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.

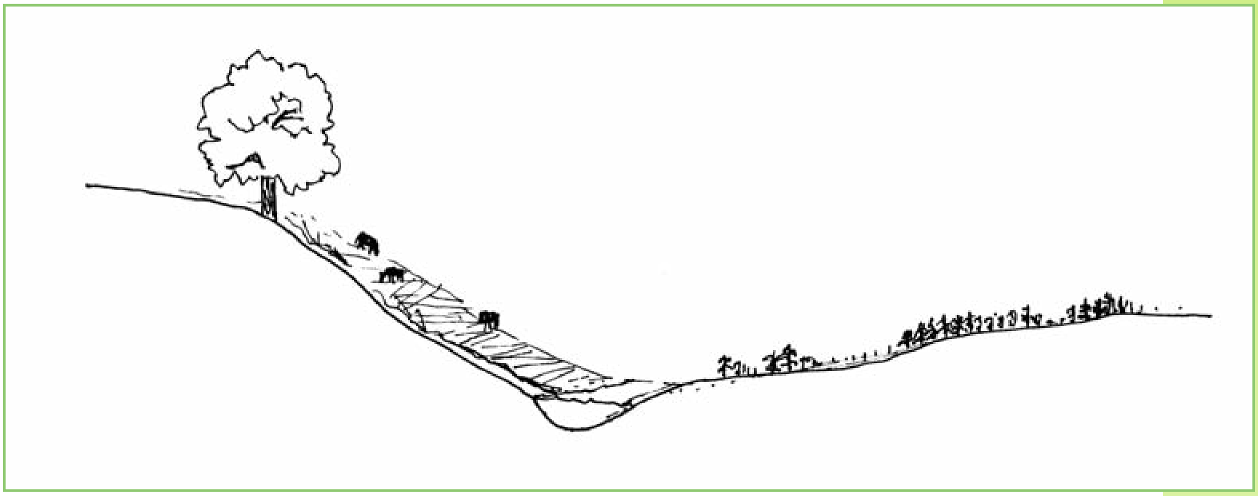
It's not just theory! Gaining a good understanding of how riparian zones "work" is crucial preparation for planning effective improvements on your property.

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.

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.

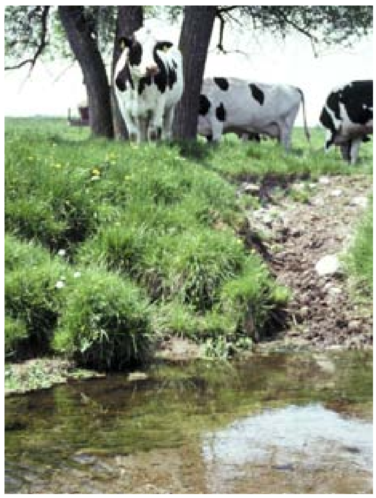
As water flows, it erodes soil materials from its beds and banks. The more resistance it encounters – such as rocks in banks and vegetation – the slower the rate of flow.

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.

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.

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.

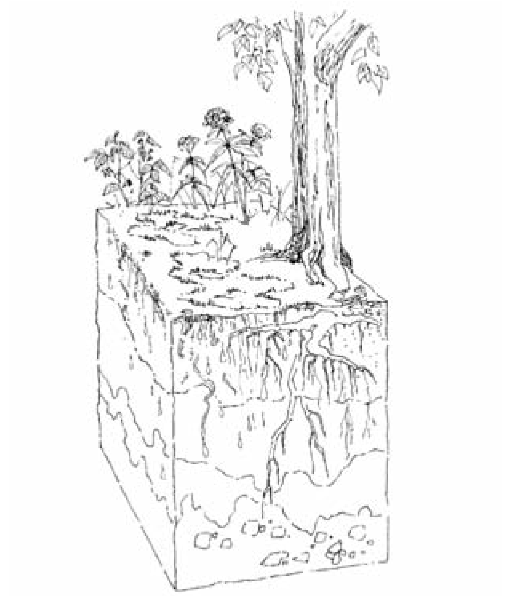
PROCESS	DESCRIPTION	EXAMPLES
WATER QUALITY FOR HABITAT AND RECREATIONAL USE		
SEPARATION	• buffers can keep farm practices away from sensitive natural areas • the greater the distance from "source" to "sink", the greater the reduction of pollution potential	• reduced or restricted livestock access access • 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

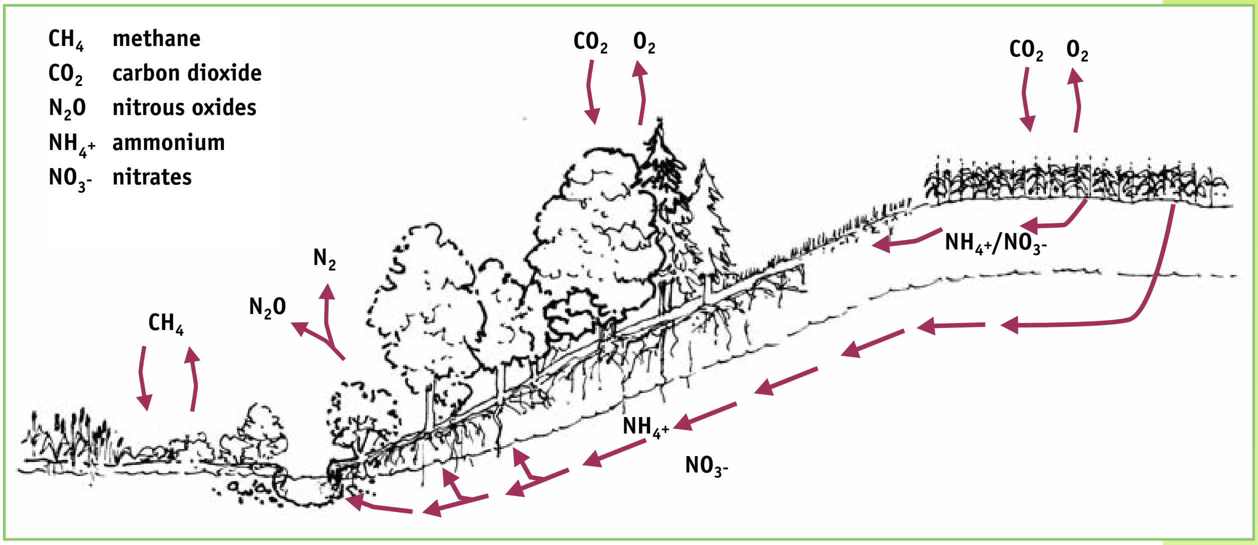
PROCESS	DESCRIPTION	EXAMPLES
AGRICULTURE		
LIVESTOCK HEALTH, PRODUCTIVITY AND FOOD SAFETY	• grassed buffer strips may provide rich pasture, shade and access to water – however, when grazing density is high or access is continual, muddy conditions prevail in wetter areas, which can be a source of disease 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.

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



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.



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.

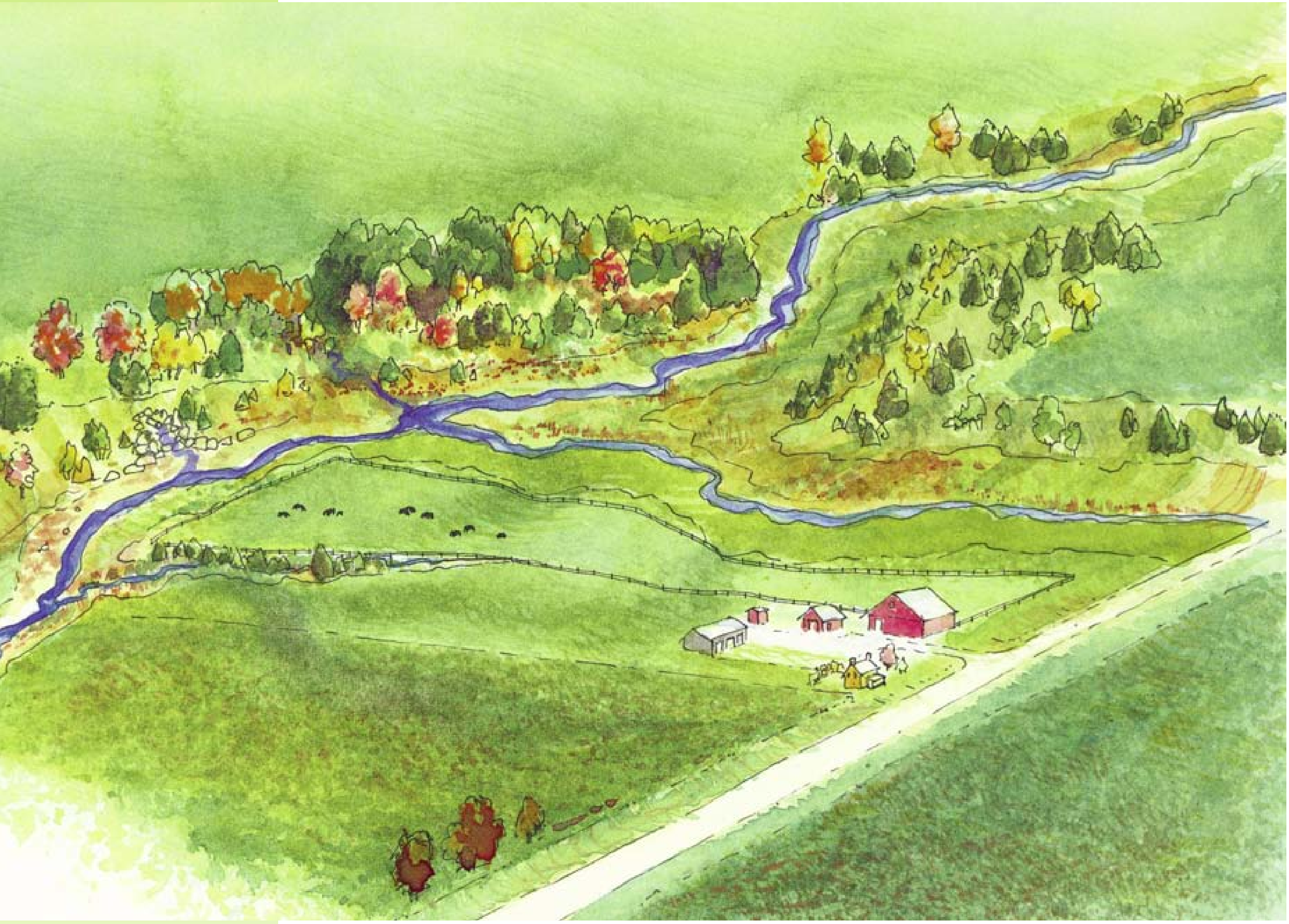
The following series of illustrations and descriptions should help you get site-specific with your property as you select BMPs that best suit your circumstances and intentions.

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.

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

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

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).

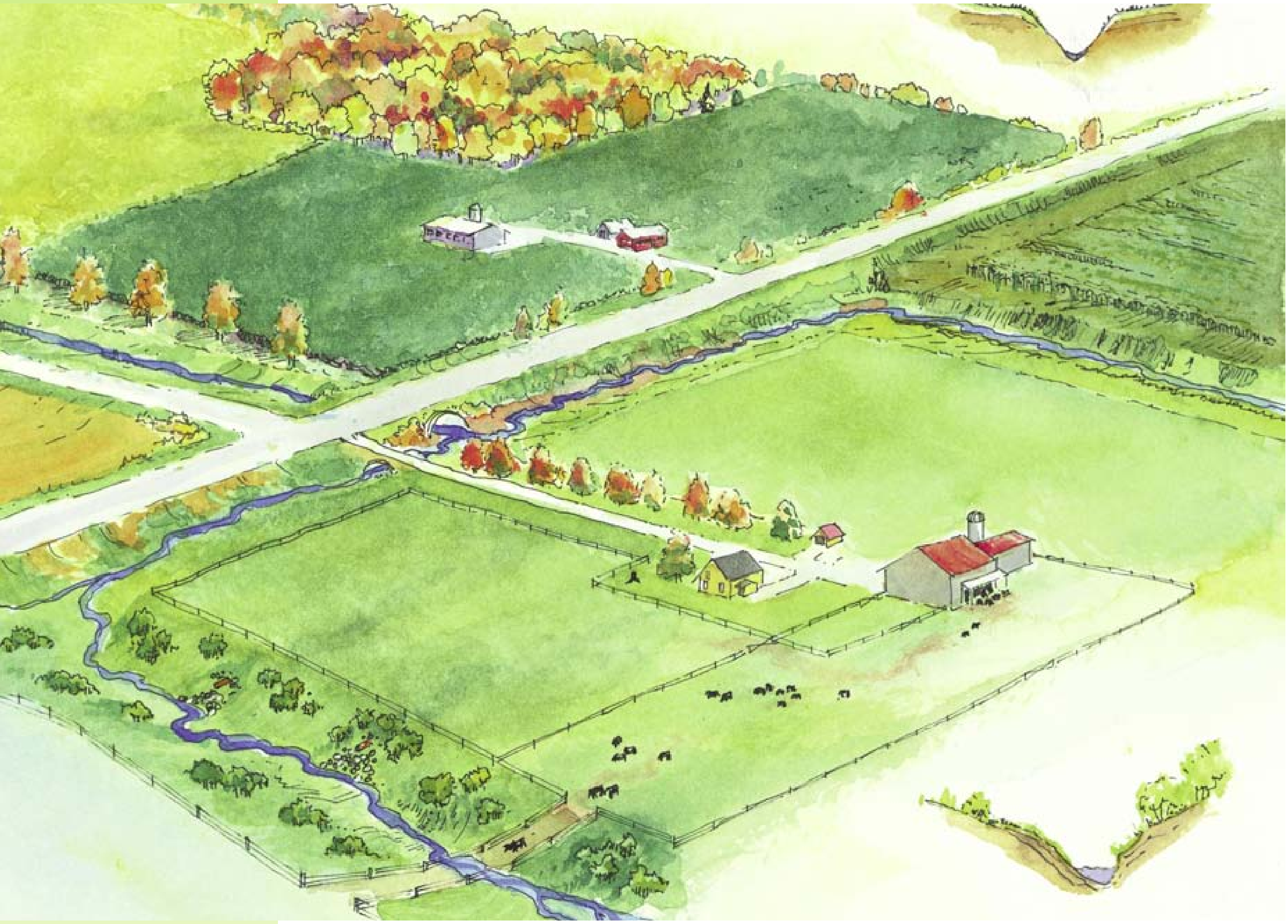
In agricultural landscapes, the riparian area is dominated by natural or nearly natural vegetation. This is due in part to a history of extensive land use as dictated by the steep slopes, stony soils and, in some settings, shallow depth to bedrock.

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.

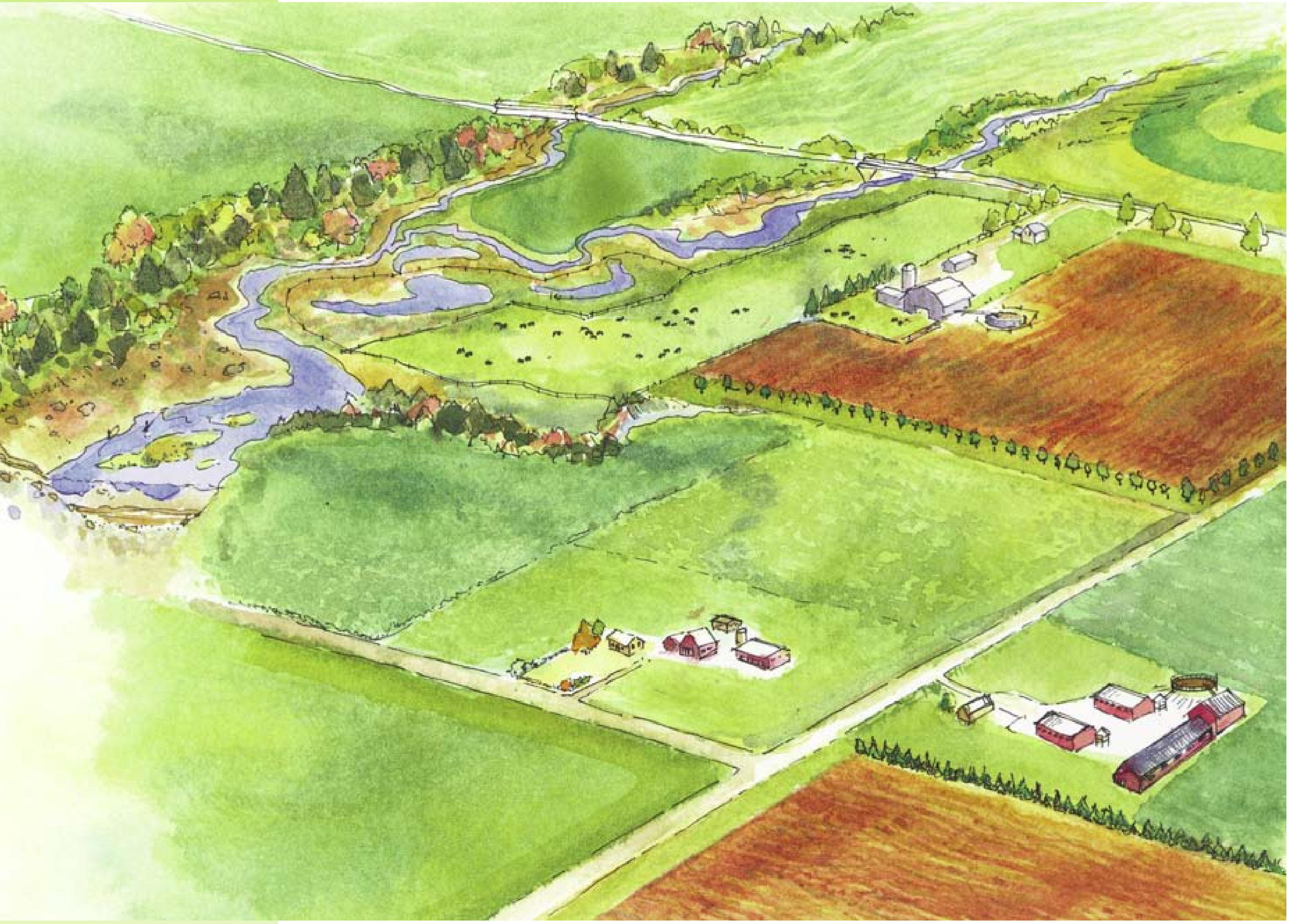
For most constructed watercourses, riparian vegetation is restricted to grassed buffer strips and banks to facilitate drain maintenance. In some cases, trees can be planted on one side of the channel to provide shade and greater stability.

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.

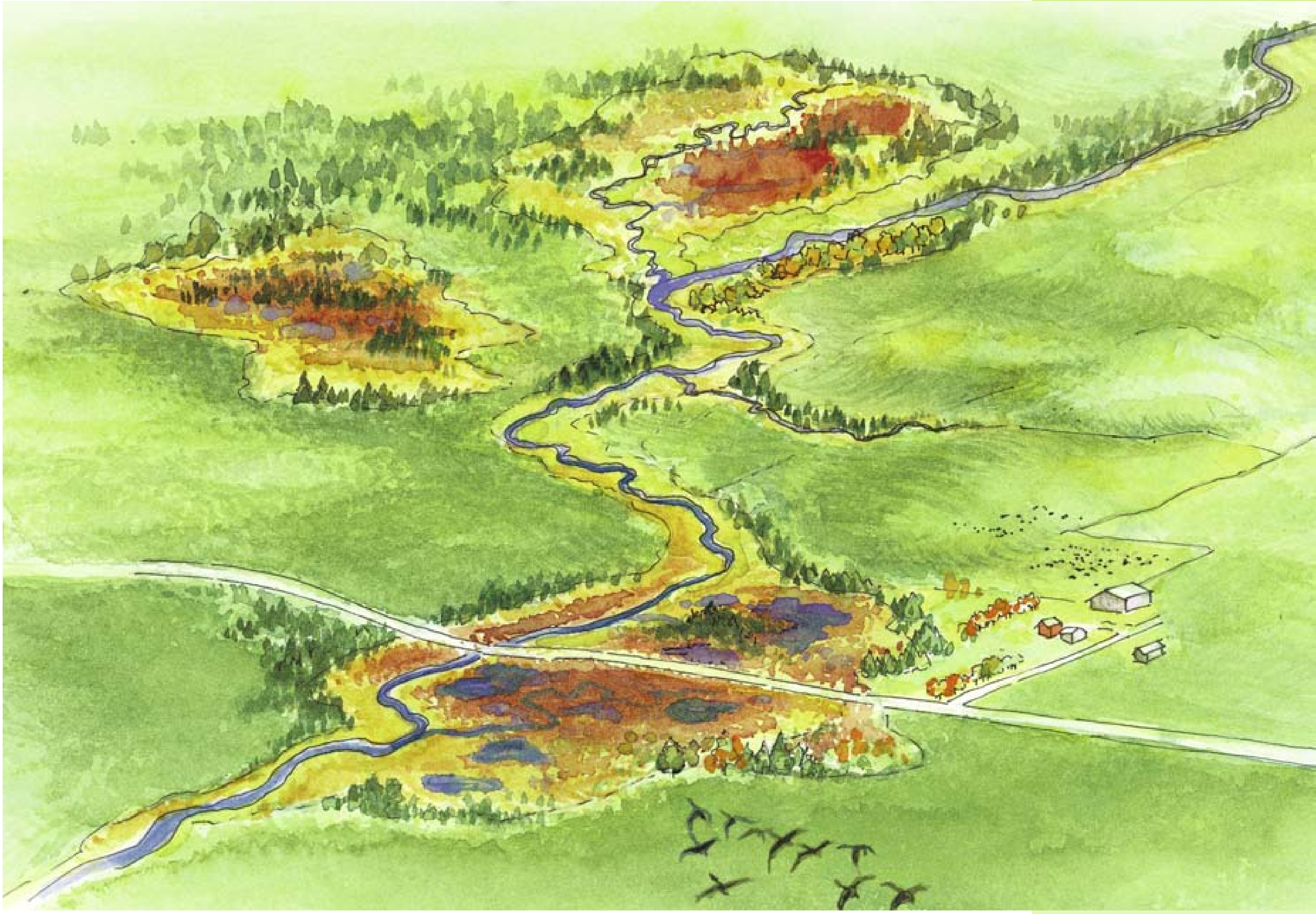
Beaches, usually found in lake bays, consist of sandy, gravelly or stony materials. Land use – often recreational, residential, or agricultural – can be intensive, leaving these areas at risk of habitat destruction and water quality problems.

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.