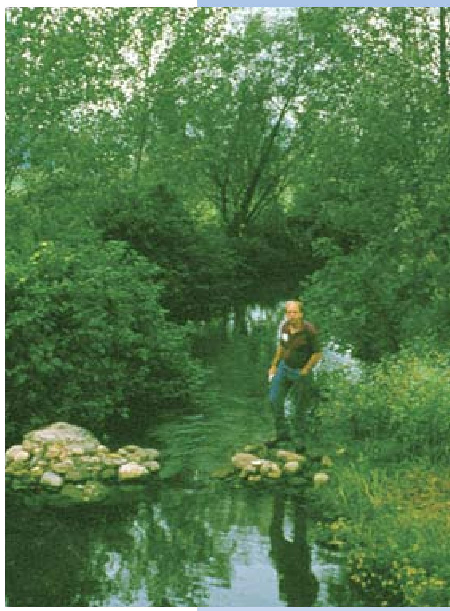
BMPs FOR TREED BUFFER STRIPS

Buffer strips come in all shapes and sizes, and for good reason. Wide buffers are needed for wildlife habitats, whereas 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.

Once established, a young treed buffer provides cover and protects the riparian area.

Riparian areas consist of banks or shores, floodplains and ravine slopes.



The key to a successful riparian buffer is to match design with desired function.

A mature treed buffer performs most of the functions of a naturally forested riparian area.

Look for multi-function when designing a buffer strip. Link natural areas wherever possible.

Tree and shrub roots provide more bank stability. A minimum buffer width of 5 metres (16.5 ft) is recommended. In this buffer, the entire floodplain was planted.

In this section, we'll look at:

► function – what you want your treed buffer strip to do

► design – the site features and considerations that will make the most effective design for your property

► plants – which trees, shrubs and grasses will work best in your buffer strip

► establishment – what steps to take to get your buffer strip in place.

Grassed 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 features greater overall diversity of plants and animals.)

Buffers make ideal wildlife corridors, which are important for survival. For wildlife, wider is better.

Shaded buffers are particularly important to cool- and cold-water fisheries.

As we get into the details, please remember: buffer strips are not stand-alone measures. In agriculture, buffer strips should be considered as part of a cropland conservation plan. To repeat, **buffers are intended as the <u>last</u> (not the only!) line of defence against erosion and runoff.**

This is a before-and-after example of a treed buffer planted on the side of a drainage ditch. The intent is to integrate the principles of improved fish habitat with practicality in a buffer design.

FUNCTION

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

For example, say 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 with a single row of fast-growing trees.

Treed buffer strips are the most effective choice for most riparian functions.

RELATIVE EFFECTIVENESS OF RIPARIAN TYPES BY FUNCTION*

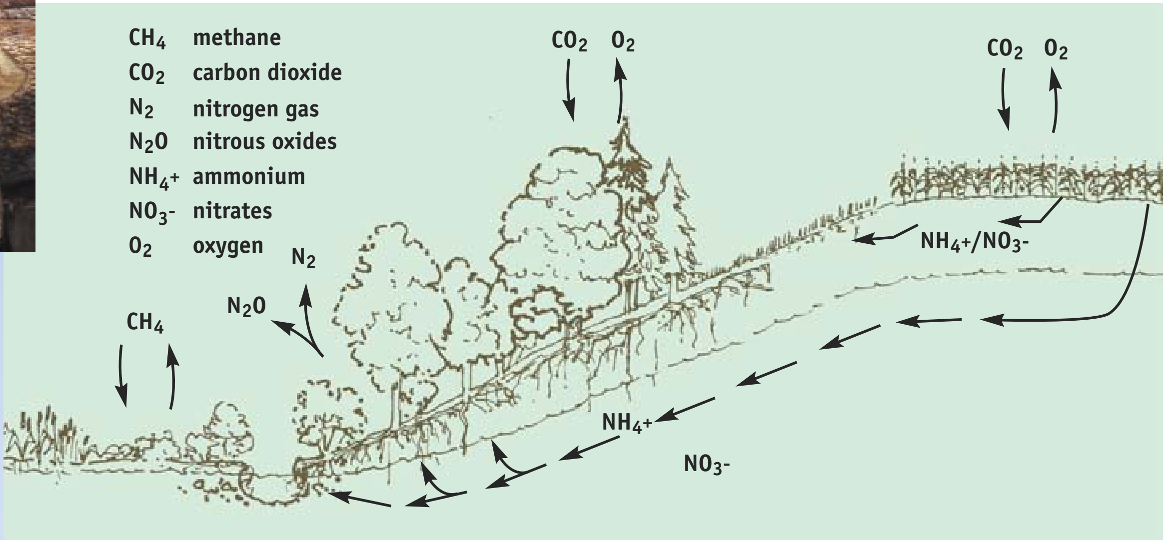
FUNCTION	VEGETATION TYPE		
	GRASS AND FORBS	SHRUBS	TREES
BANK/SHORE STABILITY	Low/Medium	Medium/High	High
FILTRATION OF SEDIMENT	High	Low/Medium	High
FILTRATION OF SOIL-BOUND NUTRIENTS, PESTICIDES, BACTERIA	High	Low/Medium	High
RETENTION OF SOLUBLE NUTRIENTS, BACTERIA, PESTICIDES	Low	Low	Medium
WATER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

* Adapted from Tjaden and Weber, 1998, Riparian Buffer Systems, MCU Extension Fact Sheet 733

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

Treed buffers moderate water temperatures, provide food for aquatic life, offer cover for wildlife, and filter nutrients and contaminants.

Treed buffer strips can produce high-value timber products.



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.

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.

EFFECT OF SITE AND LAND USE FEATURES ON DESIGN OF TREED BUFFERS

FEATURE	IMPLICATIONS
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 tree, shrub and grass species suitability (e.g., flood tolerance)
SLOPE	• the steeper the slope, the greater the 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 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 planting design should adjust to these influences on shape
LAND USE	• adjacent land uses could be residential, agriculture, natural areas, etc. ○ e.g., the nature of impacts from cottages (such as 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 species selection plantings and additional erosion control needs • similarly, a simple, narrow, grassed buffer strip with a single row of trees may work for a municipal drain, while a multiple-row planting would be more suitable for a deeply cut, meandering stream through hilly cropland

Assuming land function is the same on both sides of a watercourse, buffers on either side should be approximately the same width.

WIDTH

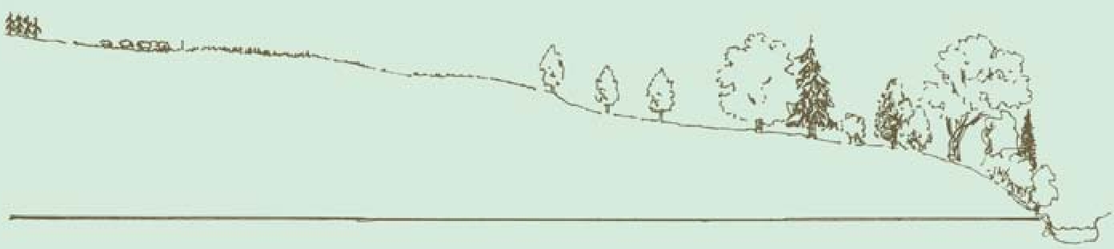
Width is a key design factor. Wider buffers are more effective at filtering contaminants, encouraging infiltration and providing diversity of habitat.

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% 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.



Bank stability, 5+ metres (16+ ft.)

Sediment removal, 10–30 metres (33–98 ft.)

Soil-bound nutrients, 10–30 metres (33–98 ft.)

Soluble nutrients, 15–50 metres (50–164 ft.)

Aquatic habitat, 15–30 metres (50–98 ft.)

Wildlife habitat, 10–300 metres (33 ft.–327 yds.) – >50 m (164 ft.) if for nesting waterfowl

Wider buffers perform a greater number of functions more effectively. However, if the recommended buffer width is impossible, don't despair. Smaller buffers still offer some environmental benefits.

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.

For more information on managing concentrated flow, please see the BMP book, *Buffer Strips*.

Several erosion control measures are often required to control sheet and rill erosion.

BANK AND SHORELINE EROSION

Buffer strip designs should provide for any bank or shoreline stabilization work. The nature and extent of the problems (including slumping) should be determined in the site assessment. See BMP *Buffer Strips* for further details.

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

PLANTS FOR BUFFER STRIP ESTABLISHMENT

This book focuses on establishing primarily treed buffer strips, although buffer strips can also be planted to grass and wildflowers – often a mix of all of the above. Whether trees or grasses or flowers, plants should be selected 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. For more information about suitable non-tree plants for buffer strips, please see the BMP book, *Buffer Strips*.

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

TREES AND SHRUBS FOR RIPARIAN AREAS

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 will provide cover, shelter and food
- ▸ **economic value** – be aware that some of our most valuable trees grow very well in riparian areas.

This planting on Washington Creek demonstrates that on productive riparian sites, fast-growing hardwoods like White Ash can fully shade narrow channels within 10 years.

Stream bottomlands are ideal sites for valuable hardwoods like Black Walnut.

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

Introducing evergreens like White Cedar in row plantings along the edge of a buffer strip creates an ideal travel corridor.

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

SUGGESTED HARDWOOD TREES FOR BUFFER STRIP PLANTINGS

SPECIES	SILVER MAPLE	GREEN ASH	BLACK WILLOW	COTTON-WOOD	BLACK WALNUT	WHITE ASH	RED OAK
FEATURES							
HARDINESS 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	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

SHRUBS FOR BUFFER STRIP PLANTINGS

SPECIES	NINE-BARK	ELDER-BERRY	RED OSIER DOGWOOD	STAGHORN SUMAC	ALTERNATE-LEAVED DOGWOOD	NANNY-BERRY	HIGHBUSH CRANBERRY
FEATURES							
HARDINESS 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 (3.3–16.5 ft)	<2 m (6.5 ft)	1–5 m (3.3–16.5 ft)	2–4 m (6.5–13 ft)	5–10 m (16.5–33 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

SUGGESTED CONIFER TREES FOR BUFFER STRIP PLANTINGS

SPECIES	WHITE CEDAR	TAMARACK	WHITE SPRUCE	WHITE PINE	RED PINE	HEMLOCK	RED CEDAR
FEATURES							
HARDINESS 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

Green Ash, Black Walnut, White Cedar, Tamarack, Ninebark and Dogwood may be suitable for riparian buffers.

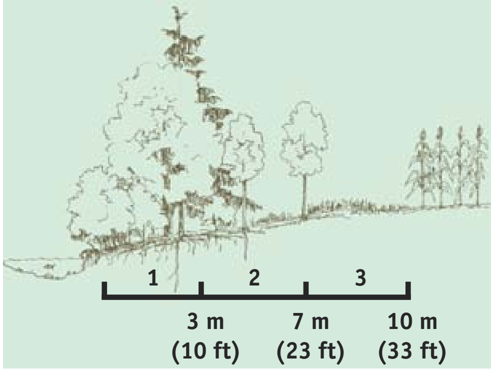
THREE-ZONE BUFFER

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 help with infiltration and floodwater storage. Zone 3 filters cropland runoff and serves as a field buffer.

TREED BUFFER DESIGN

FEATURE	SINGLE-ROW DESIGN	THREE-ZONE DESIGN	MULTI-ROW DESIGN
DESCRIPTION	• row of single trees and narrow grassed buffers established along drains	• a wide buffer design that consists of three zones (minimum total width 10 m [33 ft]) • Zone 1: trees closest to the bank or shore • Zone 2: shrubs/trees/mixture • Zone 3: grasses/legumes	• a wide buffer that follows landscape features (e.g., ravine and floodplain (usually >10 m [33 ft]) • wide range of species combinations – pure conifer/ pure hardwood/mixes/ wildlife habitat
FUNCTIONS	• setback from top of bank • ditchbank stabilization • sediment and nutrient filtering • leaves provide some nutrients for aquatic life • woody debris helps maintain sediment load • shade for stream and fish • nitrate removal from groundwater	• bank and shore stability • filtering of runoff • leaves provide nutrients for aquatic life • woody debris helps maintain sediment load • shade for stream and fish • some nitrate removal from groundwater • some carbon sequestration • wildlife corridors • wood and food products	• bank and shore stability • filters and promotes infiltration • provides nutrients for aquatic life • woody debris helps maintain sediment load • shade for stream and fish • nitrate removal from groundwater • carbon sequestration • wildlife habitat and corridors • wood products
SUITABLE FOR:	• municipal drains • intensively grazed areas where livestock have been excluded • low-order, shallow and deep-channel streams • lakeshores and ponds	• wide-channel streams • narrow watercourses with small floodplain plus steep short banks • highly erodible or fragile lands • gently sloping shorelines and river banks	• large ravine systems with steep slopes that are also of marginal economic importance for crop production or grazing, such as ravines • gently sloping shorelines and river banks
UNSUITABLE FOR:	• slopes >10% • natural riparian areas • deep ravines with broad floodplains	• intensively cropped prime farmland • wetlands (unless geese are troublesome)	• low-order, shallow and deep-channel streams

TREED BUFFER DESIGN			
FEATURE	**SINGLE-ROW DESIGN**	**THREE-ZONE DESIGN**	**MULTI-ROW DESIGN**
DESIGN CONSIDERATIONS	• width: minimum of 5 m (16 ft) for most situations • establish sod cover on buffer strip • place trees 2–3 m (6.5–10 ft) back from edge of bank	Zone 1 • use water-tolerant trees if floodplain floods frequently • select fast-growing trees • space trees between trees and rows (2–3 or 6.5–10 ft) Zone 2 • use high-value hardwoods best suited to the site • select suitable shrub species Zone 3 • could be used as turning area for cropping equipment	For floodplain • use water-tolerant trees if floodplain floods frequently • select fast-growing trees nearest top of bank



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.

Single-row design: A combination of grass and fast-growing trees can provide considerable protection for waterways without taking up much valuable cropland.

Multiple-row design: Several rows of trees and shrubs are more suitable for sites with wide valleys and steep ravine slopes.

HOW TO DEVISE 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 how-to's:

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. Consult with a conservation authority to discuss risk assessment and identify opportunities. Select functions for the buffer strips. Talk to neighbours.

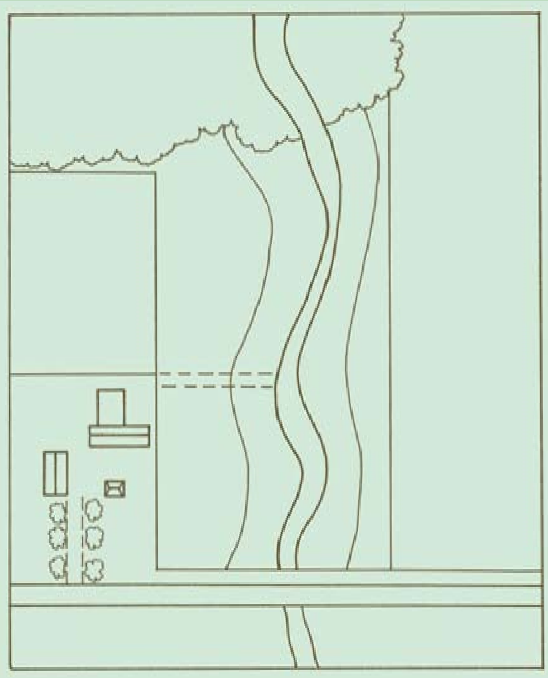
Step 3. Assess upslope conditions on the farm. Ask yourself whether additional soil and water conservation BMPs would enhance the effectiveness of your buffer strip(s).

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 irrigating, sampling the soil, fertilizing, pruning or clipping, replacement and weed control. Confirm survival rates of planted grasses, shrubs and trees. Look for washouts and rill cutting across the buffer strip. Determine if the project is fulfilling its intended functions. Assess whether additional BMPs would improve its effectiveness.

SAMPLE RIPARIAN MAP



Consult with your local conservation authority to discuss risk assessment of the riparian area and identify opportunities.

Single-row, treed, narrow buffer strip designs are most suitable along drains.

Layout

✔ **Sketch buffer strip plan on map** or aerial photograph.

✔ **Soil test** to ensure phosphorus and potassium (P and K) levels are suitable for early growth – don't apply nitrogen.

✔ **Tie in fencerows and natural areas** – where possible.

✔ **Consider setting aside odd-shaped areas** – where site features or land use change.

✔ **Fence livestock away from treed buffer** – if buffer strip is part of a livestock exclusion project.

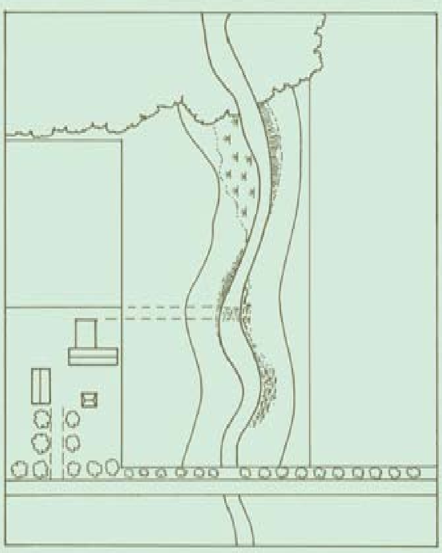
Trees

✔ **Determine whether you want the buffer width to be uniform or vary** with stream meandering, i.e., whether you want to straighten edge of field (see illustration).

✔ **Clearly distinguish zones:** Zone 1 from Zone 2 (or Zones 1 and 2 from Zone 3 if three-zone design) – if trees are to be planted into old sod before establishing Zone 2

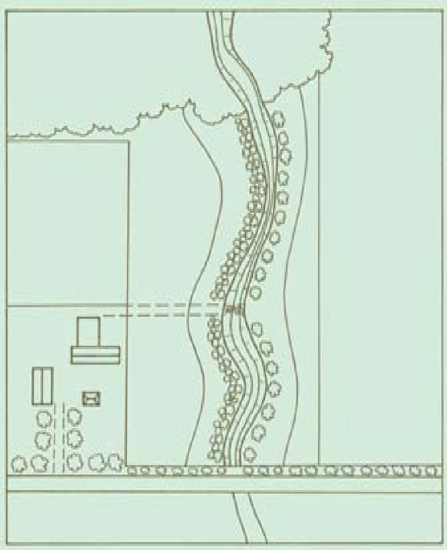
✔ **Use stakes to mark desired location of larger stock trees** – if part of the plan.

BEFORE



The sketch on the left is the "before", and the sketch below shows the planned projects for an on-farm riparian area. Cropland erosion is evident from the sloping field on the left of the stream. Bank degradation from intensive livestock access is noted on the right side of the stream.

PLANNED PROJECTS



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 grazing area adjacent to the treed buffer.

ESTABLISHMENT AND MANAGEMENT OF TREED BUFFERS

SITE PREPARATION

Trees and Shrubs

If site is to be tilled:

✔ **reconsider and use spot herbicide treatment in Zones 1 and 2** in exact spots where trees are to be planted. Tree and shrub plantings are easier into killed sod.

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

Planting

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.

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

Handle trees with care. Avoid exposing roots to sun and wind.

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 OMAFRA recommendations contained in Publication 75, *Guide to Weed Control*.

✔ **Mow regularly and maintain fertility levels** to help ensure stand composition.

Monitoring

✔ **Repair and replant damaged areas** – check tree and shrub survival.

✔ **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.

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

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

Use large tree stock and saplings rather than seedling tree nursery stock where feasible in riparian plantings. Survival and growth rates are better in these densely weeded environments.