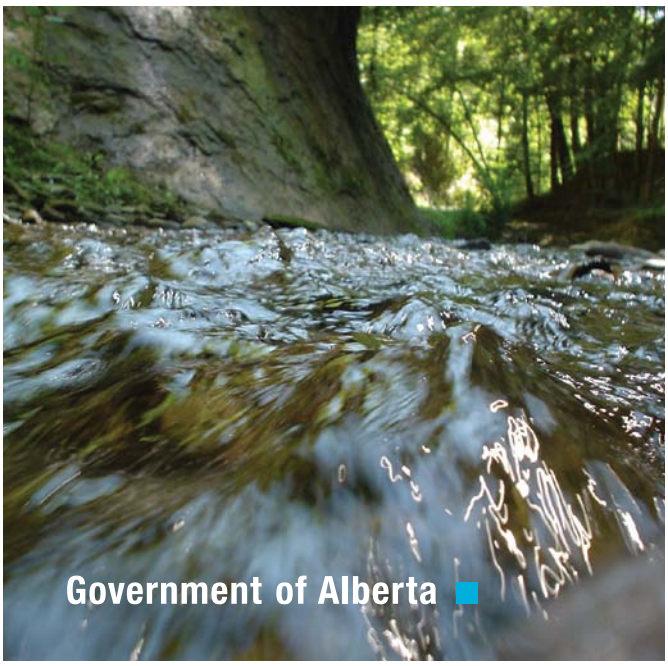
Stepping Back from the Water

A BENEFICIAL MANAGEMENT PRACTICES GUIDE FOR NEW DEVELOPMENT NEAR WATER BODIES IN ALBERTA'S SETTLED REGION



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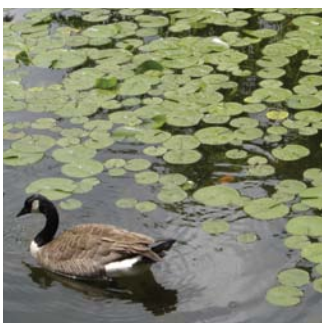

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This report can be cited as: *Stepping Back from the Water: A Beneficial Management Practices Guide for New Development Near Water Bodies in Alberta's Settled Region*.

ISBN: 978-1-4601-0058-5 (Printed Edition)
ISBN: 978-1-4601-0059-2 (On-line Edition)

Foreword

INTENDED USERS OF THIS DOCUMENT

This handbook is for anyone with an interest in minimizing the impacts and risks associated with development[1] near water bodies. The emphasis is on conserving riparian areas, the lush strips of land adjacent to lakes, rivers, streams and wetlands.

WHAT IS THE PURPOSE OF THE DOCUMENT?

The question often arises: what is the minimum setback needed to protect aquatic ecosystems from development such as buildings, roads and other permanent structures? This handbook answers this question by providing decision makers with information for determining setback widths and designing effective buffers adjacent to water bodies.

Scientific studies from around the world have shown that healthy riparian areas provide essential ecological functions. Albertans recognize the need to protect and conserve water resources and aquatic ecosystems, along with their shorelines and unique landscapes including floodplains, ravines and valleys[2]. But, construction activities in riparian areas can lead to erosion and sedimentation, flooding, slope failure, surface and groundwater pollution, and loss of valuable fish and wildlife habitat. This handbook can help avoid these and other problems by ensuring adequate setbacks and managing erosion and pollutants at source.

WHAT'S IN THIS DOCUMENT?

This publication contains the following information:

- An introduction to riparian areas;
- Recommendations for setback widths and buffers;
- An overview of riparian areas and how they function;
- Measures for protecting and conserving riparian areas;
- A listing of legislation and policy affecting riparian areas in Alberta;
- Examples of riparian guidelines from other jurisdictions;
- Managing runoff from new development; and,
- A resource list for further reading.

This document deals with setbacks only for new development adjacent to water bodies in Alberta's settled region. There are several types of setbacks for protecting water bodies in Alberta, affecting activities such as agriculture, timber operations, and oil and gas. These are beyond the scope of this document. Appendix 1 contains additional information about setback requirements in Alberta and the legislation that governs them.

[1]As defined in the *Municipal Government Act*, development may consist of a building, excavation or stockpile. See the glossary in this report for a complete definition.

[2]Sections 5 and 6.3 of the provincial Land Use polices encourage municipalities to identify unique and sensitive landscapes and take measures to minimize possible negative impacts of subdivision development.

ACKNOWLEDGEMENTS

This document was prepared by Alberta Environment and Water with assistance from AMEC Earth and Environmental and the Alberta Riparian Habitat Management Society (Cows and Fish). It is based on an extensive review of scientific studies and accepted beneficial management practices. Valuable input was received through consultation with various Government of Alberta departments, municipal officials, land-use planners, academic researchers and watershed groups. The document follows on several key recommendations and conclusions of a report[3] prepared in 2007 by a multi-stakeholder working group chaired by Alberta Environment and Water, namely:

- Healthy intact riparian lands deliver broad benefits to society;
- Riparian lands are transition zones between the land and water. Their unique and dynamic nature present special challenges for their delineation and management;
- Riparian management is a shared responsibility of governments, communities and landowners. Within this management system, it is the role of governments to assure environmental quality;
- The best tools to achieve riparian land protection are those that help achieve outcomes and fit local environmental, social and economic conditions.

[3] *Riparian Land Conservation and Management Project: Phase One Final Report.* 2007. Prepared by Alberta Environment and Water for Riparian Land Conservation and Management Project Members.

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Executive Summary

BACKGROUND

As the Ministry responsible for the *Water Act* and implementing *Water for Life*, Alberta Environment and Water has a strong interest in maintaining the integrity of riparian areas. Fundamental to the *Water Act* is the recognition that the protection of the aquatic environment[4] is essential to sustainable water management. The health of rivers, streams, lakes and wetlands involves more than managing water quantity and quality. Activities on lands near water bodies can also have a profound effect on aquatic ecosystem health and sustainability. Maintaining healthy aquatic ecosystems is one of three goals identified in Alberta's *Water for Life* strategy, which recognizes that healthy aquatic ecosystems are vital to a high quality of life for Albertans. Riparian areas, the strips of land adjacent to water bodies, have an important role in the natural regulation of water quantity and improvement of water quality. They provide many other important benefits to society including flood water conveyance and storage, groundwater recharge, shoreline protection, forage for livestock, and habitat.

The impacts and risks associated with development of riparian lands are well documented, but provincial direction on how to reduce and minimize the impacts and risks in Alberta's settled region is needed. As Alberta's population and economy continue to grow, pressure on riparian lands is increasing and the benefits they provide are being compromised. Currently, subdividing authorities have the ability to establish building development setbacks, or dedicate environmental reserve strips, for the purpose of preventing pollution. However, guidance has been lacking on exactly how wide an effective filter strip should be. In response to these and other concerns, Alberta Environment and Water has prepared this handbook to help minimize the impact of new development on water bodies in Alberta's settled region. By keeping permanent developments an appropriate distance from the water, maintaining riparian areas in a healthy state, and managing sources of pollution in our watersheds, the ecosystem services provided by riparian areas can be maintained and enjoyed for generations to come.

CONTENT AND SCOPE

The *Stepping Back from the Water* handbook is designed to assist municipalities, watershed groups, developers and landowners in Alberta's settled region determine appropriate water body setbacks for development around our lakes, rivers and wetlands. It will also encourage new policies for achieving riparian environmental outcomes. The handbook will help users with the following:

1. Identifying riparian lands, and understanding key riparian area functions;
2. Understanding how setbacks can be applied to create effective riparian buffers;
3. Conserving and managing riparian land;
4. Managing erosion and pollutants associated with new development.

The *Stepping Back from the Water* document contains recommendations for development setbacks and riparian buffer management based on a review of the scientific literature, published monographs, and regulatory and planning documents from various jurisdictions in Canada and the USA. Buffer strip recommendations for water quality functions were made using only the scientific literature, whereas a variety of sources were used relative to other core riparian functions including flood water conveyance and storage, bank stability, and habitat. In these cases, existing policies and beneficial management practices supplemented the scientific literature and offered practical guidance.

The *Stepping Back from the Water* handbook also provides guidance on watershed-scale approaches for protecting water bodies, sensitive areas, wetlands, shorelines and water quality, recognizing that riparian buffer strips alone are unlikely to reduce runoff and nutrient loading into surface waters. The importance of working together, and using a broad suite of tools and approaches to manage human impact on our natural environment, cannot be overemphasized. Later sections and the report's appendices contain information and links for land and water management beyond riparian areas.

[4]The aquatic environment is a complex system that is influenced by many factors such as climate, weather patterns, landscape and geology. It includes naturally occurring features, such as rivers, streams, creeks, riparian areas, lakes, wetlands and groundwater. Each water body is associated with a unique variety of plant and animal life as well as a riparian area.

HOW DO *STEPPING BACK FROM THE WATER'S* RECOMMENDATIONS COMPLY WITH EXISTING ALBERTA GUIDELINES AND REQUIREMENTS FOR SETBACKS ADJACENT TO WATER BODIES?

The recommendations for water body setbacks and riparian filter-strip widths in *Stepping Back from the Water* are discretionary. They are intended to assist local authorities and watershed groups in Alberta's White Area[5] with policy creation, decision making and watershed management relative to structural development near water bodies. Alberta Sustainable Resource Development provides municipalities with guidelines for minimum environmental reserve/ easement widths; however, *Stepping Back from the Water's* recommendations can be used to supplement those guidelines. When timber is cleared under a timber disposition, the Alberta Timber Harvest Planning and Operational Ground Rules will provide direction for the removal of the timber and the buffers (setbacks) required. Appendix 1 contains additional information about setback requirements in Alberta and the legislation that governs them.

STEPPING BACK FROM THE WATER HANDBOOK HIGHLIGHTS

- Setback recommendations are made with the following factors in mind:
  - » water quality functions of riparian areas,
  - » effect of slope on effectiveness of vegetated filter strips,
  - » risk of shallow groundwater contamination,
  - » flooding,
  - » shoreline migration, and
  - » bank stability.
- The 1:100 flood is recommended for determining setbacks relative to flood water conveyance and storage,
- Appropriate environmental assessments are recommended for protecting shallow groundwater and avoiding unstable ground,
- Additional buffer considerations are recommended for protecting aquatic and terrestrial habitat, wildlife travel corridors, and rare species,
- An appendix contains a summary of federal and provincial legislation, regulations, policies and guidelines that affect water body or riparian area management in Alberta,
- Examples from various Alberta municipalities and other jurisdictions are included to illustrate how others have approached riparian area management.

Alberta's Settled (White) Area

[5]Alberta's White Area was set aside as land primarily suited for agriculture and settlement. It covers about 39 per cent of Alberta (see map).

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

Setbacks and Buffers

INTRODUCING YOU TO RIPARIAN AREAS

You have likely walked in or crossed over a riparian area. You may live, work or play in one. As Alberta was settled, pioneers were attracted to agricultural land that was partly covered by woods and water. Sought-after lands often included riparian areas along rivers and streams or around wetlands and lakes. Towns and cities have since evolved from these early settlement patterns and many Albertans still live next to or in riparian areas. Over time, residential developments, recreational amenities, roads and industrial activities have encroached more and more on these attractive areas. Our current demands on riparian areas now compromise their ability to provide the environmental, aesthetic, and economic benefits that attracted settlers in the first place.

Let's Talk About Water

Albertans are concerned about water since our lives are intertwined with fresh water from surface and groundwater sources. Many of us live in areas of the province where water supplies are not abundant. The limiting factor to us isn't space, it's water. Water is essential for life and commerce; a finite amount means our care of it should be paramount.

Albertans have identified water quality and quantity as priorities. What influences water quality and quantity? In many cases it is how we treat the landscape (and watershed) and the areas that adjoin water – riparian areas. What can we do better and smarter around water bodies to improve and maintain them? To start we need to be able to identify those pieces of the landscape essential for our attention and management.

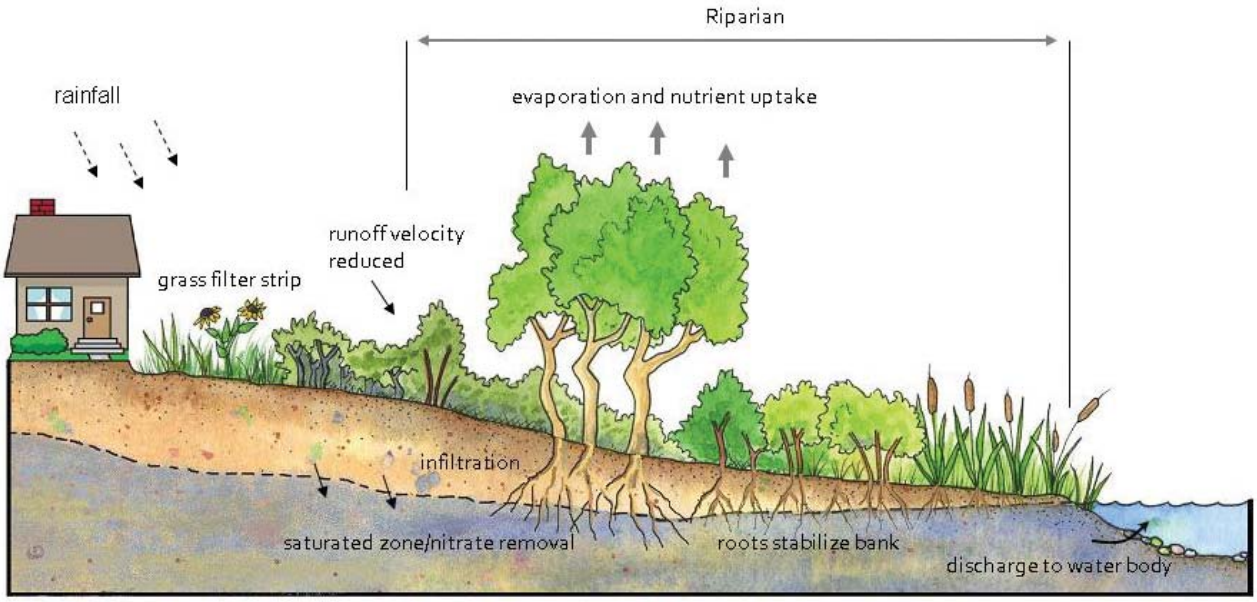
Credit: Alberta Riparian Habitat Management Society (Cows and Fish)

What are Riparian Areas?

If we get back to the basics, riparian areas are the place where water and land meet and interact. It is the interaction part that best defines a riparian area. They usually are distinctly different from surrounding lands because of unique soil and vegetation characteristics that are influenced by the presence of water above the ground and below the surface. Riparian areas occupy a small part of the landscape, but are important ecologically, socially and economically. They are the "thin green lines" between all we do in uplands and the effect of that use on aquatic ecosystems.

Riparian areas are created and maintained by water. A lot of water is present, seasonally or regularly, on the surface or close to the surface. Native riparian vegetation requires and survives well with abundant supplies of water. Soils have been modified by water, the deposition of sediment and by lush vegetation. Typical native riparian plants in Alberta's settled region include sedge, cattail, willow, cottonwood and poplar. Topographically, the riparian area can have variable widths and can be sloped or flat. Groundwater generally flows along the topographical gradient, or where the riparian area is level to gently sloping, flow direction is influenced by the surface water level. When your eye has been trained to recognize these unique areas, the distinctions between riparian and upland boundaries become clear. In some cases, because of developments that encroach into riparian areas, that distinction is lost. Only when riparian areas are inundated by high water, from a flood for example, are we reminded that these areas are created and maintained by water.

Figure 1
Illustration Showing a Riparian Area and Some of Its Interactions with Water



What Makes Riparian Areas Special?

As our understanding about the role of riparian land grows, so does our appreciation of how important these areas are to us. Healthy riparian areas possess several unique functions and provide important ecosystem services and benefits to society including:

Water Quality Functions (sediment, nutrients, flows and temperature)

- Improve water quality by trapping sediment, sediment-bound nutrients and other contaminants from surface runoff before they reach the water and downstream water users
- Reduce the velocity of sediment-bearing storm flows, allowing sediments to settle out of water and be deposited on land instead of being carried downstream
- Contribute large woody debris (snags) to streams that can trap large amounts of sediment
- Remove nutrients from groundwater via uptake in vegetation and by denitrification
- Help prevent eutrophication of aquatic ecosystems
- Shade and cover provided by riparian vegetation can moderate water temperature in small (low order) streams

Flood Water Conveyance and Storage

- Riparian areas reduce peak flows and downstream flooding. As flood water flows through a vegetated area, the plants resist the flow and dissipate the energy, increasing the time available for water to infiltrate into the soil and be stored for use by plants.
- The water that is stored in shallow groundwater (alluvial) aquifers helps maintain stream flow (and water quality) during low flow periods.

Bank and Shoreline Stabilization

- Deep-rooted, native plants protect shorelines by reducing bank erosion, bank failure, sediment transport, and loss of valuable lands

Habitat and Biodiversity

- Capture organic matter that is a source of food and energy for the aquatic ecosystem
- Support an exceptional level of biodiversity due to natural disturbance regimes, a diversity of habitats, and small-scale climatic variations
- Support species at risk
- Provide undercut banks, shade, food and woody debris to aquatic ecosystems
- Facilitate plant and animal dispersal along green corridors

Finally, naturally functioning riparian areas provide a range of social and economic benefits through their provision of water quality functions and other processes:

- Provide public access, recreational and educational opportunities in an aesthetically pleasing landscape
- Capture and slow flood waters, thereby decreasing damage to property
- Provide an important source of grazing land and forage for managed livestock grazing
- Provide green space that can increase property values
- Reduce the need to combat flooding, repair eroding stream banks, and replace damaged property

Other sections of this handbook contain more information about riparian areas and the benefits they provide to property owners, communities and to society.

DRAWING THE LINE: SETBACK WIDTHS

Setbacks identify the minimum distance required between water bodies and development, separating those areas where we want to work and live from what we want to conserve and protect. The strip of land created is generally called a buffer. Buffers are sometimes described as the boundary between the natural and the man-made world. Buffers can be comprised of a vegetated filter strip[6] consisting of riparian and upland vegetation, a slope allowance, and in some cases can include a wildlife corridor as well.

To function effectively, riparian areas must be healthy. Placing permanent structures in riparian areas not only compromises riparian function, but puts people and property at risk from flooding, ice damage, unstable ground and other dangers. Development of riparian lands can have many undesirable consequences including: altered drainage and sedimentation processes, decreased bank stability and increased erosion and pollutants, introduction of invasive species, habitat loss, and visual impacts. In many cases, development near water will be constrained by an active flood plain and topographic factors such as steep slopes and unstable ground. Keeping development back from such hazards will in most cases be sufficient for avoiding riparian areas. In others, it may be necessary to maintain a vegetated filter strip as a buffer. This chapter explains how setbacks can be determined for different types of water bodies found in Alberta's White Area, and how setbacks can be used to create effective riparian buffers.

The approach described in this document can be used for most types of permanent developments including the following:

- Urban subdivisions
- Country residential developments
- Cottages
- Farm buildings
- Golf courses (buildings)
- Commercial buildings
- Stormwater ponds
- Roads and dikes, and
- Temporary land uses such as sand and gravel pits.

Scientific studies have found that the effectiveness of riparian buffers as water quality filters varies from location to location. The size, topography and geology of the watershed determine the amount and quality of surface water and groundwater that passes through a buffer. Site characteristics such as slope, soils and substrate can determine the amount of pollutants that are filtered out before they reach the water body. Although the type and health of vegetation can affect sediment removal effectiveness, nitrate removal in riparian areas is influenced mainly by hydrogeological characteristics, for example see Vidon and Hill (2004, 2006).

The large number of variables that control the effectiveness of riparian buffers in filtering pollutants underlines the importance of maintaining riparian areas in a natural state and in so doing, maintaining ecological processes. For example, studies suggest that the quantity and quality of the organic carbon in subsurface sediments in riparian areas regulate the removal of nitrogen (Hill and Cardaci 2004), and zones of high biological activity and groundwater flow are more effective at removing this nutrient (Maitre et al. 2003). Although prescribing a minimum setback distance is difficult, scientific studies generally agree that wider, forested riparian strips are more effective at removing pollutants. The setback needed to maintain other important functions including water storage and flood control, bank stabilization, and aquatic and terrestrial habitat depend more on hydrological and landscape factors than width alone.

Setbacks should be determined on a case-by-case basis by a person or persons qualified to make these assessments. This may involve a report certified by a professional biologist, engineer, geologist or geophysicist, as defined in the appropriate legislation governing these professions.

[6]A vegetated filter strip is land left in a natural, preferably undisturbed state, usually consisting of riparian soils and native or planted vegetation, situated between development and a water body.

Thinking About Objectives

Organizing objectives according to the water body classification used in this document is recommended. The classification includes: 1) Lakes and Class III, IV, V, VI & VII Wetlands; 2) Rivers and Streams; 3) Ephemeral/intermittent streams; 4) Class I & II Wetlands, Seeps and Springs. Ephemeral streams are streams that flow only during and immediately after rainstorms. Intermittent streams flow for part of each year.

Setbacks are only one tool for achieving desired environmental outcomes for riparian lands and aquatic environments. Managing development and agricultural and industrial land uses throughout the watershed play an integral role in protecting sensitive landscapes and managing sources of pollution. Later sections and the appendices of this report contain information on policies, legislation and resource management strategies for achieving environmental outcomes.

Policy and Legislation Affecting Riparian Areas

Working knowledge of relevant policy and legislation and how they affect development adjacent to water bodies is a prerequisite for ensuring that any proposed or new setback widths complement and do not conflict with existing sets of rules. For example, municipalities may have addressed riparian and wetland protection in their plans and polices, or may have created guidelines for setbacks in their Area Structure Plans. Alternatively, watershed management plans may provide additional guidance for riparian conservation and management.

There are several important pieces of legislation affecting land development on or adjacent to shorelines and riparian areas in Alberta, including the following:

- *Municipal Government Act* – Alberta Municipal Affairs
- *Fisheries Act* – Fisheries and Oceans Canada (DFO)
- *Migratory Birds Convention Act* – Environment Canada, Canadian Wildlife Service
- *Navigable Waters Protection Act* – Transport Canada
- *Public Lands Act* – Alberta Sustainable Resource Development
- *Water Act* – Alberta Environment and Water
- *Forest Act* – Alberta Sustainable Resource Development

Appendix 1 contains a complete list of policy and legislation affecting riparian areas along with a brief summary of each policy or act.

Technical Information Needs for Determining Setback Widths

The more detailed information that is collected and used in this process, the more likely the buffer will provide desired ecosystem services and benefits. This section describes the technical information needed for determining setbacks, along with recommended data sources (Table 1). At a minimum, information assembly should support the determination of filter strip width, unstable ground, erosion-prone areas, and the flood plain.

The retention of full-width buffers to protect habitat and biodiversity may not always be practical; however, emphasis should be placed on protecting environmentally significant areas, sensitive wildlife habitats, and rare species. In the absence of recent data for the specific site or area that is being considered, a qualified environmental professional may be needed to identify and collect relevant information.

Mapping the Legal Bank of a Water Body

The legal bank[7] of a water body should be determined as defined in the *Surveys Act*. Setbacks should be measured from this line, except for ephemeral/intermittent streams where the middle axis of the channel can be used. Aerial photographs and Alberta hydro-net data can be used to map the legal bank; however, using a LiDAR-derived Digital Elevation Model (where available) will give a much more accurate representation of stream networks and wetlands, and water body boundaries. The actual legal bank will have to be determined for each individual water body in the field at time of survey. Marshland or wetland vegetation such as cattails and sedges form part of the bed and shore of a water body.

[7]Under Section 3 of the *Public Lands Act*, the Crown claims title to the beds and shores of all permanent and naturally occurring bodies of water including rivers, streams, watercourses and lakes.

Table 1
Recommended Data and Sources, by Function

Type of Data	Data Source
Water Quality Functions	
Topography and Slope[8] • Topographic slope from the legal bank extending out to adjacent uplands, including floodplains and valley escarpments.	**Maps** Alberta Geological Survey; Alberta Soil Information Viewer (AGRASID); Canadian Soil Information System (CanSIS) **DEMs** AltaLIS: Spatial Data Warehouse Ltd.; DEMs using LiDAR: Alberta Sustainable Resource Development
Parent Material • Glacial till or water/wind deposited substrate.	**Maps** Alberta Geological Survey; Alberta Soil Information Viewer (AGRASID); Canadian Soil Information System (CanSIS)
Groundwater • Surficial aquifers/alluvial aquifers (areas of high hydraulic connectivity between surface water and groundwater and vulnerable to surface contamination)	**Maps and Records** • Agri-Environment Services Branch (AESB); Alberta Environment and Water: Groundwater Information Centre, Groundwater Observation Well Network; Groundwater Centre (www.tgwc.com); Watershed Management Plans
• Shallow groundwater (< 1.8 m)	• Geotechnical studies.
• Springs, seeps	• Topographic land surveys; geotechnical studies.
Flood Water Conveyance & Storage	
Floodplains (Rivers and Streams) • Floodway and flood fringe • 1:100 year floodplain	**Flood Hazard Maps** • Alberta Environment and Water **Areas Without Flood Hazard Maps** • Use the most recent topographic maps to evaluate land contours & elevations, named water bodies, and wet areas. Choose at least four aerial photos between 1960 (or earlier) and the present to determine if the site is subject to periodic inundation by water. Photos taken during the months of April-June have a higher chance of showing flooded areas; flood photography is also available from Alberta Sustainable Resource Development. The use of satellite and LiDAR imagery is acceptable for determining flood prone areas.
Flood Water Conveyance & Storage	
Flood Levels (Lakes) • 1:100 year level	**Maps** • Alberta Environment and Water
Bank/Shoreline Stability	
Erosion Prone Lands, Undercut Banks • such as the outside bends of rivers having dynamic channels, including highly erodible soils & areas subject to channel migration	**Soil Maps** • Alberta Geological Soil Survey; Alberta Soil Information Viewer (AGRASID); Alberta Agriculture and Rural Development: Water Erosion Risk Map of the Agricultural Areas of Alberta; Canadian Soil Information System (CanSIS); geotechnical studies.

[8]There is a direct relationship between slope and erosion potential, conversion of nutrients, and retention of nutrients. A steeper slope usually results in higher erosion potential and lower nutrient conversion and retention. Slopes with grades of 15 per cent or over are steep. If disturbed, these areas can yield heavy sediment loads on streams. Very steep slopes, over 25 per cent grade, produce heavy soil erosion and sediment loading.

Type of Data	Data Source
Bank/Shoreline Stability (continued)	
Sloping Ground • including slopes more than 25%. Slope constraint maps, if available.	**See "Topography and Slope"** • Some municipalities may have slope constraint maps for areas with approved area structure plans. Note: gathering of these data can be coordinated with preparation of Master and Overland Drainage Plans.
Unstable Ground • such as the base and top of steep banks, or close to seeps and springs	• Geotechnical studies
Habitat/Biodiversity	
Environmentally Significant Areas (ESAs) • includes some riparian areas of major rivers	**Maps and Records** • Alberta Conservation Information Management System (Alberta Tourism, Parks and Recreation). Municipalities also may house updated information.
Wildlife Sensitivity Maps • includes migration corridors, critical wildlife summer or winter range(s), traditional nesting, calving, fawning, or birthing sites, endangered and threatened plants ranges, colonial nesting birds, sensitive amphibian ranges.	**Maps and Data** • available through Alberta Sustainable Resource Development Landscape Analysis Tool used by the Government of Alberta's Enhanced Approval Process. • See also: Ducks Unlimited Canada; Hinterlands Who's Who and Canadian Important Bird Areas (IBA).
Rare Species • Includes wildlife species at risk that rely on or use riparian areas, including northern leopard frog, peregrine falcon, prairie falcon, bald eagle, great blue heron, and other species. • Includes rare plant species or rare plant communities.	**Recommended Land Use Guidelines for Protection of Selected Wildlife Species and Habitat within Grassland and Parkland Natural Regions of Alberta** • Alberta Sustainable Resource Development. ***Species at Risk Act*** • www.sararegistry.gc.ca **Contacts** • Alberta Conservation Information Management System (Alberta Tourism, Parks and Recreation). If the proposed development is in a natural landscape, a rare plant survey should be considered. • Alberta Sustainable Resource Development – Fish and Wildlife Division.
Vegetation • Cover type & composition	**Aerial Photos/Imagery** • Government of Alberta Aerial Photo Distribution Centre **Inventories** • Alberta Grassland Vegetation Inventory, Alberta Vegetation Inventory (Alberta Sustainable Resource Development)

Why Are Riparian Buffers Needed in Urban Areas?

Nitrogen export from urban watersheds generally is a major contributor of water quality degradation and eutrophication of receiving water bodies (McLeod et al. 2006, Massal et al., 2007, Shields et al. 2008). Low density suburbs served by septic systems can be major contributors to downstream nitrogen loading, while more heavily urbanized, impervious areas tend to have a greater nitrogen export under high-flow conditions. Phosphorus export from non-point sources in urban areas is generally less than from agricultural land, except for urban commercial developments where it can be higher. Studies generally show that undisturbed riparian buffers can help ensure proper filtration and maintenance of water quality in urban areas.

Even though urban stormwater systems direct large amounts of stormwater away from riparian areas, substantial amounts of stormwater still reach riparian areas in urban environments, especially during high-flow storm events. Nitrogen and phosphorus loadings in runoff from urban lands are generally higher than from native grass and parkland, and are similar to loadings from pasture and cropland (Table 2). For these reasons, vegetated filter strips adjacent to water bodies are strongly recommended as a beneficial management practice in urban areas, and minimum effective widths for removing pollutants are provided in the following section (Table 3). The recommended widths for vegetated filter strips in Table 3 are based on a thorough review of the scientific literature. Developers wishing to use narrower filter strips should be able to demonstrate that narrower strips are adequate for preventing pollution.

Table 2
Selected Export Coefficients for Various Land Use Categories (kg/ha/yr)

Land Use Category	Total Phosphorus	Total Nitrogen	Author, Location
Urban, residential	0.03-1.90	0.17-0.79	USEPA (2002); Oberts (1989); MDEP (2000); McLeod (2006), Various
Urban, commercial	0.48 1.70-3.00	2.18	McLeod et al. (2006), Saskatchewan Oberts et al. (1989), Minnesota
Lawns, golf courses	0.51 0.19	1.43 1.52	King et al. (2007), Texas Reckhow et al. (1980), Pennsylvania
Parkland	0.03-0.08	0.20-0.82	Jeji (2004), Alberta
Forest	0.18	0.45-2.50	USEPA (2002); MDEQ (2001), Montana
Pasture	0.20-1.42	5.10	Mitchell & Trew (1982), Alberta
Cropland	0.01-0.63	0.010-2.13	Ontkean et al. (2000), Alberta

What is the Appropriate Setback Width?

This section contains a step-by-step approach for determining setbacks for all types of water bodies and various types of development. A checklist, recommendations by function, a table (Effective Widths for Vegetated Filter Strips), and diagrams are provided to help determine what the setback should be for any particular situation.

Checklist

1. **Define scenario**
   Assemble background information. What type of water body is affected? What type(s) of lands are being buffered (e.g., urban, country residential, agricultural)? Are large industrial spills a possibility?
2. **Summarize key information**
   What type of substrate is adjacent to the water body? What is the slope profile of the bank and backshore? Is there unstable ground, and what is its location? Where is the 1:100 year floodplain? Is there shallow groundwater and what is its location?
3. **Determine width of vegetated filter strip**
   The width of a vegetated filter strip needed for removing pollutants will depend mainly on the type of substrate (i.e., glacial tills or sands/gravels).
4. **Determine setbacks relative to site constraints**
   Consider unstable ground, slopes, shallow groundwater, and floodplain.
5. **Additional considerations**
   Adjust setback for other needs including habitat/biodiversity.

Setback Recommendations (By Function)

Water Quality Functions

- Table 3 lists effective widths for vegetated filter strips for removing nitrate, and trapping other contaminants including sediment and phosphorus. For sites that contain both till and alluvial sediments, refer to Table 4 to determine the appropriate widths.
- The risk of contacting shallow groundwater should be assessed, and where necessary, setbacks should be increased to prevent contacting shallow groundwater. Alternatively, measures should be taken to protect against its contamination in accordance with current legislation and guidelines.
- Siting of sewage disposal systems will follow standard Alberta septic system management practices (Appendix 1 contains a list of policies and legislation governing septic systems).
- Siting and maintenance of aggregate extraction pits will follow Alberta's *Code of Practice for Pits*, and *A Guide to the Code of Practice for Pits* (Alberta Environment and Water). A setback of at least 50 metres is recommended along rivers whose channels consist of coarse, alluvial sediments (Table 3). Appendix 1 contains information about the *A Guide for Code of Practice for Pits*.

Bank and Shoreline Stability

- Appropriate setbacks should be used to keep development back from areas that may be susceptible to slope movement and erosion. A geotechnical assessment should be carried out using accepted engineering principles with regard to slope stability, toe erosion and shoreline migration.

Flood Water Conveyance and Storage

Lakes, and Class III - VII Wetlands:

- Setbacks should encompass the 100-year water level, plus an allowance for wave action and, if necessary, an allowance for other water-related hazards such as ice piling.

Rivers and Streams:

- If the flood fringe and floodway have been mapped, the setback should encompass the floodway. In general, new development within the floodway is not permitted. Within the flood fringe area, development may be permitted when certain design conditions are met.
- If the flood hazard area has not been mapped, a qualified environmental professional (e.g., hydrologist) should be retained to properly assess flood hazard risk and provide setback recommendations, using the following criteria:
  - » Flood risk assessments should be conducted within 100m of all named rivers and streams, or wherever flood hazard is believed to exist. Table 1 contains information sources for identifying flood risk areas.
  - » The scope of the assessment will depend on the nature of the development relative to flood hazard. Proponents are encouraged to discuss proposed assessments with Alberta Environment and Water to clarify matters of scope.
  - » To minimize the risk from floods, developments are frequently restricted to outside the generally accepted 1-in-100-year flood elevation line. A 1-in-100-year flood is a flood having a 1 per cent chance of being equalled or exceeded in any given year. Based on the expected floodwater level data (defined by monitoring gauges or geomorphic indicators), a predicted area of inundation can be mapped out.

For more information on flood hazard mapping, go to the Alberta Environment and Water website: www.environment.alberta.ca/3823.html.

Habitat and Biodiversity

- The setbacks for other core functions will in most cases protect aquatic and terrestrial habitat including: undercut banks, shade, food, woody debris, facilitate plant and animal dispersal, and help conserve riparian-dependent species.
- Setbacks should be extended to encompass environmentally sensitive areas, sensitive wildlife areas, and rare species. Each situation should receive an assessment and recommendation by appropriate qualified environmental professionals (e.g., wildlife biologist, botanist, rare plants specialist).
- Appendix 3 contains corridor widths for various species of wildlife and species at risk.

Table 3
Effective Widths for Vegetated Filter Strips

Type of Water Body	Substrate	Width	Modifiers	Notes
Permanent Water Bodies Lakes, Rivers, Streams, Seeps, Springs Class III - VII Wetlands	Glacial till	20m[9]	If the average slope of the strip is more than 5%, increase the width of the strip by 1.5 m for every 1% of slope over 5%	Slopes > 25% are not credited toward the filter strip
	Coarse textured sands & gravels, alluvial sediments	50m[10]	None	Conserve native riparian vegetation and natural flood regimes
Ephemeral and Intermittent Streams, Gullies	Not specified	6m strip of native vegetation or perennial grasses adjacent to the stream channel crest[11]	If the average slope of the strip is more than 5%, increase the width of the strip by 1.5 m for every 1% of slope over 5%	Maintain continuous native vegetation cover along channels and slopes
Class I & II Wetlands	Not specified	10m strip of willow and perennial grasses adjacent to water body[12]	None	Maintain and conserve native wetland or marshland plants on legal bed and shore

In situations where the land near a water body consists of a combination of alluvial or coarse-grained sediments adjacent to the legal bank and glacial till further inland, use Table 4 to determine how wide a vegetated filter strip should be.

[9] Vidon and Hill 2006 (See Appendix 2 for additional supporting references)

[10] Vidon and Hill 2006 (See Appendix 2 for additional supporting references)

[11] Gharabaghi et al. 2006 (minimum width of strip required for capturing sediment > 40 µm)

[12] Liu et al. 2008 (optimal width of strip for capturing sediment)

Table 4
Width Combinations of Vegetated Filter Strips Situated on Both Till & Alluvium (metres)

Alluvium	Till	VFS Width
0	20	20
5	18	23
10	16	26
15	14	29
20	12	32
25	10	35
30	8	38
35	6	41
40	4	44
45	2	47
50	0	50

To use Table 4, first determine the average width of the alluvial sediments that are adjacent to the target water body, and find that width in the "alluvium row" in the table. Then, find the corresponding width of till in the row immediately below. This will determine how wide the alluvium and till strips will be, along with the total width of the strip, for areas with an average slope of less than five per cent.

Example:

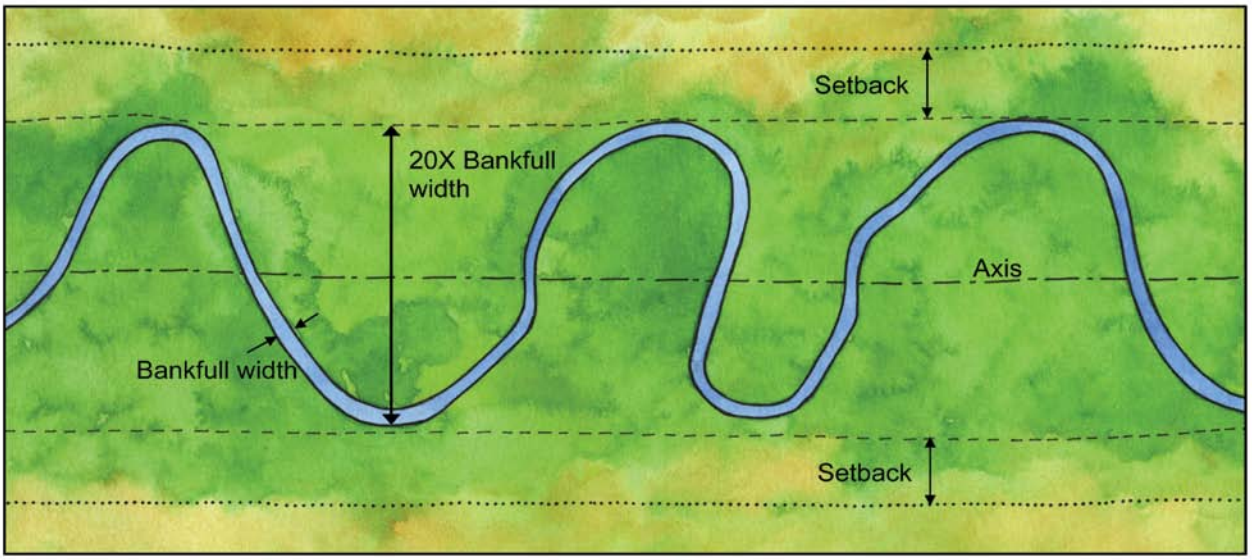
- Average width of alluvium from map or field measurements = 10 metres
- Corresponding width of glacial till = 16 metres
- Total width of vegetated filter strip = 26 metres

Figure 5 contains another example of how to determine filter strip width on sites that consist of both till and alluvium.

Additional Considerations

- Riparian areas that are currently in a natural state, especially filter strips adjacent to a drinking water source, should be maintained free of any development or impervious surfaces that may increase the chances of polluted runoff entering the water body.
- Riparian areas that are already disturbed should be reclaimed to a natural state. This may be done as compensation under *Fisheries Act* authorizations.
- The most effective filter strips contain healthy, native forest vegetation and perennial grasses to improve diffuse flow and trap sediment. In general, the wider the filter strip the better it will perform; however, the first five metres are critical for the removal of suspended sediments (Gharabaghi et al. 2006). More than 95 per cent of the aggregates larger than 40 μm in diameter (coarser silt fraction plus sand) can be captured within the five metres of a grass strip.
- Regular harvesting of buffer vegetation may reduce export of phosphorus.
- Revegetate cleared areas and bare ground by planting perennial grasses, trees and shrubs.
- Remediate concentrated flow paths where possible and install additional grass buffer strips or grassed swales.
- For medium-sized and smaller watercourses that have actively moving channels through the active processes of bank erosion and bank building, consider using the width of the meander belt (Figure 2). For such streams, aerial photos often show the existence of abandoned channels or oxbows and other associated features, and can help in mapping the meander belt. The meander belt is determined by multiplying bank full width by 20 for each reach, and is split equally on either side of the channel along its axis. Setbacks are measured from the edge of the meander belt as opposed to the legal bank of the watercourse.
- Use a minimum 30 metre buffer if the water body is fish bearing or where the riparian vegetation is dominated by trees. This would enhance shading and overhang by trees, important elements on fish-bearing streams.

Figure 2
Schematic Diagram of a Meander Belt



Reservoirs

Note:
Alberta Environment and Water requires a certain amount of land around reservoirs. This area is often referred to as the reservoir right-of-way or buffer zone. The reservoir right-of-way is determined after consideration of geotechnical data on soil and slope stability, potential flood levels, and mitigation requirements. Generally, the criteria used to determine the amount of right-of-way is the top-of-dam contour elevation with a minimum distance of 30 metres from the reservoir full supply level. Where the top-of-dam contour elevation falls across a slope, additional land is acquired to ensure stability.

Industrial Development and Transportation

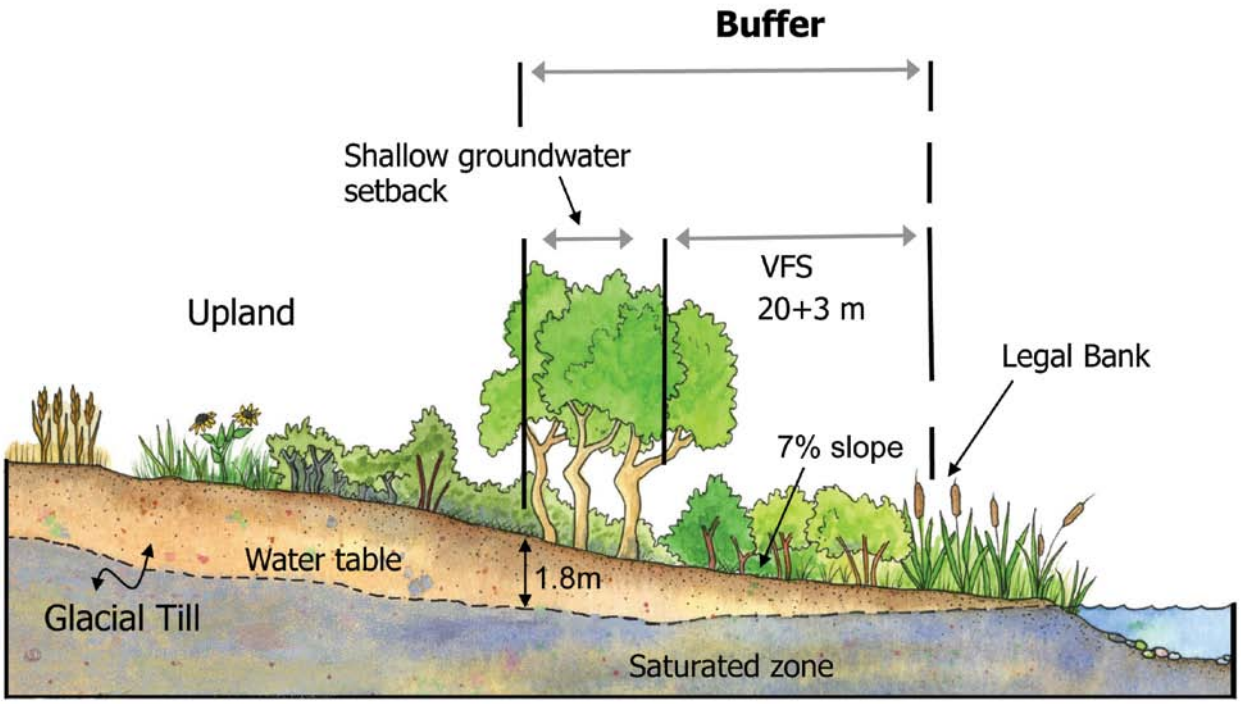
- All new proposed industrial developments will follow Alberta Environment and Water's *A Guide To Content of Industrial Approval Applications*.
- All new and upgraded rural watercourse crossings will follow Alberta Transportation's best practice *Guideline for Stormwater Management at Rural Stream Crossings*.

Buffer Diagrams

This section contains some diagrammatic examples of how setbacks can be applied to create buffer strips on various water bodies using the rules described above. The relative setback widths shown are only examples. Actual setback widths will depend on local conditions. The diagrams are drawn not to scale.

Note:
The total buffer should be wide enough to achieve all desired functions, but it should be no less than the calculated width of the vegetated filter strip (i.e., 20 metres + slope factor for glacial till; 50 metres for alluvial sands/gravels), where contaminant removal is a priority.

Figure 3
A lake or wetland buffer on glacial till, comprised of a vegetated filter strip (VFS), and setback for shallow groundwater.

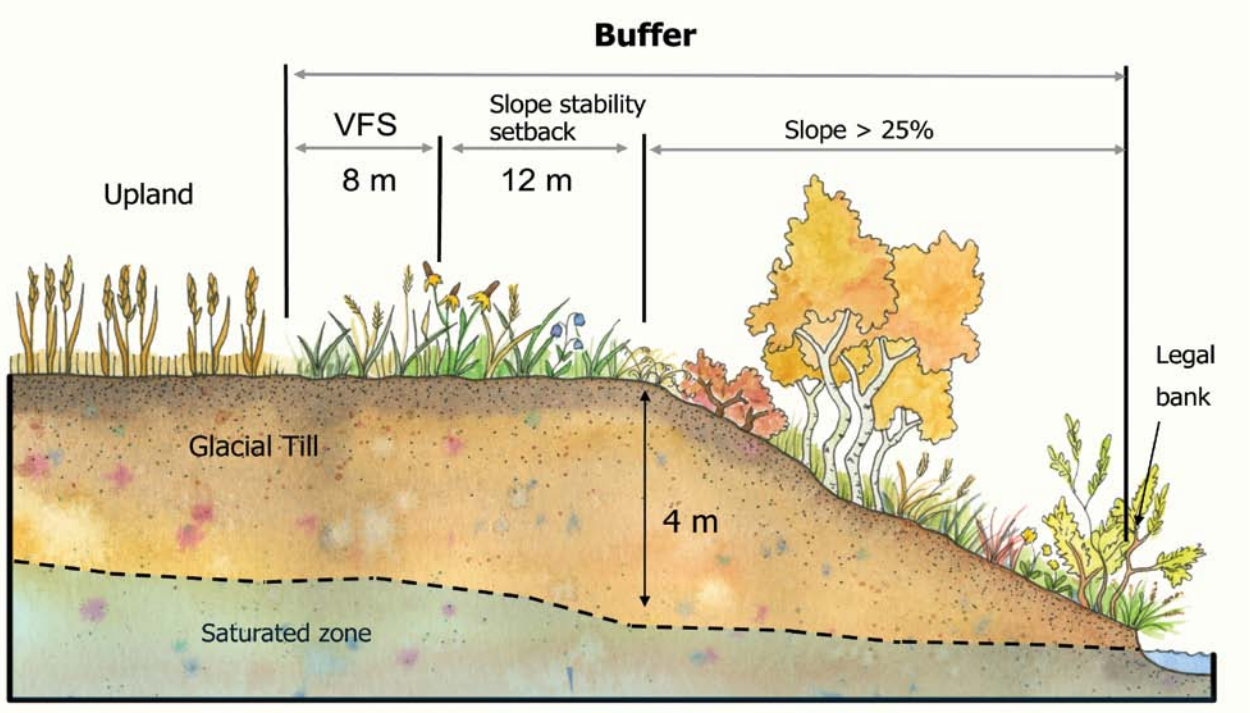


Buffer width calculation for Figure 3

Setback	*Width (metres)*
Vegetated filter strip (glacial till)	20
Slope factor, glacial till (7 - 5) x 1.5	3
Setback to avoid shallow groundwater[13]	10
Total buffer width	33

[13] The setback to avoid contacting shallow groundwater will vary depending on local conditions. Alternatives to a setback can be taken to avoid contacting shallow groundwater.

Figure 4
A stream buffer on glacial till, comprised of a steep slope, slope stability setback, and a vegetated filter strip. The steep slope does not count toward the vegetated filter strip.

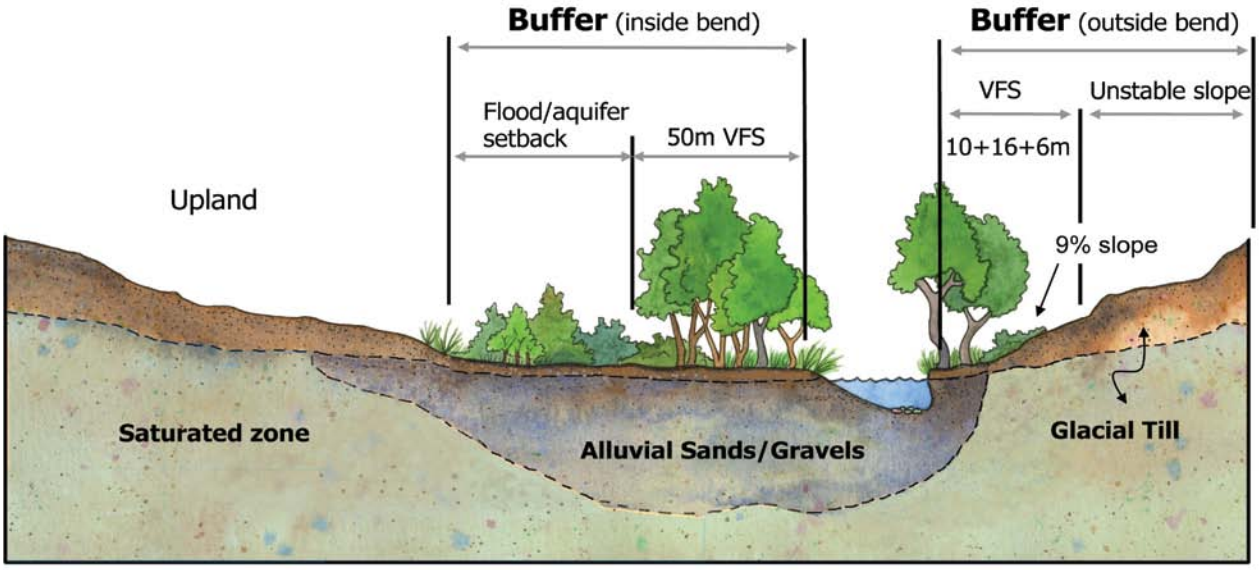


Buffer width calculation for Figure 4

Setback	*Width (metres)*
Steep slope > 25%	16
Slope stability setback[14]	12
Vegetated filter strip	8
Total buffer width	36

[14] The width of the slope stability setback will vary depending on local conditions and the geotechnical method used.

Figure 5
River buffers on glacial till and alluvial sands/gravels, comprised of vegetated filter strips, a flood/aquifer setback, and a slope stability setback.



Buffer width calculation for Figure 5

Setback (Inside Bend)	*Width (metres)*
Vegetated filter strip (alluvium)	50
Flood/aquifer setback (site dependent)	50
Total buffer width	100

Setback (Outside Bend)	*Width (metres)*
Vegetated filter strip (alluvium)	10
Vegetated filter strip (glacial till, Table 4)	16
Slope factor, glacial till (9% – 5%) x 1.5	6
Unstable slope setback (site dependent)	20
Total buffer width	52

ESTABLISHING RIPARIAN BUFFERS

Riparian buffers created through development setbacks as described above may be legally designated in accordance with the *Municipal Government Act* by various methods. These include:

- Environmental reserve or environmental reserve easement: recommended for dedicating a vegetated filter strip adjacent to a water body to prevent non-point source pollution,
- Municipal reserve: recommended where land may be used for a public park, a public recreation area adjacent to or near a vegetated filter strip.
- Conservation easement: recommended where the landowner can benefit by retaining ownership of the land or some property tax reductions, and the municipality can benefit by not having to manage small parcels of land.

Municipalities may also create defacto buffers through the creation of land-use bylaws. Section 640 of the *Municipal Government Act* enables building development setback land use bylaw provisions on land subject to flooding or subsidence or that is low lying, marshy or unstable or on land adjacent to or within a specified distance of the bed and shore of any lake, river, stream or other body of water. A "building" includes anything constructed or placed on, in over or under lands, but does not include a highway or road or a bridge that forms part of a highway or road.

Other options for landowners include the Government of Canada's Ecological Gifts program in which private and corporate landowners can make donations of ecologically sensitive land (e.g. wetland areas), or interests in these lands, and receive tax benefits.

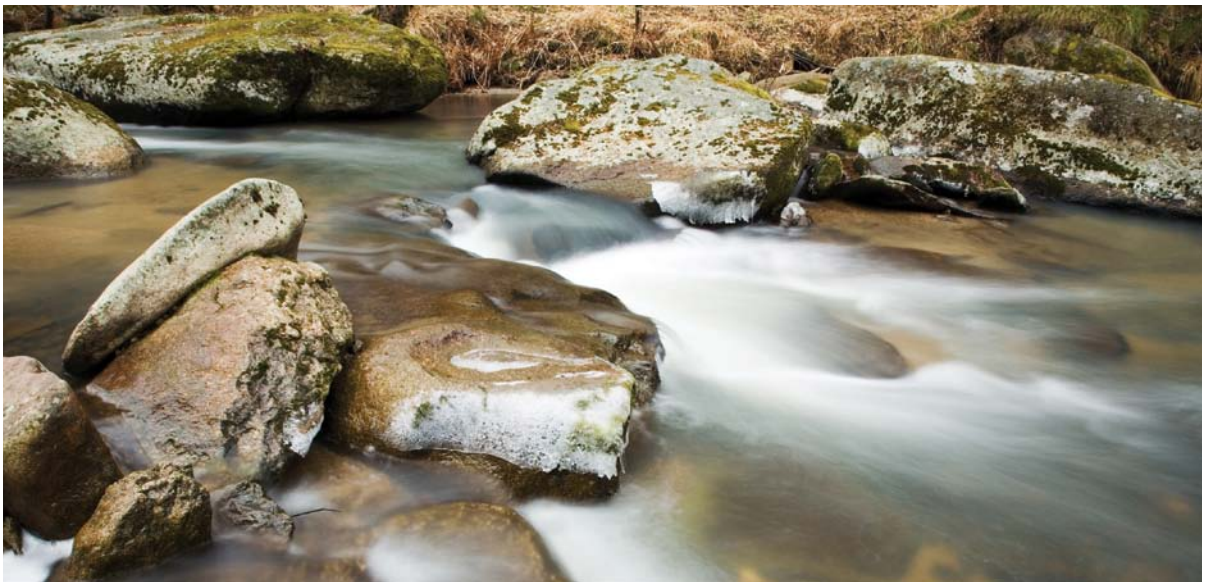
Developers are strongly encouraged to establish riparian buffers together with other environmental features associated with water bodies, with the purpose of protecting sensitive lands or providing public access for enjoyment of natural features. For example, section 664(1) of the MGA: Subject to section 663, a subdivision authority may require the owner of a parcel of land that is the subject of a proposed subdivision to provide part of that parcel of land as environmental reserve if it consists of:

- a swamp, gully, ravine, coulee or natural drainage course,
- land that is subject to flooding or is, in the opinion of the subdivision authority, unstable, or
- a strip of land, not less than six metres in width, abutting the bed and shore of any lake, river, stream or other body of water for the purpose of
  - » preventing pollution, or
  - » providing public access to and beside the bed and shore.

Riparian buffer boundaries should be clearly marked and signed in the field and on appropriate maps and drawings prior to commencement of any subdivision site work. Temporary boundary markers should be maintained until construction of buildings, roads and other subdivision amenities are completed. Once construction is finished, permanent boundary markers and signage should be installed. Fencing may have to be considered to keep unauthorized vehicles from entering buffer strips, or properly managing livestock within the buffer area.

Riparian buffers may also be required in areas where timber clearing is subject to forestry legislation (i.e., the *Forests Act* and *Timber Management Regulation*). The Alberta Timber Harvest Planning and Operation Ground Rules set out buffer requirements for timber harvesting in these areas. Agricultural producers wishing to establish appropriate buffers adjacent to water bodies are encouraged to contact their local agricultural office for information. Setbacks for feedlots are regulated by Alberta's Natural Resources Conservation Board.

Finally, provision should be made for ongoing protection and management of riparian buffers. For example, regular access may be needed for emergencies, to manage recreational activities, and resource management purposes including vegetation management. However, road construction should be avoided, and access routes should be left in a natural state such as grass to allow infiltration. Wetland vegetation and unstable areas should be left undisturbed. The appendices in this report contain resource lists and links for further information. Development of management plans for riparian land is strongly encouraged to help ensure that conservation objectives are achieved. The "Choices – Common Sense for Managing Riparian Areas" section of this document also contains helpful information for managing riparian buffers.



Understanding Riparian Areas

The following section describes some of the special features of riparian areas and the important role of water in making them a unique part of the landscape.

WATER, WATER EVERYWHERE

The water we see is a fraction of the water that is stored beneath us. All flow starts as precipitation but can follow several pathways after falling to earth. The portion of precipitation that is not intercepted or flows as surface runoff moves into the soil. A close inspection of the soil reveals millions of particles of sand, silt and clay separated by channels, or pores of different sizes. Water is drawn into the pores by both gravity and capillary action. The size and quantity of pore openings determines the movement of water, with soils of riparian areas generally having high porosity. Downward movement of water continues until a zone of saturation is encountered. This is the groundwater table, the surface of the large, complex and hidden reservoir that underlies the landscape. Riparian areas are one of the locations where ground and surface water is exchanged. Riparian areas can be recharge zones where water is added to deep storage; they can be the place where the water table meets the watercourse; or they can arise where lake and groundwater emerges as springs and seeps (also called discharge areas).

When rainfall intensity exceeds the infiltration capacity of the soil, or where the soil profile becomes saturated, excess water collects on the soil surface and travels down slope as runoff. Many factors influence runoff volume and the speed at which it travels. Sloping terrain, fine-textured soils, frozen ground, and areas lacking permanent vegetation cover have more runoff, and runoff that occurs faster.

Runoff patterns are changed dramatically in urban landscapes where sites are cleared and natural vegetation is replaced by impervious cover in the form of rooftops, streets, parking lots, sidewalks and driveways. Roads, trails and other linear features intercept runoff, channel it and often shorten the distance from source to watercourse or lake. A consequence of development is that more of the annual flow of watercourses in urban areas comes as runoff. Depending on the area of impervious cover the annual rate of runoff can be orders of magnitude greater than that of natural areas. Since pavement, concrete and other similar surfaces prevent rainfall and snowmelt from infiltrating into the soil, less flow is available to recharge groundwater. Watercourses in urban areas may have significantly reduced flows over some seasons and especially in times of drought because there has been little or no water storage during runoff periods.

Because runoff moves much more rapidly over smooth, hard surfaces than over natural vegetation, there is more energy available to erode and to transport eroded materials. Runoff from impervious surfaces can turn a tame little trickle of a stream into a land-eating monster. Riparian areas, the zone of defence against erosion, have to be well vegetated and intact to absorb this additional energy.

UNDERSTANDING FLOODS

Floods occur when excess water goes over the top of the watercourse bank or beyond the basin of a wetland, pond or lake, and on to the floodplain. How high the water will rise, how long the water will stay on the floodplain, and when to expect a similar-sized flood event to occur again are all difficult to predict. The problem is that floodplains are such inviting places. River floodplains for example lure us with their flat nature, the pleasant umbrella of trees and the proximity to water. The river doesn't use them very often so why don't we develop them? When we do, and the river periodically reoccupies its land, serious problems can arise.

The things we build on the floodplain, the bridges, roads and buildings, become the casualties of flooding. When we try to "fix" the problem, or gain some more developable land, the "solutions" can increase future erosion and flood hazard. Repairs and replacement of infrastructure are often repetitive and costly. In 1995, flooding in southern Alberta caused an estimated $33 million in damage; in 2005 the damage was estimated at more than $400 million, and in 2010 another $210 million. Recent studies also show that proximity to a flood zone lowers property values (Bin et al. 2008). Human life can also be put at risk; four people died in the 2005 flood. Many jurisdictions now recognize that the most effective way to reduce flood risk (and costs) is to locate developments outside of the floodplain, or design structures in a way that allows for flooding and lateral channel migration to occur with minimal damage to property.

It makes a whole lot of sense to invest in advance of a disaster so that when high rainfall comes in the future, we have better control and prevent substantial losses. MUNICIPAL AFFAIRS MINISTER, ROB RENNER

(Calgary Herald, May 7, 2006)

Flood Hazard Mapping in Alberta

Flood hazard (formerly known as floodplain or flood risk) mapping has been produced by the Government of Alberta for communities throughout the province since the 1970s. The Canada-Alberta Flood Damage Reduction Program was initiated in 1989. This was a joint program of the federal and provincial governments to standardize and cost-share flood hazard mapping studies to increase public safety and reduce flood damage costs. Federal involvement ended in 1999 but the Alberta Government has continued to produce flood hazard mapping studies using the same basic guidelines established for the Program. Some local planning authorities and developers may produce flood hazard mapping studies independent of the provincial government.

In Alberta, the design flood used for flood hazard mapping is the 1:100 year return period flood. This is a flood that has a one per cent chance of being equaled or exceeded in any one year. Even though a flood may have a relatively low chance of occurring in any one year, it is possible for several large floods to occur within a few years of each other.

Typically, the 1:100 year flood hazard area is divided into two zones – the floodway and the flood fringe. The floodway is the area where flood waters are the deepest, fastest and most destructive. The flood fringe area is where flows are shallower and slower moving.

In Alberta, land zoning is a municipal responsibility, and Flood Hazard Maps are usually incorporated into municipal zoning bylaws (e.g., Flood Hazard Mapping has been incorporated into the City of Calgary's Land Use Bylaw 1P2007).

In general, new development within the Floodway Area is not permitted, and should be limited to land uses which are non-obstructing in nature (e.g., natural parks, trails). For example, the City of Calgary Land Use Bylaw 1P2007 generally prohibits the development of new buildings, with new development permissible only under specific conditions. Within the Flood Fringe Area, development may be permitted, when certain design considerations are met.

Activities in the floodway that may impact the conveyances of flood flows or the aquatic environment may require approval under the *Water Act*. Any projects in the floodway should be discussed with Alberta Environment and Water Regional Staff. Within the Flood Fringe Area, development may be permitted, when certain design considerations are met.

For more information on Flood Hazard Mapping, go to the Alberta Environment and Water website: www.environment.alberta.ca/3823.html

Figure 6
Aerial View of a Typical 2-zone Flood Hazard Area Divided into the Floodway and Flood Fringe

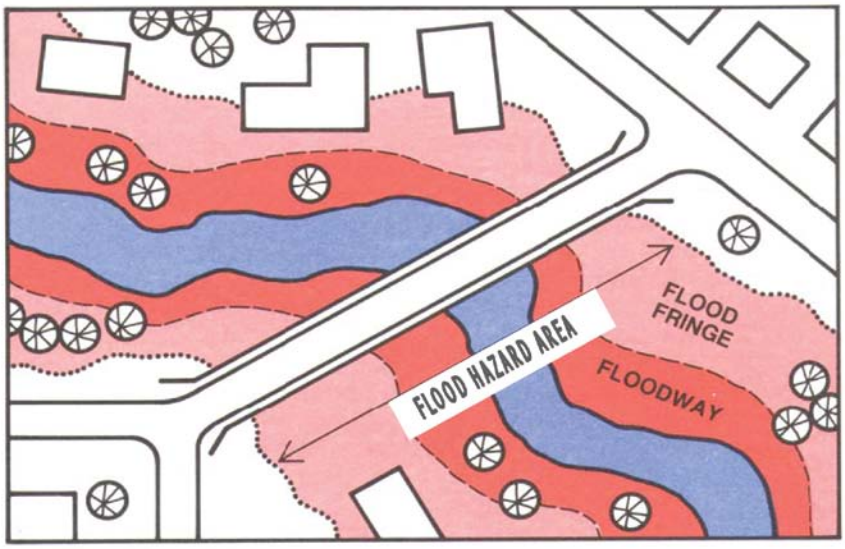
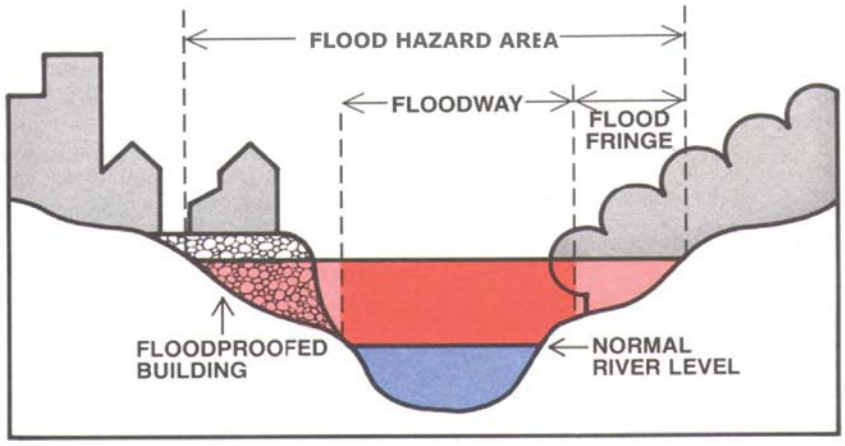


Figure 7
Cross Section View of a Typical 2-zone Flood Hazard Area Divided into the Floodway and Flood Fringe



The risk of constructing a flood-proofed building in the flood fringe area should be carefully evaluated before proceeding. Infilling in the flood hazard area can lead to increased water velocity and subsequent erosion issues elsewhere. The infilling also reduces the natural filtration and other positive effects of intact riparian habitat. Historically, many flood-proofed areas have been found later to be susceptible to flooding or erosion. When a river channel is connected to an intact, naturally functioning floodplain, flood waters are able to spread over a large area, reducing the energy of flows and reducing peak flows downstream. This reduces potential damage to infrastructure and communities and improves channel stability.

Cottonwoods in Alberta

Cottonwood trees (genus *Populus*) are abundant riparian plants that line the river valleys of the western prairies, including Alberta. Historically, these forests were abundant, but have been declining recently. Cottonwood stands regenerate after disturbances associated with flood events (Rood *et al*. 2007), and consequently, preservation of these forests will likely rely on the continued effects of floods.

Credit: Cheryl Dash

WATER ALWAYS WINS

All stream banks and river banks erode, and so do the shores of lakes and wetlands. Erosion is a natural and essential process of water in motion, and is important for creating fish habitat. Watercourses generally erode the outside of meander bends and deposit material on the inside of meanders. The meandering nature of watercourses balances water speed, valley slope and the amount of sediment carried by the system. Watercourse channels, lake shores, and the adjoining riparian areas are constantly adjusting to the energy, water and sediment supplied from the watershed.

Riparian plants, especially trees and shrubs, resist the erosive forces of moving water. For example, deep roots anchor the soil, and the flexible stems of willow bend over in a flood, reducing water velocity near the ground. But removing or altering vegetation can reduce bank stability, leading to undesirable changes to river banks and lake shores. In rivers, this can result in the loss of undercut banks, excessive widening and meandering of a water course, reducing instream habitat diversity for fish and invertebrates by creating deeper, shallower or more uniform habitat (after Lyons et al. 2000). In lakes and wetlands, impaired riparian areas can allow "shoreline creep" to occur, where the banks of the water body[15] are slowly eroded.

Furthermore, as sediment entering the lake increases, the ability of the near-shore to provide fish and amphibian habitat decreases.

Structural attempts to break the cycle of riparian alteration and shoreline erosion often involve channelization and bank armouring with concrete, rock riprap and dikes. Bank armouring can be costly, ranging from $150 to $200 per cubic metre. On lakes, this can lead to further habitat deterioration and loss. On rivers, these efforts not only lead to habitat loss, but usually redirect the volume and energy of a river's flow downstream, potentially worsening the hydrological effect and risking greater losses and costs. The meandering of streams and rivers is a necessary part of the function of these systems. Healthy, intact riparian areas resist the amount of watercourse roaming, but the floodplain belongs to the watercourse.

There is an axiom, rarely heeded, that says in the tension between water and land, water always wins. Water always wins!

[15] For the purpose of this document, a water body is any location where water flows or is present, whether or not the flow or the presence of water is continuous, seasonal, intermittent, or occurs only during a flood. The mere absence of water due to dry conditions (e.g., natural variability in precipitation, seasonal cycles of flooding and drying) may not be indicative that a water body does not exist – a temporary water body that is dry is still a water body. Roadside ditches and temporary pooling of water, as a result of snow melt, spring runoff and storms, that does not induce change in soil and vegetation are not considered water bodies.

Nutrients and Lakes

Many of Alberta's lakes are naturally eutrophic. They are therefore extremely sensitive to further nutrient enrichment. Both shoreline cottage development and agricultural activities have the potential to increase the nutrient supply to lakes, and thereby increase plant productivity. The nutrients of concern are nitrogen and phosphorus, but especially phosphorus, because it usually is in shortest supply, and therefore is the limiting nutrient in most lakes. Nitrogen, which is present in the atmosphere, is fixed by certain species of algae, thereby maintaining levels sufficient for algal growth (Mitchell and Trew 1982).

KEEP THE "LAKE" IN LAKESHORE

We are attracted to water and like to live, relax and play next to it. Who isn't attracted to Alberta's lakeshores? With increasing pressure we can love our lakes to death, both from intensive lakeshore development and extensive changes in the watershed. Most of Alberta's lakes are naturally high in nutrients and continue to accumulate nutrients, like bathtubs without drains. To a point this higher productivity supports greater levels of aquatic life, with fish being near the top of the food chain. The tipping point occurs when the cumulative effects of all our activities, near and far from the lake, exceed the lake's capacity to absorb nutrients. A kilogram of phosphorus, derived from our activities, can spark the growth of 500 kilograms of algae. With this dramatic response to nutrients, algal blooms begin to proliferate and persist. Excessive algal blooms create a cascade of issues including loss of water-based recreation, decreased water quality for domestic and agricultural purposes, decreased property values, losses of sport fish populations, and even serious health effects. To prevent or remediate problems like this a comprehensive, watershed-scale initiative may be required, including management of nutrient sources, limiting development around the lake and preserving riparian vegetation along shorelines.

A WORD ABOUT WETLANDS

Wetlands serve a vital role in the watershed by acting like natural sponges, capturing and storing rainfall and snowmelt. This allows a substantial amount of water to infiltrate and become part of the groundwater aquifer. Wetlands, like riparian areas, are extremely important for supporting a wide diversity of plant and animal life.

There are problems associated with developing near wetlands. Drainage or filling in of wetlands removes natural water storage, ultimately increasing the speed and volume of water pouring into receiving water bodies. Studies in the Broughton Creek watershed in Manitoba showed a 70 percent loss of wetlands over a 37 year period (Ducks Unlimited Canada 2008). There was a subsequent 18 percent increase in peak flows following rainstorms, a 30 percent increase in water flow in receiving water courses and a 41 percent increase in the amount of sediment dumped into downstream waters. The loss of filtering, buffering and retention of water has a cascading effect on water quality, erosion, flooding and biodiversity.

THE GROUNDWATER CONNECTION

Riparian vegetation grows where water is close to the surface. Shallow groundwater associated with riparian areas is vulnerable to contamination, compared to aquifers found deeper and covered with thick layers of impervious materials. Contaminants can enter the groundwater from developed land in a variety of ways, including basements, waste water systems, and wells. Because riparian areas are connected directly to water bodies, contaminated groundwater in riparian areas can readily put surface water quality at risk.

NATURE'S WATER FILTER

Many factors influence surface water quality including climate, soil type, vegetation, groundwater and flow conditions. For most water bodies in Alberta, nutrients and other pollutants enter primarily from the surrounding watershed. Phosphorus and nitrogen are important nutrients for the growth of algae, macrophytes (large aquatic plants), and cyanobacteria[16] in surface waters. The most common pollutants, in addition to nutrients, include sediment, pesticides, microbes and heavy metals carried by rain and snowmelt runoff.

The following sections contain an overview of the impact that sediment, nitrogen and phosphorus can have on water quality, and the role that riparian areas can play in filtering them from runoff before it reaches water bodies.

Sediment

Sediment, the product of runoff and erosion, can be a carrier of pathogens, contaminants and nutrients, each of which bond to the sediment particles. As sediment moves downstream, so do the potential contaminants. Pollutants that enter the river from diffuse or undefined sources are called non-point source pollutants. In contrast, point-source pollutants enter a water body from one, easily recognizable location such as a pipe associated with an industrial or municipal wastewater treatment facility. In an urban environment, non-point source pollutants enter water bodies through storm-drain networks. Non-point sources of pollution are more difficult to identify, regulate or control. They usually occur over wide expanses of the landscape and together, accumulate in the receiving water body.

Bank erosion is often the dominant source of sediment along water courses where poor management practices have reduced the health of riparian areas.

[16] Cyanobacteria, also known as blue-green algae, are a group of bacteria that obtain their energy through photosynthesis. Cyanobacteria are able to use atmospheric nitrogen for growth. This gives cyanobacteria a competitive advantage over algae in nitrogen-poor lakes. Cyanobacteria may impart noxious odour or disagreeable tastes to water and fish.

Sediment, at levels higher than the natural background amounts, can negatively impact aquatic ecosystems and is a major source of water quality issues. Also, water treatment costs increase dramatically with higher sediment loadings and efficiency of treatment processes can diminish.

Although sediment occurs naturally in streams, it is commonly accepted that there is an increased risk to the survival of fish and other organisms when levels exceed background values for a particular period of time. Sediment covers clean gravels needed by some species for spawning. Eggs and new fry can be covered and deprived of oxygen. The ability of fish to breathe, feed and move can also be impaired. These effects can either be acute and rapid or chronic and cumulative.

Other impacts of sediment imbalance in water bodies include:

- Scouring of periphyton from stream (plants attached to rocks);
- Abrading and damage to fish gills, increasing risk of infection and disease;
- Shifts in fish community toward more sediment-tolerant species;
- Reduced sight distance for trout, with reduction in feeding efficiency;
- Reduced light penetration causing reduction in plankton and aquatic plant growth;
- Reduced filtering efficiency of zooplankton in lakes and estuaries; and
- Adverse impacts to aquatic insects which are the base of the food chain.

Healthy riparian areas improve and maintain water quality because the lush vegetation traps sediment. During runoff, especially when the soil is frozen, upright plants help to maximize this trapping function. Native riparian vegetation also buffers the effects of soil erosion caused by runoff or flooding by slowing runoff or flood waters, and holding the soil, shorelines and stream banks in place. Reduced erosion means less sediment in lakes and streams.

Nitrogen

Nitrogen, along with phosphorus and carbon, is one of the main nutrients found in Alberta surface waters. Studies across Canada and the USA have linked high nitrogen concentrations in streams to agricultural land use and the widespread application of fertilizers and manure. Cattle grazing in streams is associated with elevated levels of total nitrogen and ammonium. Urban watersheds also frequently are significant contributors of nitrogen to receiving waters. Although emphasis has been placed on phosphorus control since the 1970s, recent experimental evidence suggests that regulation of both nitrogen and phosphorus is essential for protecting surface waters from eutrophication (Finlay et al. 2010, Lewis et al., 2011).

Most algae and aquatic plants obtain their nutritional needs directly from the water itself. Algae serve as a vital food source for microscopic animals, which then provide food for fish and other aquatic life. However, when nitrogen runs off into adjacent water, the nutrient can promote excessive growth of blue-green algae and aquatic plants, and create unpleasant conditions for recreational activities such as boating and swimming. When fertilizers containing nitrogen in the form of ammonium enter surface waters, ammonia build-up may create toxic conditions for fish. Algal “blooms” and excessive aquatic plant growth can reduce oxygen levels in the water, putting stress on aquatic animals, and can produce toxins that are harmful to aquatic life and people.

Nitrate is a form of nitrogen and a contaminant commonly found in surface waters and groundwater. Rainfall can carry nitrate that is not taken up by plants overland to surface waters, or downwards through the soil and into groundwater. If nitrate ends up in water or saturated soil with very little dissolved oxygen and a supply of oxidizable carbon, certain types of bacteria will convert it to nitrite, and eventually to nitrogen gas, which can then escape to the atmosphere. The effectiveness of a riparian area to filter nitrogen is highly dependent on the pathway of water movement through its biologically active areas. Nitrate removal is much less effective when riparian areas are overwhelmed by high volumes of runoff, and where cold temperatures in the non-growing season

restrict biotic removal. Nonetheless, studies from across North America have shown that vegetated riparian areas can help mitigate the impact of land use on stream water quality by acting as nitrate sinks in the landscape.

Figure 8
Riparian areas are important landscape features that can buffer water bodies from non-point sources of nitrogen pollution.

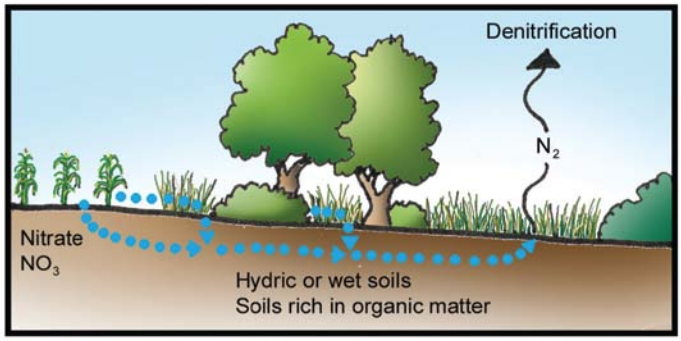


Illustration: USDA

Phosphorus

Phosphorus in aquatic systems occurs in three forms: inorganic phosphorus, particulate organic phosphorus, and dissolved (soluble) organic phosphorus. Aquatic plants require inorganic phosphorus for nutrition, typically in the form of orthophosphate ions. This is the most significant form of inorganic phosphorus, and is the only form of soluble inorganic phosphorus directly utilized by aquatic plants. Because phosphorus is usually in short supply in nature, additions of phosphorus in fertilizers are quickly taken up by organisms. In aquatic systems, excessive phosphorus can cause rapid growth of macrophytes and algae, leading to water quality problems.

Soils can become saturated with phosphorus, and excess phosphorus may be carried in runoff or leach through the soil profile and enter groundwater. Once in a lake or wetland, phosphorus can remain for some time and may cycle annually or more often. For instance, the nutrient is released from the bottom sediments of lakes into overlying water during periods of oxygen depletion. This deep, phosphorus-enriched water can mix with shallow surface waters during windy periods or during spring and fall turnover, in effect fertilizing the lake. The results are often excessive growth of both cyanobacteria and algae, which can make the lake look green and murky. In Alberta rivers, the concentration of total phosphorus often is elevated because the river flows through fertile soils. However, the highest concentrations usually occur downstream from densely populated regions, where nutrient concentrations are influenced by sewage. Beyond a certain point, phosphorus levels can have undesirable effects, including a decrease in biodiversity, increased water treatment costs, and increased risk to aquatic life, livestock and human health.

Although grass buffer strips have been shown to reduce phosphorus transport to surface waters in the short term, long-term benefits are more problematic. Vegetated buffers remove phosphorus by trapping particles, allowing infiltration into the root zone, and

through root uptake of soluble phosphate. However, the result may be a build-up of phosphorus and increased soil-phosphorus solubility in the buffer strip, leading to future export of the nutrient to adjacent water bodies, such as during storm events or spring melts. Also, buffer strips have not been found to be effective at removing dissolved phosphorus from subsurface flows. Strategies such as proper fertilizer management, strategic placement of grass buffer strips, and regular harvesting of buffer vegetation can help in reducing the amount of phosphorus that gets transported to surface waters.

The last line of defence, against all we do in the watershed, is the thin green line of the riparian area. Healthy, diverse riparian vegetation resists erosion and reduces the amount of sediment generated from watercourse banks. Plants trap sediment and reduce the amount of contaminants, nutrients and pathogens reaching the water through absorption, uptake and breakdown, while nitrate is transformed to harmless nitrogen gas in riparian sediments.

Nature has provided us with an efficient, cost-effective water filter. But improper land management practices in just a few areas within a watershed can contribute to a majority of water quality problems. Targeting better land management practices in these few, select areas may yield significant improvements (Bentrup 2008). For example, erosion should be managed at source to reduce sediment and pollutants to acceptable levels, erosion and sediment controls should be put in place at construction sites, and concentrated flows should be managed to prevent conveyance of large sediment loads directly to water bodies.

We didn't know that tiny things we couldn't smell or touch could hurt us. WALKERTON, ONTARIO RESIDENT

FISH AND WILDLIFE HABITAT

Riparian areas are among the most productive ecosystems on earth, and are "hot spots" of biodiversity. They occupy a small proportion of the landscape (often 2 per cent or less) but frequently support a greater variety and abundance of life than adjacent habitats. Important habitat components include vegetation (that is often different, more diverse and more complex than adjacent areas), food, standing water, shelter from predators, sites for nesting, and a local microclimate that moderates temperatures.

Fish and wildlife species differ in their dependence and reliance on riparian areas. Some are confined to it for their entire lives; others use these areas less frequently, yet their long term life cycle requirements depend on access to riparian areas. Wildlife use riparian areas as corridors to move to different habitats seasonally, to accommodate different life stages, and to escape unpredictable events.

Fish communities have evolved to exist in certain habitats with favourable conditions. Factors such as water temperature, light, sediment, stream channel and shoreline shape, are important. They normally fluctuate within a natural range of variability. So long as these factors remain within that range, fish communities can persist. But, if habitat conditions fluctuate beyond this normal range, the fish community is placed at increased risk of losing one or more species. Riparian areas play an important role in regulating habitat conditions and providing the necessary degree of stability. Studies suggest that maintaining the integrity of riparian areas may be critical to maintaining diverse fish communities across river basins (Lammert and Allan 1999, Meador and Goldstein 2003).

River Valleys –
Sheltered Havens for Deer

Wildlife and wild things once fed and shaped our culture; their presence today is a measure of whether the landscape we live in is healthy. For Alberta wildlife like deer, moose and elk, key ungulate habitat is usually associated with river valleys. River valley landforms contain unique conditions that provide good winter browse conditions in proximity to forest or topographic cover providing shelter from wind chills. Slopes with south-facing aspects are particularly important because they accumulate less snow than north-facing slopes. Ungulates often concentrate in these areas during winter because of the thermal advantages, and because the steep slopes and ravines provide optimal mixes of food, cover and escape terrain. White-tail deer have been reported to use riparian areas almost twice as much as upland areas in avoidance of predators (Naiman and Decamps 1997).

Forested riparian areas along river valleys also provide travel corridors for wildlife, allowing animals to move to refuges when disturbances temporarily alter their preferred habitat. Riparian corridors also help maintain connections among breeding animals, which is important for the long-term health of wildlife populations. Wider corridors generally are more functional than narrow corridors because some species avoid forest edges. Even in urbanized areas, riparian areas along water courses offer an excellent opportunity for maintaining all-important wildlife corridors.

RIPARIAN AREAS – PART OF THE COMMUNITY

In urban centres riparian areas can be community assets, offering a host of activities of economic and educational value to community members. If we turn these areas into our community front yards we add to urban diversity and enjoyment. Amid noise, concrete and pavement, riparian areas are people-friendly places offering cool, shaded places for cyclists, hikers and picnickers. Coupled with biking and hiking paths, riparian buffers offer commuter traffic a non-motorized alternative. Riparian forests in urban areas are the last refuges for a variety of wildlife, and can offer the best bird watching in town. These are places for urban dwellers, especially children, to find connections with the natural world, which encourages citizen participation and stewardship. Our waterways were the highways for native peoples, explorers, trappers, traders and early pioneers. Riparian areas have historical and archaeological values worth preserving.

Large Woody Debris and Undercut Banks – Fish Hangouts

How many lures have you lost trying to catch a big trout hiding under a log? These logs are not a nuisance, they are important for our streams, and there is a reason trout might be hiding there!

Larger woody debris is a term used to describe large logs or fallen trees greater than 10 cm in diameter which have ended up partially or wholly within a watercourse or lake. In watercourses, large woody debris is a major contributor to watercourses in terms of nutrients, habitat diversity, and stabilizing the watercourse environment.

The lateral migration and natural undercutting of vegetated banks in watercourses result in the creation of some of the best fish habitat by providing cover for fish. When the bank becomes sufficiently undercut and a tree falls in, large woody debris can act as a sweeper, create a debris dam, or lodge on the bottom of the watercourse. It often catches other smaller pieces of wood or leaves, and holds them in place while they decay, ultimately providing nutrients for invertebrates which are in turn eaten by fish. Fish and aquatic invertebrates use the large woody debris as shelter to hide from predators and as resting areas outside of the main current.

The Economic Value of a River Valley

Economic valuation generally supports preservation of natural green corridors and riparian buffers (Qiu et al. 2006). Studies in the USA have shown that there is willingness to pay a premium for living in a subdivision that has access to community-owned riparian buffers. But, willingness to pay is significantly higher for living on a property adjacent to the same riparian buffer (Qiu et al. 2006). Tradeoffs also have been identified. For example, residents pay more for living closer to a stream; however, if a property is too close to a stream, flooding threat reduces property value (Bin and Polansky 2004). The literature suggests that natural open space provides a significant benefit to property owners through increased property values, potentially a benefit to the local government through higher property tax assessments and increased quality of life in the community (Curran 2001).

Edmonton and Calgary both benefit from being located adjacent to river valleys. A 1986 study found that 70 per cent of Calgary area households used the Bow River valley for various forms of land-based recreation, including walking, jogging and cycling, and that total recreational activity amounted to 12.4 million user-days per year. The economic benefits associated with this recreational activity amounted to $5.3 million annually (Scace and Associates Ltd. 1987). Applying 2006 census data and adjusting for inflation, this value would be about $16 million annually, assuming the same household participation rate.

Economic benefits are greater when all factors are considered. The North Saskatchewan River Valley near Edmonton was found to generate between $300 and $600 million per year in economic, social and environmental benefits (AMEC 2007). Environmental benefits included management, erosion control, carbon sequestration, air and water quality improvements, and pest control. Social benefits included recreation and health. Economic effects included tourism and increased property values. The study found that houses built adjacent to the river valley were, on average, worth more than similar buildings elsewhere in the City of Edmonton, such that proximity to riparian areas added about $131 million to real estate values in 2006.

In another Alberta study, residential properties located adjacent to an amenity such as a park, open space or waterway will attract a higher capitalized value than will properties that do not have access to such an amenity (Serecon 2007). Quantitative analysis of newer, mainly single-family residential developments in an average socio-demographic found proximate premiums of up to 15 per cent on the total property (home and lot combined). High premium parks combine municipal reserve, environmental reserve and public utility corridors, such as well-managed stormwater features, because of the massing of the park area and the positive environmental impact. The value of the benefit is expressed by the view, as well as the privacy afforded by the park. The presence of a contiguous pathway, but set away from the property line, further enhances the value to the homeowner.

Appendix 1 contains more information about the economic value of river valleys (see: “Economic impacts of buffers” in “Case Studies.”)

Choices – Common Sense for Managing Riparian Areas

Whether we live beside a lake or a river, very few of us have no upstream neighbours; the rest of us live both upstream and downstream of someone. One of the results of this connectivity is that changes we make to our property can affect others in a watershed. The additive effects of these types of decisions might translate into higher nutrient loading in surface waters, higher peak flows, more erosion, increased risk of flooding and lower base flows. If we can appreciate those changes, it might help us understand that it isn't about how much more development we can undertake in riparian areas, but rather, how do we reverse this trend?

INDISPENSABLE LANDSCAPES

Riparian areas have significant values beyond the relatively small scale of their size. The water bodies they adjoin interact with them both frequently and occasionally. These small landscape bits both buffer the land from the water, and also the water from the land. The processes within them are complex, connected and essential. The more that our knowledge of riparian areas deepens through scientific investigation, the more apparent it is becoming that no part of riparian areas are or should be considered surplus or redundant, especially given the wide scope of services these areas provide us. There is no apparent silver-bullet methodology available to draw a line within a riparian area designating part of it dispensable to our needs. What is clear is that the choices we make will have costs, benefits and consequences in the future and for our near (and maybe not so near) neighbours. Those costs, benefits and consequences may not be shared equally by all watershed residents. If we choose to divide the riparian area up, we need to understand the choices and what we are willing to give up in the bargain. Which, of the attributes of water storage, filtering capacity, erosion control, flood abatement, wildlife habitat, climate change amelioration, or aesthetics, will we give up? Because of the connections and the spatial and temporal aspect of the choice, several of these attributes may be relinquished at once. Some, such as flood abatement, may have greater risk and hazard associated with them. It will be necessary to understand who or what will bear the additional costs of our decisions to forgo some or several riparian functions.

PLANNING TIPS

Municipal Conservation Planning

Not all shorelines should be developed, and buffers are only one part of ensuring healthy, sustainable landscapes. A watershed-scale approach is being used more and more to help ensure protection of sensitive areas and habitat, and prevent conflicting land uses. This approach is also important for identifying ecosystem functions and linkages, evaluating the cumulative impacts of development and resource management strategies, and setting environmental outcomes. Municipal conservation planning evaluates and integrates the physical, economic and social aspects of land management. Its purpose is to conserve the soil and water resources in the municipality while protecting the environment and quality of life of the local residents. An inventory of the soil, water and wildlife resources is used to analyze the conservation issues in the municipality. From this the objectives and related projects and activities can be determined.

Some municipal planning work has been built using a land system framework. Land systems are biophysical units with similar soils, climate and landscape characteristics within a municipality. In this way, activities and projects can be targeted within areas having similar resource concerns.

Riparian buffers are typically designed to achieve several objectives of individual landowners and the community. Often, objectives are addressed through different buffer designs in different locations, creating a system of buffers. A planning process is a structured method to organize and conduct this task and ensure that all objectives are addressed. The result is called a landscape plan (Bentrup 2008).

There are many excellent resources available to help in the design of riparian buffer systems in the context of sustainable landscapes. One such publication is Protecting Riparian Areas: Creative Approaches to Subdivision Development in the Bow River Basin: A Guide for Municipalities, Developers and Landowners, written by the Bow River Project, 2002. See also Bentrup (2008), and Johnson and Buffler (2008).

Watershed Management Planning

Watershed management plans are generally broad in scope and deal with topics that could be directly or indirectly related to the water within a water body, including riparian, non-point source pollution, and source water protection. Using the Framework for Water Management Planning as guidance, any group can develop a watershed management plan with recommendations to be considered by the Director in charge of water management decisions under the *Water Act*. A watershed management plan is not only for a Director designated under the *Water Act*, it is also a valuable tool for other jurisdictions who make decisions that could impact water, such as municipalities and First Nations. It is important that the watershed planning group include all stakeholders who make decisions that could impact water. The resulting plans provide key recommendations to minimize the cumulative effect of activities on receiving water bodies. Recommendations in a plan may or may not be incorporated into policies. The result, however, is agreed-upon recommendations to best manage the watershed. When developing a watershed management plan, it is also important to consult the regional Watershed Planning and Advisory Council (WPAC) to ensure consistency of planning initiatives. See the *Water for Life* website to find a WPAC operating in your region (www.waterforlife.alberta.ca).

Regional Land-Use Planning

Alberta's Land-use Framework, developed after extensive consultation with Albertans, sets out a new approach for managing public and private lands and natural resources to achieve Alberta's long-term economic, environmental and social goals. It is a blueprint designed to guide decision making about our land and natural resources. Implementation of the Land-use Framework has been enabled through the *Alberta Land Stewardship Act*, and a key component of the framework is the development and implementation of seven regional plans for the province. The Government of Alberta is responsible for regional

planning which will involve extensive local input, and the establishment of a Regional Advisory Council for each region to provide advice to Cabinet regarding the plan. Regional plans will be reviewed and approved by Cabinet, and they will become official policies of the Government of Alberta. Municipalities and Alberta government departments will be required to comply with regional plans in their decision-making.

See the Land-use Framework website for more information on the framework and regional planning (www.landuse.alberta.ca).

RIPARIAN ZONES

A vision for landscape and riparian health is a combination of the land we stand on and of the watershed as a whole. Good riparian management works hand in hand with sustainable land management practices. For example, healthy perennial vegetation in upland areas can intercept precipitation and resist erosion, natural wetlands can capture and slowly release runoff or store it as groundwater, and healthy riparian areas can moderate flood flows, recharge alluvial aquifers, and filter runoff. Attempts to size buffers to achieve only one ecological function or administrative objective may fail to meet other objectives. A combination of maintaining continuous riparian areas in a natural state, and extending buffers out from the water body give the best chance of providing a full range of ecosystem services and benefits.

To maximize the benefits of buffers, a three-zone approach is now widely accepted. This includes:

- **Inner or Streamside Zone**
  consisting of undisturbed vegetation along the bank intended to provide shade, and maintain the integrity of the bank and adjacent aquatic habitat;
- **Middle Zone**
  inland from the legal bank, to help filter sediment and pollutants, capture pollutants and recharge groundwater, and provide separation between the inner zone and adjacent development; the width should encompass the 1:100 year floodplain and adjacent steep slopes; and
- **Outer Zone**
  intended to minimize encroachment of adjacent development and provide initial filtering of runoff.

Typically, no development is allowed in the inner zone, and shorelines are protected and kept in a natural state as an integral part of the vegetated filter strip. Some development and supporting park amenity or open space needs may be allowed in the middle and outer zones, provided they do not compromise the integrity of the vegetated filter strip. The outer zone should have the greatest ability to trap sediments and pollutants. The following measures should be taken to maintain riparian functions:

» Protect against compaction from vehicles, livestock, and construction of impervious surfaces; rainwater infiltrating the riparian area could represent almost the same quantity as groundwater input, and the dilution effect is very important in riparian areas that are not nitrate sources;

» Avoid excessive removal of leaf litter, or alteration of the natural plant community through improper use of herbicides or herbicide drift, and improper livestock grazing; the moist soil of riparian areas makes them very susceptible to compaction by livestock and wildlife;

» Avoid activities that disconnect the channel from the flood plain such as urbanization, channelization, diking, and drain tiles.

Vegetated filter strips need to be wide enough to allow flow to spread out and slow down so that sediments can settle out. But riparian areas cannot do their work on their own. Filter strips become ineffective when runoff water is contaminated and allowed to enter directly into water bodies via concentrated flow paths. Conserving riparian areas should take a comprehensive approach, including wetland conservation and appropriate best management practices. Best management practices (as opposed to beneficial management practices) are generally classified into four categories (Novotny 2006):

- Source controls (erosion control, soil conservation, targeted fertilizer applications, nutrient management in built-up areas);
- Hydrologic modifications of source area;
- Reduction of delivery of pollutants between the sources and receiving water body (e.g. riparian buffers, infiltration). Maintain diffuse flow into buffers or install additional vegetated buffer strips near source;
- Capture, storage and treatment in ponds and wetlands. BMPs can include ponds, fertilizer application rate and timing, field-contour buffer strips, and grass waterways.

LANDSCAPE MATTERS

Urban vs. Rural Challenges

In the past, agricultural and silvicultural standards for riparian buffer design were often applied to urban areas, ignoring important differences in hydrology, physical site conditions and land use. Even though urban streams tend to suffer greater impacts than other streams, urban buffers also tend to be less effective for filtering pollutants because storm drains deliver a large proportion of runoff directly to the channel. Therefore, widening a buffer in an urban area may have less of an effect on water quality than widening a buffer in an agricultural area (Wenger 1995). On the other hand, keeping development out of flood hazard areas in higher-density urban environments can help avoid widespread impact to human life and property.

In urban and urbanizing areas, construction is the major source of sediment, whereas in rural areas natural sources, cultivation and bank degradation from improper livestock grazing are the main sources. Storm flows in urban and suburban areas are elevated owing to greater surface runoff from impervious surfaces. Consequently, bank stabilization may not be effective in these areas if the underlying causes of channel erosion are not addressed. Controlling runoff close to where it begins can reduce runoff volume and improve runoff quality. Major techniques include green roofs, water capture and re-use, pervious pavement, conservation landscaping and bioretention. The Alberta Low Impact Development Partnership promotes these and other techniques as part of its mandate to promote the recharging of aquifers, the protection of riparian areas and wetlands, and the maintenance or improvement of the aquatic health of our water bodies.

Low-Order Streams

Headwater and smaller, tributary streams have the most land-water interaction and the most opportunities to accept and transport sediment (Wenger 1999). Maintaining vegetative buffers along low-order streams may offer the greatest benefits for some stream networks as a whole. Temporary water courses also require special attention. Because they can carry appreciable flow and sediment during storms, ephemeral and intermittent streams should be properly managed to prevent pollutants from entering surface waters. This can include conserving native vegetation, maintaining buffer strips, and in urban areas, integrating ephemeral streams into engineered stormwater systems.

Non-native Plants

Riparian areas along streams and rivers are often the first areas to be colonized by invasive and disturbance-caused plants, some of which thrive to the exclusion of native species and wildlife. Non-native plants are generally not as effective as native species at binding soils with their roots and stabilizing stream banks. Also, invasive plants typically do not provide forage for wildlife and livestock. Riparian areas that have been disturbed by construction and development activities are more prone to invasion by non-native plants. Where restorative efforts are planned on previously disturbed riparian land, weed management measures should be taken into consideration.

BUCKING THE TREND

Naturalizing riparian areas that have been impacted by human activities is being used more and more in Canada and the USA to help protect shorelines, reduce erosion, improve water quality and improve aesthetics. Replacing features such as retaining walls, lawns and bare ground with natural materials and native vegetation may take some work, but pays dividends in the long run. Appendix 1 contains information sources and links on how riparian areas can be restored to healthy condition.

GETTING READY FOR CLIMATE CHANGE

As some of the predictions of climate change unfold, it is reasonable to expect more uncertainty in flows and water levels. Some predictions indicate that there will be greater variability in precipitation, which could result in more frequent and intense storm events or drought conditions. Hence, there is an increased possibility of unpredictability in flow volumes in a number of Alberta rivers. These trends suggest that protection and, in some cases, restoration of riparian areas and floodplains, especially in urban areas, should be part of the overall strategy to reduce the potential effects of increased flood risks and to avoid the potentially higher costs of maintaining infrastructure. Interaction between urbanization and climate variability also may amplify watershed nitrate export through decreased nitrogen retention during periods of drought, and higher levels of nitrogen export during high flow conditions (Kaushal et al. 2008). At a watershed level, intact, vegetated riparian areas, including wetlands, can temporarily store flood water, thereby reducing erosion and flood damage. Riparian areas capture and store water allowing infiltration to groundwater aquifers. This stored water maintains watercourse base flow and could help mitigate the impacts of low flows associated with drought.

LEARNING FROM OTHERS

A number of municipalities in Alberta have adopted policies for Environmental Reserve setback widths in excess of six metres where it can be demonstrated that wider ERs are needed to prevent non-point-source pollution in adjacent water bodies. Appendix 1 contains some examples of policies various municipalities have implemented, as well as examples from other jurisdictions in Canada.

ADDITIONAL INFORMATION FOR DESIGNING EFFECTIVE BUFFERS

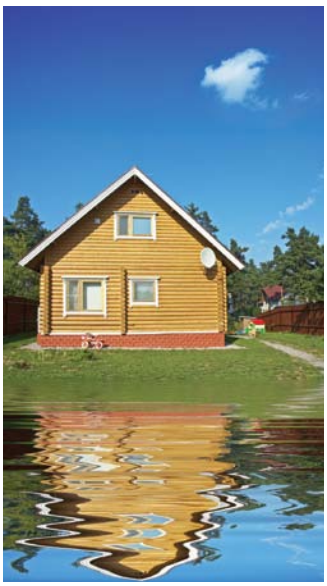
In addition to the information requirements outlined in the earlier sections, the following information should be considered when planning effective riparian buffers at watershed scales:

Table 5
Additional Information Sources

Type of Information	Data Sources
Water Quality Protection	
Adjacent Land Use • Include existing development and zoning	• Municipal development plans; Area structure plans
Lands Upstream or Adjacent to Municipal Drinking Water Sources	**Hydrography Data/Maps** • AltaLIS: Spatial Data Warehouse Ltd. **Aerial Photos** • Alberta Sustainable Resource Development Air Photo Distribution
Sedimentation Source Areas • Including concentrated flow paths and non-vegetated swales that intercept sheet flow and carry sediment directly to the water body	**Soil/Hydrography Maps** • Alberta Geological Survey; Alberta Soil Information Viewer (AGRASID); Canadian Soil Information System (CanSIS); AESA Soil Quality Resource Monitoring. Note: gathering of these data can be coordinated with preparation of Drainage Plans
Possible Pollutant Source Areas	**Reports and Maps** • related to the oil and gas industry Energy Resources Conservation Board: Maps showing buried utility lines, and oil and gas facilities: Abacus Demographics **Inventories** • National Pollutant Resource Inventory
Riparian Vegetation Condition • Type (trees, shrubs, grass) and condition (e.g., Cows and Fish assessment) • Historical extent (i.e., where vegetation has been cleared)	**Aerial Photos** • Government of Alberta Aerial Photo Distribution Centre **Inventories** • Alberta Grassland Vegetation inventory, Alberta Vegetation Inventory, Alberta Vegetation Inventory (Alberta Sustainable Resource Development); Health Assessments (Alberta Riparian Habitat Management Society: Cows and Fish) **Site Inspections/Surveys**
Habitat/Biodiversity	
Fish Habitat Sensitivity • as defined in Guide to the Code of Practice for Watercourse Crossings (2001)	**Map** • The *Code of Practice for Watercourse Crossings*

Conclusion

We cannot take care of what we cannot see. Being able to identify a riparian area and understand what it does for us is the first step. Then, appreciating the complexity of the connections between riparian areas and water bodies will help us make better choices for attaining conservation objectives while meeting human needs. For example, healthy riparian buffers can provide both ecosystem services and community benefits, including reduction of flood hazard and erosion. Integrated approaches among all stakeholders will help make informed planning decisions, aid private/corporate stewardship, and guide restoration efforts. Most importantly, however, we will be taking the necessary steps required to help ensure that our riparian areas are intact and provide the same important ecological functions for generations to come.



Glossary of Terms

Glossary of Key Terms

Aquatic Environment
The components of the earth related to, living in or located in or on water or the beds or shores of a water body, including but not limited to:

- All organic and inorganic matter; and
- Living organisms and their habitats, including fish habitat, and their interacting natural systems.

Aquifer
Refers to a sub-surface layer or layers of porous rock which hold water within the spaces between the rocks (interstitial spaces).

Alluvial Aquifer
A non-confined aquifer comprised of groundwater that is under the influence of surface water.

Bed and Shore
Is the land covered so long by water as to wrest it from vegetation or as to mark a distinct character on the vegetation where it extends into the water or on the soil itself. In Alberta, the province owns most of the beds and shores of all naturally occurring lakes, rivers and streams (*Public Lands Act, Sec. 3 (1)*).

Buffers
A buffer is a strip of land placed in the landscape and managed in such a way so as to maintain desired ecological processes and provide economic and societal benefits.

Crest
Means the dividing line between a valley slope and its upland area. The crest is also referred to as the top-of-the-bank line.

Denitrification
Denitrification is the conversion of nitrate into nitrogen gas by anaerobic microorganisms, and its subsequent loss to the atmosphere. It is an important mechanism of nitrogen reduction in many riparian systems.

Development:
As defined in Section 616 of the *Municipal Government Act*:

1. an excavation or stockpile and the creation of either of them,
2. a building or an addition to or replacement or repair of a building and the construction or placing of any of them on, in, over or under land,
3. a change of use of land or a building or an act done in relation to land or a building that results in or is likely to result in a change in the use of the land or building, or
4. a change in the intensity of use of land or a building or an act done in relation to land or a building that results in or is likely to result in a change in the intensity of use of the land or building.

Environmentally Significant Areas (ESAs)
Are those areas on the landscape that are considered to be vital to the long-term maintenance of biological diversity, physical landscape features, or other natural processes. ESAs are important within the context of regional land-use planning and protected areas design, since they provide an inventory of critical biological, physical, and cultural resources. Fiera Biological Consulting was retained by Alberta Tourism, Parks, and Recreation to update the portfolio of Environmentally Significant Areas in the province. With consultation from a variety of stakeholders, Fiera applied a systematic conservation planning approach to develop new criteria for defining, identifying, and ranking ESAs throughout the province. The Alberta government maintains a database and maps of ESAs in Alberta following a systematic approach using seven well defined criteria.

Ephemeral/Intermittent/Temporary/ Seasonal Water Bodies
Water bodies where the presence of water ceases for a time due to variation in climatic or seasonal conditions, including snow melt/spring runoff, seasonal storms and drought conditions. These changes are considered part of a natural cycle. Intermittent, ephemeral and temporary water bodies (or portions of) can remain dry for many years and may be fully restored after prolonged precipitation. Ephemeral streams are streams that flow only during and immediately after rainstorms. Intermittent streams flow for part of each year.

Escarpment
A steeply sloping area associated with a slope of 15 per cent or greater that is separating two comparatively level or more gently sloping areas, and may contain isolated pockets of lesser sloped terrain. Escarpments include ravines, gullies, coulees, side draws, and other similar features.

Eutrophication
The process whereby water bodies become biologically more productive due to an increased nutrient supply.

Floodplain (Flood Hazard Area)
A floodplain consists of the low-lying land next to a watercourse that is subject to periodic inundation. A 1:100-year floodplain, which is the result of a flood having a 1 per cent chance of being equalled or exceeded in any given year, is used for purposes of development. In the absence of information that identifies the 1:100-year floodplain elevation, the best available information must be used to establish the historic high-water level for a water body. The floodplain can be divided into two zones once a flood hazard mapping study has been completed:

1. *Floodway*
   The area within which the entire design flood can be conveyed while meeting certain water elevation rise, water velocity and water depth criteria. Typically the floodway includes the river channel and some adjacent overbank areas.
2. *Flood Fringe*
   The land along the edges of the flood risk area that has relatively shallow water (less than 1 metre deep) with lower velocities (less than 1 metre/s). In Calgary the mapping uses the term floodplain for the flood fringe area.

Hydric Soil
Soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Hydrology
The branch of geology that studies water on the earth and in the atmosphere, its distribution, uses and conservation.

Hydrogeology
The branch of geology that deals with the occurrence, distribution, and effect of ground water.

Invertebrates
Animals without backbones.

Legal Bank
The top of bank as defined by the *Surveys Act*.
The top of bank is the legal line that separates private land from the bed and shore of a water body.

Lentic
Pertaining to standing water such as lakes and ponds.

Lotic
Pertaining to flowing waters such as rivers, streams and springs.

Macrophytes
Large rooted or floating aquatic plants.

Meander Belt
The land area on either side of a watercourse representing the farthest potential limit of channel migration. Areas within the meander belt may someday be occupied by the watercourse; areas outside the meander belt typically will not.

Ordinary High Water Mark
The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the "active channel/bank-full level" which is often the 1:2 year flood flow return level. In inland lakes or wetlands, it refers to those parts of the water body bed and banks that are frequently flooded by water so as to leave a mark on the land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation (excepting water tolerant species). For reservoirs this refers to normal high operating levels (full supply level).

Qualified Environmental Professional
An applied scientist or technologist with detailed knowledge of the aquatic environment, soils, vegetation and wildlife species, hydrology and geology (biologist, agrologist, geotechnical engineer, forester, forest technologist, erosion and sediment control specialist, etc.), acting alone or together with another qualified environmental professional. The person must be in good standing as a registered professional with an association constituted under an act, and must conduct themselves in accordance with the ethics set out by their association or be subject to disciplinary action by that association. The qualified environmental professional (s) must act in their area of expertise and must exercise professional due diligence in providing their advice.

Riparian
Riparian is derived from the Latin word "ripa" meaning bank or shore, and refers to land adjacent to a water body.

Riparian Area[17]
Includes any land that adjoins or directly influences a water body and includes floodplains and land that directly influences alluvial aquifers. Typical examples include the green ribbons of lush vegetation that grow on floodplains and watercourse banks. They usually are distinctly different from surrounding lands because of unique soil and vegetation characteristics that are influenced by the presence of water above the ground and below the surface. Water is present due to a water body or elevated water table such as in a seep or spring.

- *Note*
  Riparian area/upland boundaries in some regions of Alberta can be difficult to see, such as in the Central Parkland or Boreal forest where the transitions can be quite subtle. The presence of water may also be difficult to detect. For example, Silver Sagebrush/ Western Wheatgrass communities are the driest of the riparian types and water may only be present for a few weeks during the year.

Riparian Vegetation
Vegetation growing on or near the banks of a watercourse or other water body that is more dependent on water than vegetation that is found further up slope.

Setback
For the purposes of this handbook, a setback is a minimum distance that must be maintained between a land use or development and a water body. The distance is measured from the legal bank of the water body to the boundary line of the adjacent development.

[17]Definition taken from Alberta Environment and Water's Riparian Land Conservation and Management Project (2007), with modifications from Cows and Fish (Alberta Riparian Habitat Management Society) and Alberta Sustainable Resource Development.

Shallow Groundwater
Shallow groundwater is defined as any area where the water table is within 1.8 metres of the ground surface during the frost free period up until the end of August; and within 2.4 metres of the ground surface during the remainder of the year.

Stable Slope Allowance
A horizontal allowance measured landward from the toe of a shoreline cliff, bluff, or bank reflecting a long-term stable state of the existing slope material.

Stream
A natural watercourse of any size containing flowing water, at least part of the year, supporting a community of plants and animals within the stream channel and the riparian vegetative zone.

Substrate
A layer of earth beneath the surface soil; subsoil.

Toe Erosion Allowance
A horizontal allowance measured landward from the toe of a shoreline cliff, bluff, or bank reflecting the possible erosion of the toe of the slope.

Upland Area
An area of land, usually terrestrial land (not aquatic), either upstream or surrounding the wetland. It is not part of the wetland but may contribute to the integrity of the wetland.

Vegetated Filter Strip
A vegetated filter strip is land left in a natural, preferably undisturbed state, usually consisting of riparian soils and native or planted vegetation, situated between development and a water body.

Water Body
Means any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent or occurs only during a flood, and includes but is not limited to wetlands and aquifers. The water boundary is considered bound by its ecological boundary. Water bodies can be natural or man-made:

1. *Natural Water Body*
   Examples of a natural water body are a river, stream, creek, lake, and wetland (e.g., swamp, marsh, bog, fen, muskeg, and slough).

2. *Man-made Water Body*
   Examples of a man-made water body are irrigation canals, reservoirs, and dugouts. Ditches are excluded except where they connect to a water body that includes irrigation systems.

Watercourse
A flowing water body, such as a river, stream, or creek. This includes watercourses that may be ephemeral, intermittent, temporary or seasonal in nature.

Watershed
An area of land that catches precipitation and drains it to a specific point such as a marsh, lake, stream or river. A watershed can be made up of a number of sub-watersheds that contribute to the overall drainage of the watershed. A watershed is sometimes referred to as a basin, drainage basin or catchment area.

Wetland
A wetland is land that has the water table at, near, or above the land surface, or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophytic vegetation, and various kinds of biological activity that are adapted to the wet environment" (Tarnocai, 1980). If the rooting zone extends below the water table, the area is a wetland (National Wetlands Working Group, 1988).

Wetlands in Alberta's prairie region (White Area) are commonly classified according to the Stewart and Kantrud classification system:

- *Class I*
  Ephemeral Wetlands typically have free surface water for only a short period of time after snowmelt or storm events in early spring.
- *Class II*
  Temporary Wetlands are periodically covered by standing or slow moving water. They typically have open water for only a few weeks after snowmelt or several days after heavy storm events.
- *Class III*
  Seasonal Ponds and Lakes are characterized by shallow marsh vegetation, which generally occurs in the deepest zone (usually dry by midsummer). These wetlands are typically dominated by emergent wetland grasses, sedges and rushes.
- *Class IV*
  Semi-permanent Ponds and Lakes are characterized by marsh vegetation, which dominates the central zone of the wetland, as well as coarse emergent plants or submerged aquatics, including cattails, bulrushes and pondweeds.
- *Class V*
  Permanent Ponds and Lakes have permanent open water in a central zone that is generally devoid of vegetation.
- *Class VI*
  Alkali wetlands are characterized by a pH above 7 and a high concentration of salts. The dominant plants are generally salt tolerant. These wetlands are especially attractive for shore birds.
- *Class VII*
  Fen Ponds are wetlands in which fen vegetation dominates the deepest portion of the wetland area. This wetland type often has wet meadow and low prairie vegetation present on the periphery. The soils are normally saturated by alkaline groundwater seepage. Fen ponds often have quaking or floating mats of emergent vegetation, which includes sedges, grasses and other herbaceous plants.

References

References

Alberta Environment. 2008. Flood Risk Map Information and Benchmark Retrieval System Website. Available at: www.environment.alberta.ca/3823.html.

AMEC Earth and Environmental. 2007. The Current Status of Natural, Social and Economic Capital in the North Saskatchewan River Valley. Prepared for River Valley Alliance, Edmonton, Alberta.

Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station. 110 p.

Bin, O., and Polasky, S. 2004. Effects of flood hazards on property values: evidence before and after Hurricane Floyd. Land Economics, 80: 490-500.

Bow River Project. 2002. Protecting Riparian Areas: Creative Approaches to Subdivision Development in the Bow River Basin: A Guide for Municipalities, Developers and Landowners. Airdrie, Alberta. 64 p.

Curran, D. 2001. Economic Benefits of Natural Green Space Protection. Faculty of Law & School of Environmental Studies, University of Victoria, Canada and Smart Growth British Columbia.

Dillaha, T. A., Reneau, R. B., Mostaghimi, S. and Lee, D. 1989. Vegetative filter strips for agricultural nonpoint source pollution control. Transactions of the ASAE, 32(2):513-519.

Ducks Unlimited Canada. 2008. The Impacts of Wetland Loss in Manitoba. Unpubl. Fact Sheet.

Finlay, K., Patoine, A., Donald, D.B., Bogard, M.J. and Leavitt, P.R. 2010. Experimental evidence that pollution with urea can degrade water quality in phosphorus-rich lakes of the Northern Great Plains. Limnology and Oceanography, 55(3): 1213-1230.

Gharabaghi, B., Rudra, R.P., and Goel, P.K. 2006. Effectiveness of vegetative filter strips in removal of sediments from overland flow. Water Quality Research Journal of Canada: 41(3), 275-282.

Groffman, P.M., Boulware, N.J., Zipperer, W.C., Pouyat, R.V., Band, L.E. and Colosimo, M.F. Soil nitrogen cycle processes in urban riparian zones Environ. Sci. Technol. 2002 (36): 4547-4552.

Hannon, S.J., Paszkowski, C.A. Boutin, S. and DeGroot, J. 2002. Abundance and species composition of amphibians, small mammals, and songbirds in riparian forest buffer strips of varying widths in the boreal mixedwood of Alberta. Canadian Journal of Forest Research, 32: 1784-1800.

Haycock, N.E. and Pinay, G. 1993. Nitrate retention in grass and poplar vegetated buffer strips during the winter. Journal of Environmental Quality, 22 (2): 273-278.

Hill, A.R. 1996. Nitrate removal in stream riparian zones. Journal of Environmental Quality, 25(4): 743-755.

Hill, A.R. and Cardaci, M. 2004. Denitrification and organic carbon availability in riparian wetland soils and subsurface sediments. Soil Science Society of America Journal, 68(1): 320-325.

Hubbard, R. K. and Lowrance, R.R.. 1994. Riparian forest buffer system research at the Coastal Plain Experimental Station, Tifton, Georgia. Water, Air and Soil Pollution, 77: 409- 432.

Jacobs, T.C. and Gilliam, J.W. 1985. Riparian losses of nitrate from agricultural drainage waters. Journal of Environmental Quality, 14(4): 472-478.

Jeji, Y. 2007. Export Coefficients for Total Phosphorus, Total Nitrogen and Total Suspended Solids in the Southern Alberta Region: A Review of Literature. Prepared for Alberta Environment. Available at: www.environment.alberta.ca.

Johnson, C. W. and Buffler, S. 2008. Riparian buffer design guidelines for water quality and wildlife habitat function on agricultural landscapes in the Intermountain West. U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Jordan, T. E., Correll, D. L. and Weller, D. E. 1993. Nutrient interception by a riparian forest receiving inputs from adjacent cropland. Journal of Environmental Quality, 22(3): 467-473.

Kaushal, S.S., Groffman, P.M., Band, L.E., Shields, C.A., Morgan, R.P., Palmer, M.A., Belt, K.T., Swan, C.M., Findlay, S.E.G. and Fisher, G.T. 2008. Interaction between urbanization and climate variability amplifies watershed nitrate export in Maryland. Environmental Science & Technology, 42 (16): 5872–5878.

King, K.W., Balogh, J.C., Hughes, K.L. and Harmel, R.D. 2007. Nutrient load generated by storm event runoff from a golf course watershed. Journal of Environmental Quality, 36:1021–1030.

Kwasniak, A. 2001. Alberta's Wetlands: A Law and Policy Guide. Environmental Law Centre and Ducks Unltd. for the North American Waterfowl Management Plan. Edmonton, Alberta.

Lammert, M. and Allan, J.D. 1999. Assessing biotic integrity of streams: effects of scale in measuring the influence of land use/cover and habitat structure on fish and macroinvertebrates. Environmental Management, 23(2): 257-270.

Lehmkuhl, J.F. and Peffer, R.D. 2008. Riparian and upland small mammals of the east slope of the Cascade Range, Washington. Northwest Science, Vol. 82, No. 2.:94-107.

Lewis, Jr., W. M., Wurtsbaugh, W.A. and Paerl, H.W. 2011. Rationale for control of anthropogenic nitrogen and phosphorus to reduce eutrophication of inland waters. Environmental Science and Technology, 45: 10300-10305.

Liu, X., Zhang, X. and Zhang, M. 2008. Major factors influencing the efficacy of vegetated buffers on sediment trapping: a review and analysis. Journal of Environmental Quality, 37(5): 1667-1674.

Lowrance, R. 1992. Groundwater nitrate and denitrification in a coastal plain riparian soil. Journal of Environmental Quality, 21:401–405.

Lyons, J., Trimble, S.W. and L.K. Paine. 2000. Grass versus trees: managing riparian areas to benefit streams of central North America. Journal of the American Water Resources Association, 36(4): 919-930

Maine Department of Environmental Protection (MDEP). 2000. Madawaska Lake Total Maximum Daily (Annual) Load: Total Phosphorus: Final Lakes TMDL Report. DEPLW 2000-112.

Maitre, V., Cosandey, A-C., Desagher, E. and Parriaux, A. 2003. Effectiveness of groundwater nitrate removal in a river riparian area: the importance of hydrogeological conditions. Journal of Hydrology, 278(1-4): 76-93.

Mander, U., Kuusemets, V., Lohmus, K. and Mauring, T.. 1997. Efficiency and dimensioning of riparian buffer zones in agricultural catchments. Ecological Engineering, 8: 299-324.

Massal, L.R., Snodgrass, J.W. and Casey, R.E. Nitrogen pollution of stormwater ponds: potential for toxic effects on amphibian embryos and larvae, Applied Herpetology 4: 19–39.

Mayer, P. M., Reynolds, S. K., McCutchen, M. D. and Canfield, T. J. 2007. Meta-analysis of nitrogen removal in riparian buffers. Journal of Environmental Quality, 36(4): 1172-1180.

McLeod, S.M., Kells, J.A. and Putz, G.J. 2006. Urban runoff quality characterization and load estimation in Saskatoon, Canada. Journal of Environmental Engineering, 132(11):1470-1481.

Meador, M.R. and Goldstein, R.M. 2003. Assessing water quality at large geographic scales: relations among land use, water physiochemistry, riparian condition, and fish community structure. Environmental Management 31(4): 504-517.

Mitchell, P. and Hamilton, H.R. 1982. Assessment of phosphorus export from the Majeau Creek watershed Lac la Nonne. Water Quality Control Branch, Alberta Environment and Water. Edmonton, AB.

Mitchell, P. and Trew, D.O. 1982. Agricultural Runoff and Lake Water Quality. In: Agricultural Impacts on Surface and Groundwater Quality. Lethbridge. Sept. 16-17, 1982, pp. 73-79.

Montana Dept. of Environmental Quality (MDEQ) 2001. Draft Nutrient Management Plan and Total Maximum Daily Load for Flathead Lake, Montana.

Naiman, R.J. and H. Decamps. 1997. The Ecology of Interfaces: Riparian Zones. Annual Review of Ecology and Systematics, 28: 621-658

National Wetlands Working Group, 1988, Wetlands of Canada: Ecological Land Classification Series, No. 24. Ottawa, Ontario, Sustainable Development Branch, Environment Canada.

Novotny, V. 2006. Agricultural Diffuse Pollution: Are We On The Right Track To Successful Abatement? In: Proceedings of the SAC and SEPA Biennial Conference. Edinburgh, Scotland. Ed. By: L. Gairns, K. Crighton & B. Jeffrey. 2006.

Oberts, G.L., Wotzka, P.J. and Hartsoe, J.A. 1989. The water quality performance of select urban runoff treatment systems. Rept. to Leg. Comm. Minnesota Resources Metropolitan Council Pub. No. 590-89-062a. St. Paul MN.

Ontkean, G.R., Bennet, D.R., Chanasysk, D.S. and Sosiak, A. 2000. Impacts of Agriculture on Surface Water Quality in the Crowfoot Creek Watershed. Alberta Agriculture Research Institute. Project # 97M062. 234pp.

Osborne, L. L. and Kovacic, D. A. 1993. Riparian vegetated buffer strips in water-quality restoration and stream management. Freshwater Biology, 29(2): 243-258.

Peterjohn, W.T. and Correll, D.L. 1984. Nutrient dynamics in an agricultural watershed: observations on the role of a riparian forest. Ecology, 65(5): 1466-1475.

Reckhow, K.H., Beaulac, M.N. and Simpson, J.T. 1980. Modeling Phosphorus Loading and Lake Response Under Uncertainty: A Manual & Compilation of Export Coefficients. EPA 440/5-80-011 U.S.E.P.A.

Qiu, Z., Prato, T., and Boehm, G. 2006. Economic evaluation of riparian buffers and open space in a suburban watershed. Journal of the American Water Resource Association, 42 (6): 1583-1596.

Richardson, C.T. and Miller, C.K. 1997. Recommendations for protecting raptors from human disturbance: a review. Wildlife Society Bulletin, Vol. 25, No. 3: 634-638.

Rodgers, Jr., J.A. and H.T. Smith. 1997. Buffer Zone Distances to protect foraging and loafing waterbirds from human disturbance in Florida. Wildlife Society Bulletin, Vol. 25, No. 1: 139-145.

Rood, S.B., Groater, L.A., Mahoney, J.M., Pearce, C.M. and Smith, D.G. 2007. Floods, fire, ice: disturbance ecology of riparian cottonwoods. Canadian Journal of Botany, 85(11): 1019-1032.

Scace and Associates Ltd. 1987. Bow River Recreation Study: An Assessment of Recreational Use and Economic Benefit. Report prepared for Alberta Forestry, Lands and Wildlife, Volumes 1 - 4.

Semlitsch, R.D. and Bodie, J.R.. 2003. Biological criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles. Conservation Biology, Vol. 17, No. 5: 1219–1228.

Serecon Consulting. 2007. Healthy Parks, Healthy People, Healthy Communities. Assessing the Proximate Value of Parks and Open Space to Residential Properties in Alberta. Prepared for Alberta Parks and Recreation Association. Edmonton, Alberta.

Shields, C. A., Band L.E., Law, N., Groffman, P. M., Kaushal, S. S., Savvas, K., Fisher, G. T. and Belt, K. T. 2008. Streamflow distribution of non–point source nitrogen export from urban-rural catchments in the Chesapeake Bay watershed. Water Resources Research, 44, W09416, doi:10.1029/2007WR006360.

Steinke, K., Stier, J.C., Kussow, W.R., and A. Thompson. 2007. Prairie and turf buffer strips for controlling runoff from paved surfaces. Journal of Environmental Quality, 36:426-439.

Stewart, R.E. and H.A. Kantrud. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C., USA. Resource Publication 92.

Tarnocai, C., 1980, Canadian wetland registry, in Rubec, C. D. A., and Pollett, F. C., editors, Workshop on Canadian Wetlands: Ecological Land Classification Series, Lands Directorate, Environment Canada.

Trimble, G. R., Jr., and Sartz, R. S. 1957. How far from a stream should a logging road be located? Journal of Forestry, 55(5): 339-341.

USEPA 2002. Polluted Runoff (Nonpoint Source Pollution). National Management Measures to Control Nonpoint Source Pollution from Agriculture 314pp.

Vidon, P.G.F. and Hill, A.R. 2004. Landscape controls on the hydrology of stream riparian zones. Journal of Hydrology, 292:210-228.

Vidon, P.G.F. and Hill, A.R. 2006. A Landscape-based approach to estimate riparian hydrological and nitrate removal functions. Journal of the American Water Resources Association, 42(4):1099-1112.

Wenger, S. 1999. A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation. Institute of Ecology, University of Georgia. Athens, Georgia, USA.

Appendix 1

SUPPLEMENTAL INFORMATION CONCERNING RIPARIAN AREA PROTECTION AND MANAGEMENT

Appendix 1

The main body of this report described a process for determining setbacks, beginning with the assembly of relevant policy and legislation that affect development adjacent to water bodies in Alberta. The document also included the types of environmental information that were needed to determine the appropriate type and width of buffer if riparian function was to be maintained. Finally, the document described some of the planning and management steps to consider in maintaining healthy riparian buffers once they are established on the landscape. To help the reader sort through the large amount of material that is available, this appendix summarizes the following information:

- Key federal and provincial legislation, policies, guidelines and programs that developers and planners should be aware of when designing setbacks or riparian buffers in association with planned developments;
- Examples of municipal policies and bylaws that are in place to establish environmental reserve strips in excess of six metres;
- Beneficial management practices for establishing and maintaining riparian buffers and protecting shorelines; and
- Additional information and resources on riparian areas.

The Appendix also summarizes Alberta legislation and polices that affect other types of land uses adjacent to water bodies that are beyond the scope of this document, including agriculture, timber operations, and oil and gas. These are included to help the reader understand how different areas of legislation work together to protect water bodies and adjacent riparian areas from the impacts of human activities.

FEDERAL LEGISLATION AFFECTING DEVELOPMENT IN RIPARIAN AREAS

Fisheries Act

Fisheries and Oceans Canada (DFO)

To sustain or achieve a net gain in the quality and quantity of fish habitat in Alberta, the federal Department of Fisheries and Oceans (DFO) is the primary regulatory agency for dealing with the harmful alteration of fish habitat in Alberta. The *Fisheries Act* includes provisions for the protection of fish and their habitat, where any harmful alteration, disruption or destruction (HADD) will require authorization from Fisheries and Oceans Canada (DFO). Under the *Fisheries Act*, fish habitat is identified as: “spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes”. As such, riparian areas are considered to contribute to, if not directly constitute part of, fish habitat. Additionally, the *Fisheries Act* prohibits the discharge of deleterious substances in water used by fish.

Alberta Operational Statements

The purpose of the operational statements is to describe the conditions under which DFO review of proposed project activities is not required and to provide measures which must be incorporated into projects to protect fish and fish habitat. Operational Statements applicable to riparian areas include:

- Alberta Operational Statement: Maintenance of Riparian Vegetation in Existing Rights-of-Way
- Alberta Operational Statement: Isolated Pond Construction

Migratory Birds Convention Act
Environment Canada, Canadian Wildlife Service

Environment Canada prohibits harming or killing of listed species and makes it an offence to damage or destroy their residence on federal lands, for all aquatic species, and migratory birds under the *Migratory Birds Convention Act*. The Act would apply to species at risk and their habitat which occurs within a riparian area of interest, and also allows for emergency protection where the Act would not apply. This Act requires consideration for activities within or near riparian areas which may disturb migratory birds or their nests, as defined by the Act.

Navigable Waters Protection Act
Transport Canada

Provides for the prohibition to build works in navigable waters, unless the work, its site and plans have been approved by the Minister of Transport. Navigable waters are defined as including any body of water capable of being navigated by any type of floating vessel for the purpose of transportation, recreation or commerce. Any company, organization, government agency or Crown corporation that is planning the construction or modification of a work in, on, over, under, through or across any navigable waterway is affected by this Act. Works include a wharf, dock, pier, dam, boom, bridge, overhead cable or pipeline.

Species at Risk Act
Environment Canada (Lead), Department of Fisheries and Oceans (Aquatic Species at Risk)

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was established by the *Species at Risk Act* as the authority for assessing the conservation status of wildlife species that may be at risk of extinction in Canada. COSEWIC uses the best available scientific, community and Aboriginal knowledge to evaluate risk of extinction.

PROVINCIAL LEGISLATION AFFECTING DEVELOPMENT IN RIPARIAN AREAS

Alberta Land Stewardship Act

Creates the authority for regional plans for each of the seven regions identified in the Land-use Framework. Government will appoint regional advisory councils, which will consist of members representing a wide range of interests, expertise and experience within each region. Regional advisory councils will provide advice to government, on what should be in the regional plans. Plans will be developed by Government of Alberta, under the direction of the Land Use Secretariat, with public and stakeholder input and will be reviewed and approved by Cabinet. The *Alberta Land Stewardship Act* makes approved regional plans binding on all provincial government departments and decision-making boards and agencies, municipalities and local government authorities.

The *Alberta Land Stewardship Act* enables the development of new conservation and stewardship tools to protect heritage landscapes and viewscapes. For example, the scope of conservation easements has been expanded and they are now enabled under the *Alberta Land Stewardship Act*. Under the Act, a registered owner of land may, by agreement, grant to a qualified organization a conservation easement in respect of all or part of the land for one or more of the following purposes: (a) the protection, conservation and enhancement of the environment; (b) the protection, conservation and enhancement of natural scenic or esthetic values; (c) the protection, conservation and enhancement of agricultural land or land for agricultural purposes; (d) providing for any or all of the following uses of the land that are consistent with the purposes set out in clause (a), (b) or (c): (i) recreational use; (ii) open space use; (iii) environmental education use; (iv) use for research and scientific studies of natural ecosystems.

Environmental Protection and Enhancement Act
Alberta Environment and Water

The *Environmental Protection and Enhancement Act*, in general, prohibits the release of any substance into the environment which might cause a significant adverse environmental effect. The Act provides for management of wastewater systems, contaminated sites, storage tanks, landfills, and hazardous waste.

For a comprehensive listing of legislation and guidelines under the *Environmental Protection and Enhancement Act*, see: www.environment.alberta.ca/03147.html.

Municipal Government Act
Alberta Municipal Affairs

Ordinarily, a person wishing to create one or more lots from a parcel of land must obtain subdivision approval from the municipal subdivision authority. Conditions may be attached to a subdivision approval requiring the applicant to:

- Provide land as environmental reserve in accordance with section 664 of the Act,
- Where the municipality and the landowner agree, an environmental reserve easement may be registered on title by caveat in favour of the municipality.

The *Municipal Government Act* defines the conditions under which a municipality may acquire "reserve lands" during the subdivision of a parcel of land. Under Section 664, subdivision approval authorities may require establishment of an environmental reserve if those lands consist of:

- A swamp, gully, coulee, or natural drainage course;
- Land that is unstable or subject to flooding; or
- A strip of land not less than six metres in width, abutting the bed and shores of any lake, river, stream, or other body of water for the purpose of preventing pollution or providing public access to and beside the bed and shore.

Under Section 671 environmental reserve lands are lands which must be left in their natural state or used as a public park or for public to access the area. A municipality can develop guidelines to dedicate environmental reserve strips adjacent to water bodies (setbacks) in excess of 6 metres when it can be demonstrated that such takings are required to prevent pollution in adjacent water bodies, or is needed to ensure public access.

Section 640 enables building development setback land use bylaw provisions on land subject to flooding or subsidence or that is low lying, marshy or unstable or on land adjacent to or within a specified distance of the bed and shore of any lake, river, stream or other body of water. A "building" includes anything constructed or placed on, in, over or under lands, but does not include a highway or road or a bridge that forms part of a highway or road.

Regional Health Authorities Act
Alberta Health and Wellness

Under the Act, Health Regions and corresponding Regional Health Authorities (RHAs) are established. The RHAs have the mandate to promote and protect the health of the population in the region, and as such, may respond to concerns that may adversely affect surface and groundwater.

Private Sewage Disposal Systems Regulation
Alberta Municipal Affairs

The *Private Sewage Disposal Systems Regulation 229/97*, as amended by AR 264/2009, adopts the 2009 Alberta Private Sewage Systems Standard of Practice. The private sewage standards set out design standards, installation standards and material requirements for on-site private sewage systems serving a single property or handling less than 25 cubic metres (5,500 Imperial gallons) sewage volume per day.

Public Lands Act
Alberta Sustainable Resource Development

Under the *Public Lands Act*, the Crown owns the bed and shores of a water body. Approvals are required for any activity which involves the alteration or occupation of Crown owned land.

Safety Codes Act
Alberta Municipal Affairs

Under Section 65(1), the *Safety Codes Act* provides for the regulation and enforcement of septic system management practices, including installation of septic fields and other subsurface disposal systems. The *Private Sewage Disposal Systems Regulation* enabled under the Act further refines the Minister's powers, and adopts the design and installation requirements and additional specifications and standards outlined in Alberta.

Soil Conservation Act
Alberta Agriculture and Rural Development

The *Soil Conservation Act* applies to all land within Alberta with the exception of "specified land", as defined in EPEA. Specified land does not include "subdivided land that is used or intended to be used solely for residential purposes" and "land owned by the Crown in right of Canada". Therefore, these lands are regulated by the *Soil Conservation Act.* The *Soil Conservation Act* regulates activities having erosion and sediment control concerns.

Subdivision and Development Regulation, Municipal Government Act
Alberta Municipal Affairs

The *Municipal Government Act* and *Subdivision and Development Regulation* govern subdivision of land. This legislation specifies the authority and responsibilities of the municipality in receiving and deciding on subdivisions. Each municipality must enact a subdivision bylaw to provide for a Subdivision Authority to exercise powers and duties on behalf of the municipality.

Surveys Act

Section 17(3) defines the location of the legal bank and the extent of the bed and shore of a water body.

Water Act
Alberta Environment and Water

The *Water Act* governs water diversion, allocation and usage of water in Alberta, and an approval or license is required before a construction activity can be undertaken in a water body or before diverting and using water. Furthermore, the draining, infilling or alteration of wetlands without an approval is prohibited under the Act. Under the *Water (Ministerial) Regulation* and *Water Act* Codes of Practice, activities related to watercourse crossings for roads, pipelines and transmission lines are regulated.

Alberta Environment and Water Flood Management Programs
The *Water Act* provides the Minister of Environment with the power to designate any area of land as a flood risk area, either temporarily or more generally. Approval may be required under the *Water Act* for an activity within a flood hazard area. Local governments, however, are responsible for enacting by-laws/zoning to prevent development in flood hazard areas. An integrated, coordinated approach to flood management in Alberta is encouraged.

For a comprehensive listing of legislation and guidelines under the *Water Act*, see: www.environment.alberta.ca/03147.html.

Wildlife Act

The Government of Alberta has authority for the protection and management of wildlife on all provincial lands, irrespective of whether these lands are owned by the Crown or by private interests. Land and resource users should be aware of these legislative and regulatory provisions under the *Wildlife Act* and *Wildlife Regulation*. The Minister responsible for fish and wildlife management has authority under the *Wildlife Act* to influence and control human activities that may have direct adverse effects on populations and habitat of wildlife species. The *Wildlife Act* [Sec. 96 (1) (u)] enables the Minister to establish regulations, "…*respecting the protection of wildlife habitat and the restoration of habitat that has been altered, and enabling the Minister to order persons responsible for the alteration to restore the habitat and to charge them with the cost of it if they have failed to effect the restoration.*" Section 38(1) of the Wildlife Act, states that: *A person shall not willfully molest, disturb or destroy a house, nest or den of prescribed wildlife or a beaver dam in prescribed areas and at prescribed times.*

ALBERTA GOVERNMENT POLICIES AND PROGRAMS AFFECTING DEVELOPMENT IN RIPARIAN AREAS

A Guide to Content of Industrial Approval Applications

Alberta Environment and Water

This guideline has been prepared to outline the content requirements for applications to construct, or operate, or reclaim an industrial plant, facility, or activity under the *Alberta Environmental Protection and Enhancement Act* (EPEA) and the *Approvals and Registrations Procedure Regulation*. It addresses applications for industrial activities listed in the *Activities Designation Regulation* (*Alberta Regulation 211/96*) under Schedule 1 Divisions 1, 2 and 3.

A Guide to the Code of Practice for Pits

Alberta Environment and Water

This guide explains how sand, gravel, clay or marl pits that are five hectares (12.5 acres) or larger on private land are regulated through the *Code of Practice for Pits*. The Code of Practice was made under the Conservation and Reclamation Regulation. Registration holders must meet all the requirements of the *Code of Practice for Pits*.

Administrative Guide for Approvals to Protect Surface Water Bodies Under the *Water Act* (2001)

Alberta Environment and Water is concerned about the level of unauthorized activities occurring in water bodies. Unauthorized alterations, such as draining and infilling of water bodies cause damage to the aquatic environment and shorelines, degrade water quality and destroy wildlife and their habitat. This guide identifies methods to protect all permanent and intermittent natural surface water bodies throughout the province in rural and urban areas on private and public land. The guide defines the various activities requiring approval under the *Water Act* and provides for consistent application of the *Water Act* in both rural and urban areas of the province. Alberta's *Water Act* supports and promotes the conservation and management of water. Fundamental to the *Water Act* is the recognition that the protection of the aquatic environment is an important element of sustainable water management.

Alberta Private Sewage Systems Standard of Practice 2009

The Standard of Practice was adopted by Alberta Regulation and came into force October 5, 2009. The 2009 Standard of Practice reflects substantial changes from the 1999 Private Sewage Systems Standard of Practice. Certified Installers must be knowledgeable of the 2009 Standard to appropriately apply the requirements set out in that standard when undertaking the design and installation of onsite sewage systems.

Alberta Wetland Policy

The Alberta Wetland Policy is Alberta's interim policy concerning development adjacent to wetlands, and should be consulted prior to the establishment of setback widths through by-laws or other means.

Channel Migration

Alberta does not have a written policy for how to manage channel migration, erosion and debris accumulation in watercourses. Alberta Environment and Water is considering the creation of a policy that would promote landowners and local authorities to be accountable for developments in and near water bodies while allowing for a healthy environment to be sustained and managing GOA risks, costs and liabilities. The policy would be consistent with the renewed *Water for Life* Strategy and the Department's mandate to assure the effective stewardship of Alberta's environmental systems to sustain a high quality of life.

Conservation Easement

A conservation easement is a legally recorded agreement by which landowners voluntarily restrict the use of their land to protect its natural and cultural heritage. A conservation easement protects important land resources and can be held by a qualified conservation organization such as a land trust or local unit of government. Provided that certain conditions or programs are met, donors of easements may be eligible for income, estate and/or tax benefits. One condition is that there must be an established, recognizable public benefit, such as protecting rare species, public water supplies, or heritage sites. In Alberta, conservation easements are currently enabled under the *Alberta Land Stewardship Act* (ALSA).

Environmental Reference Manual for the Review of Subdivisions in Alberta

Alberta Environment and Water

This manual provides Subdivision Authorities, planners, planning consultants and development officers with tools that can assist them to screen for, avoid and/or resolve environmental concerns associated with subdivision applications. Subdivision authorities are obliged to consider a variety of environmental factors in their decision as per the *Subdivision and Development Regulation*. In addition, users will find the manual's advice helpful with respect to the environmental aspects of development reviews and as a reference document for the preparation of land use plans. Moreover, the manual will assist users to pinpoint when a proposed development will likely require environmental approvals or authorizations pursuant to the *Environmental Protection and Enhancement Act* (EPEA), the *Water Resources Act* and/or the *Public Lands Act*.

Guideline for Stormwater Management at Rural Stream Crossings

Alberta Transportation

Potential impacts of road operations on the natural drainage system include an increase in flow rates, a decrease in water quality, and risk of contaminated spills. Stormwater management guidelines have been published by Alberta Environment and Water (AEW) to address these potential impacts. This best practice guideline documents the current Alberta Transportation (AT) practice for stormwater management at rural stream crossings.

Land-use Framework

Government of Alberta

Through the Land-use Framework, regional land use planning and co-ordination between the Government of Alberta and municipal land-use decisions is formalized. The framework divides the province into seven regions and a regional plan will be developed within each. Regional planning is expected to implement provincial policies, outline regional objectives for land use planning, and provide context for land use planning in a given region. Local governments and provincial government departments will be required to comply with each plan. Implications for what the framework holds for setbacks and riparian areas are yet to be determined.

Provincial Land Use Policies

Alberta Municipal Affairs

Provincial Land Use Policies provide broad policy direction to municipalities with respect to such matters as the environment and water resources. Municipalities are expected to reflect these policies in their municipal development plans, other statutory plans, and Land Use Bylaws

Recommended Land Use Guidelines for Protection of Selected Wildlife Species and Habitat within Grassland and Parkland Natural Regions of Alberta

Alberta Sustainable Resource Development

The guidelines provide recommended setback distances and timing restrictions applicable to various land use/surface disturbance activities for key wildlife areas and/or sites of species of the grassland and parkland natural regions considered to be sensitive. The recommended setbacks are distances from the key wildlife habitats (e.g., hibernaculae, nests, or ponds) and vary depending on the species under consideration.

Stormwater Management Guidelines for the Province of Alberta (1999)

Alberta Environment and Water

These guidelines outline the objectives of management and the available methodologies and concepts for the planning, design, and operation of stormwater drainage systems. In addition to the water quantity aspects of stormwater management, the publication also describes some of the techniques that can be applied for quality management of stormwater. It is important that these guidelines be viewed as a tool to assist in making decisions and not as a rulebook for management solutions. The designer is solely responsible for decisions made with respect to management for any given site.

Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems

Alberta Environment and Water

To meet the requirements of the *Potable Water Regulation*, the *Wastewater and Storm Drainage Regulation*, and *Wastewater and Storm Drainage (Ministerial) Regulation*, water works systems, wastewater systems, and storm drainage systems are required to be designed to meet (at a minimum) the performance standards and design requirements outlined within this publication.

Standard Recommendations to Municipal Subdivision Referrals (Includes Recommended Minimum Environmental Reserve Widths)

Alberta Sustainable Resource Development

This document identifies Alberta Sustainable Resource Development's (ASRD) common interest with municipalities relating to the conservation of the natural environment through the establishment of environmental reserves/easements. ASRD's goal is to have adequate riparian buffers established between a proposed development and a lake, river, watercourse, or wetland. ASRD supports the use of all available tools and best management practices to ensure that the long-term integrity and functionality of Environmental Reserve lands are maintained. These tools include, but are not limited to, by-laws and conditions on development permit that:

1. reflect the sensitivity of the lands and which are likely to continue to preserve the functions that a healthy riparian area provides;
2. ensure Environmental Reserves are not affected by grading of adjacent lots prior to construction and development arising out of the subdivision and development process. For example, the use of Grading Permits would provide a mechanism where erosion and sediment control measures can be directed to prevent pollution of aquatic environments;
3. ensure the protection of tree cover in areas deemed to be environmentally sensitive, especially in areas adjoining water bodies and watercourses, or where lands are subject to erosion or slope failure; avoid, wherever possible, the enclosure of long stretches of a natural watercourse so that they continue to remain above ground. SRD encourages municipalities to utilize bridges at larger or more sensitive streams rather than culverts; and
4. incorporate natural wetland areas into green space and park systems wherever possible with sufficient buffer areas to facilitate their long-term sustainability.

Water for Life Strategy

Alberta Environment and Water

The *Water for Life* Strategy has been developed and implemented as an overarching strategy or vehicle for water management in the province since 2003 (and renewed in 2008). The strategy is based on three principle outcomes: safe, secure drinking water supply, healthy aquatic ecosystems and reliable, quality water supplies for sustainable economy. The *Water for Life* strategy is implemented through a variety of initiatives or programs, including conservation, efficiency and productivity sector plans, as well as partnerships, such as Watershed Planning and Advisory Councils and Stewardship Groups.

Watershed Management Plans

Contain recommendations for protecting and managing watershed and riparian health.

Wetland Management in the Settled Area of Alberta

This is an interim policy used to achieve the department's no net-loss strategy of wetlands on private and public land. The intent of the policy is to:

- conserve slough/marsh wetlands in a natural state
- mitigate degradation or loss of slough/marsh wetland benefits as near to the site of disturbance as possible
- enhance, restore or create slough/marsh wetlands in areas where wetlands have been depleted or degraded

Wetland Restoration/Compensation Guide: Revised Edition 2007

Alberta Environment and Water

This guide has been written for government regulators, land developers, the public, wetland restoration agencies, and government departments whose mandates or activities affect wetlands. It explains how applications under the *Water Act* will be reviewed when loss of wetlands will occur. It also explains wetland compensation; a process to help reduce loss of wetland area by restoring drained or altered, naturally occurring wetlands. Alberta Environment and Water's priority is to avoid having land development impact wetland area whenever possible. When this is not an option, Alberta Environment and Water requires developers to explore how they can reduce impacts to the wetland area or, if this is not possible, how they can compensate for the disturbance. Compensation for the loss of naturally occurring wetlands will be required when an approval to impact a wetland is issued under the *Water Act*, and when the regulator has decided the most appropriate action is to restore a wetland. Wetland loss includes infilling, altering, or physically draining the wetland, any impact to the riparian area and buffer strips, and any type of interference with the hydrology to and from the wetland.

ALBERTA LEGISLATION, POLICIES AND PROGRAMS AFFECTING AGRICULTURE, OIL AND GAS, AND OTHER ACTIVITIES IN RIPARIAN AREAS

Agriculture Operation Practices Act

Natural Resources Conservation Board

The *Agricultural Operation Practices Act* (AOPA) and regulations include manure management requirements for all livestock operations in Alberta. Under AOPA, all livestock producers are expected to follow the setbacks required from common bodies of water when locating wintering sites and livestock corrals. This practice will help minimize the risk of contaminated runoff potentially affecting the water quality of common water bodies. The following key setbacks are in effect:

1. Manure storage sites must be located at least one metre above the 1-in-25 maximum flood level,
2. Wintering sites and livestock corrals must be located a minimum 30m from a water body unless mitigating management strategies are applied or there is a natural slope away from the water body,
3. Manure must be stored a minimum 100m from spring or well, unless groundwater is monitored.

Alberta Environmentally Sustainable Agriculture

Alberta Agriculture and Rural Development

The goal of the AESA program is to encourage the agricultural industry to enhance efforts in environmental stewardship. It identifies and promotes practical, effective solutions for existing challenges and assesses emerging environmental issues. Through an extension component, AESA staff as well as municipalities, producer, aboriginal environmental groups and other agencies are linking researchers to the extension process and transferring new knowledge, information, tools and ideas to Alberta's farmers and ranchers.

Environmental Farm Plan
Is an awareness tool that the AESA extension staff use to help producers identify their environmental risks. EFP takes a whole farm approach directing a producer to analyze their farming operation and develop a plan to mitigate the identified risk. EFP is now only available through trained extension staff mostly made up of AESA funded positions.

Alberta Tier 2 Soil and Groundwater Remediation Guidelines

Alberta Environment and Water

Alberta's framework for the management of contaminated sites is designed to achieve three policy outcomes: pollution prevention, health protection and productive use. Under this framework, three management options are provided: Tier 1, Tier 2, and Exposure Control. The Tier 1 approach is based on the assumption that all exposure pathways and receptors relevant to a particular land use are actually present. At Tier 1, exposure pathways that are part of the generic scenario for the applicable land use may not be screened out. Under Tier 2 it may be possible to screen out certain exposure pathways and/or modify the Tier 1 guidelines on the basis of site conditions.

Beneficial Management Practices: Environmental Manual for Alberta Farmsteads – Fuel Storage and Handling

Alberta Agriculture and Rural Development

At present, the Alberta Fire Code governs the storage and handling of petroleum products. Although Alberta producers are exempt from the Code, its standards are used as guidelines for producers to follow as beneficial management practices.

Environmental Code of Practice for Land Treatment of Soil Containing Hydrocarbons

Alberta Environment and Water

Made under the *Environmental Protection and Enhancement Act* RSA 2000, cE-12. Any person who constructs, operates, or reclaims a registered site, must do so in accordance with this Code of Practice, unless the site is the subject of an approval issued under s.6(3) of the *Activities Designation Regulation*.

Energy Resources Conservation Board Draft Directive February 10, 2009: Oil and Gas Development Within or Proximal to Water Bodies

Energy Resources Conservation Board

The Alberta Government aims to protect water bodies on both public and private lands and has established setback distances to separate water bodies from oil and gas developments. The goal is to avoid disturbance to water bodies and to ensure that the appropriate mitigative measures are in place to protect them when siting oil and gas developments.

The requirements set out in this directive have been jointly developed by the ERCB, AEW, Alberta Sustainable Resource Development (ASRD), and the Special Areas Board (SAB) of Alberta Municipal Affairs. They are designed to provide a consistent, field-applicable methodology that can be used to identify and delineate water bodies and to accurately determine whether a new oil and gas development will meet the water body setback requirements or whether an existing development is meeting the setback requirements.

Forests Act

The Forests Act provides the legal framework for management of forests in Alberta. It defines the basic rules governing forest tenure and provides the Minister and Cabinet with the power to set policies and regulations governing logging methods, wood utilization standards, and broader issues concerning use of forest land.

Timber Management Regulation
Timber Management Regulation and policy are used to implement and administer the *Forests Act*. **Alberta Timber Harvest Planning and Operating Ground Rules** are authorized under Section 5 of the *Forests Act* and Section 100 (b) of the *Timber Management Regulation*. The ground rules highlight the current standards and guidelines for timber harvest planning and operations, road construction and reclamation, reforestation and the integration of other forest users and values.

Pesticide Ministerial Regulation

Alberta Environment and Water

Pesticides are regulated under a specific regulation under the EPEA (*Pesticides Ministerial Regulation*) and the Environmental Code of Practice for Pesticides. Under the ministerial regulation, pesticide application within 30 metres of a water body requires a permit. The Environmental Code of Practice for Pesticides allows specific pesticides to be used within 30 metres of an open body of water provided specified conditions and practices are followed.

Snow Disposal Guidelines for the Province of Alberta

This guidance document was developed to assist urban centres and municipalities in developing snow removal methods which minimize potential environmental impacts. In Section 9 of the document, a minimum setback distance of 200 metres from any water body is considered required for snow disposal, and slopes greater than 15 degrees will require additional setback.

EXAMPLES OF ALBERTA MUNICIPAL POLICIES AND BYLAWS AFFECTING RIPARIAN AREAS

City of St. Albert

The City of St Albert has a 50 metre setback from the top of bank of Carrot Creek. There also are 50 per cent Municipal Reserve credits for protection of lands between the 1:25 year flood line and 1:100 year flood line provided other amenities (e.g., trail surfacing) are provided.

City of Brooks

The City of Brooks has variable setbacks from permanent water bodies that range from as little as 6 metres to more than 40 metres. The Municipal Development Plan identifies that sensitive and important water and landscape features and ecosystems will be identified and set aside for environmental protection. In the past, the City has protected many of its water bodies through the use of municipal reserve and environmental reserve dedication.

City of Calgary Environmental Reserve Setback Guidelines

City of Calgary environmental reserve policy contains base setbacks up to 50 metres depending on stream order (size of stream) and which allows for adjustments according to slope, hydraulic connectivity, and vegetation cover.

City of Edmonton Guidelines for Determining Environmental Reserve (ER) Dedication for Wetlands and Other Water Bodies

City of Edmonton guidelines recommend greatest extent of all environmental reserve components: floodplain, unstable lands, pollution prevention (fixed minimum width of 30 metres), and public access needs. See also: Background Report: Rationale for Guidelines for ER Dedication for Wetlands and other Water Bodies. City of Edmonton, Office of Natural Areas. 2006.

City of Lethbridge

The City of Lethbridge has adopted a River Valley Area Redevelopment Plan intended to provide direction to guide the development of the Oldman River Valley area within the City of Lethbridge. This plan establishes parameters within which various options may occur. Within this broad framework it is intended that the Plan will provide adequate protection for the river valley and its users. Protection of the river valley resource will be achieved through the development of land use control measures, land use bylaws and development guidelines.

City of Spruce Grove

The City will not permit development in areas which are unstable or within defined floodplains, unless it can be shown to the City's satisfaction that development would not be a significant risk.

Industrial Heartland Complementary Area Structure Plans – River Valley Setbacks

The Alberta Industrial Heartland Association has as its members Strathcona County, the City of Fort Saskatchewan, Sturgeon County and Lamont County. The association is working with Alberta Environment and Water on a cumulative effects management plan for the Industrial Heartland which has a strong existing industrial base, and significant proposed industrial development. Complementary area structure plans are in place, which contain minimum 30 metres and 50 metres setbacks from the top-of-the-valley breaks along major river valleys. See also: Strathcona County, Sturgeon County.

Lac La Biche County

In 2007, Lac La Biche County adopted a riparian setback model called The Riparian Setback Matrix Model as a methodology for determining development setbacks. Aquality Environmental Consulting Ltd. created the model, which requires the services of a qualified professional and assessment of site specific factors to determine the appropriate setback required for a given site. The model was designed to consider four biophysical parameters: slope, bank height, groundwater influence, and vegetation type.

Lacombe County

The County shall, as a condition of subdivision approval, require an environmental reserve or environmental reserve easement of not less than 30 metres in width from the high water mark of water bodies and/or the top of bank of watercourses to the lot line. A greater setback may be required by the County based on the recommendations of a geotechnical study undertaken by a qualified professional. As a condition of development permit approval where there is no subdivision, a comparable setback of 30 metres (98 feet) shall be required from the high water mark of water bodies and/or the top of bank of watercourses to the building.

Leduc County

A riparian setback matrix model will be used to establish environmental reserves and/or conservation easements. The overall goal is to delineate and protect sensitive areas. The riparian setback matrix model is currently being applied as a pilot project for the Pigeon Lake and Wizard Lake Area Structure Plans.

MD of Bighorn

The Municipal Development Plan for the MD of Bighorn contains 30 metre development setback to ensure protection of watercourses, water bodies and their banks. Applications can be made to the MD of Bighorn for relaxation of this setback. Any major development or subdivision that is located near a water course may require environmental assessment prior to consideration of the subdivision or development. In some instances, before subdivision or development of land is allowed, the MD of Bighorn may require that the proponent of the subdivision or development prepare an Area Structure Plan (ASP), at the expense of the proponent. The ASP will normally include direction to guide subdivision and development, including among other requirements, a groundwater impact assessment.

MD of Foothills

Proposed revisions to the Municipal Development Plan will support science-based setbacks. Applicants will be required to determine appropriate setbacks from water bodies by considering slope, vegetation and other factors.

Red Deer County Off the Creek Program

The purpose of the Off the Creek Program is to conserve or improve watershed health in Red Deer County, through support of on-the-ground projects impacting native range, riparian areas, surface water quality and shallow groundwater quality. Among other public and private benefits, healthy (that is, ecologically functional) watersheds can reduce flooding, erosion and runoff, stabilize banks and shorelines, provide fish and wildlife habitat, and diversify opportunities for landowners. The program is intended to be a cost-shared program. Landowners will be expected to contribute 25% to 50% of the project costs, either in cash or in-kind (labour, equipment, etc.).

Rocky View County

Bylaws include requirements for protection from hazards where land is situated adjacent to or includes the banks of any watercourse, and where the slope of the bank adjacent to any watercourse is in excess of 15 per cent. Development restrictions are in place for Bragg Creek and the Elbow River. In 2010 the County adopted policies for riparian and wetland conservation and management. The purpose of the riparian policy is to conserve and manage riparian lands in recognition of the important functions that riparian areas perform. The riparian policy includes the following statements:

1. The County will rely on science-based standards to develop setback requirements for riparian lands adjacent to watercourses and water bodies.
2. When approving development within its boundaries, the County will require applicants (developers, landowners and others) to consider and demonstrate plans for the maintenance and/or restoration of riparian lands adjacent to natural water courses and water bodies to a functional condition, and where possible, to an enhanced or improved condition.

Strathcona County

Strathcona County's Municipal Development Plan, Bylaw 1-2007 sets out a number of environmental management objectives, along with the following buffer requirements to protect lands and water resources adjacent to watercourses:

- The North Saskatchewan River, a minimum 50 metre buffer from the top of bank where no buildings or structures will be allowed, except under unique and appropriate circumstances;
- Old Man Creek and its tributaries, a minimum 36 metre buffer from the top of bank where no buildings or structures will be allowed, except under unique and appropriate circumstances as determined by the Approving Authority; and
- All other lakes, water bodies and watercourses, a minimum 30 metre buffer from the top of bank where no buildings or structures will be allowed, except under unique and appropriate circumstances. Top of bank is defined as the top of the valley crest.

Sturgeon County

Sturgeon County has a 30 metre setback from the valley crest. No permanent structures are permitted within the 1:100 year floodplain, excepting residential development that demonstrates the lands are suitable. No permanent structure will be permitted within the 1:100 year floodplain of the Manawan, Sandy, Gladu and Big Lakes.

In addition, Sturgeon County will require a 50 metres (164 ft) lot setback from the top of the bank of the North Saskatchewan and Sturgeon River Valleys to provide for an environmental buffer and recreation corridor. This should consist of 30 metres (98 ft) Environmental Reserve (ER) dedication as required by the MDP, with the balance of 20 metres (66 ft) taken as Environmental Reserve (ER), Municipal Reserve (MR) and / or conservation easement. The 30 metres (98 ft) generally commences from the 1:100 year flood line unless a discernable top of bank exists beyond this. The embankment is often a geotechnical constraint and therefore the 50 metres (164 ft) setback should generally commence beyond this. To enable the determination of top of bank setbacks, each industry proponent shall undertake a top of bank survey for the North Saskatchewan River and Sturgeon River as a condition of the development permit.

Town of Cochrane

The Town of Cochrane has land-use bylaws affecting development within flood risk areas and adjacent to river escarpments, steep slopes, top of bank, toe of slope, and wetlands. No development shall be permitted in riparian lands.

EXAMPLES OF RIPARIAN GUIDELINES FROM OTHER CANADIAN JURISDICTIONS

British Columbia
Riparian Areas Regulation

Valuable riparian fish habitat is protected by the federal *Fisheries Act* and the provincial *Fish Protection Act* (including the *Riparian Areas Regulation*, and the *Water Act* and municipal bylaws). If a project is a residential, commercial or industrial activity within 30 metres of a watercourse, the Riparian Areas Regulation may affect the development. The regulation encourages responsible development. It helps conduct activities responsibly to avoid degrading valuable riparian fish habitat.

If the *Riparian Areas Regulation* applies to a development, the property is assessed by a Qualified Environmental Professional. The assessment will determine the Streamside Protection and Enhancement Area (SPEA) on the property, which represents the development setback to prevent degradation of fish habitat. Additional measures to maintain riparian fish habitat, such as sediment and erosion control, may be included in the assessment. SPEA vegetation must be left in, or allowed to return to, a natural, undisturbed state. Formal trails and landscaping may be restricted in SPEAs if they have the potential to damage vegetation and/or interfere with the ability of the riparian area to provide fish habitat.

Carolinian Canada Draft Guide for Determination of Setbacks and Buffers

Setback is defined as the distance measured from a rear lot line or edge of developed area to an identifiable natural heritage feature. The width of the setback will be determined on a site specific basis and will take into account geotechnical assessments and hazards, an ecological buffer zone to protect features of the natural heritage system and other needs such as corridors and rights-of-way.

Buffer zone is an area within a setback that is required for the protection of natural heritage features and ecological functions. Key ecological functions may include, but are not limited to, acting as a filter to minimize impacts from adjacent land use, providing linkage as a wildlife corridor around or between habitats and contributing to habitat and species diversity.

Establishment and maintenance of buffer zones may involve natural successional processes or require planting of native vegetation. The width of the setback and the type of buffer required will depend on: 1) the function and features of the natural heritage feature and their sensitivity to disturbance; 2) site- specific topography, hydrology and soils; 3) existing and future land uses; and 4) the required land uses within the setback (e.g. site stability, ecological buffer, rights-of-way and access). Because of great differences in site specific requirements for setbacks and buffers, a standardized approach for determining setback distance is not recommended. Rather setbacks should be determined based on minimum distances required for buffers to protect ecological features and functions plus other considerations. The width of the buffer will depend on the type and sensitivity of the feature. In general,the wider the buffer, the more protection it provides. Best available information suggests the following minimum buffer widths are appropriate, and necessary to provide protection for natural features and maintain ecological function.

Wildlife habitat: 100 metres. Woodlands: 10 metres beyond the drip line of trees (protects the rooting zone). Wetlands: 30 metres for water quality benefits. Ratio of 3:1 of upland to wetland habitat area for protection of small wetlands. Watercourses: 30 metres from the high water mark (50 metres + 0.5 metres per 1 per cent of slope for cold water streams). Corridors: 100 metres (urban) and 200 metres (rural). Buffer widths may be increased depending on the expected impacts from the development and the sensitivity of the features and functions being buffered.

Cataraqui Region Conservation Authority, Ontario

The Cataraqui Region Conservation Authority recognizes that buffers adjacent to water bodies provide numerous conservation benefits which can include the following:

- restoring and maintaining the chemical, physical and biological integrity of the water resources;
- removing pollutants delivered in urban stormwater;
- reducing erosion and controlling sedimentation;
- stabilizing stream banks;
- providing infiltration of runoff;
- maintaining the base flow of streams;
- contributing the organic matter that is a source of food and energy for the aquatic ecosystem;
- providing tree canopy that shades streams and promotes desirable aquatic organisms;
- providing riparian wildlife habitat;
- maintaining critical floodplain setbacks; and
- furnishing scenic value and recreational opportunities.

General buffer plan requirements include, subject to review by CRCA staff, a riparian buffer plan to be prepared by a qualified environmental professional or Landscape Architect. Each riparian buffer plan shall contain the following information:

- a location or vicinity key map;
- a map showing: field-delineated and surveyed streams, springs, seeps, waterbodies, and wetlands (include a minimum of 60m into adjacent properties);
- a map showing field-delineated and surveyed forest outline, taken at the drip line of the trees;
- a map showing the limits of the regulatory (1:100 year) floodplain, where it has been identified;
- a map showing slopes greater than 15 percent for areas adjacent to and within 60 metres of a water body;
- a narrative of the species and distribution of existing vegetation within the buffer.

Buffer Width Guidelines

The buffer shall begin at the normal water's edge of a lake or reservoir, and at edge of the bank of an active stream channel. The buffer width shall be increased as necessary to include contiguous sensitive areas, such as wetlands, floodplains, steep slopes or erodible soils. The minimum width for all buffers (i.e., the base width) is 30 metres. The buffer width shall be extended beyond 30 metres based upon:

- stream order – in third order and higher order streams, add 8 metres to the base width;
- percent slope;
- the regulatory (1:100 year) floodplain – the entire floodplain should be included in the buffer; and
- wetlands or other critical aquatic, riparian, and terrestrial habitat areas – the buffer shall be measured from the edge of the habitat.

A complete copy of the Cataraqui Region Conservation Authority riparian buffer guidelines can be obtained at the following link: www.cataraquiregion.on.ca/management/Buffer_Guidelines.pdf

City of Hamilton 2005 Official Plan Review Discussion Paper #7: Buffers

This paper has been prepared for the purpose of public and agency consultation as part of preparing the City of Hamilton's new Official Plan. This is one of a series of discussion papers dealing with natural heritage policies in Hamilton. The contents of this paper are meant to promote dialogue and should not be construed as policy or the position of the City at this time.

ADDITIONAL SOURCES OF INFORMATION

Alberta's Wetlands: A Law and Policy Guide
Kwasniak, A. 2001. Environmental Law Centre and Ducks Unlimited Canada for the North American Waterfowl Management Plan. Edmonton, Alberta.

Caring for the Green Zone: Riparian Areas and Grazing Management – Third Edition
Alberta Riparian Habitat Management Society (Cows and Fish)

Caring for Shoreline Properties: Changing the Way We Look at Owning Lakefront Property in Alberta (Booklet)
Alberta Conservation Association

Classification of Natural Ponds and Lakes in the Glaciated Prairie Region
1971. Bureau of Sport Fisheries and Wildlife, Washington, USA R. E. Stewart and H. A. Kantrud

Creative Approaches to Subdivision Development in the Bow River Basin: A Guide for Municipalities, Developers and Landowners
Bow River Project

Field Manual on Buffer Design for the Canadian Prairies
2010. Stewart, A., Reedyk, S., Franz, B. Fomradas, K., C. Hilliard and S. Hall. Agri-Environment Services Branch, Agriculture and AgriFood Canada.

Guide to Naturalizing a Lakefront Shoreline
2010. Wabamun Watershed Management Council.

Guidelines for Lakeshore Use (Brochure)
Alberta Sustainable Resource Development

Green Zones: Riparian Areas and Wetlands
(Contains Beneficial Management Practices for maintenance of healthy riparian areas) in: Milk River State of the Watershed Report 2008. Milk River Watershed Council Canada. Milk River, Alberta.

Lake Stewardship Reference Guide
Association of Summer Villages of Alberta. 2006.

Municipal Guide: Planning for a Healthy and Sustainable North Saskatchewan River Watershed
2008. Prepared for North Saskatchewan Watershed Alliance by G. Beaudry.

Riparian Areas: A User's Guide to Health (Booklet)
Alberta Riparian Habitat Management Society (Cows and Fish)

The Active River Area: A Conservation Framework for Protecting Rivers and Streams
Smith, M.P., Schiff, R. Olivera, A. and MacBroom, J.G. 2008. The Nature Conservancy, Boston, MA.

The Shore Primer, Prairies Edition: A Cottage Owner's Guide to a Healthy Waterfront
Department of Fisheries and Oceans and Cottage Life.

Tools to Help Restore Ecological Processes in Alberta's Built Environments
Primeau, S., Bell, M., Riopel, M., Ewaschuk, E. and Doell, D. 2009. Land Stewardship Centre of Canada. Edmonton, AB.

Wetlands on My Lands
Ducks Unlimited Canada. Case Studies

CASE STUDIES

A Fish-based Index of Biological Integrity for Assessing River Condition in Central Alberta

A multi-metric, fish-based Index of Biological Integrity (IBI) was developed for assessing the health of aquatic ecosystems in central Alberta. Data on fish assemblages collected via electro-fishing by the Alberta Conservation Association were combined with reach and basin-scale environmental variables for 80 river sites on the Battle River. Twelve candidate metrics representing attributes of the Battle River fish assemblage were screened for redundancy, as well as their sensitivity to human disturbance variables, using statistical methods. Three metrics were selected for the IBI representing two trophic guilds (i.e., percent carnivores and percent omnivores) and one measure of community structure (i.e., species richness) that were unrelated to river size but related to measures of human disturbance.

The multi-metric IBI was highly sensitive to changes in cumulative anthropogenic disturbances (statistically indexed as road densities). Statistical analysis indicated that cumulative disturbances associated with road densities as low as 7 metres/ha (i.e., 0.7 km/km2) in basins may impair the integrity of fish assemblages. The Battle River IBI provides a single, defensible, easily understood measure of the health of watercourses in the prairie parkland ecoregion. With the aid of a simple spreadsheet, land managers and researchers can quickly calculate an IBI score using fish data collected from a river section.

Additional research on ecological functions and requirements of species in northern systems is recommended to strengthen the basic foundation of guild based bioassessment methods in Alberta. For a digital copy of the full report, visit the Alberta Conservation Association website at: www.ab-conservation.com.

Economic Impacts of Buffers

Although riparian forest buffers are frequently seen as a loss by developers and property owners, studies have shown that the preservation of these buffers increases the value of property. A national survey was conducted in 1992 by the Metropolitan Washington Council of Governments to determine the financial impact of existing riparian buffer programs. Twenty-nine of the thirty-one respondents indicated that existing buffers had a positive or neutral effect on the value of adjacent property. The remaining two respondents indicated that they were unsure of the effect that buffers had on adjacent property values.

Builders, real estate agents, and homeowners have acknowledged the financial advantage of having forests and trees near home sites. A survey of builders by the National Association of Home Builders found that home buyers are willing to pay more for lots with trees. The survey results showed that 43 per cent of home buyers paid up to $3,000 more for homes on wooded lots, 30 per cent paid between $3,000 and $5,000 more, and 27 per cent spent over $5,000 more for wooded lots – with 8 per cent of that group spending an additional $10,000. In a 1994 Bank of America Mortgage survey, 50 per cent of 1,350 real estate agents surveyed believed that trees had a positive impact on potential buyers' impression of a home and its neighborhood and 84 per cent felt that a home on a treed lot would be as much as 20 per cent more sellable than a similar, treeless home.

Riparian forest buffers may decrease the public's investment needs in management and waterway restoration and protection. For example, Fairfax County, Virginia reduced its costs by $57 million by protecting riparian forest areas and buffers. Citizens in Johnson County, Kansas voted to spend $600,000 to create a stream way park system, as opposed to $1.2 million on control projects. Also, New York City opted to spend $1.5 billion to protect 80,000 acres of its upstate watershed to avoid the need to build an $8 billion water filtration plant that would need an additional $300 million annually to operate.

The preservation of riparian forest buffers can also have additional economic value to landowners. For example, on a typical subdivision construction site, the average cost for clearing a forest is $4,000 per acre and sediment control is $800 per acre. However, by conserving some forest, developers will reduce sediment loss from the site and reduce the time and labor needed for regrading, stabilizing, and re-landscaping the site.

Real world examples also exist to demonstrate the high cost of restoring degraded waterways. In response to public demands, Montgomery County, Maryland is spending $20,000-$50,000 per household lot in some areas to repair damaged streams and riparian forests. Also, Fairfax County, Virginia has passed a local bond issue to supply the needed $1.5 million to restore two miles of stream and riparian areas that were degraded.

Source: Final Report of the Statewide Task Force on Riparian Forest Buffers, University of South Carolina. 2000.

ONLINE RESOURCES

Alberta Amphibian Monitoring Program
www.srd.alberta.ca/ManagingPrograms/FishWildlifeManagement/AmphibianMonitoring/AlbertaVolunteerAmphibianMonitoringProgram.aspx

Alberta Conservation Association
www.ab-conservation.com/go/default/index.cfm

Alberta Environment and Water
Water for Life Program
www.waterforlife.alberta.ca

Water Information Centre
http://environment.alberta.ca/2013.html

Respect our Lakes
www.environment.alberta.ca/03036.html

Alberta Lake Management Society (ALMS)
www.alms.ca

Alberta Low Impact Development Partnership
www.alidp.org

Alberta Native Plant Council
www.anpc.ab.ca/content/index.php

Alberta Riparian Habitat Management Society (Cows and Fish)
www.cowsandfish.org

Alberta Stewardship Network
www.ab.stewardshipcanada.ca

Alberta Sustainable Resource Development
Fish and Wildlife
www.srd.gov.ab.ca/fishwildlife/default.aspx

Lakeshores
www.srd.alberta.ca/ManagingPrograms/Lands/Shorelands/Lakeshores.aspx

Municipal Planning Referrals
www.srd.alberta.ca/ManagingPrograms/Lands/MunicipalPlanningReferrals.aspx

Association of Summer Villages of Alberta
www.albertasummervillages.org/

Canadian Council of Ministers of the Environment: Water Quality Guidelines
www.ccme.ca/ourwork/water.html

Ducks Unlimited Canada
www.ducks.ca

Fisheries and Oceans Canada
www.dfo-mpo.gc.ca/index-eng.htm

Healthy Shorelines
www.healthyshorelines.com/why.html

Healthy Shorelines (Federation of Alberta Naturalists)
www.fanweb.ca/projects-and-programs/living-by-water/workshop-in-a-box/healthy-shorelines

Land Stewardship Centre of Canada
www.landstewardship.org/about_lscc.asp

Trout Unlimited Canada
www.tucanada.org

Don't forget your own municipality or county administration and watershed groups active in your area. These organizations and individuals will be able to provide a wealth of knowledge, or point you in the right direction for finding more information.

Appendix 2

CONTAMINANT REMOVAL RESULTS FOR NITRATE, PHOSPHORUS AND SEDIMENT

Appendix 2

Contaminant Removal Results for Nitrate, Phosphorus and Sediment

Reference	Width (m)	Vegetation Type	Flow Path	% Reduction
Nitrate				
Dillaha et al 1989	9.1	Grass	Surface	73
Jacobs and Gilliam 1985	<16	Forest	Subsurface	90 +
Jordan et al 1993	25 35	Forest Forest	Subsurface Subsurface	50 90
Haycock and Pinay 1993	5 5	Poplar Grass	Subsurface Subsurface	99 84
Hill[18] 1996	5-55 130	Various Forest	Mainly shallow lateral Shallow lateral	High (variable) 100
Hubbard and Lowrance 1996	7-12	Forest	Subsurface	Most
Jordan et al 1993	25-30	Forest	Subsurface	90
Mander et al 1997	20 28	Forest Forest	Overland and subsurface Overland and subsurface	81 80
Mayer et al 2007	26-50	Various	Various	90
Lowrance 1992	10	Forest	Subsurface	95
Osborne and Kovacic 1993	16 39	Forest Grass	Subsurface Subsurface	90 90
Peterjohn & Correll 1984	19 19 50	Forest Forest Forest	Surface Subsurface Subsurface	79 90 98
Vidon and Hill 2006	20 40 +	Forest Forest	Subsurface (loamy sand) Subsurface (sand/gravel)	90 90
Phosphorus (Total)				
Dillaha et al 1989	9 5	Grass Grass	Surface Surface	79 61
Wenger[19] 1999	9 5	Grass Grass	Surface Surface	46 18
Sediment				
Gharabagi et al. 2006	5	Grass	Surface	95[20]
Liu et al 2008	10	Grass	Surface	85-95

[18] The author presents the effects of riparian zones on the nitrate-nitrogen removal from several studies worldwide.

[19] A review of more than 140 articles and books for determining riparian buffer width, extent and vegetation.

[20] Sediment capture limited to particles > 40 μm in diameter.

Appendix 3

CORRIDOR WIDTHS FOR CONSERVATION OF WILDLIFE HABITAT IN ALBERTA LAKES, RIVERS, STREAMS AND WETLANDS

Appendix 3

Corridor Widths for Conservation of Wildlife Habitat in Alberta Lakes, Rivers, Streams and Wetlands

Species of Interest	Width (m)	References
Foraging and loafing water birds	100	Rodgers and Smith 1997
Raptors	400-150	Richardson and Miller 1997
Amphibians and reptiles	177-340	Semlitsch and Bodie 2003
Amphibians, small mammals and songbirds	100-200	Hannon et al 2002
Small mammals	60-100	Lehmkuhl et al 2008
Winter habitat for ungulates in large river valleys	400 m from water body or top of valley break + 100	Alberta Energy Resources Conservation Board

Design: Fox Design

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