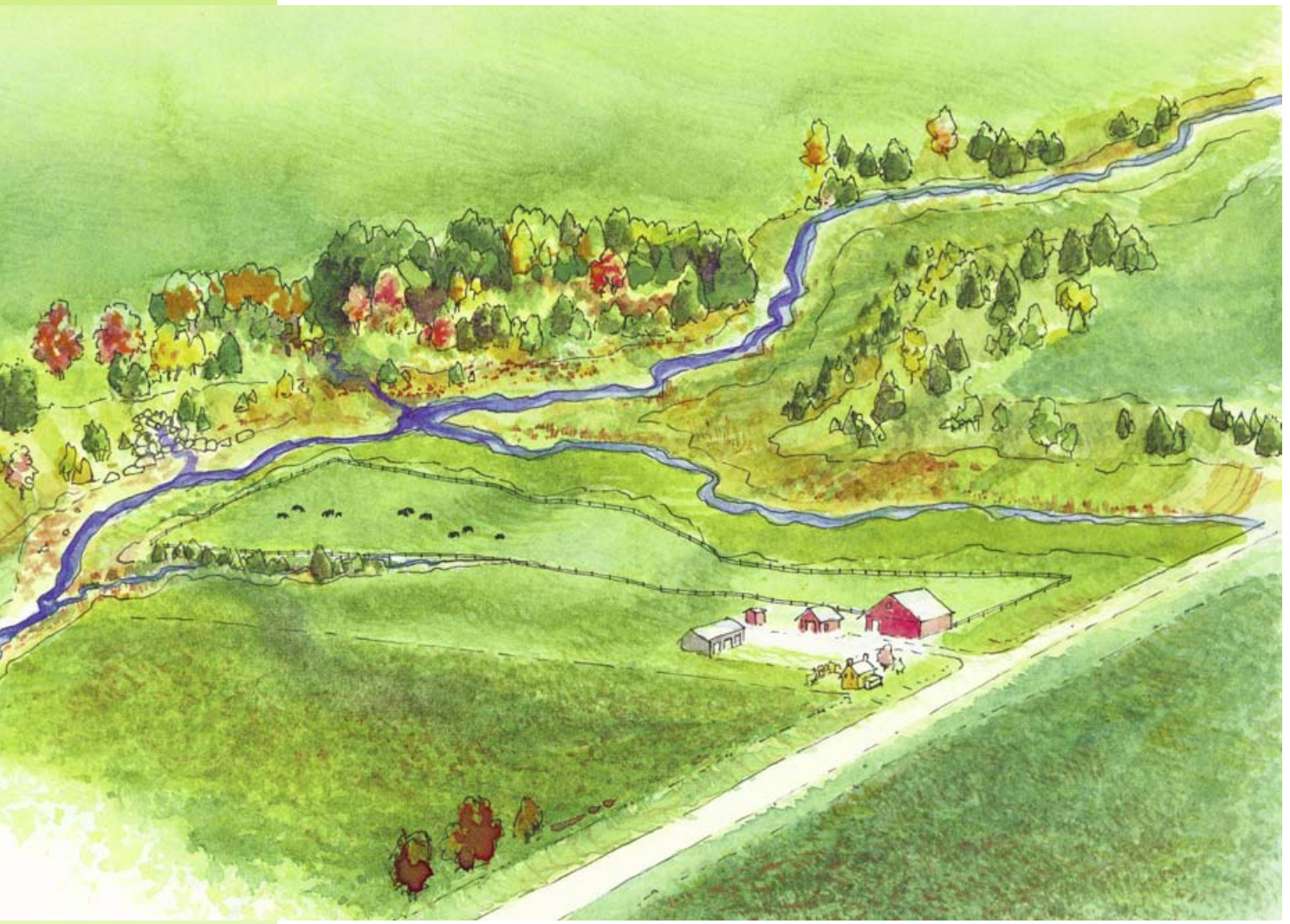
The following series of illustrations and descriptions should help you get site-specific with your property as you select BMPs that best suit your circumstances and intentions.

The riparian areas and buffer strips found in an agricultural watershed in southern Ontario are depicted here. The drainage system moves from sources of the upper "reaches" of the watershed in the upper-right corner (wetlands, ponds, creeks) to the lower reaches that empty into a lake found in the lower left. Generally speaking, natural areas and extensive farm practices are more common at the top of the watershed, whereas intensive farm management practices are more common in the lower reaches.

The types of riparian areas found in the distinct components of this watershed are described over the next few pages.

Though the illustration depicts a typical southern Ontario watershed, the same general components are present just about anywhere across agricultural Ontario.

UPPER REACHES – NARROW CHANNELS



In the upper parts or reaches of many watersheds, you'll find natural watercourse riparian areas adjacent to streams or creeks in level landscapes. They're characterized by narrow, shallow valleys and deep channels (1–2 metres [3–6 ft.] deeper if in clays). Typical soil types range from fine sands to clays found in sand and clay plains.

In agricultural settings, the riparian vegetation consists mostly of narrow buffers, grassed pastures and cropland, some of which is tiled.

In areas with natural vegetation, riparian forest cover consists of lowland deciduous trees, lowland conifers, or if wetter, shrub–meadow mix and marsh or swamp wetland vegetation.

On these level landscapes, soil erosion and runoff on cropland are usually not as much of an issue as bank erosion and sediment loading from cultivated fields, livestock damage to streambanks, or livestock access points along the watercourse.

Typical examples are small creeks and streams in clay plains (e.g., those found in Temiskaming, Renfrew, Victoria, and Kent-Essex-Lambton) and sand plains (e.g., Prescott-Russell, Simcoe, and Norfolk).

Intensively cropped soils in these landscapes are prone to severe forms of erosion and runoff. A combination of BMPs for in-field soil and water conservation, water and erosion control, buffer strips, and bank erosion control can prevent these problems.

Crop rotation, narrow forage or treed buffers, and drop structures combine to offer protection from intensively cropped plains in the upper reaches of rivers.

Bank erosion and damage at access points on the upper reaches of rivers can be reduced with controlled and restricted-access BMPs.

UPPER REACHES – WIDE-CHANNELLED WATERCOURSES

At the watershed level, upper parts or reaches are dominated by rolling landscapes, rivers with steeply sloping valleys, and medium-width (10–30 metre [33–98 ft.]) shallow channels. Bank and bed materials are usually cobbly or bedrock-controlled. Typical soils are stony or gravelly sandy to loamy soils. In northern Ontario and parts of central and eastern Ontario, these areas are often shallow to bedrock (Otonabee, Ganaraska, Rideau). In southern Ontario, these landscapes can be dominated by loamy soils (e.g., Upper Grand and Upper Thames).

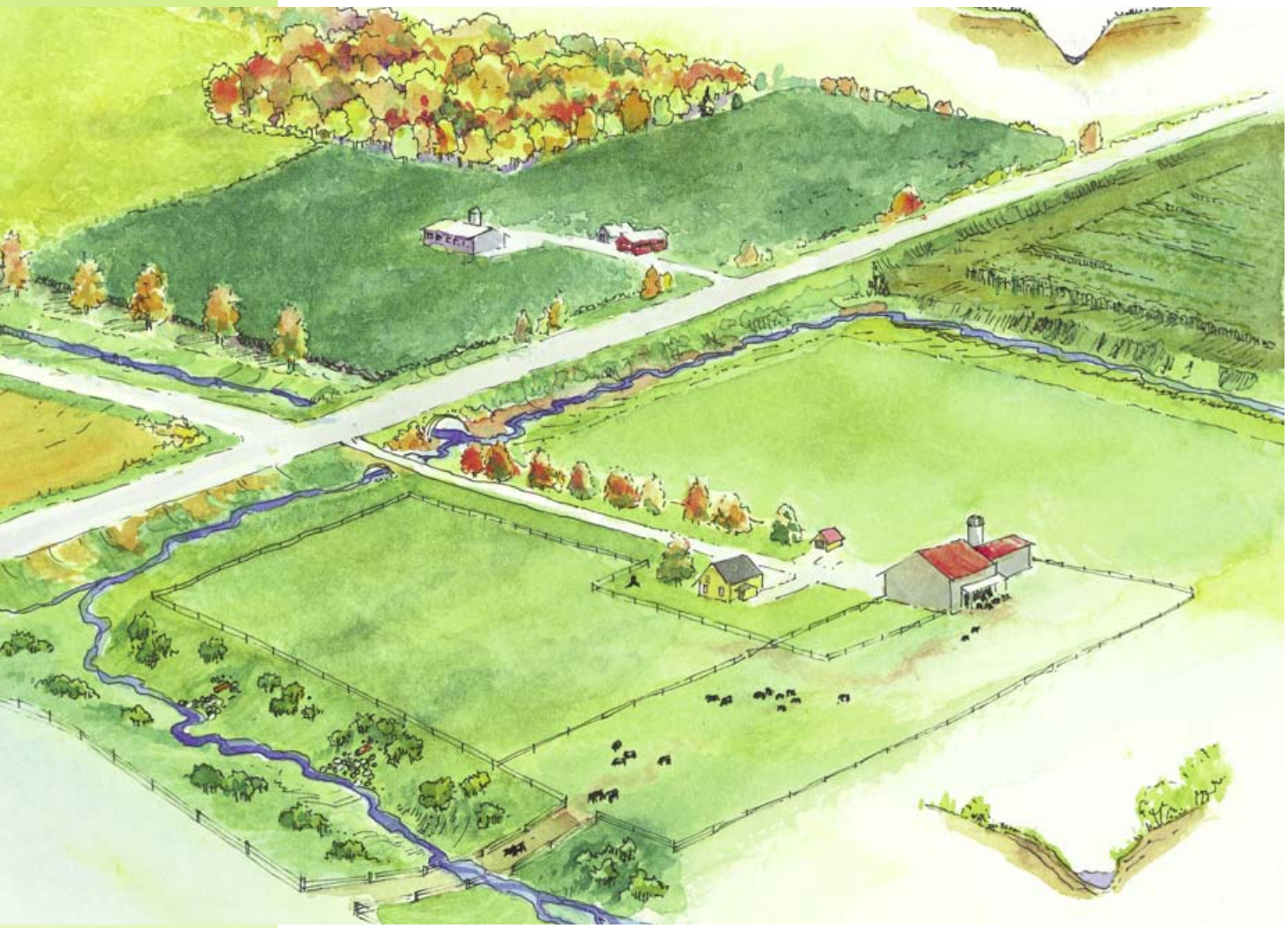
In agricultural landscapes, the riparian area is dominated by natural or nearly natural vegetation. This is due in part to a history of extensive land use as dictated by the steep slopes, stony soils and, in some settings, shallow depth to bedrock.

Nearly natural settings have pasture species, shrubs and trees. Forest cover dominates the natural vegetation, ranging from deciduous in the south (oak–ash–hickory), to mixed conifer–deciduous in the near north (maple–beech–pine–hemlock), to jack pine–red pine–black spruce in the north.

Riparian areas in upper reaches can be highly erodible due to the steep valley slopes and soil materials. Livestock access is rarely intensive but can be a source of bank erosion where access is localized and concentrated.

In extensively grazed shallow channels, it's the habitat functions that are most negatively affected. BMPs such as controlled access, delayed grazing, and alternative water sources are effective in minimizing impacts on riparian habitat.

CONSTRUCTED WATERCOURSES – DRAINS AND CHANNELIZED STREAMS



Constructed watercourses are open drains or channelized streams designed and constructed (or altered) to convey water from tile-drained lands, field surfaces and upstream surface waters.

Normally, these watercourses have steep banks, shallow channels, and no valleys. Drains and channelized streams are often part of the same drainage system as creeks and streams. They usually flow through level landscapes containing clayey, loamy or sandy soils with higher-than-average soil water tables, such as in eastern and southwestern Ontario.

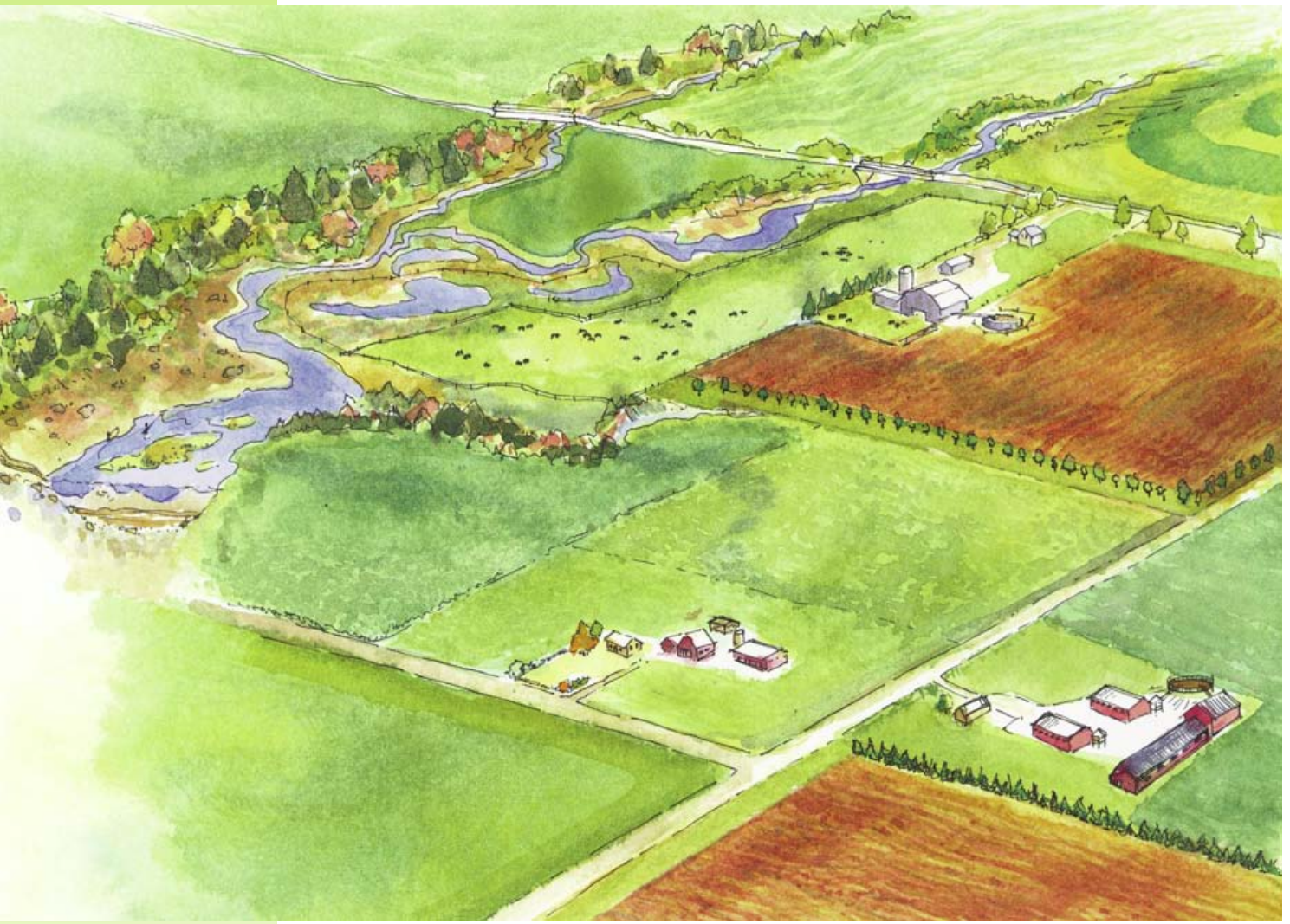
For most constructed watercourses, riparian vegetation is restricted to grassed buffer strips and banks to facilitate drain maintenance. In some cases, trees can be planted on one side of the channel to provide shade and greater stability.

Constructed watercourses are prone to bank erosion, receiving runoff from adjacent cropland and tile drain effluent.

Grazed livestock should be kept out of constructed watercourses. Provide alternative water, and move salt and shade structures well away from the watercourse.

To reduce cropland erosion and runoff into drains, establish narrow, forage or treed buffers. The buffers should complement in-field soil and water conservation practices such as reduced tillage and residue management.

MIDDLE REACHES OF RIVERS – STEEP VALLEYS AND EXTENSIVE FLOODPLAINS



Riparian areas in the middle reach zone of rivers have steep valleys and broad floodplains.

The valleys have slopes of over 10 percent, i.e., 10-metre (33 ft.) drops over 100-metre (328 ft.) distances. Slopes are even steeper through clayey soils or bedrock faults (gorges). The floodplains are often wide (30–500 metres [98–1640 ft.]) with shallow, meandering channels.

Soils in the valleys and floodplains are highly variable. Generally, the valley soils reflect local soil conditions. Valley vegetation is often upland forest or pasture. Natural floodplain vegetation is a combination of meadow, wetland and forest species. Where floodplains are farmed, grazing predominates; field crops are less common. These areas are prone to flooding and channelizing.

Intensively cropped floodplains are fragile lands. They reduce the ability of a buffer to store water, filter nutrients and soil, and provide habitat. Floodplains are ideal sites for treed buffers and floodplain meadows. This landowner has successfully turned to crops such as Christmas trees, which have economic return and lead to a well-functioning riparian zone. Note that the area has been enhanced with the addition of an osprey nesting structure.

On fragile steep slopes, livestock exclusion with permanent or temporary fencing at the top of the slope is recommended. Ravine slopes can be planted to trees and shrubs.

LOWER REACHES OF RIVERS – DELTAS AND BROAD FLOODPLAINS

Riparian areas of the lower reach (or near the river mouth) consist of shallow valleys, a wide channel, broad floodplains, and as they approach the mouth, delta "islands" and braided streams.

Soils in the floodplain and deltas consist of silty and fine sand materials. Natural vegetation is most often grass and wetland species, with small pockets of ravine forest.

Local landscapes are often level and highly productive, and lend themselves to intensive field crop, horticultural crop and livestock operations. Lower reach areas are somewhat less sensitive to erosion and runoff from adjacent cropland.

LAKES – BEACHES, BLUFFS AND BEDROCK-CONTROLLED SHORELINES

Lakes are also riparian areas. There are three main types.

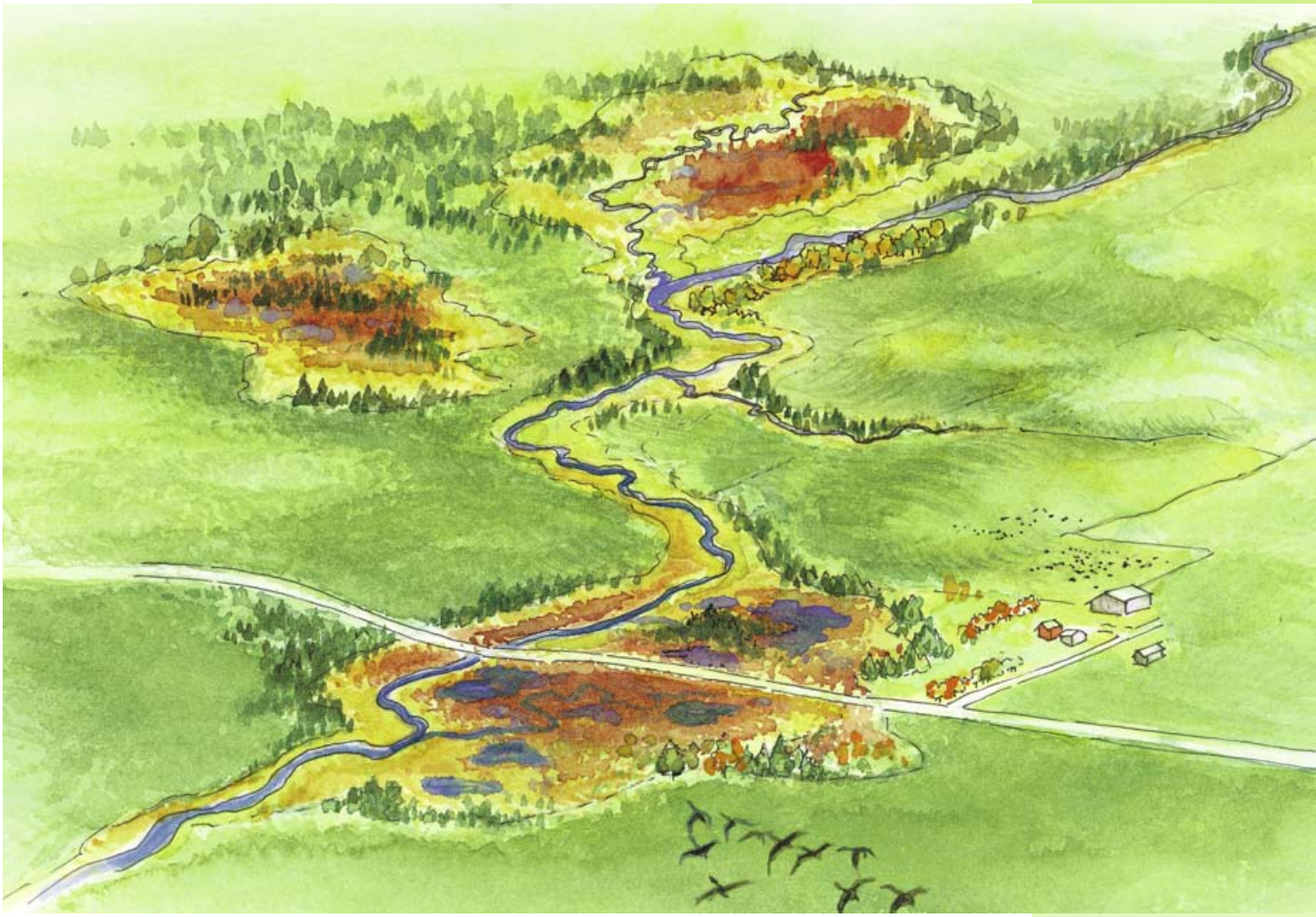
Beaches, usually found in lake bays, consist of sandy, gravelly or stony materials. Land use – often recreational, residential, or agricultural – can be intensive, leaving these areas at risk of habitat destruction and water quality problems.

Bluffs are shorelines with sizable elevation drops (5–50 metres [16–164 ft.]) from the top to the water's edge. Some are formed from bedrock, like the lakes in the Canadian Shield. Others, such as Lakes Erie, Ontario and Huron, are formed from silty and clayey materials. Clay bluffs are prone to severe shore and gully erosion. Intensive land use practices are not suited to these fragile lakeshores.

Between bluffs, points and bays on lakes in the Canadian Shield can be found **bedrock-controlled shorelines.** In their natural condition, these riparian areas are dominated by forest cover in uplands and wetland vegetation in lower areas. Intensive land uses are normally not well-suited to these areas.

Bluffs are often prone to severe gully and shoreline erosion. BMPs can significantly reduce erosion. These include establishing treed buffer strips, applying soil and water conservation practices to adjacent cropland, creating drop structures, diversions and spillways, and retiring gully lands to trees, shrubs and wildlife plantings. See page 112 for more information.

WETLANDS AND NATURAL PONDS



Wetlands are permanently or seasonally flooded areas with high water tables, saturated soils and water-tolerant plants. In agricultural areas, wetlands can be found in depressional areas away from watercourses and lakes, or can be part of the riparian areas of watercourses and lakes. The wetlands described above are in or adjacent to the upper reaches of the watershed. The types illustrated are:

fens

- wetlands with sedges, reeds and grasses
- normally associated with springs (groundwater discharge areas) and creeks

bogs

▸ wetlands with sphagnum moss, shrubs and conifer trees, e.g., black spruce

swamps

▸ wetlands dominated by forest cover – trees and shrubs – and are often only seasonally flooded

marshes

▸ wetlands without trees that are covered by rushes, reeds, cattails and sedges.

Sometimes watercourse wetlands can enhance the function of buffer strips by storing water and filtering field runoff. These areas require buffers and other BMPs to protect them.

Ponds are small bodies of non-flowing surface water – like miniature lakes. Ponds can be fed by discharging groundwater, overland flow or by flooding watercourses. Riparian vegetation around ponds closely matches nearby wetland vegetation. Ponds are fragile and should have buffer strips to protect them when adjacent to pastures and cropland.

Ponds are fragile ecosystems and could be directly connected to the quality of the drinking water for both your family and your livestock. Livestock should be excluded from grazing around ponds and wetlands.

LIVESTOCK GRAZING NEAR WATER

Whenever agriculture and riparian issues are discussed, attention soon turns to livestock access to water bodies.

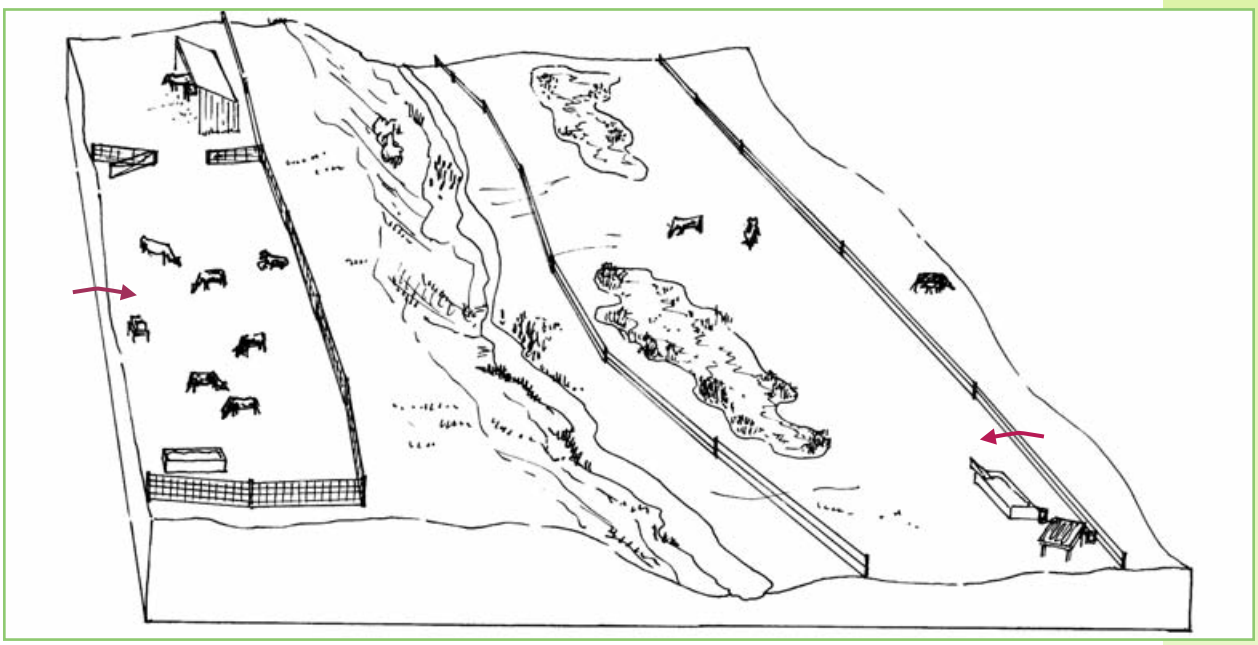
Historically, riparian areas have been viewed as important parts of grazing or livestock-holding systems. Today, our focus has shifted to the risks of allowing livestock free access to streams, wetlands, ponds, etc. Our shared concern for water quality is enough to discourage free access, and in some cases cut off access altogether.

INTENSIVE OR HIGH-DENSITY GRAZING

The risk of riparian degradation increases with livestock density. If density exceeds 1 nutrient unit (NU) per acre per year, it's considered intensive. Density at a level of more than 1 NU per acre per year is more commonly associated with livestock-holding areas, dry lots and exercise yards (e.g., for dairy). Most pastures cannot be sustained and feed has to be imported.

What also happens at this density is that deposited manure and runoff from intensive areas will have to be managed to reduce the risks to adjacent surface water and groundwater.

The BMP for livestock-holding and intensively pastured areas is to **restrict access from riparian areas.** In most cases, a permanent fence is best!



Streamside grazing can be defined by density. INTENSIVE GRAZING (or high-density grazing) describes grazing densities equal to or greater than 1 NU/ac/yr. EXTENSIVE GRAZING refers to densities less than 1 NU/ac/yr. On the left side of the stream, intensively grazed livestock have been excluded with a permanent fence. On the right side of the stream, extensively grazed livestock are kept away from the stream using a combination of temporary fencing, alternative water sources and rotational grazing practices.

Livestock may have access to areas of sheetwater where runoff has temporarily collected – provided BMPs such as shade structures and alternative water sources have been established.

WHAT THE NUTRIENT MANAGEMENT ACT SAYS ABOUT OUTDOOR CONFINEMENT AREAS AND LIVESTOCK ACCESS TO SURFACE WATER

If you have a high-density permanent outdoor confinement area or areas (OCA), the *Nutrient Management Act* requires you to ensure that livestock have no access to surface water.

OCAs are housing systems where the animals are kept outdoors, and grazing and foraging provide less than 50 percent of dry matter intake. In other words, more than half of the animals' feed requirements is supplied rather than provided by the pasture.

A **permanent OCA** is one to which livestock have access for 4800 hours (200 full days) a year. A **high-density permanent OCA** is more than 120 nutrient units per hectare (NU/ha). This confinement type also includes operations that are 300 NU or greater and that contain livestock for less than 4800 hours per year, but have a livestock density of more than 5 NU/ha/yr. Under section 57 of the Act, "No person shall permit animals to have access to surface water if the animals are kept in a high-density permanent outdoor confinement area or a permanent outdoor confinement area used in the course of an agricultural operation that is carried out on a farm unit, on which the number of farm animals is sufficient to generate 300 or more nutrient units annually."

Please refer to the *Nutrient Management Act*, 2002, Ontario Regulation 267/03 for more information.

EXTENSIVE OR LOW-DENSITY GRAZING

The rest of this chapter pertains to lower densities, i.e., less than 1 NU per acre per year.

First of all, conduct a risk assessment for impact on surface and ground water quality. A risk assessment will identify problem areas.

Secondly, fix the problems! Let this book be your guide.

RISK ASSESSMENT FOR EXTENSIVELY PASTURED RIPARIAN AREAS

Undergoing a risk assessment process will help you identify the degree and sources of risk posed by your set of circumstances. It will give you a solid foundation on which to plan the right BMPs where they're needed most.

Risk assessment will also help you in grazing management planning for streamside areas.

Risk assessment has several dimensions. You'll be asked to consider the following criteria.

SITE LIMITATIONS – physical characteristics you can't change but need to take into account

CRITERIA	IMPORTANCE
SOIL TEXTURE	• texture affects how quickly water moves through soil to water table (water permeates more quickly through gravelly soils) • also affects how likely water will flow overland (runoff)
VALLEY SLOPE	• length and steepness of slope will affect runoff to surface water areas
BEDROCK DEPTH	• shallow soils are a higher risk for ground and surface water contamination
FLOOD RISK	• frequently flooded areas are a higher risk as a source for contamination
NEARBY WELLS	• improperly abandoned or poorly maintained wells near grazing areas pose a risk to groundwater quality

MANAGEMENT RISKS – characteristics you can control but relate to potential problems	
CRITERIA	**IMPORTANCE**
BUFFER STRIPS	• the wider the buffer, the lower the risk
LOCATION OF FEED, SALT, ETC.	• locating feed, salt and shade structures away from the riparian area will reduce impact
DRINKING WATER	• providing an alternative water source will reduce need for access
GRAZING MANAGEMENT	• the density and duration of grazing in or near the riparian area will affect the risk of impact on water quality
LIVESTOCK ACCESS/ CROSSING	• less access = less impact • consider differences among livestock behaviours, e.g., sheep are less likely to choose to access surface water than other livestock

SITE CONDITIONS – evidence of problems in the water or on the banks or shoreline	
CRITERIA	**IMPORTANCE**
BANK CONDITION	• bare soils, trampled and slumping banks are evidence of severe access problems
WATER CONDITIONS	• if the water leaving your property looks worse than when it entered, this could indicate severe access problems
VEGETATION QUALITY	• trampled, over-browsed and damaged vegetation indicates a high, rather than low, grazing density
HABITAT QUALITY	• diversity and quality of aquatic life reflect the habitat condition

OFF-SITE USES – concerns regarding downstream or nearby users of the same resource	
CRITERIA	**IMPORTANCE**
IRRIGATION	• there's a higher risk of produce contamination if the water is used for irrigation downstream
HABITAT DESIGNATION	• if the riparian area is part of a designated fishery or other habitat area, it's at risk of impact from livestock access
WATER RETENTION	• how well does your riparian area store water to supply surface water?
DRINKING WATER	• how close is the nearest urban centre?
RECREATIONAL USE	• are you near a recreational area that uses the same water?

INTERPRETING THE RISK ASSESSMENT

Once the risk assessment is completed, your next plan of action will in large part depend on the nature and extent of any problem areas on your property.

If, according to your risk assessment results, the problem is **severe**, you should tackle the problem in the same manner as intensive grazing, and manage it similarly (i.e., no access).

If your results indicate a **moderate risk**, you should use the risk assessment to determine which impacts are most severe. Then, deploy BMPs to gain a benefit similar to what is achieved through exclusion.

If your risk assessment indicates few concerns, the problem is **minor**. Use BMPs to address critical spots or key functions of interest.

There will be very few situations where the risk assessment is so low that no corrective measures are necessary. However, BMPs for grazing near riparian areas that reduce access are always recommended.*

Risk assessment as part of your grazing management planning will help you develop a clearly defined set of planning steps that integrate production targets with environmental goals and practicality.

This is an example of a severe rating based on a risk assessment. Note the high density, poor site conditions, and lack of management. These cattle should be excluded.*

This situation warrants a moderate-risk rating. The density is moderately high. There are no BMPs in place to encourage alternative behaviour. Site conditions reveal a wide channel, turbid water and some bank damage. Streamside-grazing BMPs, such as temporary fencing, are needed here to reduce the impact of livestock access.*

Low-density lakeside grazing has little impact on limestone shores; hence, the minor-risk rating. Alternative watering BMPs, such as temporary fencing, could be introduced to keep cattle away from the shore altogether.*

* Please note that allowing livestock access is not in full compliance with the *Fisheries Act*.

WHAT'S INVOLVED IN A GRAZING MANAGEMENT PLAN

Grazing management planning is recommended for rotational grazing systems near riparian areas. Here are some of the things to consider.

▸ Step 1. Estimate the forage demand.

The forage demand is the amount of forage dry matter (DM) required to feed the herd/flock for one day. It is calculated based on the rule of thumb that grazing animals require an amount of forage dry matter equal to about 2.5% of their body weight per day.

FORMULA

Average weight per animal X 0.025* = requirement X no. of animals = forage demand

CALCULATION

_____ X .025* = _____ X _____ = LBS/DAY
AVG. WEIGHT/ANIMAL (LBS) LBS DM/HEAD/DAY HEAD

** Please note: For lactating dairy cows, use 0.03*

▸ Step 2. Estimate the forage supply.

This is the amount of forage dry matter that is predicted to be available for grazing after a 15-day growth period in the spring and a 30-day growth period in the summer and fall. Please note: Actual pasture growth rates are extremely variable. As a result, the numbers presented are for planning purposes only. Optimum growth periods may be longer or shorter than those indicated.

Unless actual measured yields are available, use estimated yields data for grass–legume hay. Use the following table to convert to forage availability on a rotational basis.

FORAGE AVAILABILITY ESTIMATES

HAY YIELD TONS/ACRE/YEAR	5.5	5.0	4.5	4.0	3.5	3.0	2.5
FORAGE AVAILABILITY LBS/ACRE/ROTATION	2200	2000	1800	1600	1400	1200	1000

FORAGE SUPPLY _____ LBS/ACRE/ROTATION

▸ Step 3. Select residency period.

In other words, decide how long you want your livestock to remain in a particular paddock. One to two days is recommended for lactating dairy cows, three to seven days for all other livestock. Please note: For maximizing harvest efficiency, use the shortest residency period indicated for the type of livestock operation.

RESIDENCY PERIOD _____ DAYS

▸ Step 4. Determine paddock size.

The paddock size is based on meeting the total forage demand for the number of days of grazing indicated by the residency period.

FORMULA

Forage demand X residency = total forage demand ÷ forage supply = paddock size

CALCULATION

_____	**X**	_____	**=**	_____	**÷**	_____	**= ACRES**
LBS/DAY		**DAYS/ROTATION**		**LBS/ROTATION**		**LBS/ACRE/ROTATION**	

▸ Step 5. Calculate the number of paddocks.

The number of paddocks required is based on meeting the longest regrowth interval recommended, i.e., 30 days.

FORMULA

Required regrowth ÷ residency period = # of paddocks + 1* = total # of paddocks required

CALCULATION

30 DAYS/PADDOCK ÷	_____	**=**	_____	**= TOTAL # OF PADDOCKS**	
	DAYS		**PADDOCKS +1**		

** The extra paddock is included because you need to give all paddocks the prescribed rest. If you determine the rest period is 30 days and the animals are in the paddock for one day and you have 30 paddocks, then there are only 29 days of rest/regrowth. By adding one, you give each paddock 30 days rest and one day for harvest.*

▸ Step 6. Estimate the total number of acres.

FORMULA

Size of paddock X number of paddocks = total acreage required for rotational grazing

CALCULATION

_____ X _____ = ACRES
ACRES/PADDOCK PADDOCKS

▸ Step 7. Complete the risk assessment for extensively grazed riparian paddock areas. Consider:

- site limitations (e.g., soil type, depth to bedrock, slope), and
- management risks (e.g., water source, grazing practices), or characteristics you can control, and
- site condition (e.g., water quality, bank or shoreline damage) – otherwise, evidence of problems, and
- off-site problems (e.g., downstream fisheries, waterfowl habitat area, etc.) to address concerns about downstream or nearby users of the same resource.

▸ Step 8. Determine what needs attention.

PADDOCK #	ACREAGE	CURRENT PROBLEMS/RISKS	CURRENT MANAGEMENT PRACTICES	BMP OPTIONS

▸ Step 9. Assess options:

- which options match problems/risks?
- which are suitable for the situation and site?
- which are practical and affordable?

▸ Step 10. Schedule plan.

1. List the BMP options decided upon in order of sequence and by paddock area.
2. Take action and keep records.
3. Observe results – one week, one month and one season after putting into action.

GRAZING NEAR RIPARIAN AREAS

Grazing livestock is all about management – trying to get the best production on the hoof while sustaining pasture quality and minimizing environmental impact. This is especially true in pastures near riparian areas.

We've all seen it – chronic overgrazing around riparian areas. It looks bad, it's harmful to water quality, and it's a completely inefficient use of pasture resources!

In riparian areas with high stocking rates, the BMP for grazing livestock is exclusion.

The BMP for low-density areas is to exclude where evidence warrants, according to the results of your risk assessment.

Otherwise, the strategy for low-density grazing near riparian areas should be to mimic exclusion by using a suite of BMPs. Use the risk assessment and grazing management plan to pinpoint where access-related problems exist and which BMPs would be best to address them.

Complement these measures with a well-planned grazing system, high quality pasture, a suitable fencing system, and non-fencing approaches such as alternative water sources.

PRINCIPLES

Grazing management alone can reduce much of the impact of livestock on most environmentally sensitive areas and improve productivity. But it's most effective when used with other BMPs for pastures near riparian areas. Understanding the principles is the key to identifying which grazing management system will work in your operation.

Stocking Rate

Each acre of pasture has the capacity to sustain a certain number of livestock over the grazing season – beyond which the pasture can't recover quickly enough or site damage is severe (e.g., compaction). Stocking rate is influenced by site type (floodplain vs. upland), soil type and quality, and weather conditions. By managing for stocking rates, graziers can maintain production and minimize impact.

Site Conditions

Even at lower densities, grazing in a fragile riparian area can be harmful. "Low-order" streams, ponds and wetlands that are saturated most of the time may not be able to withstand much grazing pressure without being damaged. The situation is considerably different in large, broad floodplains of the middle and upper reaches of rivers. These sites can withstand higher livestock densities for very short periods if grazing is delayed until conditions are drier.

"Stream order" refers to a numerical system that ranks streams from headwaters to river end. It's used to designate the position of a stream or stream segment in a drainage basin. A low-order stream is the smallest stream in a watershed with year-round flow and few tributaries.

Grazing Frequency

Pasture and riparian species require rest periods for regrowth. Otherwise, they can be grazed out and replaced by weeds, or even bare soils. Progressive graziers monitor regrowth patterns and manage grazing frequency to maintain production.

Livestock Distribution

Livestock may have preferred areas in the pasture, and riparian zones are commonly at the top of the list. This is more noticeable in drought years, when there's more to eat in the riparian zone.

Graziers can use a wide range of fencing options (e.g., temporary fencing, controlled access) or non-fencing options (e.g., location of water, salt, shade, etc.) to help distribute livestock more evenly or on a preferred-site basis.

Livestock with access to riparian areas will often congregate in preferred areas with shade, ease of access, and/ or rich pasture growth.

Grazing Season

When managing grazing near riparian areas, not all seasons are equal.

- **Spring** – In most cases, try to avoid access in spring. High soil-moisture content leads to compaction and bank damage.
- **Early summer** – Without other BMPs in place, summer grazing can be the most damaging time for vegetation. The grazed area doesn't have sufficient recovery time before winter.
- **Late summer and fall** – These are usually the preferred seasons for access. Plants are mature, root reserves are up, and winter hardiness should not be affected. Moreover, low soil moisture content at this time reduces the risk of compaction and bank damage.
- **Winter** – Grazing is site-specific. Grazing grassy buffers in open winters will have minimal impact, similar to fall grazing. However, grazing treed or forested riparian areas can be devastating to vegetation.

Late summer and fall are the best seasons for low-density streamside grazing. BMPs to consider are short-duration or deferred grazing systems with water, shade and salt kept away from surface water.

BMPS FOR LOW-DENSITY GRAZING ON PASTURES NEAR RIPARIAN AREAS

A SEASON-LONG grazing system allows animals maximum forage selectivity. However, livestock should not spend too much time near or in riparian areas. In some cases they may need to be excluded, as is the case for pastures near wetlands, ponds, narrow-channel watercourses and drainage ditches. Another drawback is that some forage species can be over-grazed and damaged.

Repeated seasonal or SITE-SPECIFIC grazing involves paddocks designed to maximize grazing efficiency and minimize risk to riparian areas. Pasture species, growing season, and site position are factored in. Drier sites are grazed early and for short durations; wetter sites are deferred and also grazed for short intervals. The system can work well in grassed ravines, floodplains and adjacent to wetland areas. Here, access can be limited to the preferred (drier) season, and for very short periods to control weedy vegetation.

A well-planned and fenced REST–ROTATION system provides at least one season's rest for each paddock. It's well-suited for pastures near riparian areas. Riparian areas can be favoured to allow for restoration or for improvements to become established.

In a SHORT-DURATION grazing system, livestock are rotated through several paddocks over short intervals. Stocking rates are high for short periods of time, with rest periods for recovery. The system is suitable for grassy pastures near riparian areas with permanent or temporarily fenced paddocks. Note that the rest periods must be long enough for sufficient recovery, and grazing times must be short enough to prevent rapid re-grazing. There is also potential for damage in spring.

PASTURE MANAGEMENT

Pasture management is a planned system of pasture production that includes establishment and improvement as part of a grazing management system.

PRINCIPLES

Pastures are forage crops managed specifically for grazing. They are subject to the forces of natural succession, i.e., the shift of plant communities from grass/legumes to grasses to non-forage or undesirable pasture plants, shrubs and trees. To combat this natural process, and to reduce the need for costly renovation, pastures need to be managed intensively. Intensively managed pastures are more efficient (for meat and milk production) and deter natural succession.Your pasture management goals should include the following: proper soil fertility, careful pasture crop selection, effective weed control, sustained grazing, a well-planned fencing system (intensive grazing management), planned water–shade–mineral supply, attention to animal health, and protection of riparian areas.

Proper Soil Fertility

Forage grasses and legumes are competitive plants. But they need a continual supply of crop nutrients to out-compete weeds and provide sustained forage production. Fertile pastures are an environmentally friendly land use.

Crop Selection

Pasture species and mixtures should be selected to meet your site conditions, animal requirements and management expectations. Mixes that are durable, nitrogen-efficient and provide sustained yields are the best choices for pastures near riparian areas.

Grazing Management

Here, your aim is to leave enough recovery time for sufficient top growth and root reserves for regrowth following grazing. Managed pastures, with the judicious use of fenced paddocks, are one of the most sustainable forms of agricultural crop production – hence the term “permaculture”.

Advantages of Pasture Management

Cropland converted to managed pasture can be more productive, profitable and environmentally responsible. As you can see by the long list below, the advantages are many!

- ▸ erosion rates are drastically reduced
- ▸ nutrient loadings to surface waters are decreased
- ▸ nitrogen loss to atmosphere and groundwater is less than in croplands
- ▸ pesticide use and runoff are reduced
- ▸ energy consumption is lowered considerably
- ▸ soil carbon sequestration rates are higher than with unmanaged pastures
- ▸ quality of surface water and groundwater is improved
- ▸ wildlife habitat and corridor opportunities are greater
- ▸ production and profitability are higher than on unimproved pasture
- ▸ weeds are controlled

In a DEFERRED GRAZING system, grazing is put off until key pasture plants have reached desired growth and soil conditions are less damage-prone. Suitable for low-density stocking in riparian areas near wide-channel streams and middle-reach rivers, it helps prevent springtime damage and minimizes plant stress in mid-summer. This system also helps newly planted buffer areas get established.

BMPS FOR PASTURE

In this section we'll list tips for establishing pastures, improving grazing management, and protecting the environment.

Test for phosphorus and potassium levels one year prior to establishment.

Establishment

- ▸ **1. Test soils.** Fertile pasture soils will help pasture crops become established, grow and compete with weeds. Test one year before establishment. Keep phosphorus and potassium levels high – forage/pasture species are big feeders. Sample unique areas separately, e.g., eroded knolls for retirement.
- ▸ **2. Match seed mixture to goals.** Select a mixture that meets your goals for site conditions, growth, gain targets, and use. Species that are durable, fast-growing, and nitrogen- and water-efficient will help lower greenhouse gas emissions.

- **3. Seed with care.** Plant seeds less than 1 cm deep. Use companion crops such as spring cereals only in areas prone to erosion. No-till planting disturbs less soil. Consider using it after a cover crop is killed prior to establishment
- **4. Get an early jump on weeds.** Kill perennial weeds prior to establishment. Clip weeds during early establishment.

Use recommended weed control methods prior to establishment.

Improvement

To improve a pasture, you can choose between rejuvenating it or renovating it.

Rejuvenation is a quick way to improve undergrazed areas with low fertility. Test soils and improve fertility to increase survivorship and production of desired species. Develop and follow a grazing management plan to sustain production.

Renovation means increasing productivity by introducing pasture species without disturbing the soil. Successful renovation depends on these elements:

- proper pasture mix selection
- site preparation
- timing of seeding
- legume inoculation
- soil fertility and moisture levels during establishment, and
- weed control during establishment.

For a more detailed approach to pasture management, please refer to *Pasture Production* (OMAF Publication 19).

To decide which path to take, you should:

- assess pasture condition
- determine production goals and timeframe
- determine conditions that limit improvement (soil depth, etc.)
- assess costs.

FENCING

FENCING FOR EXCLUSION

As the term suggests, fencing for exclusion means livestock have no access to a watercourse, pond, lake or wetland. Fencing doesn't have to be permanent and expensive – but it must be effective.

Functions and Benefits

Exclusion fencing is the first step towards rehabilitation of riparian areas. There's less sediment disturbance and no direct manure deposition. Bank, bed, and local riparian erosion are also reduced. Water quality improves. Fish and wildlife habitat begins to come back.

Suitable For

Permanent fencing is suitable for these circumstances:

- dry lots, exercise yards, and holding areas (low density, oudoor confinement areas) adjacent to riparian areas
- intensively grazed areas where the density exceeds 1 NU per acre in a given year
- extensively grazed areas with severe problems or with moderate problems where fencing is the most suitable solution
- extensively grazed areas where fencing for exclusion is determined to be the only effective long-term solution
- most watercourses, wetlands, ponds and lakeshores.

In some cases, permanent fencing is the most suitable solution. This site in Norfolk County shows remarkable improvement since the watercourse was fenced to restrict livestock access.

If your watercourse is a municipal drain, you must confirm the appropriateness of your plans with the engineer's report for the municipal drain. Check with your local municipality.

Permanent fencing is NOT suitable for:

- riparian areas prone to ice floes
- riparian areas subject to frequent and extensive flooding.

Permanent or seasonal fencing to restrict livestock access may not be practical in areas with frequent high water conditions and seasonal ice floes. If there is substantial forest cover in upstream riparian areas, logs and debris carried by high water can destroy fences downstream.

On this Oxford County pasture, the level of the creek often rises a metre or more from normal summer levels, sometimes several times from late spring to early fall (as indicated by the water line on the trees). Frequent and costly repairs to the fence would be required.

The landowner has found a better approach by carefully managing stocking rates and applying other techniques that minimize the time spent by livestock in the watercourse. As a result, the streambanks are stable and minimal risk is posed to water quality. As evidenced by the bass, there are still good angling opportunities in the watercourse.

Design Considerations

Consider a setback of 5 metres (16 ft.) or greater if you're planning to install a permanent fence.

As you plan, consider the following:

- ▸ size of area and length of fence
- ▸ 5-metre (16-ft.) minimum buffer (recommended) between fence and top of bank
- ▸ square-off for maintenance ease
- ▸ electric fencing with flexible posts for ice floes
- ▸ cedar rail designs for shallow to bedrock or extensively stony areas
- ▸ special fencing for high water table conditions – e.g., fencepost cemented in steel drum.

Maintenance Checklist

- ✔ inspect permanent fences seasonally for repair
- ✔ inspect posts regularly
- ✔ manage vegetation near electric fences

Enhancements and Complementary BMPs

Permanent fencing can and should be complemented with any of the following:

- ▸ controlled access
- ▸ buffer strip and treed buffer establishment
- ▸ alternative source of drinking water
- ▸ relocating shade, salt and feeding
- ▸ temporary grazing of riparian areas.

If previous access provided drinking water for livestock, you must provide an alternative source. See page 60 for suggestions.

FENCE TYPES

TYPE	DESCRIPTION	WHERE	ESTABLISHMENT TIPS	ADVANTAGES	DISADVANTAGES
RAIL 	• permanent • traditional fencing method	• most riparian areas • not suitable in areas subject to flooding or ice floes	• place a strand of electric or barbed wire along fence • some styles rest on top of ground, thus a good choice on shallow bedrock or groundwater • allow space for drain maintenance – leave at least 5 metres (16 ft.) from top of bank / shore as buffer	• permanent • minimal inspection and maintenance • moderate cost	• construction can be time-consuming • not suitable for ice floes and floods
PAGE WIRE 	• permanent • page wire	• most riparian areas • not suitable in areas subject to flooding or ice floes	• select fence height and wire spacing based on animal type to be excluded • fence must be adequately anchored • allow space for drain maintenance – leave at least 5 metres (16 ft.) from top of bank / shore as buffer	• permanent • minimal inspection and maintenance	• construction can be time-consuming • not suitable for ice floes and floods • expensive
SUSPENSION 	• permanent • high-tensile smooth wire	• best on level terrain • can be installed quickly • suitable in areas subject to flooding or ice floes	• 3–8 strands of wire on posts set at 27-metre (90-ft.) centres • can be electrified, i.e., 1 or 2 strands 12.5 gauge – smooth wire is most common • allow space for drain maintenance – leave at least 5 metres (16 ft.) from top of bank / shore as buffer	• permanent • relatively quick and easy to install in floodplain areas • moderate cost	• electrified fence requires some vegetation maintenance

TYPE	DESCRIPTION	WHERE	ESTABLISHMENT TIPS	ADVANTAGES	DISADVANTAGES
ELECTRIC	• temporary or permanent • polywire / polytape	• in areas prone to severe flooding and ice floes – such as narrow and wide channels in upper reaches and some mid-reach floodplains • highly accessible areas	• can be installed quickly • posts usually spaced at 17 metres (56 ft.) • tape, wire or combinations with easy-to-install posts • must be properly grounded • train livestock to use	• easily installed and moved • suitable for flood-prone areas • low cost	• requires power source • some maintenance / management requirement with vegetation • requires regular checking

NOTE: *Never electrify barbed wire fence.*

VIRTUAL FENCE – AN INNOVATIVE IDEA

During spring melt and intense summer storms, this site becomes prone to high water flows. Keeping an effective fence in place to restrict livestock access proved frustrating and expensive.

A farmer worked with the local conservation authority and other partners to investigate the idea of a "virtual fence." Wire was installed underground along the top of the banks on both sides of the watercourse. A trough fed by the barn was strategically placed to provide an alternative water source. Radio-activated collars or ear tags were to be fitted to the cattle to receive an audio signal as they ventured towards the creek or a correction if they attempted to cross over the hidden fence.

It's an innovative new management option that is still in the testing stage. Only after repeated success will it be considered a BMP, but the concept shows promise. For more information, contact the Upper Thames River Conservation Authority in London at tel: 519-451-2800, or www.thamesriver.on.ca

FENCING TO REDUCE ACCESS

Controlled access involves fencing with openings that permit livestock access to the water for drinking or crossing. It is not intended for high-density grazing areas.

Allowing livestock access is not in full compliance with the *Fisheries Act.* However, it may be a necessary step where total exclusion is not possible.

Fencing one side of the stream is suitable for low-density streamside grazing where access does not cause severe bank erosion problems.

Suitable For

- low-density riparian grazing areas where access is causing moderate problems
- upper and middle reaches, and some ponds
- where pasture length is long and/or stream meanders, making it difficult to establish continuous fencing
- where there are pastures on both sides
- where creating a reliable water supply would be difficult and expensive
- where streambed materials are coarse enough (e.g., gravels, stones, cobbles) to reduce impact or to reduce appeal for livestock crossing

This pond is fenced to control access from grazing beef cattle.

Management Tips

- use permanent or temporary fence as part of your grazing management system
- leave at least a 5-metre (16-ft.) setback from the top of bank
- determine approach to crossing
  - don't focus all livestock to one crossing in extensive pastures
  - distribute crossings to points that currently exist – this distributes the smaller impacts to several areas and allows for stream recovery between crossings (see page 58)
- monitor livestock movement in the pasture to determine favoured access points
  - place planned crossings nearby, and use limited fencing to funnel livestock to the new crossing
- consider a planting strategy on streambanks and setbacks (see page 102)
- consider improvements to fish and wildlife habitat – leaving wider buffers can create productive habitats and opportunities for assistance (e.g., Wetland Habitat Fund)

Advantages

- makes water available for drinking
- reduces time that livestock are in water
- stabilizes banks

Disadvantages

- can increase impacts at focal points
- may require maintenance at entry points
- top of bank trailing can cause impact unless fence is set back from top of bank

LIMITED ACCESS POINTS

Limited access allows livestock to reach water for drinking but does not permit crossing. Again, strictly speaking, access is not allowed under the *Fisheries Act*. However, it's better to do whatever possible to protect water quality, than to do nothing at all.

Limited access points with added protection of erosion-resistant base materials is a reasonable BMP in some circumstances.

Suitable For

- pasture systems where livestock pasture on only one side of a watercourse
- pastures where there's already a bridge or culvert crossing that can be used by livestock to get to other pastures
- areas where alternative watering isn't feasible
- upper reach areas where ice damage or flooding hasn't been a concern

Management Tips

- construct a fence corral with fence that can be moved during high water periods
- make it large enough for several livestock to water at once
- protect with erosion-resistant materials

Advantages

- low cost
- livestock don't get in flowing water
- livestock are not permitted to access the entire channel
- livestock are concentrated in only a few areas

Disadvantages

- only access one side
- impact on sloped entry to water
- limited use for pastures on both sides
- susceptible to ice and floods
- requires fencing along entire access
- should also include stabilization work in area where livestock have access to drink (ramp, shore, upstream and downstream)

CROSSINGS

When pastures are located on either side of a watercourse, you may need to manage access while minimizing damage.

Closely monitor livestock movement in the pasture to determine favoured watercourse access points. Establish crossings nearby, and consider using limited fencing to funnel livestock to preferred access sites. Trees along the banks have proven water quality benefits, but may also be detrimental to riparian areas. They attract livestock who enjoy rubbing against the trunks and are seeking shade.

Remember that structural features should be designed to reduce access, but should not cause damage to fish habitat or prevent others from using navigable waters. Poorly designed crossings can obstruct fish movement in flowing waters and limit navigation by small watercraft.

You must check with regulatory authorities to obtain approvals before creating any type of crossing structure. Start with your local Conservation Authority or Ministry of Natural Resources (MNR) office. Remember that work in and around water may require assistance from an engineer or other professional.

If there are no environmental concerns with a natural crossing between extensively grazed areas, then you may want to consider leaving well enough alone. Sometimes the siltation that could result from improvements can make things worse.

FEATURE TYPE	DESCRIPTION	ESTABLISHMENT TIPS	ADVANTAGES	DISADVANTAGES
BRIDGE CROSSING	• wood or steel bridge adequately designed as crossing • suitable for upper reach watercourses with excessive flooding or ice floes	• check with federal Dept. of Fisheries, local Conservation Authority and MNR • should span from the top of the banks of both sides	• permanent or seasonal • dry crossing • can be used by machinery	• expensive • can be a risk to fish habitat, flooding and navigable waters • requires permits and approval • not suitable for drains • must be professionally designed

FEATURE TYPE	DESCRIPTION	ESTABLISHMENT TIPS	ADVANTAGES	DISADVANTAGES
MID-LEVEL CROSSING WITH LOW FLOW CULVERTS	• culverts and concrete are used to construct these bridge-like crossings at mid-bank level • culverts are usually placed at bed-level (embedded to 10% diameter) • may be suitable for narrow-channel streams and drains	• check with federal Dept. of Fisheries, local Conservation Authority, MNR and municipality • approvals are required from the various agencies for work in and around water • key features include: culverts; gated entrances; erosion-resistant materials on travel surfaces underlaid by geotextiles	• permanent dry crossing for most of the year • will convey water from most storm events through culverts	• relatively high cost • can cause flooding upstream • poorly designed mid-level crossings can obstruct flow during periods of low water • requires approval
BED-LEVEL CROSSING	• crossing is established at watercourse bed-level • materials used are concrete slats, coarse, angular stone and other prefabricated materials • suitable for wide-channel streams and some drains	• check with federal Dept. of Fisheries and local Conservation Authority, MNR and municipality • approvals are required from the various agencies for work in and around water • key features include: locate at straight part of stream; avoid riffles, pools or bends – this will prevent erosion; attain proper bed-level elevation	• permanent • moderate cost • no negative impact on water flow if built properly	• should be gated and part of rotational grazing system to be effective • livestock still have impact while crossing
LEAVE NATURAL CROSSING AS IS	• livestock use one or multiple natural (non-constructed) crossing areas • bed is firm and contains >50% coarse materials • suitable for very low-density grazing systems with coarse-textured beds	• use other BMPs to alter grazing and traffic behaviour • use rock or boulder deflectors or thorn-shrubs to direct livestock to preferred crossing areas • try in-stream BMPs to improve fish habitat in these situations • check with federal Dept. of Fisheries, local Conservation Authority, MNR and municipality	• minimal cost • minimal input • minimal risk	• could be in violation of *Fisheries Act* • livestock still have impact while crossing

ALTERNATIVE WATER SOURCES

Providing an alternative water source alone can dramatically reduce the amount of time livestock spend in and around water. Depending on the circumstances, livestock even show a preference to water troughs over the stream. Alternative water may come from streams, wells or groundwater springs.

Your alternative water system will be most effective if you complement it with other BMPs aimed at reducing livestock access.

ALTERNATIVE WATER SYSTEM	DETAILS
NOSE PUMPS	• place foot valve in water source • place pump less than 6 metres (20 ft.) above the water source • livestock drink individually so it is limited to fewer than 20 animals per pump • not suitable for calves or sheep
WATER FROM BARN	• bury line below frost level and use frost-free waterers for winter use • bring intake pipe up through bottom of watering tank • select water pipe size to carry required flows • lay pipe along uniform grade to avoid air locks • stabilize the area with good drainage around the water tank to provide firm footing and avoid erosion • consider shading the trough to limit algal growth if this is a permanent site • if water trough is not used in winter, drain the tank and pipes

This diaphragm pump is mechanically activated by a lever. The pumping action draws water through an intake line and foot valve.

If a barn is nearby, this is the simplest approach to accessing groundwater supplied through an existing well.

ALTERNATIVE WATER SYSTEM	DETAILS
WINDMILL	• determine size of windmill and pumping capacity by water requirements and prevailing wind • provide batteries or a storage reservoir as backup to supply water during low wind periods • locate windmill to obtain maximum exposure

A windmill can be expensive, but is reliable and low maintenance. Old mills can be rebuilt to keep costs down.

SEEPAGE TROUGHS	• construct interceptor drain network with tile or perforated pipe laid at right angles to flow • backfill with gravel trench • construct spring box to trap sediment – clean regularly • gravity-feed water to supply tank farther downslope • if used year-round, place inlet and outlet pipes close together to increase surface turbulence so as to keep ice-free

Seepage troughs intercept groundwater from seepage areas on hill slopes.

RAM PUMPS	• select an area that provides flowing water and sufficient water to supply herd • estimate the stream slope and amount of flowing water • determine the height that water must be pumped to a trough • based on these numbers, get a supplier to help you determine the appropriate pump for your situation • must have sufficient water depth, stream slope

This trough, fed by a ram pump, takes advantage of falling or flowing water to drive the pumping mechanism.

SOLAR-POWERED PUMPS	• determine the amount of water needed to supply herd • ensure storage is available to manage for high water demand • if batteries are not used, ensure an adequate storage is provided in low sunlight times • be aware that solar panels aren't needed if you're prepared to change batteries regularly • consider a storage tank to help distribute to more than one paddock

Recent designs of more efficient pumps and solar power panels result in a feasible, reliable source. Solar panels can recharge deep-cycle marine batteries in periods of low sunlight intensity.

ALTERNATIVE WATER SYSTEM	DETAILS
DUGOUT POND	• if using groundwater, dig a test hole to determine final water elevation during the driest time of the year (this may change over the year and from year to year) • create a buffer of plants and trees to protect water quality and shade the water (cows prefer cold clear water) • keep livestock out of pond through limited access points or pump to water trough

Dugout ponds are excavated to collect surface runoff, groundwater and tile drainage water as an alternative water source. Buffer areas around the pond and fencing should be considered to protect the quality of the water source. Conduct a soils investigation prior to excavation to be sure water will stay in the pond – otherwise you'll need artificial liners of bentonite clay or synthetic materials.

NON-FENCING OPTIONS TO REDUCE ACCESS

In extensively grazed areas with moderate-to-minimal risks, sometimes just a combination of a few BMPs can make all the difference. For example, moving feed, salt and water away from the riparian area can be as effective and less costly than permanent fencing. In areas of low risk, placing deflectors in areas of habitual access and adding alternative watering may be sufficient to reduce the risk of environmental impact.

VEGETATIVE BARRIERS

Thorny shrubs or very dense evergreen trees can deter livestock from riparian areas. In addition to those trees and shrubs that are already thriving, consider species such as wild rose, black locust, wild apple, red pine, white spruce, white cedar and tamarack. Temporary fencing and some weed control practices must be used to protect the trees until they're established, especially on floodplains.This approach is suitable for low risk areas where livestock have access at several points. Use this BMP in combination with other non-fencing options to increase its effectiveness.

Well-established evergreen trees and thorny shrubs can deter livestock from accessing riparian areas.

STONE DEFLECTORS AND BARRIERS

Place stones and other materials in the path leading to riparian areas. Livestock will gain access at a different place, or go to an alternative watering facility.

To deflect livestock, try these materials:

- large natural stone (cobbles or larger) on the top of bank – space them far enough apart to permit plants to grow
- permanent fence in segments – this keeps livestock completely out of sections to permit permanent plant cover, tree growth and root stabilization.

RELOCATING SHADE, WATER, SALT AND FEEDING AREAS

Livestock are attracted to shade, drinking water, salt and feeding areas. Moving them away from riparian areas will reduce the risk of impact in moderate-to-low risk areas. Again, these BMPs work best if done in combination. To be effective, salt, feed and shelter(s) should be located more than 50 metres (164 ft.) from surface water (ponds, lakes, watercourses or wetlands) where there is no fencing.
Trees planted in riparian areas where extensive fencing is not planned may eventually encourage access by livestock seeking shade.

Moving salt from traditional access points provides incentive for livestock to graze away from riparian areas.

On this farm, a slab of concrete is positioned at channel grade at the down-stream end of a culvert. This provides comfortable footing for cattle to drink from the intermittent watercourse. Even before planned fencing is in place downslope to restrict access, cattle show a clear preference for the protected watering access point, and the environmental impact is minimal.

ESTABLISHING AND MANAGING BUFFER STRIPS

Buffer strips come in all shapes and sizes, and for good reason. Wider buffers are needed for wildlife habitats. Narrow buffers are perfectly adequate for simple setbacks from cropland. Local site conditions also affect buffer strip design. On steeply sloping land, for example, buffers need to be wider to be effective in reducing cropland runoff to water.

In this chapter, we'll look at:

- function – what do you want your buffer strip to do?
- design – what are the site features and considerations that will make the most effective design for your property?
- plants – what grasses, trees and shrubs would work best in your buffer strip?
- establishment – what steps should you take to get your buffer strip in place?

Choose the design that best suits your goals, and the type and condition of your riparian area.

Tree and shrub roots will provide more bank stability. A minimum buffer width of 5 metres (over 15 ft.) is recommended.

A treed buffer strip will protect the watercourse and link natural areas.

Grass buffers provide range habitat, while planted tree buffers provide more diverse "edge" habitat for mammals, beneficial birds and insects. ("Edge" is the transitional area between two habitats, and generally offers greater overall diversity of plants and animals.) For wildlife, wider is better. Buffers make ideal wildlife corridors, which are important for survival. Shaded buffers are particularly important to cool and cold water fisheries.

Before we get started, please remember: buffer strips are not stand-alones. In agriculture, buffer strips should be considered as part of a cropland conservation plan. To repeat, **buffers are intended as the last (not the only!) line of defence against erosion and runoff.** For more on this, please see the next chapter, starting on page 93.

Well-managed grassed buffers effectively filter cropland runoff.

Here is a before-and-after example of a treed buffer planted on the south and west side of a drainage ditch. The buffer's design was practical and focused on improving fish habitat.

FUNCTION

Have a clear idea of what key functions (or benefits) you're seeking. The functions will affect width, cover types, and special features or concerns.

For example, if you want a buffer strip to act as a setback and offer some sediment control on flat, clayey, intensive cropland, your buffer strip will probably be narrow and grassed.

In a watercourse riparian area through moderately sloping cropland, erodible soils and concentrated flow, the buffer will have to be wider – perhaps with woody plants and some streambank and in-field erosion control measures.

RELATIVE EFFECTIVENESS OF RIPARIAN TYPES BY FUNCTION

	VEGETATION TYPE		
FUNCTION	**GRASS AND FORBS**	**SHRUBS**	**TREES**
BANK/SHORE STABILITY	Low/Medium	Medium/High	High
FILTRATION OF SEDIMENT	High	Medium	High
FILTRATION OF SOIL-BOUND NUTRIENTS, PESTICIDES, BACTERIA	High	Medium	High
RETENTION OF SOLUBLE NUTRIENTS, BACTERIA, PESTICIDES	Low	Low	Medium
WATER STORAGE	Low	Medium	High
FLOOD PROTECTION	Low	Medium	High
FISH HABITAT	Low	Medium	High
WILDLIFE HABITAT	Medium	Medium	Medium
FORESTLAND HABITAT	Low	Medium	High
GREENHOUSE GAS – CARBON SEQUESTRATION	Low	Medium	High
NITRATE UPTAKE	Low	Low	Medium/High
PHOSPHORUS	High	Low/Medium	High
ECONOMIC PRODUCTS	Low	Low	High
VISUAL DIVERSITY	Low	Medium	High

(adapted from Tjaden and Weber, *Riparian Buffer Systems*, MCU Extension Fact Sheet 733, 1998)

Natural riparian areas offer diverse habitats for fish and wildlife.

Soils in treed buffers have the porosity and structure to store floodwaters.

DESIGN

One of the most important steps in planning an effective buffer strip is your design choice. Consider the following criteria to help you identify the best one for you.

SITE CONDITIONS AND FEATURES

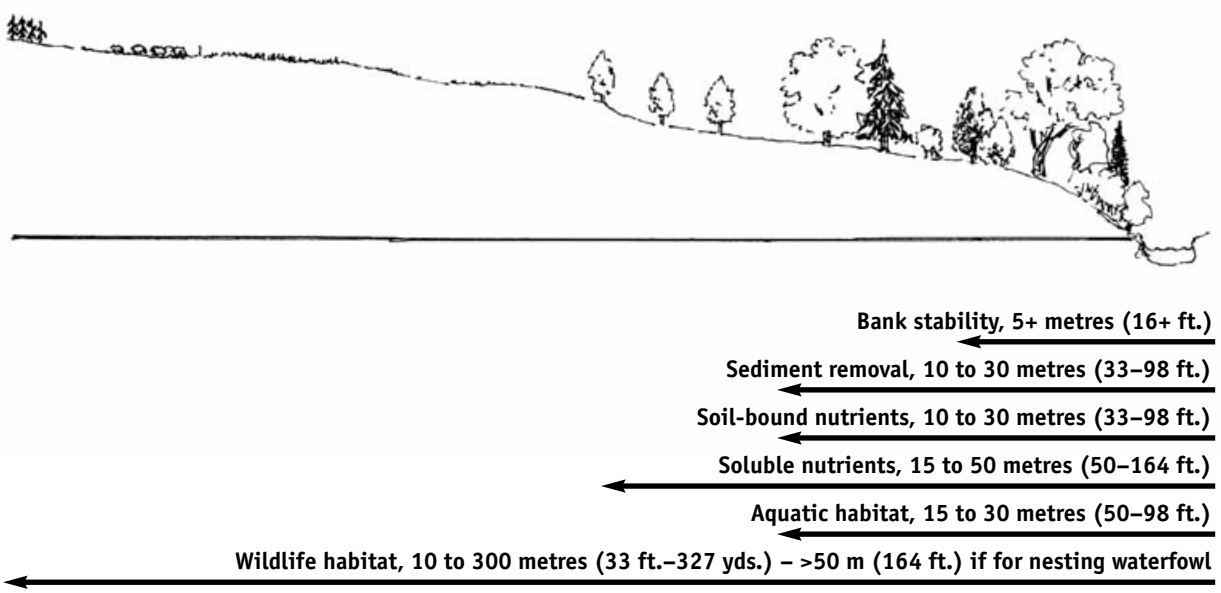
A site assessment should help determine features such as soil types, slope, surrounding land use, and riparian type (e.g., stream vs. river). These features affect design in the ways summarized in the next chart.

FEATURE	EFFECT ON DESIGN
SOIL TYPE (SAND, LOAM, CLAY)	• runoff is greatest on clayey soils ○ the design should prevent or manage this (e.g., drop structures, grassed waterways) • loamy soils are most erodible ○ special features may be needed for sediment control in the design and during construction (e.g., silt fences) • soil drainage will affect species suitability (e.g., flood tolerance)
SLOPE	• the steeper the slope, the greater the potential rates of erosion and runoff ○ buffer type and width plus in-field BMPs must be designed to address this • slope length and slope segments will affect the cover type and the species selected (e.g., if the riparian slope is too steep, it may be unsuitable for hay cropping but not for trees and shrubs)
SHAPE	• in some riparian areas, the banks follow a straight path (drains, shores) and the floodplain width is uniform ○ the same design should work throughout the length of the proposed buffer strip (here, overall length is important) • in other areas, the watercourse meanders, the floodplain width varies, and the slopes of the ravine are deeply cut ○ this causes irregularly shaped field borders for the cropland or pasture adjacent to the riparian area – buffer strip type and planted species should adjust to these influences on shape
LAND USE	• adjacent land uses could be residential, agricultural, natural, etc. ○ the nature of impacts from cottages (e.g., removal of shoreline wetlands) differs from farm operation impacts on croplands in lakeshore areas – designs should recognize this ○ within agriculture, a buffer strip beside an orchard differs from one beside steeply sloping cropland
RIPARIAN TYPE	• lakeshore buffer strips differ from small stream buffers, in terms of plantings and additional erosion control needs • similarly, a simple, narrow, grassed buffer strip may work for a municipal drain, but may not suffice for a deeply cut, meandering stream through hilly cropland

WIDTH

Width is a key design factor. Wider buffers are more effective at filtering contaminants, encouraging infiltration and providing diversity of habitat.

Effective width varies with soil type, slope, adjacent watershed size, function and cover type. The following illustration is an attempt to specify the range of widths by function. Please note that it assumes bare soil conditions in the adjacent land upslope from the buffer area and less than 10 percent slope conditions.



Once again, width alone will rarely replace the benefit of upland soil and water conservation BMPs.

How to measure buffer strips

Buffer strip width is the distance from the top of a bank to the edge of a field. Where streams meander, take the average of three measurements.

Assuming land function is the same on both sides of a watercourse, buffers on both sides should be approximately the same width. Wider buffers perform a greater number of functions more effectively.

CONCENTRATED FLOW

Buffer strips are intended to manage sheet flow from adjacent land use. They are not meant to manage concentrated or channel flow of runoff to riparian areas, as seen with draws, rills, and gullies that "short-circuit" buffer strips. Concentrated flow is faster and will cut a deeper channel if unmanaged.

Soil and water conservation BMPs and structures should prevent this flow from entering riparian areas unchecked. But in some cases, more effort is required. This should be part of the overall design of the buffer strip.

In most cases, you have four options for managing concentrated flow:

- disperse the energy with soil cover – forages, cover crops and crop residues
- divert the flow with embankments, berms, terraces or sediment control basins
- re-channel the water with grassed waterways and drop structures to adequate outlets or subsurface drainage systems
- convey the flowing water safely at the bank or shore using rock chute spillways and drop pipe structures.

For more information on managing concentrated flow, please see page 104.

Buffers strips are intended to manage sheet flow – not concentrated flow – from cropland.

Here is a graphic example of how grass buffer strips can intercept and hold sediment carried with surface runoff. A suite of erosion control measures is often required to control sheet and rill erosion.

BANK AND SHORELINE EROSION

Buffer strip designs should provide for any necessary bank or shoreline stabilization work. The nature and extent of the problems (including seepage) should be determined in the site assessment. See page 102 for further details.

Please note that in some cases, the stabilization work should proceed before any site preparation for planting.

PLANTS FOR BUFFER STRIP ESTABLISHMENT

Buffer strips can be planted to grass, wildflowers, shrubs and trees. Select plants according to the desired buffer function and also the plants' suitability to local site conditions, including climate, soil, soil drainage, soil pH and risk of flooding. Avoid invasive, non-native species, wherever possible.

Plants can be established in many arrangements and mixtures to suit design needs. The following charts describe species suitable for buffer strip plantings.

Grasses

Grasses for buffer strips should have as many of the following features as possible:

- dense branching
- upright stems that remain erect in winter to trap sediment in runoff and offer superior waterfowl nesting
- strong rooting systems
- appropriateness for local soil and site conditions
- usefulness for grazing or harvesting forage.

COOL-SEASON GRASSES	
REED CANARY GRASS	Tall, coarse, sod-forming, perennial with aggressive rhizomes. Tolerates very poor drainage. Will survive long periods of flooding. Has very good acid tolerance; moderate saline and alkaline tolerance. Can be used for streambank and gully stabilization where woody plants are not suitable. Introduced. Can be invasive. Grows 1–2 metres (3–6 ft.) tall.
PERENNIAL RYE GRASS	Introduced, rapid developing, short-lived perennial bunchgrass. Prefers imperfectly drained soils. Moderately alkaline tolerant. Requires over 50 cm (20 in.) annual precipitation. Grows 0.3–0.6 metres (1–2 ft.) tall.
ORCHARD GRASS	Introduced, drought-tolerant bunchgrass. Exhibits some shade tolerance. Prefers imperfect drainage conditions.
TIMOTHY	Perennial bunchgrass that forms more open sod. It should be seeded in a mixture with a legume or other grasses. Tolerates imperfect drainage but prefers well-drained sites.

WARM-SEASON GRASSES	
	 **Native grasses can provide dense cover to meet nesting-bird habitat requirements.**
BIG BLUESTEM	Robust, native bunchgrass (with short rhizomes). Prefers imperfectly drained soils, but is more drought tolerant than other warm-season grasses. Good acid tolerance. Grows 2–2.5 metres (6–8 ft.) tall.
LITTLE BLUESTEM	Warm-season, native bunchgrass. Fair to excellent acid tolerance. Drought tolerant. Grows 1 metre (3 ft.) tall. Usually sown in mixtures with other native grasses. Seeds are light and fluffy.
EASTERN GAMA GRASS	Large, native, colony-forming bunchgrass. Useful in lowland or irrigated sites. Not alkaline tolerant. Do not include in seeding mixture with other warm-season grasses.
INDIAN GRASS	Native perennial. Acid and drought tolerant. Difficult to establish in pure stands; best used in mixtures. Seed light and fluffy.
SWITCH GRASS	Native, perennial, tall grass. Drought resistant, but grows under a wide range of conditions. Salt and acid tolerant. Used as a sand stabilizer and for erosion control. Earliest maturing warm-season grass. Grows 1–3 metres (1–10 ft.) tall.

LEGUMES	
ALFALFA	Well-suited to a wide range of soil conditions but not acidic. Has a high nutrient value and is high yielding on neutral-to-high pH, well-drained soils. Alfalfa should be used in a mixture with sod grasses for erosion control.
ALSIKE	Short-lived perennial adapted to a cool climate and wet soils; it can even tolerate periodic flooded conditions and acid soils. Should be seeded in a mixture with sod grasses for erosion control.
BIRDSFOOT TREFOIL	Has a well-developed root system and generally is adapted to a moderate climate. Because of its nonbloating nature, birdsfoot trefoil can be used without grass in a pasture situation. Has excellent feed quality and should be seeded in a mixture with sod grasses for erosion control. Will tolerate low pH levels.
RED CLOVER	Relatively short-lived perennial that's best suited to moderate temperatures and adequate moisture. Good for hay and pasture and for improving soil tilth. Red clover is easy to establish with no-till methods, and should be seeded in a mixture with sod grasses for erosion control.
WHITE OR LADINO CLOVER	These clovers adapt to fertile soils with sufficient soil moisture. High moisture levels make it difficult to harvest as a hay crop. To reduce the possibility of bloat in grazing cattle, this clover should be grown in a mixture with grasses. Its fibrous root system makes it well suited for erosion control.

SUITABILITY OF FORAGE SPECIES FOR DIFFERENT USES

FORAGE SPECIES	INTENSIVE GRAZING	ROTATIONAL GRAZING	STORED FEED
ALFALFA	Not recommended	Suitable	Highly suitable
TREFOIL	Not recommended	Highly suitable	Highly suitable
RED CLOVER	Not recommended	Suitable	Highly suitable
WHITE CLOVER	Highly suitable	Highly suitable	Suitable
ALSIKE CLOVER	Not recommended	Suitable	Suitable
SWEET CLOVER	Not recommended	Suitable	Suitable
BROME GRASS	Not recommended	Suitable	Highly suitable
TIMOTHY	Not recommended	Suitable	Highly suitable
REED CANARY GRASS	Not recommended	Highly suitable	Highly suitable
ORCHARDGRASS	Highly suitable	Highly suitable	Highly suitable
PERENNIAL RYE GRASS	Highly suitable	Highly suitable	Highly suitable
ANNUAL RYE GRASS	Highly suitable	Highly suitable	Highly suitable
TALL FESCUE	Not recommended	Suitable	Highly suitable
MEADOW FESCUE	Not recommended	Suitable	Highly suitable
CREEPING RED FESCUE	Highly suitable	Highly suitable	Not recommended
MEADOW FOXTAIL	Not recommended	Suitable	Not recommended
KENTUCKY BLUE GRASS	Highly suitable	Highly suitable	Not recommended

TREES AND SHRUBS FOR RIPARIAN AREAS

Plant trees. Wide, treed buffers are the most functional cropland buffer strips.

On productive riparian sites, fast-growing hardwoods can fully shade narrow channels within 10 years. Shown here is green ash, silver maple, red oak and poplar along Washington Creek in Oxford County.

Base your selection of trees and shrubs for buffer strip plantings on the following criteria:

- **climate** – think globally and plant locally by using plants suited to the region
- **soil drainage** – promote survival and growth by matching trees to site conditions
- **flood tolerance** – ensure any trees in floodplains are flood tolerant
- **shade tolerance** – ensure slower growing trees and shrubs, or ones that are likely to be in the shade for most of their existence, are shade tolerant
- **growth rate** – plant fast-growing trees if you need to create shade as soon as possible
- **wildlife value** – determine which trees are best suited to providing cover, shelter and food
- **economic value** – be aware that some of our most valuable trees grow very well in riparian areas.

Stream bottomlands are ideal sites for valuable hardwoods like black walnut.

FEATURES	SUGGESTED HARDWOOD TREES FOR BUFFER STRIP PLANTINGS						
SPECIES	**SILVER MAPLE**	**GREEN ASH**	**BLACK WILLOW**	**COTTON-WOOD**	**BLACK WALNUT**	**WHITE ASH**	**RED OAK**
FROST ZONE	4–9	3–9	5–9	7–9	7–9	3–9	3–9
SOIL TYPE	All	All	All	Loamy to sandy	Loam to clay loam	All	All sandy to loamy
DRAINAGE	Imperfect to very poor	Imperfect to very poor	Poor to very poor	Poor to very poor	Well to imperfect	Well to imperfect	Well to imperfect
FLOOD TOLERANCE	High	High	High	High	Medium	Medium	Medium
ROOTING	Shallow	Shallow	Shallow	Shallow	Taproot	Moderate lateral	Deep lateral
GROWTH RATE	Medium	Very fast	Very fast	Very fast	Medium	Fast	Fast
HEIGHT	Medium	Tall	Medium	Tall	Tall	Tall	Tall
SHADE TOLERANCE	Medium	Low to medium	Low	Low	Low to medium	Low to medium	Low to medium
WILDLIFE VALUE	Low to medium	Low to medium	High	Low	Medium	Low	High
ECONOMIC VALUE	Low to medium	Moderately high	Very low	Very low	Very high	High	Very high

Introducing evergreens like white cedar in row plantings along the buffer strip edge creates an ideal travel corridor.

FEATURES	SUGGESTED CONIFER TREES FOR BUFFER STRIP PLANTINGS						
SPECIES	**WHITE CEDAR**	**TAMARACK**	**WHITE SPRUCE**	**WHITE PINE**	**RED PINE**	**HEMLOCK**	**RED CEDAR**
FROST ZONE	1–8	0–9	1–5	2–9	2–5	3–9	4–9
SOIL TYPE	All	Sandy to loamy	All	Sandy to clay loams	Sandy to sandy loams	Loamy	All
DRAINAGE	Well to very poor	Imperfect to very poor	Rapid to poor	Rapid to imperfect	Rapid to imperfect	Well to imperfect	Well to imperfect
FLOOD TOLERANCE	High	High	Medium to high	Low to medium	Low	Low to medium	Low to medium
ROOTING	Shallow	Shallow	Shallow	Deep lateral	Deep lateral	Shallow	Shallow
GROWTH RATE	Slow	Fast	Medium to slow	Fast	Fast	Slow	Slow
HEIGHT	Short	Medium	Medium to tall	Tall	Tall	Tall	Short
SHADE TOLERANCE	Medium	Low to medium	High	Medium to high	Low to medium	Very high	Low
WILDLIFE VALUE	Very high	Low	Medium	Medium	Low	High	Medium
ECONOMIC VALUE	Medium	Medium	Medium	High	Medium	Medium	Low

Group or block plantings create excellent tree-growing environments and wildlife cover.

Mature cedar creates ideal wintering sites for a wide range of wildlife.

FEATURES	SUGGESTED SHRUBS FOR BUFFER STRIP PLANTINGS						
SPECIES	**NINEBARK**	**ELDER-BERRY**	**RED OSIER DOGWOOD**	**STAGHORN SUMAC**	**ALTERNATE LEAVED DOGWOOD**	**NANNY–BERRY**	**HIGHBUSH CRANBERRY**
FROST ZONE	3–9	2–9	2–8	2–9	3–9	3–9	3–9
SOIL TYPE	Wide range	Loams to sandy loam	Wide range	Sandy and gravelly	Most soils	Most soils	Fertile soils
DRAINAGE	Imperfect to very poor	Imperfect to very poor	Poor to very poor	Rapid to imperfect	Well to imperfect	Well to poor	Well to imperfect
FLOOD TOLERANCE	High	High	High	Low	Low	Moderate	Moderate to low
ROOTING	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow
GROWTH RATE	Fast	Fast	Fast	Fast	Medium	Medium	Medium
HEIGHT	2–4 m (6.5–13 ft.)	1–5 m (3–16 ft.)	<2 m (<6.5 ft.)	1–5 m (3–16 ft.)	2–4 m (6.5–13 ft.)	5–10 m (16–33 ft.)	2–4 m (6.5–13 ft.)
SHADE TOLERANCE	Low	Moderate	Moderate	Low	Moderate	Moderate	Low
WILDLIFE VALUE	High	Very high	High	High	Very high	High	High

HOW TO ESTABLISH A BUFFER STRIP PROJECT

The most effective buffer strip projects are planned. Keeping in mind the principles we've covered, you're ready to undertake your own project. Here are some planning considerations.

- **Step 1. Assess existing conditions in your riparian area(s), e.g., instream conditions, water quality, and vegetation quality.** Draw a map showing soil types, slopes, existing vegetation, adjacent croplands, and other riparian and natural areas. Complete a grazing management plan if appropriate.

- **Step 2. Predict the benefits of a well-maintained, planted buffer strip.** Put your list of desired benefits together with other related management goals and objectives. Contact your Conservation Authority to discuss risk assessment and identify opportunities. Select functions for the buffer strips. Talk to neighbours.

- **Step 3. Assess upslope conditions on the farm.** Ask yourself whether additional soil and water conservation BMPs would enhance the effectiveness of your buffer strip(s).

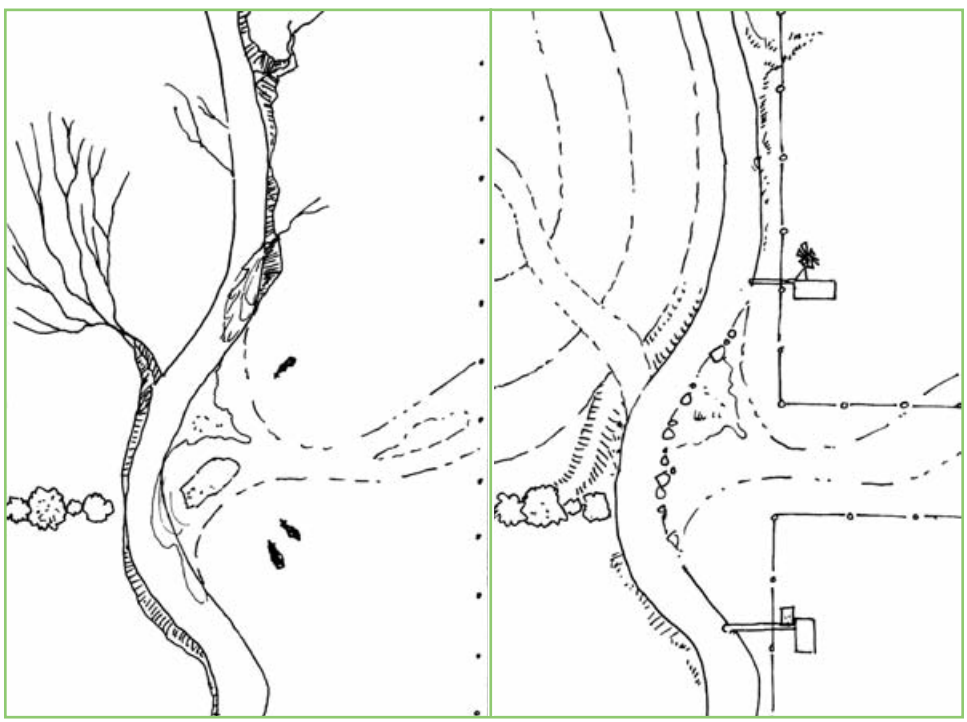
- **Step 4. Examine and select options.** Which BMPs will do the job? Do the advantages outweigh the disadvantages? Which options require approvals, permits and technical assistance? Which agencies offer financial assistance?

- **Step 5. Design and implement.** Refer to the designs in this book and other references. Seek technical advice from a Conservation Authority and other agencies and from experienced landowners. Obtain permits and approvals where necessary. Create an action plan – outline your resources, your time, and a schedule of activities. Remember that the project can be phased in over several years.

- **Step 6. Maintain, monitor and evaluate.** Maintain planted vegetation by watering at critical periods, sampling the soil, fertilizing, pruning or clipping, replacement and weed control. Confirm survival rates of planted grasses, shrubs and trees. Look for washouts and rills cutting across the buffer strip. Determine if the project is fulfilling its intended benefits. Assess whether additional BMPs would improve its effectiveness.

Consult with your local Conservation Authority to discuss risk assessment and identify opportunities.

Inspect your project routinely to ensure that it's doing its job. Note any improvements needed.



This is the "before" situation. You can see cropland erosion from the sloping field on the left of the stream. Bank degradation from intensive livestock access is also evident on the right side of the stream.

Above we can see planned projects for an on-farm riparian area. Soil and water conservation measures, including a cropland buffer strip, are planned for the sloping field. Intensive grazing management, fencing and alternative water sources are planned for the streamside grazing area.

DESIGN 1

NARROW BUFFERS FOR DRAINS AND LIVESTOCK EXCLUSION

Description

- narrow grassed buffers established along drains

Functions

- setback of farm operations or grazing from top of bank
- ditchbank stabilization
- some sediment and nutrient filtering

Suitable For

- municipal and other open drains in flat, intensively cropped areas (e.g., clay plains)
- intensively grazed areas where livestock have been excluded and tree plantings are not suitable (e.g., tiles are invaded by tree roots)
- low-order, shallow and deep-channel streams
- lakeshores and ponds

Narrow buffer strip designs are most suitable along drains.

Narrow buffers can be used as turning areas for cropping equipment.

Unsuitable For

- slopes greater than 10%
- slopes greater than 5% with no BMPs for soil and water conservation
- natural riparian areas
- cold-water fisheries
- deep ravines with broad floodplains
- wildlife habitat (very low quality)

Design Considerations

- width: minimum of 5 metres (16 ft.) for most situations
- should be 10 metres (33 ft.) if used as a pesticide application setback – check pesticide label
- severe bank and shore erosion should be managed (see page 102)
- concentrated flow needs to be diverted and controlled with erosion control structures (see page 104)
- can be used as turning area for cropping equipment

Narrow buffers are also suitable for riparian areas fenced out from intensively grazed pastures.

Wide, shallow and channelized streams will narrow after buffer strips are established.

DESIGN 2

ONE-ZONE BUFFERS FOR FORAGE AND DELAYED GRAZING

Description

- wide grassed buffers (5–50 metres or 16–164 ft.) established along around natural areas
- established for forage harvest or grazing

Functions

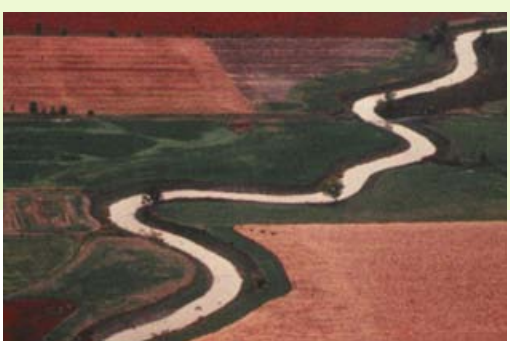
- setback of cropland management from bank or shore
- setback of livestock grazing from most of the riparian area
- forage management – cropland not lost to production
- livestock grazing – delayed grazing until late summer or fall as part of a grazing management plan
- sediment, pesticide and nutrient filtering
- wildlife habitat for mammals, grassland bird species, amphibians and insects

Suitable For

- most riparian areas and site conditions
- most suited to waterfowl nesting areas (wetlands, lakes, ponds, large rivers)
- livestock operations that use forages or graze

Wide buffers adjacent to streams make suitable headlands and forage crop strips.

A single row of red osier dogwood planted along the outer edge of this grass buffer strip, right alongside the crop edge, will be enough to keep field equipment back and provide some wildlife habitat. The shrubs will present only minimal obstruction to future drain maintenance, and bounce back quickly after disruptions.



This is an aerial shot of a buffer strip that provides a forage crop and a source for delayed grazing. It spans many properties and several kilometres along the south branch of the South Nation River municipal drain in Dundas County.

Having the buffer included in the engineer's report and accepted through bylaw helps ensure the buffer's integrity indefinitely.

Unsuitable For

- very steeply sloping, narrow ravines
- intensively managed cropland – horticulture and field crops
- cropland in areas with no local market for forages

Design Considerations

- should be 5–50 metres (16–164 ft.) wide – buffer width should be compatible with forage harvest equipment
- greater widths are most suited to managed grazing areas
- species mixtures should be for forage, grazing or dual purpose
- later maturing warm-season species would be best for wildlife habitat
- severe bank and shore erosion plus concentrated flow should be managed (see page 102)
- use the zone to accommodate alternative water storage site (e.g., off-line pond)

If you want to promote wildlife habitat, don't clip the grass. Another reason to leave the grass long is that short, lush grass can attract nuisance Canada geese to the buffer.

Cropland converted to forages is not lost farmland.

3 DESIGN

TREED BUFFERS – THREE-ZONE DESIGN

Description

- a wide buffer design that consists of three zones (minimum total width 10 metres or 33 ft.)
- Zone 1 consists of trees closest to the bank or shore
- Zone 2 consists of shrubs (or trees or a mixture) and is placed between Zone 1 and Zone 3
- Zone 3 is planted to grasses and/or legumes

Functions

- ZONE 1
  - roots from mature trees provide bank and shore stability plus stability for the streambed
  - trees filter runoff, taking sediment, nutrients and pesticides out of runoff and promoting infiltration
  - addition of leaves and woody debris helps the watercourse maintain its sediment load and provides nutrients for aquatic life
  - as trees mature, adjacent waters are cooled by the shade provided
  - trees remove nitrogen from groundwater and fix carbon from the atmosphere
  - trees provide wildlife habitat
  - wood products, nut crops, sugar maple, alternative forest products, Christmas trees, etc. offer revenue opportunities

Treed buffer strips can produce high-value timber products.

- ZONE 2
  - shrubs (or trees) and grasses (or natural cover) help water infiltrate
  - Zone 1 and Zone 2 help store floodwaters
  - woody tissue offers long-term storage of nutrients and carbon
- ZONE 3
  - erosion control: sheet erosion is controlled in this zone
  - infiltration is increased in sod cover, which can boost water storage capacity
  - nutrients, pesticides and sediment in sheet flow are filtered by standing forage vegetation

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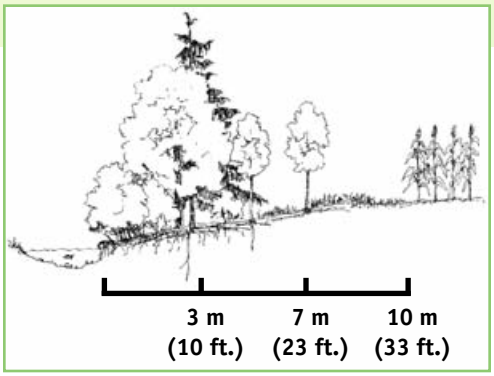
Suitable For

- most suited for wide-channel streams
- also suitable for narrow watercourses with a small floodplain, steep but short banks and erodible soil on table lands (see illustration below)
- highly erodible or fragile lands that are also of marginal economic importance for crop production or grazing, such as ravines
- gently sloping shorelines and river banks
- previously pastured ravine lands



In the three-zone treed buffer design, each zone has its distinct place and function. The trees in Zone 1 shade the water and stabilize the banks. Zone 2 soils and vegetation help to filter sediments, and promote infiltration and floodwater storage. Zone 3 filters cropland runoff and serves as a field buffer.

With its narrow channel and small floodplain, Washington Creek in Oxford County was an ideal setting for a demonstration of the three-zone treed buffer design.

Unsuitable For

- intensively cropped prime farmland
- wetlands (unless geese are troublesome)

Design Considerations

SPECIES TO PLANT

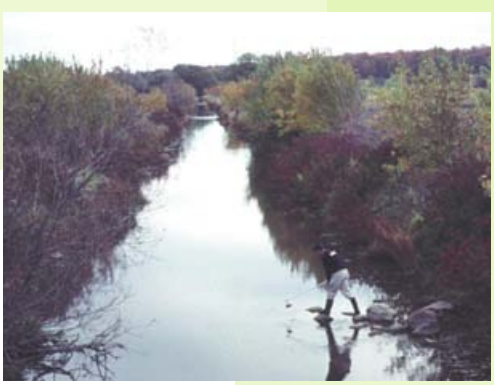
- ZONE 1
  - use the chart on pages 75-76 to select suitable trees
  - use water-tolerant trees if floodplain floods frequently; if drier, use higher-value trees
  - select fast-growing trees if you plan to leave Zone 1 as a no-management zone
  - space trees within and between rows to maximize height growth (2–3 metres or 6.5-10 ft.)
  - try to plant all of floodplain to trees for maximum functionality
- ZONE 2
  - use high-value hardwoods (or mix with conifers for habitat effect) that are best suited to the local soil and site conditions
  - also consider fast-growing, high-value and long-living trees to reduce greenhouse gas emissions
  - use the shrub chart on page 77 to select suitable shrub species – avoid usage during wet conditions

- ZONE 3
  - based on what your purpose is (habitat vs. erosion control), select suitable mixtures of cool-season, warm-season grasses and other plants from the chart on pages 71-72
  - could be used as turning area for cropping equipment

Other Considerations

- for bank or shore stability,
  - apply bioengineering techniques to control severe erosion problems (see page 105)
- for areas of concentrated flow,
  - use suitable BMPs for soil and water conservation or drop structures to convey water safely through buffer strip planting
- for riparian areas that were previously grazed or cropped and have been since abandoned,
  - consider planting the entire area to trees and shrubs for timber production, wildlife habitat, water quality improvement, greenhouse gas abatement and aesthetics

When suitable habitat is provided, wildlife will move in. In time, that could mean beavers moving into treed buffer strips.



Trees can provide shade to moderate water temperatures, and attract insects that will be a food source for aquatic creatures.

LAYOUT

Grassed Buffer Strips

- ▸ sketch buffer strip plan on map or aerial photograph
- ▸ stake out buffer width in fall or early spring – use widths that are multiples of the widest piece of equipment to be used to establish planting
- ▸ soil test to ensure phosphorus and potassium levels are suitable for early growth – don't apply nitrogen
- ▸ tie in fencerows and natural areas where possible

When fencing to exclude livestock, work with existing vegetation as a buffer strip.

- ▸ consider setting aside odd-shaped areas where site features or land use changes
- ▸ if buffer strip is part of a livestock exclusion project,
  - ▹ consider just working with the existing vegetation OR
  - ▹ time the buffer planting with existing plan for pasture improvement or pasture-crop rotation
- ▸ for rotational grazing systems,
  - ▹ this is a good time to reconfigure paddocks
- ▸ if alternative watering or electric fencing is being considered,
  - ▹ this is the time to bury water and electrical lines if desired
  - ▹ establish planted buffer strip before fencing
- ▸ use forward-grazing to get the vegetation down to ground level. Grazing this way will deplete forage root reserves. This will weaken the sod so that tillage or site preparation operations will more effectively kill the sod.

Trees

- ▸ determine whether you want the buffer width to be uniform and straighten the edge of the field, or vary with stream meandering
- ▸ if, prior to establishing Zone 2, trees are to be planted in old sod, be sure to clearly distinguish Zone 1 from Zone 2 (or Zones 1 and 2 from Zone 3 if using a three-zone design)
- ▸ use stakes to mark desired location of shade trees

SITE PREPARATION

Grassed Buffer Strips

- ▸ monitor soil fertility more closely in established forage stands
- ▸ remember recommended separation distances from riparian areas if manure is to be applied prior to stand establishment
- ▸ for tillage,
  - ▹ if herbicides are not being used, ensure that all perennial weeds (e.g., quackgrass) are killed by fallowing, since many warm-season grasses can't compete with them
  - ▹ as with any forages, a level, firm seedbed is required for establishment
- ▸ for no-till method,
  - ▹ apply glyphosate or similar herbicide in mid-fall or early spring – remember to stay back from the water's edge
  - ▹ use BMPs for pesticide application to reduce the risk of drift and runoff – ensure a complete kill before drilling grass mixture

If the area is already sod and is not to be used for grazing or forage, leave it.

Trees and Shrubs

- ▸ if site is to be tilled,
  - ▹ reconsider and use spot herbicide treatment in Zone 1 and Zone 2 in exact spots where trees are to be planted – tree and shrub plantings are easier into killed sod
- ▸ if it's already tilled,
  - ▹ consider using a spring cereal cover crop to reduce over-winter erosion and suppress weed growth
- ▸ begin site preparation in the fall before planting (ideally)
- ▸ if planting trees in riparian areas, check with the local municipality first – some require significant setbacks to accommodate future drain maintenance

PLANTING

- ▸ broadcast (only for tillage method); use hand-held, tractor- or ATV-mounted broadcast seeders (follow guidelines in OMAF *Agronomy Guide* for seeding rate)
- ▸ harrow or cultivate lightly to increase soil-seed contact
- ▸ for no-till, calibrate drill to ensure proper depth, penetration, residue control and slot closure
- ▸ broadcast straw mulch on erodible areas during establishment period – under-seeding or direct seeding is more feasible in wider buffer designs
- ▸ for tree establishment,
  - ▹ ensure all weeds are controlled prior to planting
  - ▹ use saplings where affordable and available – survival and growth rates are better than with seedling stock
  - ▹ handle trees with care – avoid exposure of roots to sun and wind
  - ▹ order about 10–20% more seedlings than are needed to plant – heel in the extra seedlings in a temporary "nursery" for replanting after assessing first-year survival
  - ▹ trample all soil around planted trees to reduce air spaces in disturbed soil
  - ▹ mulch the trees to conserve moisture and control competing vegetation
  - ▹ consider tree protection systems to get them off to a good start

Handle trees with care. Don't expose roots to sun and wind.

Trample all soil around planted trees to reduce air spaces left by disturbed soil.

MAINTENANCE

Weed Control

- control weeds around trees during the first year of establishment – mulching is the best method
- if you choose to clip, do so before weeds reach 30 cm (12 in.)
- use selective herbicides according to recommendations from OMAF Publication 75, *Guide to Chemical Control*
- for some species mixtures, regular mowing and the maintenance of fertility levels will help ensure stand composition.

As with all natural or non-crop areas, buffer strips can be sources of weeds and other pests. Addressing pest pressures from these areas will become part of a pest-monitoring program.

Mulching and tree shelters are an excellent combination to protect valuable shade trees from weeds and rodents.

Monitoring

- during the first year, check strip for rills and washouts after snowmelt and rain events
- repair and replant damaged areas – check tree and shrub survival
- prevent future problems by adopting BMPs for soil and water conservation (such as drop structures) OR
  - create temporary shallow diversion trenches or small berms to divert small runs of concentrated flow
  - delay haying, ideally until July 15, to promote wildlife habitat (e.g., waterfowl and songbird nesting)
  - manage delayed access by livestock to reduce impact – try forward, delayed grazing within the riparian area to improve efficiency and reduce the access time, and restrict access if you've planted trees or shrubs
  - water trees regularly for the first year after planting unless conditions are wetter than normal
  - prune crop trees and thin out poor quality trees as buffer matures (usually about 10–25 years after planting)

Use signs to protect new plantings from field operations.

Where feasible, use large tree stock and saplings rather than tree nursery seedlings in riparian plantings. Survival and growth rates are better in these densely weeded environments.

Some vegetated buffers are designed to invite existing seed to take hold with an absolute minimum of planned maintenance. Within a few years, this "free-to-grow" buffer, designed for the James Berry Municipal Drain in Norfolk County, experienced a significant shift away from troublesome weed populations towards a sustainable and desirable mix of grasses and wildflowers.

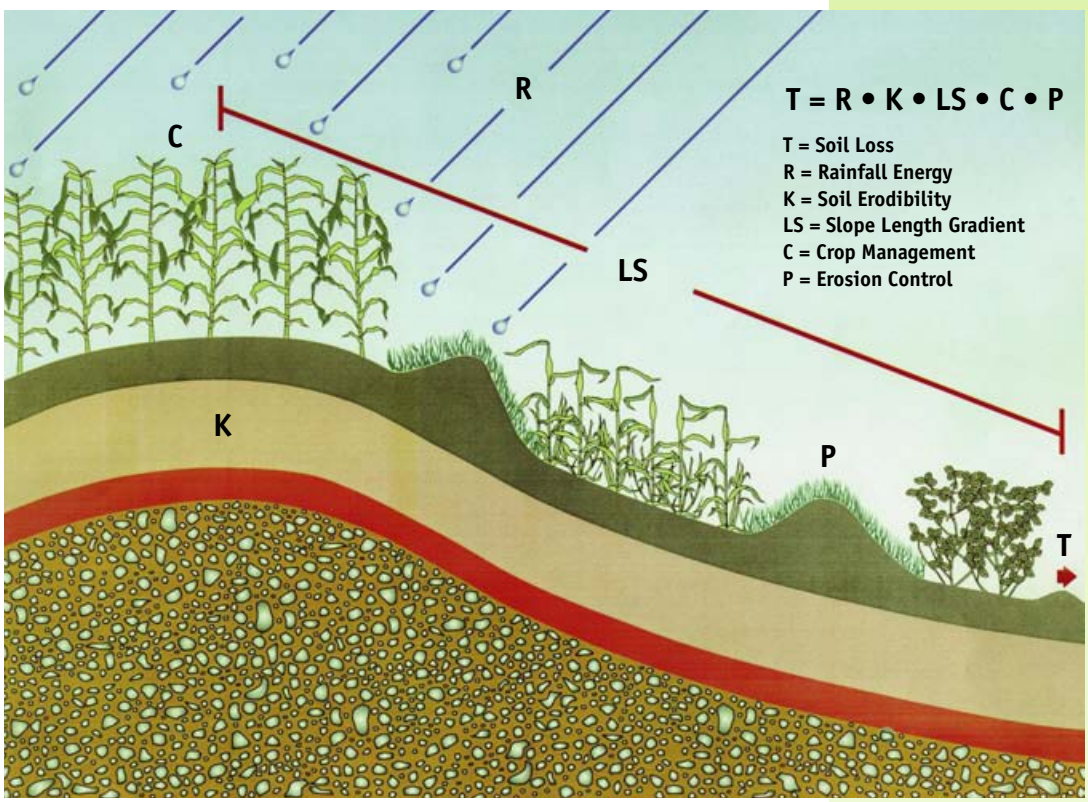
SOIL AND WATER CONSERVATION ON ADJACENT CROPLAND

By themselves, buffer strips cannot control erosion and runoff from cropland. Much of the risk of surface runoff and concentrated flow from cropland can and should be managed in the field by soil and water conservation structures and practices. Buffer strips are one part of this soil and water conservation system – to repeat, they are the last line of defence.

The systems approach is perhaps best described when using the Universal Soil Loss Equation in the example and illustration below.

A producer has a loamy field with a 5% slope. In a bare soil condition, he can lose up to 10 tonnes/ac./yr. of topsoil. With the following BMPs, he can reduce his losses.

BEST MANAGEMENT PRACTICE	ESTIMATED REDUCTION IN SOIL LOSS
SPRING TILLAGE	15%
REDUCED TILLAGE	50%
STRIP CROPPING + REDUCED TILLAGE	65%
TERRACING + NO-TILL	85%



The factors that affect erosion and runoff relate to rainfall frequency and intensity, steepness and length of slope, soil type, crop cover, and erosion control measures.

A bare field with long slopes, silt loam soils and no erosion control measures could lose a surprising amount of soil in a single rainfall. Soil conservation practices are intended to protect the soil from the destructive forces of rainfall and snowmelt – and keep the soil in place.

If cropland soil and water conservation BMPs reduce soil loss by up to 80 percent, then buffers can be designed for other functions – such as bank stability, fish habitat and carbon sequestration.

Cover crops and plowdowns are examples of soil conservation options that build soil and prevent cropland runoff. Use in concert with cropland buffer strips. Soil conservation options range from reduced tillage practices (e.g., no-till, chisel plow) to slope management (e.g., strip cropping), to soil management practices that improve soil quality and reduce runoff.

In this chapter we'll look briefly at:

- soil and cropland conservation practices and structures, and
- BMPs for nutrient and pesticide application on nearby cropland.

We don't go into great detail about these practices, as there is already a wealth of information in other excellent resources. These include other titles in this BMP series, to which we'll refer you throughout the chapter.

Grassed waterways can safely convey concentrated flow from cropland before it enters surface waters.

A variety of erosion control structures can be designed to reduce soil loss and safely convey surface water through a tile intake to a properly protected outlet.

This terrace ridge intercepts surface flows to form a temporary pond which slowly drains to a tile system.

Concentrated Flow

On the field slope illustrated on page 93, the soil loss and runoff would be even greater if there were draws or convergent pathways for water to run downhill. Unchecked, these draws can lead to rills and gullies. To prevent this, or to reduce potential risks, you must:

- protect the draw
- reduce the grade
- reduce the length of run, OR
- divert the flow below the surface.

In fact, most erosion control structures are designed to attain one or more of these goals. For example, water and sediment control basins reduce the slope length and divert the flow below the surface.

Planning

Consider the following factors in the planning process:

- **future land use** – whether the land will remain in its current land use
- **slope, slope length, soil type, in-field watershed size** – must be considered when designing structures for size and safety
- **cropping and tillage practices** – how compatible a particular structure would be for current crop rotation, tillage options
- **cost of options** – which option provides the most value for the investment required.

Erosion control structures are very effective, and can also be quite expensive. Minimize the need for structures by blending appropriate conservation cropping and tillage options.

SOIL MANAGEMENT

Don't underestimate the value of healthy soils near riparian areas. Soil management BMPs improve soil quality and build resistance to erosive forces by adding organic matter, improving soil structure and increasing infiltration rates.

Soil management BMPs include cover crops, crop rotation and reduced tillage systems.

See the BMP books, *Soil Management and No-Till: Making it Work,* for more details.

Where conventional tillage is used, it will take many years using a good crop rotation to build up organic matter. In conservation cropping systems, organic matter levels may increase more quickly.

Reduced tillage systems, including no-till, maintain soil quality and will reduce erosion and runoff rates.

Cover crops such as fall-planted oats and barley will tie up nutrients and protect the soil between crops.

Crop rotations that include annual and perennial crops will add organic matter, help maintain soil quality, and keep soils covered longer throughout the year.

CROPLAND CONSERVATION PRACTICES

Conservation practices are non-tillage practices intended to control erosion by reducing the effect of slope and increasing soil cover. They can be designed for effective water or wind erosion control.

Contour strip cropping – alternate strips of row crops, cereals and forages on the contour – slows surface flow and increases infiltration rates.

Field strip cropping maintains strips of row crops, cereals and forages at uniform widths across the main, simple slope. On complex slopes, this makes it easier to manage than contour strip cropping.

CROPLAND CONSERVATION STRUCTURES

Erosion control structures are designed to control erosion and safely convey surface water to an adequate outlet. You should seek technical advice for design and construction. Common examples include grassed waterways, drop pipe structures, terraces and water and sediment control basins.

For more on cropland conservation structures, see the BMP book, *Field Crop Production.*

Water and sediment control basins are earthen embankments across draws, with retention basins and drop pipe structures to convey water to an adequate tile outlet. The duration of temporary ponding is carefully engineered to reduce the risk of damaging the crop.

Grassed waterways are dish-shaped, graded and grassed channels placed in draws with subsurface drainage tile, intended to divert and transfer runoff to a properly protected outlet.

NUTRIENT AND PESTICIDE APPLICATION ON ADJACENT CROPLAND

Cropland erosion and runoff rates can be curbed somewhat with soil and water conservation BMPs. To drastically reduce the potential for contaminated runoff, combine those BMPs with BMPs for nutrient and pesticide application.

SEPARATION DISTANCES

For those farmers who are required by the *Nutrient Management Act* Regulation 267/03 to have a Nutrient Management Plan (NMP), the following minimum separation distances for the application of nutrients on cropland adjacent to surface water must be adhered to.

- **No person shall apply nutrients on cropland adjacent to surface water unless there is a vegetated buffer strip with a minimum width of 3 metres from top of bank.**
- **No person shall apply commercial fertilizer of agricultural source material (e.g., manure) within 13 metres (43 ft.) of surface water unless one of the following application methods is used: applied using injection or band method; materials are incorporated within 24 hours; materials are applied to a living crop; or the material is applied to a high crop residue (>30% cover) field.**
- **Effective immediately, irrespective of whether a NMP is required, no person shall apply non-agricultural source materials (e.g., biosolids) within 20 metres (65 ft.) from the top of the nearest bank of surface water.**

In all cases, no materials can be applied within the minimum 3-metre (10 ft.) vegetated zone.

For more detailed information on separation distances for nutrient application, please refer to Regulation 267/03.

NUTRIENT APPLICATION

- Complete and follow your Nutrient Management Plan. It will help balance crop nutrient requirements with manure applications.
- Calibrate manure application equipment.
- Develop a monitoring and contingency plan for manure application.
- Apply your manure and fertilizer when soil conditions are right and when the crop needs it. Where suitable, pre-till tile-drained lands before applying liquid manure – this will break up large pores and reduce infiltration to tiles.
- Incorporate manure within 24 hours following application.
- Avoid working on wet soils and in wet weather, and you'll avoid nutrient loss, runoff, soil compaction and tile effluent. Avoid spreading manure if:
  - rainfall occurs shortly before application OR
  - heavy rains are forecast within 12–24 hours of spreading on tile-drained lands.
- Comply with separation distances for nutrient application as regulated by legislation or as stated in your Nutrient Management Plan.

For more detailed information, refer to the Ontario Regulation made under the *Nutrient Management Act*, 2002 (267/03) and the Nutrient Management Protocol. Please see the back cover for links.

Use injection carefully as a method to ensure immediate incorporation of applied nutrients.

Monitor tile outlets after applying liquid manure.

PESTICIDE APPLICATION

- Employ Integrated Pest Management strategies. Identify, monitor, and determine critical pest and economic thresholds – before selecting pest control methods.
- Read and follow the label instructions before making application.
- Ensure you comply with recommended separation distances. If not otherwise stated, leave 15-metre (50 ft.) buffer strips between your treatment and the top of the bank along the watercourse or water body.
- Select nozzles to attain the droplet size spectrum that will bring about proper coverage and deposition and to reduce drift.
- Calibrate your application equipment before using it.
- Don't spray pesticides if weather is inappropriate, e.g., rain or high wind. Washed-off insecticides and fungicides can cause off-site damage and reapplication is expensive.

For more information on pest management, see the BMP books, *Integrated Pest Management* and *Pesticide Storage, Handling and Application*.

When applying pesticides, follow label directions for separation distances from environmentally sensitive areas. Here, the boom has been carelessly extended over the buffer, destroying established vegetation.

Select nozzle size and application conditions that will minimize spray drift.

Tiles can outlet into buffer areas for pre-treatment before discharging.

STREAMBANKS AND SHORELINES

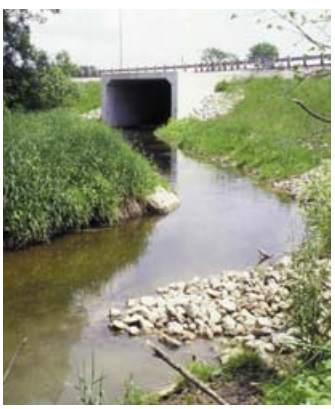
Some watercourse erosion is natural. Sediment is needed to replenish gravel and sand beds, and bars in watercourse curves. But too much erosion causes problems, such as destruction of fish and wildlife habitat and loss of land.

Streams will form meanders, thus reducing the erosive energy of watercourses.

Watercourses are dynamic, in a constant state of flux. In their natural state, streams will balance water flow, sediment load and shape. Flowing water moves from bank to bank and over time develops meanders. Meanders, pools, non-obstructive streambank vegetation and fallen trees will reduce the erosive energy of watercourses.

But when there is a drastic change in the balance that a watercourse has attained, erosion and flooding result. There are three major causes for increased streambank erosion, and they're outlined in the photos below.

STRAIGHTENING STREAMS – when urban development, road works or surface drainage construction leads to straightened streams, there is less bank resistance to flow. Consequently, flow rate increases sharply, causing severe erosion and flooding in high-risk areas.



LAND USE CHANGES – whenever natural land cover is replaced by hardened surfaces such as roads, parking lots and sidewalks, runoff increases and infiltration is reduced. In rural areas, land use changes include wetland drainage and woodlot removal. Cropping and grazing too close to riparian areas will also increase runoff.

FLOW OBSTRUCTIONS – roads, culverts, in-stream irrigation dams, poorly designed crossings, and large fallen trees can all have a "damming" effect. These "dams" will slow water energy and cause suspended sediment to drop out. The next time the flowing water reaches its peak flow, it will use some of that energy to erode susceptible banks.

In most cases, bank and shoreline stabilization projects are complex. You should always consult your local Conservation Authority and municipality. Seek advice on construction, habitat issues, permits and approvals.

KNOW WHAT YOU'VE GOT

You'll very likely need professional assistance to really understand what's going on and what needs to be done. The first thing they'll need to know is what kind of erosion needs to be addressed. Look for evidence of one or more of the following types:

- **stream flow** – high flow rates at high water levels cause erosion in the bottom of the channel and on the banks
- **surface runoff** – concentrated flow in the form of rill erosion can lead to gully erosion
- **bank damage** – direct and excessive livestock access or equipment use can lead to bank damage or bank destabilization
- **subsurface flow** – where there are two contrasting layers of soil material, groundwater movement can be accelerated or "piped" out of the streambanks; projects that address this require designs from professional engineers.

Knowing what your erosion problem is before you consider any work on banks is the key to successful erosion control.

Bank erosion from streamflow.

Bank damage from livestock access.

If livestock access is the problem, address this first! See the Livestock Grazing Near Water chapter, starting on page 35.

If there is no buffer between the top of the bank and adjacent cropland, see Establishing and Managing Buffer Strips, page 64.

If there is excessive cropland soil erosion and runoff, address these first. For BMPs to control runoff around municipal drains, see page 110. For soil and water BMPs, see the previous chapter, beginning on page 93.

Bank erosion is often the symptom of one or more of the foregoing problems. If these are addressed adequately, much of the work is done.

STREAMBANKS

BANK EROSION CONTROL STRUCTURES

These structures involve hard materials such as rock, concrete and wood being anchored to a bank to protect it from erosion (e.g., crib walls, rock riprap).

Several generations of field experience suggest that, in streams, "hard" structures are not always suitable.

Hard techniques provide a solid defence against the energy of flowing water, particularly at the "toe" of the slope where erosive energy is greatest. When designed and constructed properly, they work well. However, when poorly designed or improperly constructed, they can be susceptible to collapsing. Areas with significant subsurface flow, areas with wide fluctuations in stream flow, and strongly meandering watercourses are particularly vulnerable.

There is a place for hard structures – in channelized watercourses, or when used in combination with plant bioengineering methods, or when placed in spots of extreme bank failure. Some of these techniques are described below.

BIOENGINEERING helps streams naturalise quickly.

ROCK RIPRAP is a hard erosion control structure for banks where angular rocks are strategically placed at 2-ft. horizontal for every 1-ft. vertical rise, or flatter to protect bank soil materials. The structure must be underlaid with filter cloth.

Rock riprap is most suited to local spots of extreme erosion. It may not be suitable for sandy areas or areas with significant subsurface flow. In these areas, soil materials can be washed from beneath the rock, causing failure and severe erosion. Consider using these structures in combination with plant bioengineering techniques.

The creation of RIFFLES AND POOLS helps slow water. Coarse materials are placed in beds to create riffles. Streambeds are deepened to create pools.

BMPS FOR SOIL BIOENGINEERING

Soil bioengineering involves living and dead plant materials being used to restabilize eroding soil materials in banks (e.g., live fascine or brush mattresses).

Rocks, logs and roots, when combined with live plant materials, will hold soil, slow water, filter contaminants and grow to provide habitat. Several techniques are described below. See the next page for project tips.

LIVE STAKING

Live, rootable cuttings are planted along eroded banks of small streams to create a living root mass that will stabilize and bind the soil.

BRUSH LAYERS

Bundles of live cuttings are set at right angles of slopes to break up slope length and create a living root mass.

GEOTEXTILES

Also known as biodegradable soil support materials, geotextiles can be used with other soil bioengineering techniques to cover bare banks until the vegetation becomes established.

Rootwads have been placed along vulnerable outside bends of streambanks to protect them.

YOU CAN BANK ON THIS: CONSIDERATIONS FOR BANK PROJECTS

BEFORE YOU START

Verify the problem. What type of erosion is it, e.g., is it stream or subsurface flow?

GET TECHNICAL ASSISTANCE from your Conservation Authority, the Ministry of Natural Resources or Ducks Unlimited, to name a few. They can help you assess the situation and discuss BMP options. Some groups may offer financial assistance.

Talk to your neighbours. You may share a problem, and perhaps a project. At the very least, share your views!

Get the necessary permits and approvals. Don't let oversight stop good intentions.

Use local natural materials and plants wherever possible. Select the most suitable species for the job.

ONCE YOU'VE STARTED

Install sediment control features, e.g., coir logs, erosion control blankets, bales, etc.

Disturb only when necessary: soil and plants in place are already stable. Don't use invasive species or wood treated with preservatives.

WHEN THE PROJECT IS COMPLETED

Restrict access to plantings during establishment. Water plants during droughts. Control weeds until your plants are established. Monitor the site and make adjustments.

Look into local habitat or environmental group initiatives. Volunteers can make a difference.

Riffle and pool structures were strategically placed into the south branch of the South Nation River municipal drain in Dundas. The work was completed as part of the engineer's report, in hopes of providing fish habitat.

Coir logs made from coconut fibre can be put in place to narrow flow channels, and trap sediment behind them to encourage vegetation to stabilize.

BMPS FOR DITCHBANKS

Open drains are waterways that have been changed or constructed, and therefore have unique ditchbank challenges when compared to streams or rivers. Usually, the ditchbanks are meant to quickly convey the channelled flow of drainage water. Streambanks, on the other hand, have been formed by the erosive action of naturally flowing water.

Nevertheless, ditchbanks need to be stable to prevent bank erosion. Ditchbanks are mostly subject to the same erosive forces as streambanks (i.e., channel flow, bank damage, surface runoff and subsurface flow). However, generally ditchbanks have fewer problems with channel flow and more with cropland runoff and bank damage from cropping practices.

Ditches, whether for private open drains, mutual agreement open drains or open municipal drains, convey subsurface drainage water and surface water from cropland. As such, they have tile outlets and surface inlets entering into them. If improperly designed or managed, they can be a source of bank erosion.

All ditches should have a 5-metre (16-ft.) maintained, grassed buffer on each side to keep cropping practices and farm equipment away from surface water. (A 3-metre or 10-ft. buffer is an absolute minimum.) Minimum-width grassed buffer strips can be enhanced with any of the following:

- trees or shrubs on one side to improve wildlife habitat potential and add biodiversity
  - if positioned on the outside edge, woody vegetation can help keep cropping equipment from encroaching on the buffer
- a secondary buffer to make it wider and more effective, and
- drop structures and berms where field runoff regularly flows in a draw before it reaches the ditch.

The following BMPs are unique to ditchbanks.

Ditches should have a 5-metre (16-ft.) buffer.

Design

Two numbers separated by a colon (e.g., 2.0:1.0 or 1.5:1.0) indicate the side slope. The first number represents a horizontal distance and the second a vertical distance. An important advantage of the flatter slope, other than stability, is that it's easier to get vegetation established on the banks.

Angular rock was used by the engineer to stabilize the "toe"of the bank on this outside corner. Vegetation alone will stabilize the upper bank.

To prevent erosion and provide bank stability, ditchbanks should be shaped. Different soil types naturally require different side slopes. In general, however, 1.5 horizontal to 1.0 vertical should be considered an absolute minimum with 2.0 to 1.0 preferred maximum. Fine sands and silts may require much flatter side slopes to provide a stable channel.

Some "hard" bank erosion control structures may be necessary on sharp turns. See the section on Bank Erosion Control Structures on pages earlier in this chapter.

Establish vegetative cover as soon as possible on the bare ditchbank. A proven method of seed establishment is called "daily seeding", which simply means that a section of ditch constructed on a specific day is seeded the same day. This can be easily achieved with a cyclone seeder. The main reason for this method's success is that a newly cut bank will normally provide enough moisture to germinate the seed.

Remember that all ditches are connected to a downstream watercourse. Consult the drainage superintendent and ensure you get the proper permits before proceeding if the project is along a municipal drain.

Tile Outlet Protection

To reduce bank erosion around tile outlets, install non-perforated rigid pipe (minimum length of 3 metres or 10 ft.) with a rodent gate, filter cloth and rock riprap. Install a header tile to reduce the number of outlets.

Improperly protected tile outlets can be a source of bank erosion. Tile outlets can also carry pollutants from cropped lands. Here are some BMPs to reduce the risk of surface water contamination:

- consider using header tiles and fewer outlets when upgrading drainage systems – this can help reduce ditchbank erosion
- install non-perforated rigid pipe (minimum length – 10 ft.) with a rodent gate, filter cloth and rock riprap to prevent or correct ditchbank erosion problems
- check the condition of the outlet pipe, rodent gate and riprap – especially in the spring
- check outlet effluent to ensure liquid manure, sediment or other contaminants are not getting into watercourses.

Drop Structures

Check with your local drainage superintendent and Conservation Authority before taking any action around municipal drains.

One of the major causes of ditchbank failure and washouts is from concentrated surface flow entering the ditch over the bank. Here are three common methods to control this problem.

ROCK CHUTE SPILLWAYS

These spillways are sloped riprap structures placed at points of entry for surface runoff from cropland that's level or gently sloping. They have to be wide and deep enough to adequately carry the surface flow and should extend from well into the field to below the level of flowing water. Rock chute spillways prevent ditchbank failure caused by scouring.

WASCOBS (WATER AND SEDIMENT CONTROL BASINS)

WaSCoBs are earthen berms constructed across a low draw in the field with the function of ponding runoff water. They prevent gully erosion by intercepting concentrated flow and creating temporary ponding conditions behind an earth dam or "berm". Ponded water is slowly released through a drop pipe to a tile outlet. Water is ponded behind the berm for up to 24 hours. Placed at the edge of fields near ditches and other watercourses, drop pipe inlets drop concentrated flow and ponded waters safely to watercourses. Pipe designs can be steel or plastic.

GABION BASKETS

Gabion baskets are systems where the rock materials are held in place with wire cages. Filter cloth must be used underneath the structure. They are suitable in areas with local spots of extreme erosion, used either on their own or in combination with other hard structures such as bridges and crossings. In other situations, gabion baskets may be considered in combination with plant bioengineering.

BMPS FOR DRAIN MAINTENANCE

Check with your local drainage superintendent and Conservation Authority before taking any action around municipal drains.

REVEGETATING BARE BANKS

Bare banks are prone to erosion during high water and any storm event. A vegetative cover will protect the soil material and provide important wildlife habitat. Ground-nesting birds prefer native grasses. The grasses can be more difficult to establish, but will persist longer. Tame forage grasses and legumes are easier to establish, but are less preferred as habitat. Use cover crops, nurse crops or mulches to aid establishment. Consider planting trees or shrubs on one side of the drain.

DRAIN MAINTENANCE – TIMING AND TECHNIQUE (BOTTOM CLEANOUT)

Sediment and woody debris at the bottom of the drain may obstruct flow excessively. Remove it during the early part of the growing season (June) where possible to minimize disturbance. Bottom cleanouts will restrict destruction of the vegetation to the channel area only. Bank stability is not affected. Removed sediment should be spread well back from the top of the ditchbank. Spread it on the buffer – or truck it away.

Vegetation can block the flow of draining water during times of high flow. Removing obstructions can stabilize the banks. This involves the judicious removal of woody vegetation by trimming, pruning and thinning, or mowing only heavily grassed areas. Removal from the channel bottom or only one side of the ditchbank may be all that's necessary.

SHORELINES

Ditchbanks and shorelines are quite different. With banks, water flows in a channel along the toe of the banks. The sediment from eroding banks is carried downstream and sorted as the flow changes. By contrast, lake waters move cyclically in waves directly at the beach. Coarser sediment is deposited at the shore to form beaches. Finer particles (silt and clays) are carried out by near-shore currents to be deposited in deeper waters.

There are several types of shorelines: bluffs, points, bays, deltas and wetlands.

BLUFFS

Bluffs are shores with a vertical or near-to-vertical elevation drop from the land to the water. Bluffs consist of layered soil materials or exposed bedrock – often lacking vegetation due to erosion or lack of topsoil. Bluff erosion is most severe where there are exposed clayey and silty soil materials, and when these materials cause piping (significant subsurface flow). Erosion can also be severe when land use (e.g., buildings) has put undue pressure on the bluff.

POINTS

Points are shores where the land juts into the lake like a peninsula. Points can be formed of most soil types, but are often naturally protected by coarser materials such as stones, cobbles and boulders. Waves and off-shore currents are the main erosive forces affecting points.

BAYS

Bays are shore areas where the land is "indented." Sandy beaches form where the bay is sharply indented between two points. The dynamic nature of the wave action sorts the sand and gravels on the beach and carries finer materials to deeper waters. Shoals or flag beaches are usually less indented, near exposed bedrock, and subjected to high wave energy.

DELTAS

Deltas are shore areas where major watercourses enter a lake. The energy of flowing water interacts with the energy of lake water (e.g., Grand River and Lake Erie). Fine sands and silts are deposited nearby and are constantly cut into new channels. Like bluffs, deltas are unstable and should be left in a natural condition.

LAKESHORE WETLANDS

Lakeshore wetlands are usually marshes and are most often formed in bays or near deltas. These marshes trap sediment, utilize excess nutrients, and create habitat for fish, songbirds, waterfowl and many other wildlife species.

BMPS FOR LAKESHORES

Shoreline erosion is often caused by other disturbances, e.g., the removal of vegetation or shoreline wetlands, or by the installation of a new structure. Check with authorities to ensure you understand the source of the problem.

The goals of BMPs around lakeshores are to:

- prevent and control shoreline erosion, as well as erosion from adjacent land use
- prevent contamination from crop nutrients, bacteria, and pesticides, and
- conserve fish and wildlife habitat.

BMPs involve structural work and maintenance.

Shoreline erosion is a natural process, but can be greatly accelerated by human activities.

Structural

Structural BMPs for shores can use "hard" materials (e.g., rock) or "soft" materials (e.g., soil bioengineering and other uses of vegetation).

Shoreline erosion is a natural process, but can be greatly accelerated by human activities.

Hard Structures

In areas of severe erosion or where bioengineering techniques are ineffective, always use properly designed, hard erosion control structures. Poorly designed structures often fail, in part because there was not a thorough site assessment before project planning and construction.

A professional engineer should assess the site to:

- ▸ determine the limits of shoreline reach
- ▸ assess local erosion types
- ▸ document the sorting, redistribution and direction of movement of near-shore sediment, and
- ▸ check for subsurface flow (piping).

Permission and approvals must be obtained for all lakeshore structures.

CRIB WALLS

Crib walls are soil-retaining walls designed to resist current and wave action. Avoid treated wood. Crib walls act as a bulkhead to protect shorelines, but can cause off-site erosion problems down-current from the structure. Stone aprons can limit this negative effect.

REVETMENTS

Revetments are stone retaining walls containing quarry stone of various sizes. The stones are arranged for maximum strength by wedging the smaller, angular pieces between larger, angular boulder-size rocks. Gabion baskets, filter cloths and stone aprons are sometimes used to ensure stability.

GROYNS

Groyns are protective barriers that are constructed at right angles from the shore to deter erosion from near-shore currents and to trap sand. If these structures trap too much sand, they can cause severe erosion at "sand-starved" shores down-current from the structure.

Hard structures require expert design and construction supervision to be effective and to reduce the risk of off-site damage. They're often expensive. By comparison, soil bioengineering and other vegetative techniques also need expert design, but may be less expensive and more sustainable. Soft structures will strengthen over time as vegetation establishes.

Soft Structures (Bioengineering)

While these BMPs may be less costly than structural changes, due care must be taken in the design and selection of plant materials to guarantee long-term success. Here are some possibilities.

BMP	SUITABLE FOR	TECHNIQUES	BENEFITS
BRUSH MATTRESSES 	• lake shoreline protection	• small depression in bank is excavated • bundled branch cuttings are set as mat layer and staked with live and dead wood • bundle is covered with soil and watered regularly until vegetation establishes	• lake shoreline protection
BRUSH LAYERING	• bluffs	• live branch cuttings are placed on 1-metre-wide terraces (benches) to form terraces perpendicular to the slope	• alternative to bulkhead or gabion baskets
JOINT PLANTING (VEGETATED RIPRAP)	• high and low-relief bluffs	• live cuttings are placed between riprap rocks on slope face	• has strength of hard feature plus longevity of natural technique
RECREATE WETLAND	• filled-in beaches • former wetlands	• revetment boulders are placed at or just above water level, 5–10 metres (16–33 ft.) from shore of shallow bay to form a protected near-shore ("littoral") zone	• will reduce erosion of beach area and provide high quality habitat
LIVE CRIBWALL	• exposed shorelines, points, etc.	• boxlike interlocking arrangement of untreated wood/timber filled with backfill and live cuttings • rootings establish and vegetation takes over	• where wall is required to provide stability at toe of slope to reduce slope steepness

Lakeshore Maintenance

Not all BMPs for shores are intended to control erosion. Runoff control, pollution control and habitat management should be part of a comprehensive shoreline conservation effort too. Here are some BMPs that will help you conserve and maintain shores.

- Establish buffer strips between the water body and cropland to prevent erosion and bank faulting.
- Exclude or deter livestock access where grazing intensity is high or where impact is noticeable.
- Follow separation distance guidelines for the application of crop nutrients and pesticides.
- Use water diversion structures to prevent gully formation and to control surface runoff.
- Ensure your septic system is properly installed, especially if you have a dwelling near a shore. Ensure that the tank and leaching bed systems are suited to the local soil conditions and sufficiently set back from the shore.
- Maintain your septic system through water conservation, system inspections, and regular cleanouts.
- Don't remove shoreline vegetation, i.e., trees, shrubs and wetland vegetation.
- Don't plant invasive plant species adjacent to shore area. Appropriate native plants will have the best survival rate.
- Reduce the amount of lawn cover and reintroduce natural vegetation.
- Restrict intensive water recreation activities (e.g., water skiing, boating) to designated areas and protect sensitive zones from traffic.

RULE OF THUMB –
"Don't make soft shores hard or hard shores soft."

At the time of settlement, farms were established near watercourses and lakes. Today the challenge for these operations is to eliminate runoff from nutrient sources.

BUFFER STRIPS AROUND WETLANDS AND PONDS

Like all buffer strips, those around wetlands and ponds cushion water bodies from the impact of upland activities such as farming, forestry, residential and commercial activities.

In so doing, and through a rich mix of trees, shrubs and plants, buffer strips can play an especially important role in improving the diversity and quality of natural habitat, as well as water quality. Fish and other aquatic species, songbirds, waterfowl, deer and other mammals find protection in them. They connect natural areas (i.e., wetland and watercourse) or can be suitable habitat in themselves (e.g., nesting areas for waterfowl). By shading marshes and ponds, trees help cool the water and improve its quality and value as habitat.

Riparian and lakeshore wetlands are essential habitat for birds such as this least bittern.

Like the wetlands and ponds they protect, buffers also provide a measure of flood control by storing water.

Our appreciation of wetlands' and ponds' contributions to water quality and habitat has grown considerably in recent years. As we'll see in this chapter, well-planned buffers allow wetlands and ponds to function at their best. The habitat created by buffers may attract wildlife that can lead to crop and livestock depredation.

WETLANDS

Wetlands are lands that:

- are seasonally or permanently covered in water
- have water tables close to or at the surface for most of the growing season
- have soils that reflect long-term saturation, i.e., organic (muck) soils or dull grey-coloured mineral soils
- support water-tolerant vegetation.

There are four types of wetlands.

SWAMPS

Any permanently or seasonally flooded wetland that supports trees and shrubs can be considered a swamp.

MARSHES

Marshes are wetlands vegetated by rushes, reeds, cattails and sedges.

BOGS

Bogs are peat-filled depressional wetlands that support sphagnum mosses, sedges, shrubs and trees.

FENS

Fens are usually associated with areas of groundwater discharge and are vegetated by sedges, mosses, grasses, reeds and some shrubs.

PONDS

There are six types of ponds.

IN-STREAM

Created by damming watercourses, in-stream ponds interfere with the natural functioning of the stream, increase stream temperature and alter the habitat. It is difficult to get approval for in-stream ponds.

BYPASS

Bypass ponds are created in the floodplain of watercourses, and are fed and outletted by small channels or pipes connected to the watercourse.

IMPOUNDMENT OR EMBANKMENT

Impoundment or embankment ponds are the products of damming intermittent streams, draws and groundwater seepage areas.

DUGOUT

Fed by groundwater and surface runoff, these excavated ponds are isolated from other surface water bodies.

NATURAL

Natural ponds are found in landscape depressions, often as part of a small marsh or swamp, and are mostly fed by discharging groundwater.

SHEETWATER

The temporary ponds that form after snowmelt in spring, or after excessive rains in cropland and abandoned farmland, are known as sheetwater ponds.

FUNCTIONS

Wetlands and ponds perform many essential functions that are naturally complemented by buffer strips. These include:

- **water quantity** – wetlands and ponds collect surface water, prevent floods, and store water for release into streams and other surface water systems as well as shallow aquifers
  - ▹ they can also help serve irrigation needs
- **water quality** – vegetation and soils in wetlands and ponds can utilize excessive crop nutrients and assimilate bacteria and organic pollutants from farm runoff
- **fish habitat** – many warm and cool water fish species need wetlands and ponds for fish nurseries
- **habitat** – an incredible number of species of plants and animals depend on wetlands for their habitat needs
- **renewable products** – these areas can be a source of timber, firewood and other natural plant products and fur
- **recreation** – hunting, fishing and nature appreciation.

WILDLIFE HABITAT NEEDS

A flushing bar is attached ahead of forage harvesters to scare hens (and other wildlife) off nests and resting areas to prevent their being killed.

If wildlife habitat is the main reason you're interested in pond and wetland buffers, here are a few considerations.

- Buffers add diversity to the habitat afforded by adjacent wetlands and ponds.
- Land use activities around ponds and wetlands can be as important as the habitat itself – particularly to vulnerable, threatened or endangered ("VTE") species.
- Female dabbling ducks (e.g., blue-winged teal, mallards) nest next to wetlands in long grass. A minimum of 300 metres (984 ft.) or a contiguous 12-hectare (30 ac.) block is necessary unless hay or pasture land is nearby. Ideally, adjacent pasture is managed with deferred grazing, or forage with delayed haying (after July 15).A flushing bar is recommended when cutting forage.
- Many species of birds depend on wetlands for their habitat. Generally, more species diversity will be found in larger buffers.
- Frogs, salamanders and reptiles are wetland-dependent, too. Wide buffers provide the necessary land habitats for these amphibians and reptiles.

BMPS FOR WETLAND AND POND BUFFERS

It bears repeating: buffer strips should be part of an army of BMPs aimed at soil conservation, runoff control and pollution prevention. They can't do it alone! See the Soil and Water Conservation chapter on page 93.

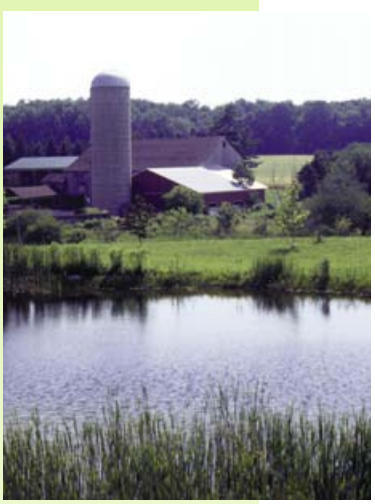
Another caution: buffer strips aren't intended to protect wetlands and ponds from concentrated flow. That's what erosion control structures and practices do, by helping divert flow from cropland to a proper outlet. See the Streambanks and Shorelines chapter on page 102.

Buffer strips need to be wide enough to perform the function they were intended for. **In the absence of other BMPs**, wetland and pond buffers should have the widths presented below for their respective function.

WIDTH OF BUFFER STRIP AROUND WETLAND AND POND	FUNCTION OF WETLAND OR POND THAT BUFFER PROTECTS
3–5 metres (10–16 ft.)	• bank and shore protection • some erosion control • some aquatic habitat protection – more if treed (e.g., travel corridor)
15 metres (50 ft.)	• moderate protection from runoff (sediment and other contaminants) • more aquatic habitat protection • good corridor width for some fur-bearers and predators • habitat for edge bird species, and some amphibians and reptiles
30 metres (98 ft.)	• better protection from sedimentation and contaminants • good aquatic habitat protection • better corridor width for mammals
50 metres (164 ft.)	• good protection from sedimentation and contaminants • good aquatic habitat protection • very good corridor width for mammals • good habitat for tree and grassland bird species
120–300 metres (130–327 yds.)	• best protection from sedimentation and contaminants • very good aquatic habitat protection • best corridor width for mammals • best habitat for most treed and grassland bird species

- Read the chapter on Establishing and Managing Buffer Strips, starting on page 64, before you begin.
- Think of the slope. Remember that pond and wetland buffers work best on a slope of between 1 and 10 percent.
- Use designs suited to ponds and wetlands. Two zones may be suitable: a narrow buffer (<5 metres or 16 ft.) at the same contour of the wetland or pond shore, with an upland buffer of trees or shrubs. Width and vegetation type are dependent on function and practicality.
- Grade the land before seeding and pack or roll to improve success with establishment.
- Select the species suited for the site conditions. Use grass and legume mixtures that can tolerate flooding and high water tables. Protection is more effective when woody plants are also chosen. Deeper-rooted plants, particularly trees, will more effectively uptake nutrient-rich base-flow.
- Depending on desired function, buffers may have to be mowed a couple of times each year. Another option is to forward rotational graze over a minimum number of days, being very careful not to cause overgrazing, compaction or contamination of the water body. When carefully managed, pasture can enrich wildlife habitat.

A two-zone buffer design is suitable around ponds.



A "good" buffer around a pond or wetland has one zone and is often used for forages.

A "better" buffer design includes trees + shrubs for shade and bank stabilization with a grassed buffer for filtration and separation.

A "best" buffer is wide, continuous, contains diverse vegetation and is connected to other natural areas.

NATURAL (EXISTING) RIPARIAN AREAS

You may already have existing, at least somewhat natural, riparian areas on your property, in the form of woodlands and meadows. If you've read preceding chapters, you'll already be well aware of their potential benefits. This chapter describes their functions in greater detail, and will give you practical information on how to identify and manage them.

Some landowners have previously farmed riparian areas, such as ravines, gullies and floodplains (above). Such areas are suitable for reforestation and restoration. By planting trees and shrubs and restoring meadows and wetlands, these lands can return to their original function (right). For more information on tree, shrub and grass planting, please see pages 70–77.

RIPARIAN WOODLANDS

FUNCTIONS

Like most riparian woodlands, this ravine along Shelter Valley Creek in Northumberland County provides multiple benefits in terms of environmental protection and habitat provision, not to mention natural beauty.

Riparian woodlands cover ravine slopes, banks, shores and wetlands. In many respects, they reflect the functions and value of most woodlands in terms of protecting soil and water quality, offering habitat, and providing woodland products.

Like other woodlands, they are more effective at delivering on these when they are extensive in size, distributed evenly – without breaks along the riparian corridor – and left relatively undisturbed. However, riparian woodlands are generally more fragile than most upland woodlands. They are often on sloping lands, on shallow or erodible soils and are directly adjacent to surface waters. Care must be taken to minimize damage.

The specific functions of riparian woodlands are listed below.

Streambank and Streambed Protection

Tree roots form "living gabion baskets" around soil materials in banks and shores. This reduces erosion and sediment loss without interfering with natural channel process, such as meandering, bank shaping and stream shaping (narrower and deeper).

Trees and branches that fall in watercourses help form riffles, pools and meanders and improve aquatic habitat. However, excessive woody materials in streams and ponds can cause streambank and streambed erosion. Some of these materials should be removed.

Water Quality and Quantity

Trees, the "understory" vegetation, and layers of decaying leaves and debris filter sediment and other contaminants from runoff.

Years of root growth and organic matter additions increase infiltration rates. More runoff water and the materials it carries are "filtered" through riparian soils.

Baseflow – or groundwater moving on a downslope gradient – carries nutrients (such as nitrates) in solution. Woodland plants are particularly effective at capturing and using these nutrients before the groundwater reaches the surface water.

High organic matter levels and diverse soil life help to biologically and chemically alter contaminants into living tissue or less harmful forms.

Riparian woodlands help manage water supplies by slowing snowmelt and runoff as well as increasing water storage in woodland soils.

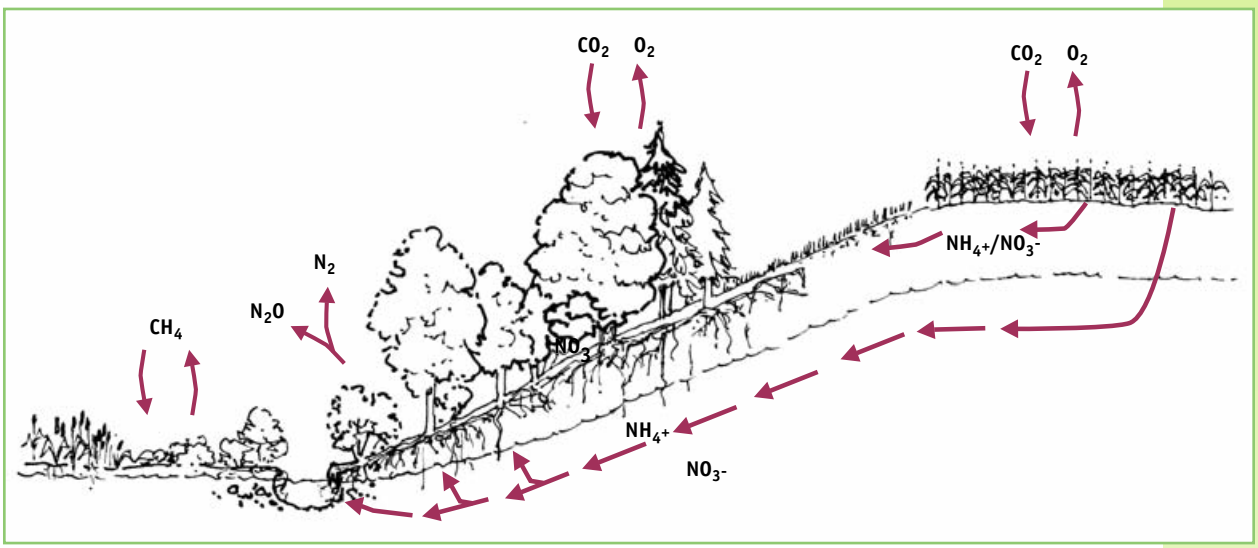
Fish and Wildlife Habitat

Surface waters shaded by riparian woodlands provide cool- and cold-water aquatic habitats for fish.

Leaf fall and other organic debris feed aquatic insects as part of the food chain in aquatic environments. Fallen trees and branches provide cover for fish and other aquatic animals.

Riparian woodlands help to fulfill habitat needs – space, cover, food and water – for many of the mammals, birds, reptiles and amphibians that live in Ontario. They're also important corridors for wildlife travel between other habitat areas.

Additional Functions



Trees and shrubs are efficient at fixing carbon (CO_2) from the atmosphere to form wood and woodland soil organic matter and, by nutrient uptake, preventing dissolved nitrate (NO_3) from turning into nitrous oxide (N_2O). N_2O is a very harmful greenhouse gas.

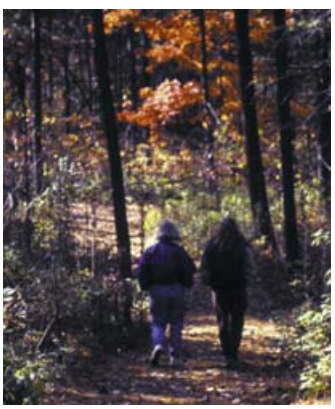
Riparian woodlands are the most effective buffers. Runoff is reduced and erosion is controlled.

For recreational activities such as hunting, fishing, hiking and trail use, they provide a diverse setting.

Riparian woodlands add beauty and diversity to the rural landscape – improving the quality of life and the value for real estate and tourism.

Woodland products such as fuelwood, timber, cedar posts and maple sugar can diversify farm and rural property income.

BMPS FOR RIPARIAN WOODLANDS



Leave them! Not all riparian forests need management. Some lowland forests and upland forests on very shallow or steep sites may be better off left alone. At the very least, consider a no-harvest zone adjacent to your watercourse, wetland or lake. With no effort at all, important habitats can be protected.

- Develop a plan for your riparian woodland. Contact the Ontario Ministry of Natural Resources or a Wetland Habitat Fund representative for a sample planning exercise. Inventory your forest resources and site limitations. Seek technical assistance where necessary. Schedule your activities. Harvest carefully. Monitor sensitive areas.
- Don't use them as landfills. Riparian woodlands can be inaccessible or hidden from view. In the past, they may have seemed like ideal dump sites. Only approved and properly managed municipal landfills are intended for the disposal of solid wastes – use them!
- Match forest management system to cover type. Use selection management systems to promote shade-tolerant trees in riparian woodlands. Other systems (e.g., shelterwood or sequenced partial-stand removal) can work for other species (e.g., pines and spruces) when not on fragile lands.
- Introduce harvesting equipment when soils are dry or frozen to minimize site damage and erosion. Use horses or equipment with high flotation tires on sensitive sites. Cables and winches should be used to harvest high value timber on severe slopes.

- ▸ Harvest to reduce felling and skidding damage to residual stand.
- ▸ Design roads and skid trails to minimize damage:
  - ▹ avoid wetlands and watercourses
  - ▹ follow contours where possible
  - ▹ rehabilitate damaged areas caused by skidding and hauling.
- ▸ If crossings are necessary, create them to minimize any sediment loadings and washouts. Use cull trees as temporary bridges and silt fences to avoid siltation. Reduce the number of crossings.
- ▸ Avoid handling hazardous products in the riparian area. Fuel up and lubricate harvest equipment a safe distance from water.
- ▸ Time operations to minimize disturbances to wildlife (e.g., nesting periods).
- ▸ Leave rock piles alone and create piles of treetops for cover.
- ▸ Create openings or plant nut (e.g., beech, oak, and hickory) and catkin trees (e.g., birch) in upland areas.
- ▸ Monitor beaver activity. Control with trapping if necessary.

Set landings as far away as possible from water. Where you can, keep all landings at the top of ravines.

Leave 5–10 "snag" trees (small, dead and dying) and fallen logs per acre for wildlife habitat.

Maintain 2–5 cavity trees per acre in remaining stand for cavity-dwelling birds and mammals.

Keep treed fencerows and plant windbreaks to connect other natural areas (e.g., woodlands, wetlands and ponds) to riparian woodland area.

RIPARIAN WETLANDS

Wetlands can be found throughout riparian areas, particularly in the broad floodplains of larger rivers and adjacent to the shores of lakes. In southern Ontario, riparian wetlands are most often marshes and swamps. In the north, they are more often fens and to a lesser extent bogs.

While there are definite similarities between riparian and conventional wetlands, riparian wetlands are more influenced by moving surface water (flooding and high flows). They're also subjected to more flooding, erosion and sediment (plus debris) deposition than their upland counterparts.

Riparian wetlands are more influenced by flooding, erosion and deposition.

In southern Ontario, riparian wetlands are mostly marshes or swamps.

FUNCTIONS

Riparian (or "riverine") wetlands are among the most important types of wetlands as they perform many essential functions.

WATER
• water storage for flood control, stream maintenance and plant growth
NUTRIENT
• removal of nutrients from adjacent land, base flow and from flood deposition
• nutrient cycling in wetland area
• sediment trapping in wetland
• increase of carbon in soil
HABITAT
• improved, more diversified habitat offering space, cover and food

BMPS FOR RIPARIAN WETLANDS

Remember these key principles for managing riparian wetlands.

Manage wildlife with regulated hunting and trapping. Remove problem animals in accordance with provincial and federal laws.

Don't dump fill or debris or discard waste in wetlands.

- Avoid physical damage to soils, waterways and vegetation.
- Prevent any harmful substances from entering the wetland.
- Seek approvals and permits if you plan any changes.
- Harvest timber on a sustainable basis – ensure a long-term supply with minimal impact on habitat.
- Exclude livestock from riverine wetlands.
- Just "keeping it" is a wetland BMP.
- Establish upland buffers – wider is better.
- Consider in-stream habitat improvements – for more information, see the BMP book, *Fish and Wildlife Habitat Management*
- Don't create barriers to fish and wildlife movement – riparian ecosystems are key travel corridors.

For wetland meadow management, please see further on in this chapter.

For Timber Harvests

- Plan your operation – inventory and identify sensitive features to avoid them.
- Seek professional assistance for your timber harvest.
- Time operations to reduce impact.
- Minimize area and duration of disturbance.
- Avoid working during high-flow periods.
- Use heavy machinery in winter and only when soil conditions are frozen.
- Use proper crossing techniques to avoid damaging and blocking the flow of any watercourses in wetlands.
- Don't create conditions that impede the travel of wildlife.
- Don't clear-cut vegetation – use a management-free zone around sensitive areas.

For wetland restoration and marsh management techniques, please see the BMP book, *Fish and Wildlife Habitat Management*.

RIPARIAN MEADOWS

Riparian meadows are natural grasslands, consisting largely of grass, wildflower and wetland vegetation and a few trees. While you usually find them along lakeshores and in the floodplains of large rivers, small meadows can be an important part of natural riparian areas too. And in the drier parts of ravines, such as gravelly ridges and near bedrock outcrops, you may find prairie or savannah vegetation "communities".

In drier communities, you'll see grass species such as big and little bluestem, Indian grass, and switchgrass. In wetter sites, look for reed canary grass, blue-joint, prairie cordgrass, sedges and rushes. A large assortment of wildflowers can be found in both wet and dry meadows.

Wet riparian meadows consist of grasses, wildflowers and wetland vegetation.

Warm-season grasses will provide cover throughout the summer season.

Cool-season grasses provide quick cover in the spring and will regrow in the fall.

FUNCTIONS

Riparian meadows perform similar functions to other riparian natural areas. However, they provide different and important habitat functions for various avian species:

Meadows are important habitat for gamebirds such as wild turkey.

- ▸ waterfowl – riparian meadows are particularly favoured for waterfowl nesting
- ▸ songbirds – meadows provide food (insects and seeds), cover for nesting and shelter from severe weather
- ▸ meadow-dependent species, such as bobolinks and Henslow's sparrow
- ▸ gamebirds, such as woodcock, wild turkey, pheasants and quail – scrubby meadows provide nesting, brood rearing and roosting cover.

The biggest threats from agriculture to riparian meadows are:

- intensive cropping on floodplain – annual crops such as corn, soybeans and cereals are grown intensively on former riparian meadow sites
- intensive grazing – unmanaged access by grazing livestock will destroy most habitat functions, and
- runoff from cropland or livestock operations – soil, nutrients and pesticides can alter the quality of these fragile ecosystems.

Without disturbance by flooding or fire, meadows are subject to the pressures of natural succession. The natural "invasion" of shrubs and trees can lead to the ultimate loss of meadow vegetation, especially warm-season grasses and wildflowers. To maintain a meadow, judiciously remove woody trees and shrubs. This meadow is found along the lower reaches of the Ganaraska River in Northumberland County.

PURPLE LOOSESTRIFE

PHRAGMITES

All riparian plant communities, particularly meadows, are at risk of invasion by non-native plants. Certain weeds, ground covers, forage grasses and landscape trees are more aggressive than native plants – spreading and out-competing them. These species do not necessarily perform the habitat functions that native plants do, and threaten the natural balance of plant communities that has developed over the past millennium.

BMPS FOR RIPARIAN MEADOWS

For Protection

- Exclude livestock or delay graze at low densities.
- Don't intensively crop riparian meadows. If you do crop, use conservation tillage to control erosion risk.
- Establish upland buffers – wider is better.
- Don't dump waste in wetlands.
- Stay out of meadows in spring and early summer so as not to disturb bird nesting. If possible, delay haying and pasture until July 15.

For Maintenance

- Just keeping it is a reasonable strategy to manage meadows.
- With permits and approvals, well-planned, prescribed burns when woody vegetation encroaches will keep the grass component in riparian meadows.
- Practise delayed mowing, and forward-graze only one-third of the meadow each year (for habitat and sustained regeneration purposes), and rotate to a new section each year.

For Restoration

- Use prescribed burning in late fall or early spring (end of April), plus light cultivation, to prepare flatter parts of wetter meadows for replanting.
- Choose warm-season grasses or prairie grasses such as big and little bluestem, Indian grass, and switchgrass to restore the meadow, if you're interested in providing cover for wildlife
  - ▷ warm-season grasses take several years to establish but in time will be more competitive than cool-season grasses
  - ▷ wildflowers can be planted or will seed in more readily with warm-season grass stands.
- Choose cool-season grasses such as brome, orchardgrass or timothy if you wish to use the meadow for forage or pasture, and also want to provide cover for early-season nesting birds.

Wildflowers will seed in more readily into meadows with warm-season grasses.

CASE STUDIES

CASE STUDY #1	BOOMER CREEK TRIBUTARY IN WATERLOO REGION
CONCERN	• streambank erosion and poor vegetation cover • 35 cattle pastured on Farm A • 35 cattle pastured on Farm B
LANDOWNER	• two adjoining landowners • both run mixed cattle/hog operations • culvert crossings were already in place on both farms (i.e., prior to fencing)
ACTION TAKEN	• consulted Grand River Conservation Authority • fenced 720 m (2400 ft.) between 1999 and 2001 • installed, in total, an additional 1200 m (4000 ft.) page wire fence • created 10 ft. buffers on either side of creek on both farms • established one row of trees in the buffer on the north side of the creek on both farms • did not plant other side of the creek into trees • planted a mix of white ash, silver maple, red maple, sugar maple and black cherry saplings at 3 m (10 ft.) spacing
BENEFITS TO DATE	• since the cattle have been restricted from the creek, the channel has become noticeably narrower and deeper • grass cover has re-established itself on the streambanks, and erosion is no longer evident • tall grasses now shade the creek and filter

Shown here is the Boomer Creek Tributary before fencing.

A few months after fencing in 2002, trees were established on the north side, as evidenced by the white tree guards.

CASE STUDY #2	CONESTOGA RIVER TRIBUTARY IN WELLINGTON COUNTY
CONCERN	• two creeks cut through this pasture • 25 cow-calf pairs had unrestricted access • streambanks were severely eroded in several locations
LANDOWNER	• Roger Weber
ACTION TAKEN	• built 1740 m (5800 ft.) of five-strand high-tensile fence in 2000, with the help of family members • constructed three bed-level crossings (reinforced by concrete slats) • installed two nose pumps in each of the three pasture sections as alternative water sources • restricted cattle from the crossing area, except when they are rotated into the next pasture • retired 2.5 ha (6.25 ac) of land to buffer/trees • established green ash and bur oak saplings as well as white pine, white spruce, and white cedar seedlings in the buffer on both sides of the creek
BENEFITS TO DATE	• by fencing the two creeks, three paddocks for rotational grazing management were created • convenience: "the rotational grazing system is working well, with nose pumps in each section – all I have to do is open up the gates and chase the cattle into the next pasture"

"This is something everyone should be doing, to protect the water for future generations." Roger Weber

Secondary creek before fencing. Note severe bank erosion.

Several months after fencing.

CASE STUDY #3	HOGG CREEK, SIMCOE COUNTY
CONCERN	• flash high flows and flooding • streambank erosion • loss of young calves in creek during springtime • problem in summer with foot rot from cattle having stream access
LANDOWNER	• Brian and Vivian Jones initiated projects in 1991 • Son Ian and wife Barb Jones, who now own the property, continue to support the buffer
ACTION TAKEN	• fenced 2.5 km (1.5 mi.) of stream (5 km or 3 mi. of streambank) • installed 1,130 m (3,765 ft.) of fence • retired 26 ha (64 ac) of pasture • fenced top of bank so that fence would be straight and easier to maintain • created average width of 23 m (75 ft.); at widest part, buffer is 90 m (300 ft.) on both sides of the stream • installed 1 pasture pump and 1 gravity-fed water source • used ¾ in. stone to create a low-level crossing that was gated – used to move cattle from pasture to pasture (no access while in pasture) • planted 13,100 trees in 1992 – work done by 350 Boy Scouts and local volunteers – 2 years later, tree survival rate was 96% • stabilized banks • placed bird boxes – work done by school groups
BENEFITS TO DATE	• safer during calving season • creek is narrow and deeper • flash high flows and flooding drastically decreased to almost none

Vivian, Brian, Ian and Joshua Jones – three generations caring for a buffer strip in North Simcoe County.

"We lost 17 acres from pasture, which had to be compensated. In 1995–97, our son Ian used this project to introduce intensive rotational grazing to compensate, and the result was not needing to rent additional pasture land." Brian Jones

"The buffer is a great recreational spot for the kids. They travel back and forth. It is a great benefit for our grandchildren." Brian Jones

GLOSSARY

Alkaline – basic or high pH conditions (opposite of acidic); base-rich (high concentrations of calcium and magnesium chemical compounds)

Adsorb – to attach one substance onto another

Bars – coarse-grained deposit of sediment from a stream or ocean currents

Bay – a body of sheltered water found in a crescent-shaped coastal configuration of land

Bedrock – rock substrate that underlies all soil, sand, clay, gravel, and glacial material on the Earth's surface

Berm – an elongated mound in a naturally level land area or one made artificially by a landscaper to gain privacy or interest in a private or public area. 2) a narrow embankment, shelf or mound that breaks the continuity of a slope often used as dike or dam. 3) an earth mound positioned across a natural draw or gully to intercept surface runoff of water

Best management practice (BMP) – proven, practical and affordable method, measure or practice to prevent or reduce water pollution, including but not limited to, structural and nonstructural controls, operation and maintenance procedures, other requirements and scheduling and distribution of activities

Bio-engineering – an applied science that combines structural, biological and ecological concepts to construct living structures for erosion, sediment, and flood control

Bluffs – an escarpment or cliff formed from bedrock or unconsolidated geological materials in a riparian area

Bog – a peatland that is isolated from ground or surface water (only significant water inputs are directly from rain) and dominated by mosses (*Sphagnum* spp.), shrubs, sedges, and evergreen trees such as black spruce and tamarack

Brush layering – bio-engineered erosion control structures created by placing live branch cuttings across slope contours

Brush mattress – bio-engineered bank stabilization structure where live and dead brushes are placed along banks and covered in soil

Buffer strip – a strip of vegetation – usually a mix of trees, shrubs and grasses – planted alongside natural areas, e.g., watercourses, to protect them from surrounding land uses

Bulkheads – soil-filled retaining walls (timber, steel or concrete) designed to resist wave action along shores

Carbon sequestration – the capture of carbon gas, making it unavailable for biological processes (as part of plants or soil organic matter); a means of lowering greenhouse gas emissions

Clear-cutting – technique used in even-aged timber management that involves one cut, and which may remove an entire stand

CO_2 – carbon dioxide gas (naturally occurring) generated by the respiration of all living organisms

Coffer dam – temporary dams, often constructed of wood, used as an interim measure to allow construction of other riparian structures

Concentrated flow – the convergent flow of surface runoff from farmland that can carry pollutants to outlets, and if unmanaged can lead to large rill and gully erosion

Cool-season grass – grass that develops most rapidly during spring and fall when cool nights follow warm days

Corridor – a tract of land forming a passageway; an ecological connection between two areas

Delayed grazing – the restriction of grazing livestock to a paddock, e.g., adjacent to riparian area, until conditions are suitable

Deleterious substance – as applicable to livestock operations, means any substance that, if added to water, would degrade or alter the quality of that water, making it harmful or "deleterious" to fish or fish habitat

Delta – large deposit of sediment located at the mouth of a stream where it enters a body of standing water

Denitrification – process by which nitrate-nitrogen is converted to nitrogen gas by soil organisms under anaerobic conditions.

Deposit – any discharging, spraying, releasing, spilling, leaking, seeping, pouring, emitting, emptying, throwing, dumping or placing

Drop structure – spillway or pipe inlet intended to drop concentrated flow or ponded water to a sub-surface pipe system

Embankments – see **Berm**

Erosion – process in which a material is worn away by water or wind, often worsened by the presence of abrasive particles in the stream or air respectively

Erosion control structure – in-field, built structure designed to reduce soil loss and safely convey surface water to a proper outlet

Extensive grazing – less than 1 nutrient unit (see below) per acre per year

Fen – a type of peatland that receives mineral-rich inputs of ground or surface water and is dominated by sedges and other grass-like vegetation

Fish habitat – spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes

Floodplain – that portion of a stream valley adjacent to the channel that is built by sediments of the stream and covered with water when the stream overflows its banks at flood stage. 2) also the nearly level land situated on either side of a channel that is subject to overflow flooding

Forb – herbaceous plant other than grass, trees, or shrubs – i.e., wildflowers

Forward grazing – a form of rotational grazing where a small number of livestock are channelled forward within the confines of narrow, row-shaped paddocks

Gabion basket – terraced rock riprap systems where the rock materials are held in place with wire cages

Grassed waterway – a natural or constructed vegetated channel that is shaped and graded to carry surface water at non-erosive velocity to a stable outlet, or that spreads the flow of water before it enters a proper outlet

Grazing management plan (GMP) – for pastures in or near riparian areas, a plan completed by graziers to assess the environmental risks of grazing and to set a plan of management actions to reduce the impact on the riparian area and water quality

Greenhouse gas – gases responsible for the greenhouse effect, including carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O)

Groyns – are stone-filled or concrete protective barriers constructed at right angles from shorelines to reduce the impact of shoreline erosion

Groundwater – water that flows or seeps downward and saturates soil or rock, supplying springs and wells. 2) water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust

Gully – an erosion feature where the concentrated flow of water and surface runoff have created a ravine-like depression in the landscape – wide and deep enough to prevent crossing by farm equipment

Infiltration – the downward movement of water from the atmosphere into soil and rock formations

Intensive grazing – more than 1 nutrient unit (see below) per acre per year

Intermittent stream – a defined channel in which surface water is absent during a portion of the year

Invasive – plants (often non-native) that spread into natural ecosystems and crowd out the natural vegetation

Live cribwall - a retaining wall for lakeshore stabilization consisting of interlocked timber, back-filled with soil and brush materials

Marsh – shallow-water area that sustains water-loving plants such as cattail, sedge, arrowhead, bulrush, water lily and pond weeds

Meadow – a tract of grassland, either natural or used as pasture or for growing hay

Meander – a circuitous winding or bend in the river

Nitrate – one of the plant-available nitrogen compounds (NO_3-) found in soil and can be a pollutant at high concentrations in ground and surface water

Nutrient unit (NU) – in Ontario, a means of describing manure volume and livestock density; as defined in the *Nutrient Management Act*, the amount of nutrients that give a fertilizer replacement value of the lower of 43 kg of nitrogen or 55 kg of phosphate as nutrients (roughly equivalent to the impact of 1 beef cow, including unweaned calf and replacement; 8 ewes; 8 goats; 2 ponies; or 2 dairy heifers)

Point – a shoreline that juts into the body of water like a peninsula

Ravine – the landform – usually steeply sloping – formed by a river valley as it cuts a channel through the underlying bed materials over many years

Revetment – stone retaining wall

Riffle – shallow section of a stream or river with rapid current and a surface broken by gravel

Rill – a very small steep-sided channel carrying runoff water – this landscape feature is intermittent, and can be easily crossed with farm equipment.

Riparian – near surface water

Riparian zone –the area adjacent to streams, rivers, and other bodies of water that serves as a transition between aquatic and terrestrial environments, and directly affects and is affected by that body of water

Rock riprap – stones of varying size used to dissipate energy or stabilize a soil surface

Rotational grazing – where pastures are grazed and rested in sequence to allow for regrowth

Runoff – water that is not absorbed by the contributing area, but rather drains off by surface flow onto the area of other land and waterbodies

Sediment – fragmented material that originated from weathering rocks and decomposing organic material that is transported by, suspended in, and eventually deposited in the streambed

Shade tolerant – plant's ability to thrive in shady conditions; important feature to match species to local site conditions

Soil conservation/Soil management BMPs – BMPs that range from reduced tillage practices (e.g., no-till, residue management) to slope management (e.g., strip cropping) to soil management practices that improve soil quality and reduce runoff

Stream – perennial or intermittent watercourse having a defined channel and banks (excluding manmade ditches), which contains flow from surface and groundwater sources during at least 50 percent of the time during an average rainfall year

Stream order – a numerical system (ranking from headwaters to river end) used to designate the relative position of a stream or stream segment in a drainage basin

Streambank – the portion of the channel cross-section that restricts lateral movement of water at normal water levels

Surface water – a natural or artificial channel that carries water either intermittently or continuously throughout the year; also a lake, reservoir, pond, sinkhole or wetland

Terraces – a form of farmland erosion control structure where berms are constructed along contours or across field slopes to reduce slope length and divert surface runoff to a safe outlet

Watershed – an area of land that drains into a particular river or body of water; usually divided by topography. 2) The total area of land above a given point on a waterway that contributes surface runoff water to the flow at that point; a drainage basin or a major subdivision of a drainage basin

LEGISLATION

The following chart shows a **partial** list of legislation with some relevance to Ontario's rural landowners who undertake activities in and around riparian areas. For practical purposes, the list provides "at a glance" information only. You're advised to read the statutes in full for complete information. Err on the side of caution. Contact the authorities to determine whether permits or approvals are needed!

Legislation is also subject to change, and what's listed here may no longer be accurate by the time you're reading this. The Government of Ontario provides a list of "E-laws" at the following website: www.e-laws.gov.on.ca.

LAW / GUIDELINE	CONTACT	GOAL	RELEVANCE TO LANDOWNERS
CONSERVATION AUTHORITIES ACT	• Conservation Authority	• to regulate conditions that affect watersheds and the flow of flood waters in them	• permits are required to fill or build in floodplains
DRAINAGE ACT	• Ontario Ministry of Agriculture and Food	• to regulate the construction and improvement of land drainage	• allows farmers to drain land
FISHERIES ACT	• Dept. of Fisheries and Oceans and Environment Canada	• to protect fish and fish habitat	• prohibits destroying fish and discharging deleterious substances that would harm fish or fish habitat • general prohibitions against harmful alterations to fish habitat [see pg.7 for more information]
FISHERIES ACT WILDLIFE CONSERVATION ACT	• Ontario Ministry of Natural Resources	• to manage and protect the wildlife resources of Ontario • to regulate access to fish and wildlife resources	• allows farmers to destroy some nuisance wildlife • licenses may be required or hunting – contact the ministry
LAKES AND RIVERS	• Ontario Ministry of Natural Resources	• to regulate alterations to lakes and rivers	• any work that forwards, holds back, or diverts water must receive prior approval from the ministry
MUNICIPAL BYLAWS	• local municipality	—	• must consider natural heritage, environmental protection, and hazard policies

LAW / GUIDELINE	CONTACT	GOAL	RELEVANCE TO LANDOWNERS
NUTRIENT MANAGEMENT ACT	• Ontario Ministry of Agriculture and Food • Ontario Ministry of the Environment	• to ensure all land-applied materials are managed in an environmentally responsible manner	• regulates the storage, handling and application of nutrients that could be applied to agricultural cropland
ONTARIO WATER RESOURCES ACT	• Ontario Ministry of the Environment	• protects the quality and quantity of Ontario's surface and ground water resources	• contains general prohibitions against discharging any materials to or near water that could impair water quality, which might lead to harm to any person, animal, bird, or other living thing
PLANNING ACT	• Ontario Ministry of Municipal Affairs and Housing	• to ensure orderly development and growth by regulating land use change on private land	• provides a mechanism by which policies, representing matters of provincial interest, are considered when land use changes are proposed • key policy areas include the protection of: prime agricultural lands, natural heritage features and areas, the quality and quantity of surface and ground water, natural hazards, etc.
PUBLIC LANDS ACT	• Ontario Ministry of Natural Resources	• to protect and perpetuate public lands and waters for the citizens of Ontario	• requires landowners to obtain work permits for activities on shorelands adjacent to navigable waters • shorelands include public or private lands, as well as areas that are seasonally inundated with water • beds of navigable waters (below high water mark) are considered Crown Lands
TREES ACT	• local municipality	• to conserve woodlands	• requires landowners to obtain permits for the removal or clearing of trees under some circumstances

Agencies and Offices

ONTARIO MINISTRY OF AGRICULTURE AND FOOD
Agricultural Information Contact Centre
1 Stone Rd. W.
Guelph, ON N1G 4Y2
Tel: 1-877-424-1300
E-mail: ag.info@omaf.gov.on.ca
Internet:
www.gov.on.ca/OMAF/english/index.html
Nutrient Management Act:
www.gov.on.ca/OMAF/english/nm/reg.html#reg

ONTARIO CATTLEMEN'S ASSOCIATION
130 Malcolm Rd.
Guelph, ON N1K 1B1
Tel: 519-824-0334
E-mail: gwh@cattle.guelph.on.ca
Internet: www.cattle.guelph.on.ca

ONTARIO FEDERATION OF AGRICULTURE
40 Eglinton Ave. E.
Toronto, ON M4P 3A2
Tel: 416-485-3333
E-mail: inquiries@ofa.on.ca
Internet: www.ofa.on.ca

Publications

Best Management Practices: Fish and Wildlife Habitat, Agriculture and Agri-Food Canada and Ontario Ministry of Agriculture and Food, 1993

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Working Around Water? What you should know about Fish Habitat, Factsheet #1 – Working Around Water, Department of Fisheries and Oceans and Conservation Ontario, 1999

For a complete copy of the *Fisheries Act* go to:
http://laws.justice.gc.ca/en/F-14/index.html

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