Watershed Management Plan:

Land Management Component

Understanding the Policy Context for Riparian Areas of the Battle River and Sounding Creek Watersheds

Susanna Bruneau

Research and Stewardship Coordinator

11/30/2015

Front cover photo: Pipestone Creek (BRWA staff)

Back cover photo: Ferry Point Reach on the Battle River (BRWA Staff)

Acknowledgements

I would like to thank the assistance of Alberta Environment and Parks for their financial and in-kind support of this project, and Environment Canada for their support of the Ferry Point Reach Riparian Restoration Program and the development of this report.

Thank you to Nathalie Stanley for the hands-on work done with landowners of the Ferry Point Reach Riparian Restoration Program and beginning the research for this report. As well, Cows and Fish for their work with the Ferry Point Reach Riparian Restoration Program and for information and input in this report.

Thank you to all who participated on the Ferry Point Riparian Restoration Committee.

Thank you to all the landowners who have, either through our Ferry Point Riparian Restoration Program or on their own, protected and helped to restore their riparian areas.

Table of Contents

Table of Figures

Table of Tables

List of Acronyms

AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
AESRD	Alberta Environment and Sustainable Resource Development
ALUS	Alternative Land Use Services
BMPs	Beneficial Management Practices
BRWA	Battle River Watershed Alliance
ER	Environmental Reserves
ESAs	Environmentally Significant Areas
IBI	Index of Biological Integrity
OHV/ORV	Off highway/Off road Vehicles
RSMM	Riparian Setback Matrix Model
WPAC	Watershed Planning and Advisory Council
WRRP	Watershed Resiliency and Restoration Program

1.0 Introduction

1.1 Overview

The purpose of this report is to highlight the riparian area policies and management approaches that are currently in place locally, regionally, provincially, federally, and internationally that will support and contribute to the development of policy recommendations as they pertain to the management of riparian areas in the Battle River Watershed Alliance planning area. This report also outlines the policy background for riparian area management, as well recommendations and potential restoration measures that could be used to develop riparian management guidelines for the Battle River and Sounding Creek Watersheds.

The information in this report addresses the riparian areas associated with lotic (flowing) waterbodies, such as rivers, creeks, and streams, and lentic (non-flowing) waterbodies such as lakes, ponds, and wetlands.

1.2 Battle River Watershed Alliance

The Battle River Watershed Alliance (BRWA) was created in 2006 as a non-profit society. Shortly after formation, the BRWA was selected by Alberta Environment and Parks (then Alberta Environment), under the Water for Life: Alberta's Strategy for Sustainability as the designated Watershed Planning and Advisory Council (WPAC) for the Battle River watershed. The BRWA works in partnership with communities, watershed stewardship groups, four orders of government (first nations, municipal, provincial, federal), industry, non-governmental organizations and residents, to improve the health of the Battle River and Sounding Creek watersheds using the best science and social science available.

The interplay of interests and pressures to and from governments, and the many layers of negotiation involved in instances of policy making are of interest to the BRWA. Interests and pressure include external influences that exist in all aspects of policy making and regulation, including those from industry, four orders of government that exist in Canada (First Nation, Federal, Provincial, Municipal), international governments, and organization and public groups of various forms.

The BRWA uses a policy community approach to examine the interplay of interests and pressures to and from governments, and layers of negotiation involved in instances of policy making (Atkinson & Coleman, 1992; Coleman & Skogstad, 1990; Skogstad, 2005). In this way, we define policy making as a series of decisions made before, during and after where policies take shape.

The Watershed Management Plan (Battle River Watershed Alliance [BRWA], 2012a) is comprised of four general topic areas: water quality, water quantity, land management, and biodiversity. Though riparian areas are one component under land use, it has implications for all areas (Figure 1).

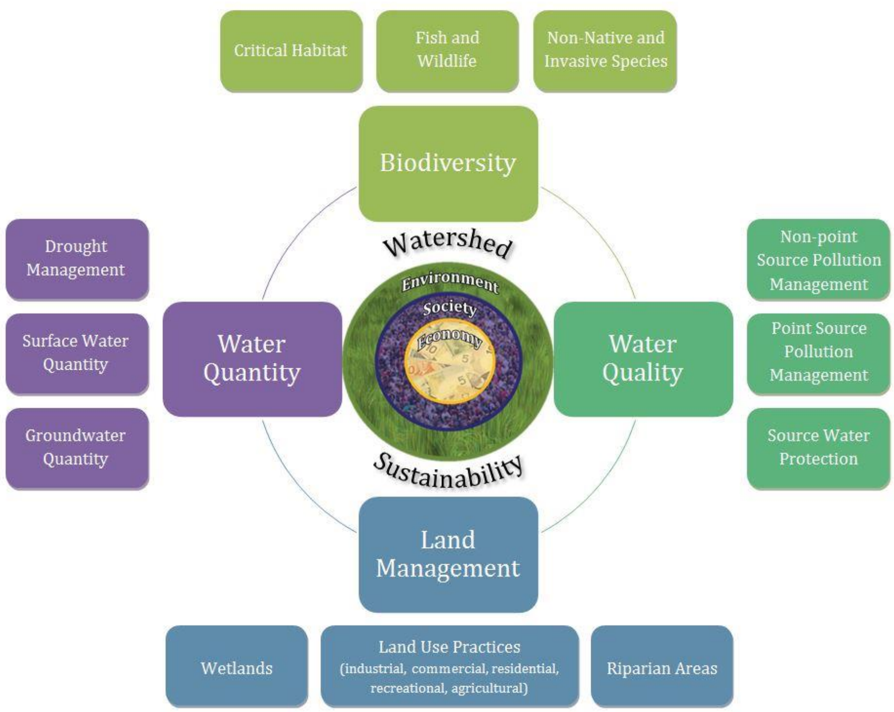

Figure 1. Framework for watershed management planning components in the Battle River and Sounding Creek watersheds.

Adaptive management is an approach to natural resource policy that embodies a simple imperative: policies are experiments that, over the course of the adaptive management planning cycle (Figure 2), may prove inappropriate (Lee, 1993). Adaptive management learns from these experiments in a manner that links science with social and economic values found within the watershed (Mitchell, 1997; Sauchyn, Diaz, &

Kulshreshtha, 2010). By adopting an adaptive management approach for watershed management planning, the BRWA acknowledges that the natural and social systems functioning within the watershed is not completely understood. Both the natural and social systems will, in the course of time, present surprises that will test the adaptive management approach. The BRWA and its partners must approach watershed management planning with the expectation that some policies and actions identified during the planning process may well be inappropriate, but that the experiences and lessons learned allow us to collectively improve watershed management approaches over time. These stages of adaptive management for watershed management planning described in *Water for Life: Alberta's Strategy for Sustainability* (Government of Alberta, 2003).

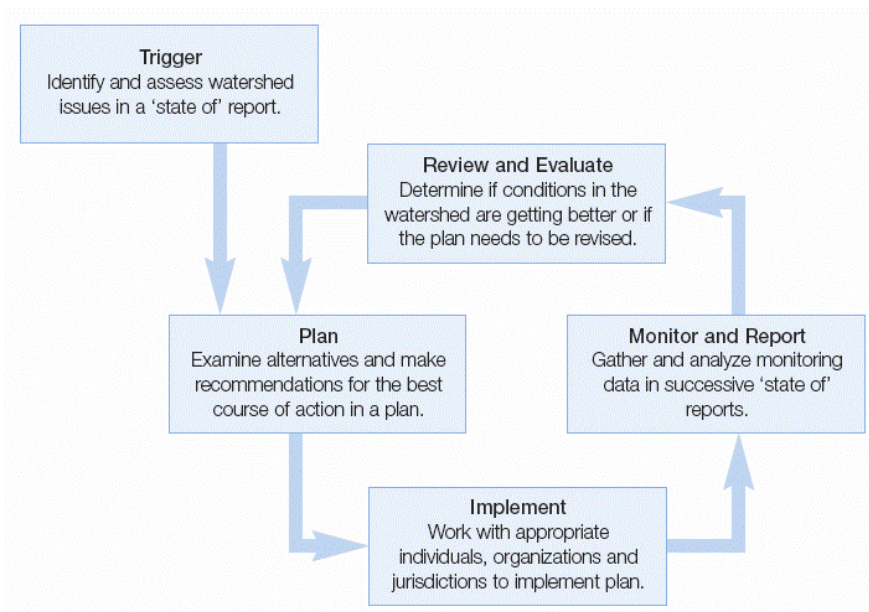

Figure 2. Adaptive management planning cycle for watershed management planning in the Battle River and Sounding Creek watersheds (Government of Alberta, 2003).

Policy background research, policy recommendations, and guidelines will be developed for each watershed management component for each sub-watershed throughout the watershed management plan development (Figure 3). Policies examined should incorporate formal and informal (*ad hoc*) policies, and address economic, social, and environmental impacts of the topic. Examples of short term (i.e. during the current crop year) and longer term (longer than the current crop year) adaptations are presented by topic area.

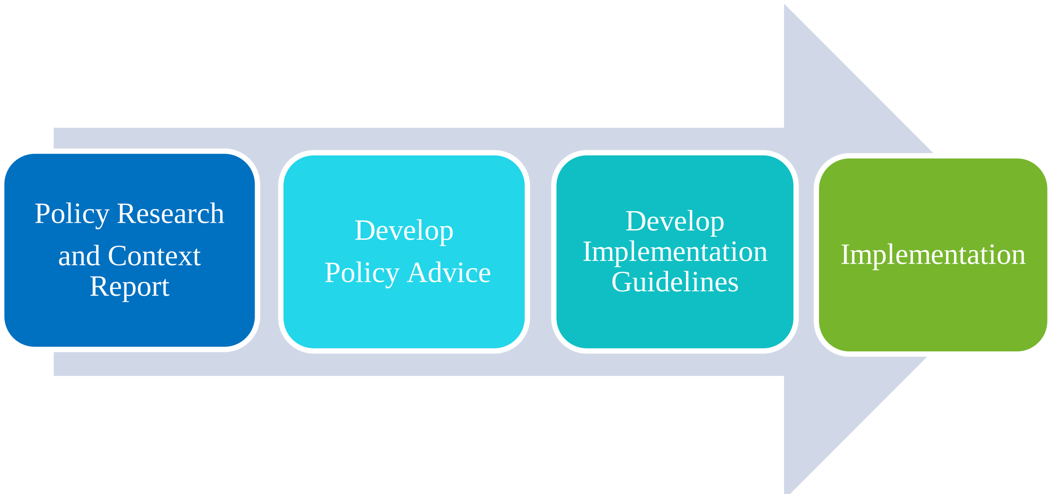

Figure 3. Policy research and development process.

The purpose of this report is to explore the policy context within which the management of riparian areas occurs in the planning areas of the Battle River Watershed Alliance. From this report, and in accordance with the watershed management plan, policy recommendations and implementation guidelines will be developed by the Battle River Watershed Alliance.

2.0 Riparian Areas

2.1 Riparian Definitions

2.1.1 Riparian Areas

'Riparian' describes those portions of the landscape immediately surrounding water sources, such as lakes, rivers, and wetlands, where water strongly influences the immediate ecosystem. They are characterized by the close interaction of water, soil and vegetation (Fitch & Ambrose, 2003). Riparian areas are transitional, providing the buffer between aquatic and upland habitats. Riparian areas (in healthy areas) can be defined by the presence of surface or 'near-to-the-surface' water (seasonally or regularly), the presence of water-loving vegetation such as willows, cattails or sedges, and soils that are influenced and modified by the presence of abundant water, water movement, and lush, productive vegetation (Fitch & Ambrose, 2003).

Floodplains are also part of the riparian area. These are the areas of land beyond the stream or river channel, or the shore of lentic waterbodies, that store excess water and reduce the water's energy in flood events. They are part of the riparian area, but are often disregarded in operational policies. The floodplain, as with other parts of riparian areas, has important ecological functions that can be disrupted by development or stream modification (de Loe, 2000; Fitch & Ambrose, 2003). These areas often include numerous wetlands, important for riparian functioning.

2.1.1.1 Importance of riparian areas

Riparian areas are important for various ecological, social, and economic reasons. Riparian areas perform many important ecological functions, including trapping and storing sediment and nutrients, build and maintain banks and shorelines, store water and energy, recharge aquifers, filter and buffer water, reduce and dissipate water energy, maintain biodiversity, create primary productivity, and buffer against chemical drift from fields (Agriculture and Agri-Food Canada [AAFC], 2010; Fitch & Ambrose, 2003; Kay, Edwards, & Foulger, 2009; Lovell & Sullivan, 2006). These functions create various products, services, and benefits we experience as health, industry, agriculture, recreation, and tourism. Throughout history, people have often settled by water and close to riparian areas because of these many services.

Due to the transitional nature of riparian areas, they are equally important to terrestrial systems as they are to aquatic systems. Riparian land with intact vegetation provides:

- organic matter to a river (a major food source for instream flora and fauna);
- a supply of woody debris within the river, providing important habitat areas for many fish and invertebrates, and influences the shape of the river substrate;
- a source of shade in upland areas which influences water temperature and light penetration, and regulating instream primary production;

- stability to banks, minimising erosion in many areas;
- highly diverse flora and fauna, being a transition ecosystem;
- refuge in dry times, when it may be the only place where plants have new growth, flowers or are producing seed, thus can be an important source of food;
- often the only reasonably healthy remnant of native vegetation in catchments which have been largely cleared, giving it special importance to biodiversity; and
- depending on the size and structure, can act as a wildlife corridor linking habitats, especially in cleared catchments. (Victoria Department of Natural Resources and Environment, 2002)

Though riparian areas for lotic and lentic systems perform similar functions, there are some differences (Table 1).

Table 1. Differences in functions of riparian areas (modified from Cows and Fish, n.d.).

Stream and Rivers (Lotic)	Lakes and Wetlands (Lentic)
trap sediment	trap and store sediments; prevent re-suspension of sediments
build and maintain banks	build and maintain shorelines and banks
reduce flood damage	reduce damage from high water levels and wave action
store water, especially flood water	store water, especially flood and spring runoff water; act as a surface reservoir
extend perennial flows or levels by recharging underground aquifers	extend seasonal or long-term levels by recharging underground aquifers
dissipate flow and ice energy	dissipate wave and ice energy
high primary production, including forage and shelter values	high primary production, including forage and shelter values
maintain or improve water quality	maintain or improve water quality
filter and buffer water, both from over-land flow (runoff) and water from within the channel	filter and buffer water, both from over-land flow (runoff) and water from within the basin
maintain biodiversity and habitat	maintain biodiversity and habitat
	trap nutrients and sediments to balance nutrient cycling, in-filling and primary production

2.1.1.2 Riparian health

When in good condition, riparian areas are one of the most ecologically diverse ecosystems in the world. Healthy riparian areas sustain fish and wildlife populations, improve water quality and supply, offer forage and shelter for livestock, buffer the impacts of floods and droughts, and support people, communities, our lifestyles and often our businesses on the landscape. Although riparian areas make up a small portion of the landscape, approximately 2 to 5% of Alberta's settled areas, they play a role that is disproportionately important to the amount of area they encompass (Spicer-Rawe, O'Shaughnessy, & Bach, 2010). Vital to a healthy, functioning landscape, riparian areas also form part of an extensive watershed, and are critical to overall watershed condition and ecological function.

Riparian health is defined as "the ability of a reach of a stream, river, lakeshore or wetland to perform a number of key ecological functions" (Spicer-Rawe, eta l., 2010, p.1), such as those described in the previous section. By creating and maintaining healthy riparian areas, we ensure their ecological services continue, increase the resiliency of the ecosystem, and provide stability to the landscape (Fitch & Ambrose, 2003).

2.1.2 Riparian Management Area

The delineation of riparian areas has been challenging, especially when it comes to development and application of policy. Various methods have been developed to delineate the riparian area. The biogeography, topography, vegetation, and soils are all used in this process (Figure 4).

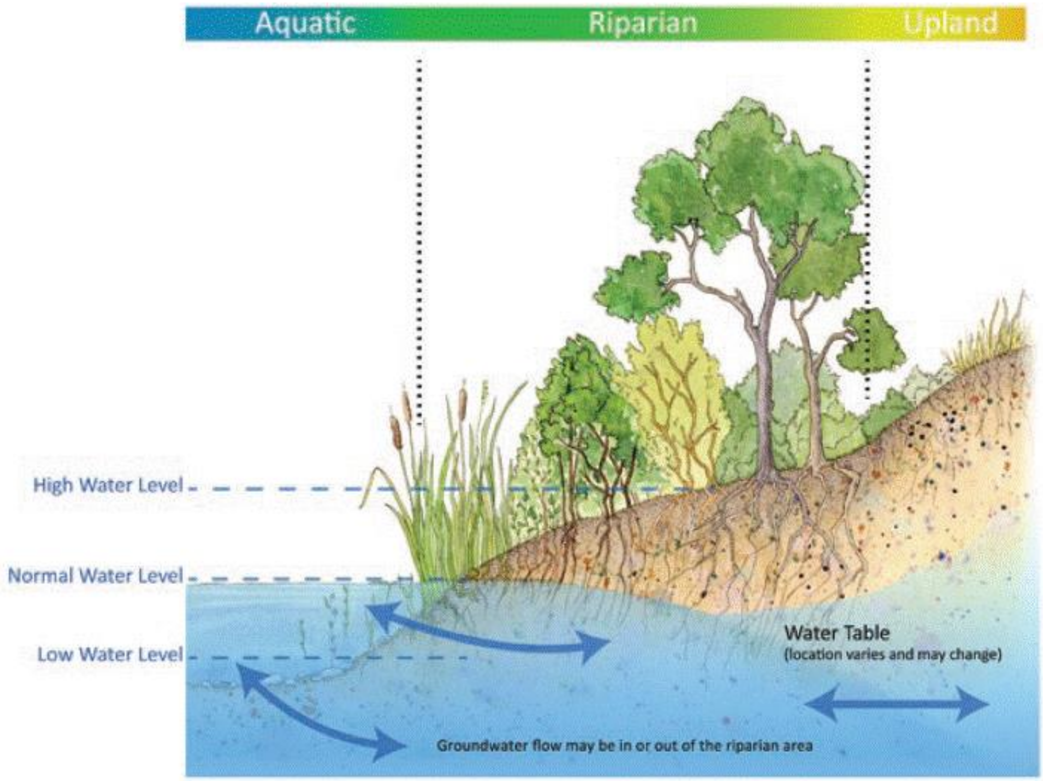

Figure 4. Example of the riparian area from an ecological perspective (Copyright Cows and Fish, 2013).

Literature and examples from the media suggest that riparian management areas are far more controversial and politically motivated than the ecologically-defined riparian areas. This is likely primarily due to the multi-stakeholder use of many riparian areas, and thus the need to manage these activities in balance with maintaining riparian health.

Policies, as will be discussed throughout this report, often focus on the riparian zone and the riparian management areas of these waterbodies. However, how large the riparian management area is and how much it encompasses depends on many factors, including the class of waterbody, the steepness on the bank, and whether it is a lotic or lentic waterbody. Riparian management areas, as they will be referred to in this report and in further documents, include the riparian area as well the buffer zone and the emergent vegetation zone. Teichreb and Walker (2008) developed a visual delineation of the riparian management areas for lentic (Figure 5) and lotic (Figure 6) waterbodies for use in aerial videography, based off the work of Mills and Scrimgeour (2004).

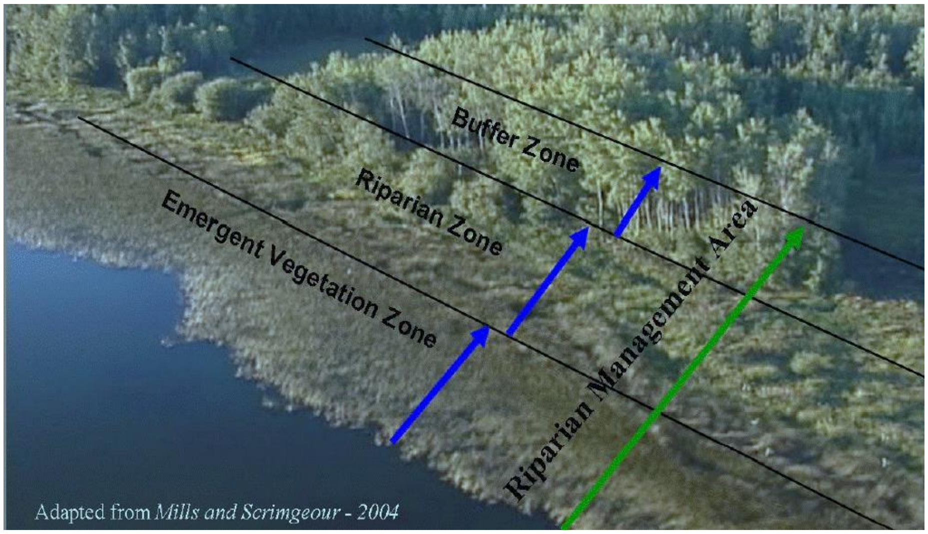

Figure 5. Riparian management area on a lentic waterbody (Teichreb & Walker, 2008).

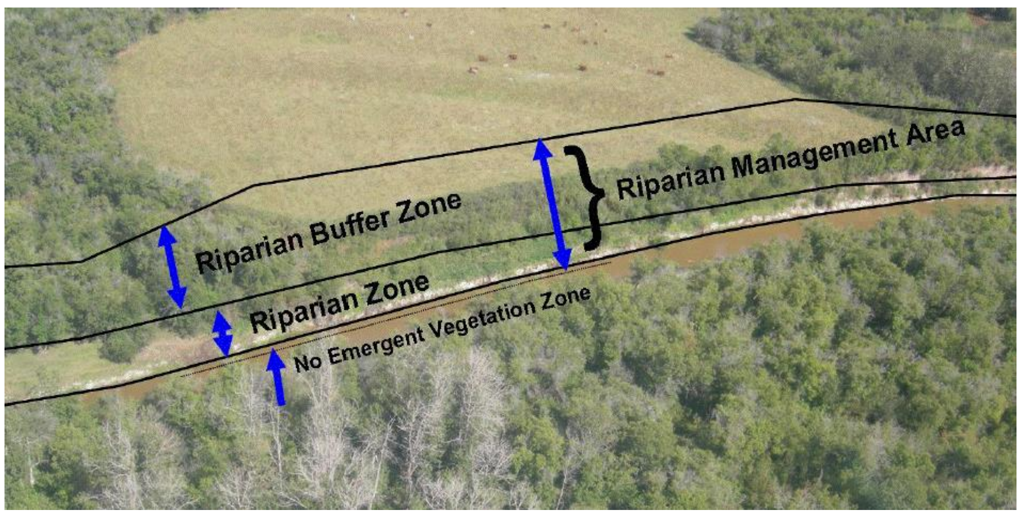

Figure 6. Riparian management area on a lotic waterbody (Teichreb & Walker, 2008).

3.0 Background

The planning area for the watershed management planning process includes the Alberta portions of both the Battle River and Sounding Creek watersheds. In this section, the geographic context for each watershed is provided.

3.1 Battle River Watershed

3.1.1 Location

The planning area for the Battle River Watershed Alliance begins just west of Highway 2 at Battle Lake, and continues east to the Alberta-Saskatchewan border (Figure 7). The planning area boundary is defined as the portion of the Battle River watershed that lies within Alberta. Topography defines the entire watershed, as it shapes the course and speed of water moving through the area. The boundaries of the watershed are known as drainage divides (i.e. the height of land between adjoining watersheds). Within the Battle River watershed there are five sub-watersheds: Bigstone, Iron Creek, Paintearth, Blackfoot, and Ribstone. Sounding Creek watershed to the southeast is also part of the BRWA planning area, and incorporates Alberta's Special Areas (BRWA, 2012a).

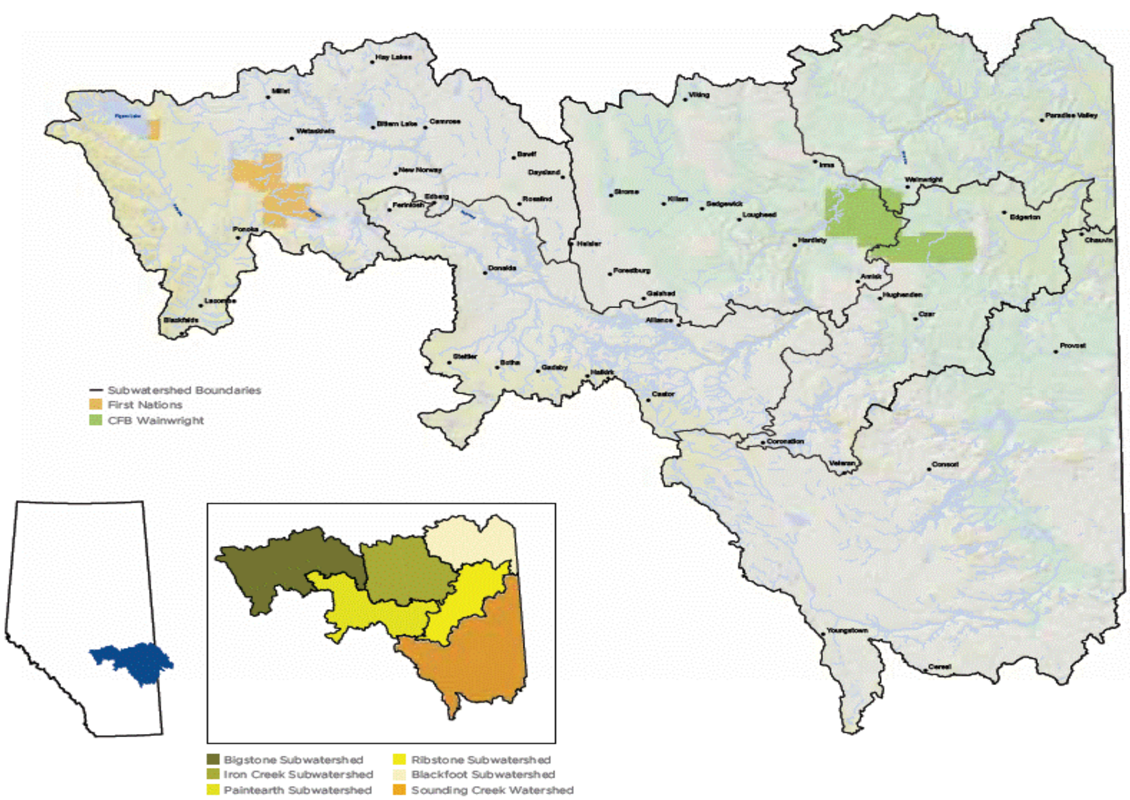

Figure 7. Battle River Watershed and Sounding Creek Watershed.

3.1.2 Natural Landscape

The Alberta portion of the Battle River watershed is located entirely within the province's settled "White Zone", and takes in portions of the Lower Foothills, Central Mixedwood, Dry Mixedwood, Central Parkland and Northern Fescue Natural Sub-Regions (BRWA, 2012a).

The Battle River watershed is a sub-watershed of the greater North Saskatchewan River Basin, draining approximately 40 per cent of the land base of this watershed. However, the Battle River only contributes approximately 3 per cent of the water that flows in the North Saskatchewan River. There are two primary reasons for this: (1) the headwaters of the Battle River originate in the Western Plains at Battle Lake. This means water flowing in the Battle River originates as groundwater and surface water runoff from local snow melt and rains, rather than from mountain and foothills snowpack runoff; (2) the topography of the Battle River Watershed is predominantly flat (the river's average gradient is less than 0.4 m/km) with large tracts of land that are considered non-contributing, either naturally or due to human influence (e.g. ditching and draining practices). Non-contributing means that water falling as snow or rain collects in small lakes and wetlands, where the water will eventually either infiltrate into the ground or evaporate before it reaches the Battle River. All of this results in low flows in the Battle River, except for a short period of time annually in spring flows and periodically in summer months during major rain storm events (BRWA, 2012a).

3.2 Sounding Creek Watershed

3.2.1 Location

The planning area for the Sounding Creek watershed begins just east of Sullivan Lake near Highway 36 and continues east to the Alberta-Saskatchewan border (Figure 1). The planning area boundary is defined as the portion of the Sounding Creek watershed that lies within Alberta (BRWA, 2012a).

3.2.2 Natural Landscape

The Alberta portion of the Sounding Creek watershed is entirely within the province's settled "White Zone", and takes in portions of the Central Parkland, Northern Fescue and Dry Mixed Grass Natural Sub-Regions (BRWA, 2012a).

The Sounding Creek watershed is considered non-contributing as the water does not drain into a waterbody. Sounding Creek begins near Hanna, Alberta and flows into Sounding Lake. The outlet from Sounding Lake is Eyehill Creek, which flows into Saskatchewan and culminates in Manito Lake. There is no outlet from Manito Lake. As outflows from Sounding Lake are believed to have only occurred once or twice in the last fifty years, the area upstream of Sounding Lake is generally considered a non-contributing area. Despite being a non-contributing watershed, it is classified by PFRA as a sub-watershed of the greater North Saskatchewan River Basin (BRWA, 2012a).

3.3 Riparian Areas in the Battle River & Sounding Creek Watersheds

Declining health of riparian areas within the Battle River was first noticed as early as 1977 (Christiansen, 1977). In the 35 years since, several studies have been done on riparian health in the Battle River and Sounding Creek watersheds. According to Alberta Environment and Sustainable Resource Development (AESRD) (2014a) (now Alberta Environment and Parks [AEP]), under current flow regimes, riparian areas are exhibiting measurable reduction in the recruitment of riparian plant species to such an extent that this is likely insufficient to support the riparian community over the long-term. As well, riparian condition is highly vulnerable to impacts of local land management.

A recent aerial photo interpretation exercise subjectively compared photos from 1963 and 1998 (scale 1:30,000) to determine general trends in riparian vegetation cover adjacent to the Battle River (AMEC Earth and Environmental, 2004). This study showed that much of the riparian zone vegetation has been depleted due to human activities (Table 2).

Table 2. Results of aerial photo interpretation exercise (scale 1:30,000) comparing photos from 1963 and 1998, delineated by reach (adapted from AMEC Earth and Environmental, 2004)

Reach	Results
Alliance to North Saskatchewan River (in Saskatchewan)	By 1963, extensive riparian zone depletion occurred as a result of agricultural land clearing with much of the upland area being utilized for agriculture. In 1998, more areas exhibited land clearing right to the riverbank, with riparian areas adjacent to the river bank becoming narrower than what was observed in 1963.
Donalda Bridge to Alliance	Extensive reductions in the riparian vegetation both adjacent to the bank and upland from the channel occurred prior to 1963. By 1998, riparian vegetation near the riverbank was similar to that observed in 1963, with new locations being cleared right to the riverbank.
Driedmeat Outlet to Donalda Bridge	By 1963, much of the upland vegetation in this reach was already removed. Riparian vegetation remained relatively intact for 100 to 300 meters from the riverbanks. This reach is characterized by extensive meanders that may render the land less useful for agriculture and therefore less susceptible to land clearing.
Ponoka to Driedmeat Lake	Very little riparian vegetation was observed in the 1963 photos. The 1998 photos showed that a small amount of additional vegetation had been removed.
Battle Lake to Ponoka	Aerial photos suggest that in 1998 this reach was the most ‘intact’, having the most riparian vegetation in comparison to the other reaches. However, between 1963 and 1998 riparian vegetation appears to have been drastically reduced in some areas.

For the 2011 State of the Watershed report, the BRWA developed their riparian health indicator for the Battle River watershed using aerial videography data from Teichreb and Walker (2008). Aerial videography was collected for the entire Alberta reach of the Battle River mainstem (with the exception of the shores of Driedmeat Lake) on August 28, 2007 and August 28, 2008 (Teichreb & Walker 2008). Aerial videography data of the Battle River watershed demonstrated that over the reaches measured in the study, overall only 39% of the riparian areas were healthy, 18% were in moderate health, and the remaining 43% were unhealthy/highly impaired (BRWA, 2011; Teichreb & Walker, 2008) (Figure 8). No data was collected for the Sounding Creek basin.

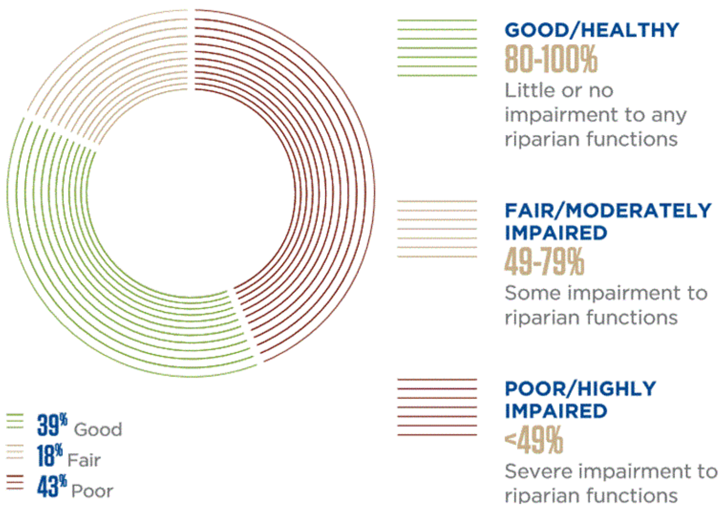

Figure 8. Aerial videography riparian health assessment scores for the Battle River mainstem (Battle River Watershed Alliance, 2011).

Aerial videography data from Teichreb and Walker (2008) shows that in 2008, over 80% of Battle Lake's riparian areas were healthy, with just over 5% highly impaired/unhealthy (Figure 9). As the source of the Battle River, maintaining the health of these riparian areas is crucial in managing other issues in the Battle River watershed. Aerial videography of Pigeon Lake, also in our headwaters, revealed that as much as 65% of the lake's riparian areas are highly impaired.

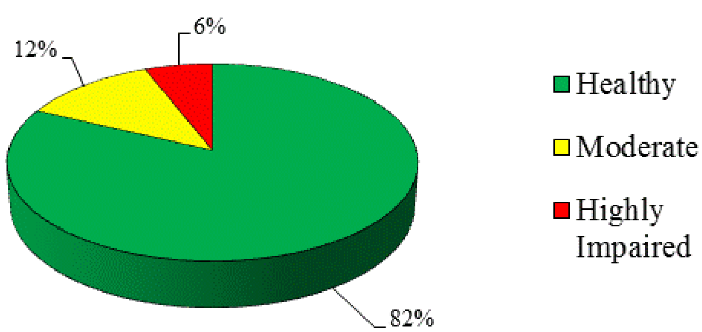

Figure 9. Riparian health of Battle Lake using data from Teichreb and Walker (2008).

3.4 Cows and Fish Battle River Watershed Heath Assessment

Riparian health assessments performed by Alberta Riparian Habitat Management Society (Cows and Fish) in the Battle River watershed (Spicer-Rawe et al., 2010) provides a slightly different picture of overall riparian health (Figure 10). Only one site (Gooseberry Lake) out of 195 sites evaluated in this study was gathered from Sounding Creek watershed. Overall, the average health of sites evaluated within the Battle River watershed was 67% (healthy but with problems).

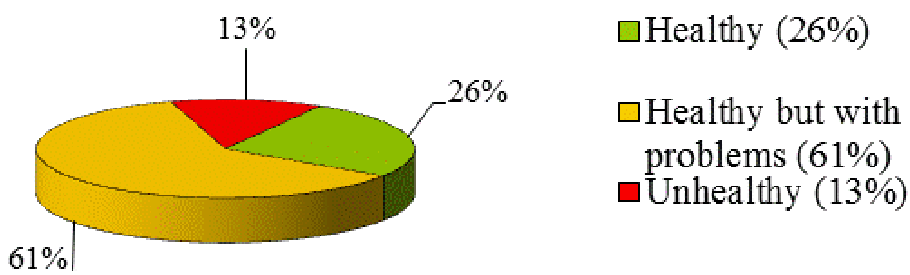

Figure 10. Overall riparian health of the Battle River watershed (Spicer-Rawe et al., 2010).

Riparian health on five lentic waterbodies (18 sites) has been evaluated by Cows and Fish (Figure 11). These included Driedmeat Lake, Gooseberry Lake, Mirror Lake, Little Beaver Lake, and Grattan Creek (Coulee). However, no riparian health information is available for Miquelon Lake, Coal Lake, or Bittern Lake. Average health of lake and wetland riparian areas evaluated was 63% (Spicer-Rawe et al., 2010).

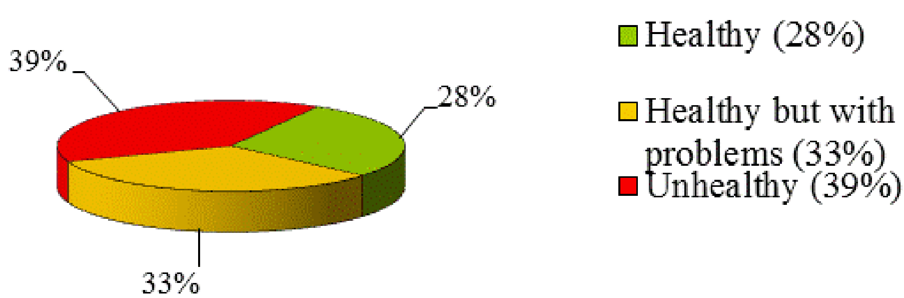

Figure 11. Overall lentic riparian health of the Battle River watershed (Spicer-Rawe et al., 2010).

Overall, 177 lotic sites on the nine rivers and streams were evaluated by Cows and Fish (Spicer-Rawe et al., 2010). The average health of sites on these lotic systems in the Battle River watershed was 67%. (Figure 12).

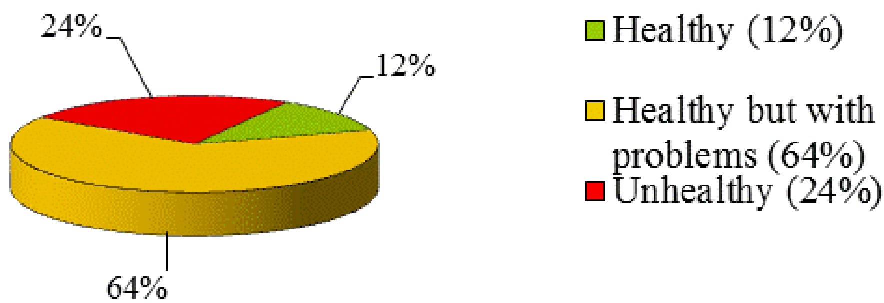

Figure 12. Overall lotic riparian health of the Battle River watershed (Spicer-Rawe et al., 2010).

In 2004, Cows and Fish also did a riparian health inventory of Camrose Creek and Mirror Lake (Spicer-Rawe, 2005). 11 polygons were assessed, most of which were healthy but with problems (Figure 13).

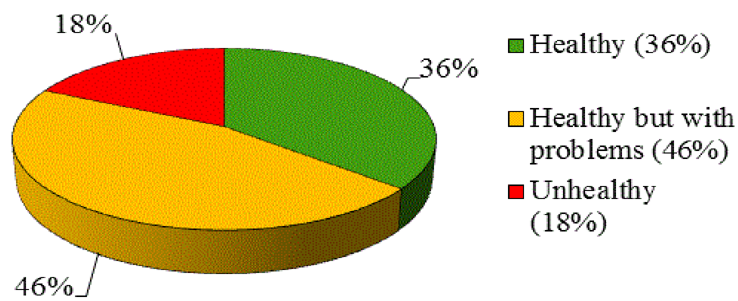

Figure 13. Overall riparian health of the Camrose Creek and Mirror Lake project area (Spicer-Rawe, 2005).

No matter the assessment tool, it is evident riparian areas within the Battle River watershed are in less than ideal condition. As well, the lack of data from within the Sounding Creek watershed makes suggestions for management and improvement difficult. In this report, we will explore who is involved, who else should be involved, and what is being done in the policy context with riparian areas.

4.0 Methodology

4.1 Policy community approach

The Battle River Watershed Alliance policy committee strives to build a broad understanding of the 'policy context' in which our work occurs and work to anticipate potential issues in order to "provide policy advice in a place-based context and recommendations that minimize social, economic, and ecological challenges regarding watershed related issues" (BRWA, 2012b). By utilizing the policy community approach (Atkinson & Coleman, 1992; Coleman & Skogstad, 1990; Skogstad, 2005), this allows the BRWA to systematically assess decisions made before, during and after the period where such 'policies' take shape.

The policy community approach is built on the premise that policy is created in decentralized and coordinated interactions between governing bodies and other societal actors. *Actors* are all the stakeholders and other people who are impacted by the policy issue. This approach examines the interplay of interests and pressures <u>to</u> and <u>from</u> governments and every layer of negotiation involved in policy making (Figure 14).

The *policy community* is made up of actors that form surrounding an issue area and/or common interest while working together to shape and influence the development of policy. These include: corporate, government, public, and potentially (to a lesser extent) the scientific community and media (Skogstad, 2005).

A *policy network* is created when people are pulled in at certain times to influence specific decisions. It looks at the number and type of interactions between actors within the community. They often involve more numerous clusters of actors than in a policy community, each of which has an interest in the policy topic and the capacity to help determine policy (Skogstad, 2005).

The *policy map* tries to define the relationship between and among the actors or players in the policy community. Therefore it can be used to analyze the political environment that surrounds and affects the formation of policy.

To make policy work, each actor and party must participate, providing the information and knowledge they have surrounding the issue. Above all, cooperation is critical for policy to be effective (Skogstad, 2005).

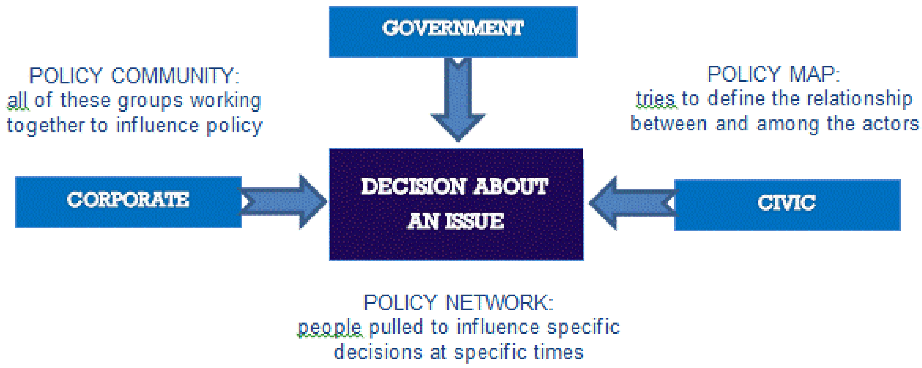

Figure 14. Policy community approach.

4.2 Policy Research

An eleven-step process to policy research was used. The steps in this research method included literature reviews, searches of media (e.g. newspapers and newsletters), research framework development and application, and the use of criteria to improve understanding of adaptation effectiveness. The steps of the process involve:

1. Media Scan – Identifying actors and themes surrounding an issue with local/regional focus, expanding to encompass provincial, national, and international media coverage of issue.
2. Actor files – Policies and other supporting documents of actors identified in media scan
3. Government documents – Four levels of government policies, guidelines, publications
4. Corporations – Corporate policies or documents
5. Legal documents – Government acts and legislation
6. International agencies – Any international agency or organization that is involved with the policy issue on an international scale.
7. Public – Includes any non-governmental organizations and similar entities working on or have spoken out about the policy issue.
8. Conferences, workshops, etc.
9. Taking stock – Look for gaps in data
10. Literature – Peer-reviewed and other literature
11. Interviews – Used to supplement and cover gaps in data

Dynamics in media discourse regarding riparian area are discussed in the next section. Information from the other steps is incorporated throughout the rest of this report.

4.3 Media Scan

There were two main methodologies used to develop a policy research database: 1) searches of various media sources 2) literature searches of formal and primary documents. The media searches were comprised of print media such as newspapers, newsletters, websites, and magazines. This portion of the media scanning is similar to other media surveys conducted in the past by Stranberg (2005). Similarly media articles were organized by the themes, key words, and by geographical and timing identifiers.

The newspapers that were used ranged from local to provincial types which included some of the prominent local agricultural papers such as the County Market or Alberta Farmer Express. Provincial and national news websites were also searched. Websites from organizations regarding riparian areas were utilized, including: Alberta Beef Producers, Agriculture and Agri-Food Canada (AAFC), as well as provincial and federal agricultural and environmental departments.

The geographical extent of the scan focused on the entire area of the Battle River and Sounding Creek Watersheds as well as areas surrounding the watershed. A database was then developed and its more detailed steps are discussed below.

Steps in Media Scan:

- Newspapers are selected and scanned A search method for articles relevant to the riparian areas within each newspapers archives was conducted developed, beginning with selected key words;
- Electronic searching was the primary means to find articles;
- Articles were read, ensuring their relevancy. Title, article summary, date article was printed, key words, and actors were recorded in a database in Microsoft Excel/Access by the date the article was released; and
- Themes were also chosen for each article based on the content of the article.

The themes that were chosen to start the search were: Cattle Management, Grazing Management, Stewardship, Recreation, Wildlife, Habitat, Ecological Integrity, though many more emerged. These themes were chosen by reading through the articles and then deciding what type of themes the article would fit under best. In all, 67 themes were identified. Many articles dealt primarily with rivers, creeks and streams, though a few dealt with the riparian areas surrounding lakes and wetlands. Most articles discussed the issues of cattle and grazing within the riparian area, and people that have worked to minimize/eliminate these issues.

Actors and key words were identified along with themes that were identified for each article. Actors were chosen based on who the key players were in the article. For example, there may have been a biologist with Alberta Environment (now Alberta Environment and Parks) commenting on riparian areas, in which case Alberta Environment would be the actor. There are also articles where the actor is not an organization but it may be a producer commenting on the challenges of having riparian areas on their land, or the work they have done to maintain riparian areas. In this case the producer would be the actor. Once the actors for each article are identified, searching for primary documents from each actor began. Each of these were filed and were be used in following steps in the policy research process.

For each article, key words were chosen that were relevant to riparian areas. Key words were identified in each article based on which words were used the most often and specifically related to riparian areas. Some articles only had one key word that appeared often and some articles had 4 or 5 words that emerged. All the key words that showed up most often would be underlined. The tally for each key word was recorded on the hard copy of the article, and recorded in the data base in Microsoft Access. Key words can then provide a filter for conducting further analysis during the development of policy advice.

4.3.1 Results and analysis from media scan

In the media scan, a total of 92 articles were found, with 67 themes identified. In total, 27 media sources were used, 19 of which were regional or provincial newspapers and newsletters from regional organizations. The remainder consisted of national news agencies, international newspapers, and current events magazines.

Due to the many ways this topic is discussed, many terms were used to search for articles. Most of the articles (76%) referred to riparian areas and associated issues in the context of lotic waterbodies. Only 3% specifically referred to lentic waterbodies (Table 3).

Table 3. The number of media articles that discuss riparian areas pertaining to different waterbody types.

Waterbody type	Number of Articles
Lotic	70
Lentic	3
Lotic and Lentic	9
None specified	10
Total	**92**

Of the 67 themes identified, the most common was livestock and cattle management (29%), followed closely by wildlife habitat (27%) (Table 4).

Table 4. Most common themes throughout media articles.

Theme	Number of Articles
Beavers & Beaver Management	13
Economic Benefits	9
Grazing Management	12
Land Use	15
Livestock & Cattle Management	27
Recreation	17
Riparian Restoration	14
Water Quality	10
Wildlife Habitat	25

Through the media scan, 119 actors were identified. Though most were mentioned in only one article, 29 were mentioned in between 2 and 21 articles (Table 5). All actors mentioned in media scan were included in actor files.

From the media scan, actor files were set up to organize all the information gathered regarding the actor. Information was gathered from online sources, email correspondence, as well as personal contact.

Table 5. Actors mentioned in two or more articles.

Actor	Number of Articles
Agriculture Canada (now Agriculture and Agri-Food Canada)	5
Agricultural Producers Association of Saskatchewan	2
Alberta Agriculture	3
Alberta Cattle Commission	2
Alberta Conservation Association	3
Alberta ESRD (formerly separate Sustainable Resource Development and Environment ministries)	6
Alternative Land Use Services ALUS	2
B.C. Agriculture	2
B.C. Agroforestry	2
B.C. Ministry of Environment	2
Camrose Wildlife and Stewardship Society	2
Cattlemen's Association (national and provincial branches)	10
City of Camrose	2
City of Edmonton	3
Cows & Fish	8
Ducks Unlimited Canada	5
Farmland Riparian Interface Stewardship Program	2
General Public	7
Government of Alberta	2
Government of Canada	4
Keystone Agricultural Producers	2
Lacombe County	5
Land owners	21
Livestock Producers	16
Municipal District of Rocky View	2
Nature Conservancy of Canada	2
Ponoka County	2
Town of Blackfalds	2

Following the eleven step research process, policy information was gathered from these actors and compiled. Though some actors do not have riparian management policies (*ad hoc* or formal), many identified riparian areas and their management as an important issue for life in rural Alberta and expressed the need for such measures to be in place. One of the most prominent issues raised by stakeholders in the Battle River and Sounding Creek Watersheds is the issue of livestock grazing and its impact on riparian areas.

5.0 Policies, Governance, and Legislation

In Alberta, and across the country, management of riparian areas is complex. As jurisdiction often overlaps pertaining to use, regulation, and management, how riparian areas are dealt with varies from province to province, and from municipality to municipality.

In 2012, Alberta Water Council commissioned the report *Riparian Lands in Alberta* (Clare & Sass, 2012), which acknowledges the complexity of this issue as it looks at the state of riparian areas across Alberta, and the legislation and policies on the federal, provincial, regional, and municipal levels that inform riparian management in Alberta. It also highlights some conversation tools and management approaches. This document focuses primarily on the ecological/environmental aspect of riparian area management, but acknowledges that there is a need to apply systems-thinking to the management of these socio-ecological systems, addressing the social and economic sides of the issue.

5.1 Federal

Much of the federal policy legislation relevant to riparian area management pertains to wetland conservation, but also includes fish habitat management, and agricultural buffers. Mostly, provinces have created their own policies and legislation to deal with riparian areas.

5.2 Provincial

5.2.1 Alberta

In Alberta, the *Water Act*, with is associated strategies, is the primary piece of legislation that addresses riparian areas. Under this act, many important codes of practice and policies were developed. Most are explained further in Clare and Sass (2012).

In 2012, AESRD released *Stepping back from the Water*, a document outlining beneficial management practices for new development near water bodies. In 2000 AEP (then Alberta Environment) first developed the guide on *Code of Practice for*

Watercourse Crossings (2013b), which outlines how to avoid or minimize the potential harmful effects of watercourse crossings activity within a water body.

The *Watershed Resiliency and Restoration Program* (WRRP) (Alberta Environment and Sustainable Resource Development [AESRD], 2014b) is an initiative set up by the Alberta government to promote and strengthen the "non-structural" (wetlands and riparian areas) means of flood and drought mitigation following the 2013 floods in southern Alberta. This program aims to improve natural watershed functions through restoration of degraded or lost wetlands, riparian areas, and floodplains.

5.2.1.1 Municipal

In Alberta, the *Municipal Government Act* gives municipalities the authority to establish environmental reserves (ERs) and municipal reserves when private lands are subdivided (City of Grande Prairie, 2012). Grande Prairie (2012) mapped the riparian areas, wetlands and other environmentally significant natural features both within the city and in their surrounding Intermunicipal Development Plan (IDP) annexation area in order to identify priority areas and to define some science based setbacks to manage and conserve these areas. The Riparian Setback Matrix Model, described in the section 10.2.2, has been incorporated into the Lac La Biche County Land Use Bylaw (Lac La Biche County, 2012).

A couple of municipalities in Alberta have developed riparian management strategies to address emerging concerns about water quantity in the area. The City of Calgary's (2013) riparian strategy identified a need for a more comprehensive and coordinated riparian protection. Their riparian strategy examines the environmental, social and economic benefits provided by riparian areas and the need to integrate the value of these areas in decision-making processes. The riparian strategy objectives include:

- A vision that sets the foundation for strategic planning in riparian areas;
- Goals for riparian areas that will focus strategies and future implementation activities;
- Strategies to achieve goals and ultimately the vision;

- Approaches for future stakeholder engagement; and
- An adaptive management approach to be used to monitor progress toward desired goals.

Rocky View County has investigated implementation of their riparian policy (2014) in their background report (2009). The purpose of the Rocky View County riparian policy (2014) aims to "conserve and manage riparian areas through:

- Aligning with provincial objectives;
- Using science-based standards to develop setback requirements; and
- Implementing appropriate development patterns to minimize negative effects on riparian land." (para.2)

Creation of floodplain policies by the Alberta government in regards to development, and changes in insurance policies will play heavily into future riparian management, especially in urban settings. This is currently underway

Within our watershed, several counties have developed policies and bylaws to enable conservation of riparian areas and limit development. Under the *Municipal Government Act*, municipalities can designate some ER land, though this is limited in how much municipalities can do.

The Battle Lake watershed, the headwaters of the Battle River, is protected by several County of Wetaskiwin bylaws, and the provincial government has established the Mount Butte and South Battle Lake Natural Areas to protect approximately one third of the shoreline and riparian zones, as well as some of the upland habitat.

Though much of the Miquelon Lakes area is within the provincial park, it lies within Camrose County. The areas not covered by the provincial park are managed under the *Miquelon Lake Area Structure Plan* (Camrose County, 2012). In this document, there are policies that apply to future development and riparian health. The main policies that address riparian area management are as follows, under section 4.1.1 (Camrose County, 2012, p.18):

- **Policy 1.** No new public lake access points to Miquelon Lakes should be created outside of Miquelon Lake Provincial Park to minimize potential contamination sources.

- **Policy 2.** A 30.0 metre minimum riparian buffer from the lake shore must be designated as Environmental Reserve. The setback distance may be adjusted according to a report prepared by a professional engineer or biologist recommending the area-specific buffer to maintain a healthy riparian zone.
- **Policy 3.** Clearing of lots within 400 metres of a lake shore is limited to establishing a minimum building envelope for all developments unless otherwise provided in this study.
- **Policy 4.** Natural drainage and wetlands should not be diverted, modified, or filled unless under unnecessary hardship or practical difficulties, as determined by the County and approved by provincial authorities.
- **Policy 5.** Livestock access to the water course and water body is discouraged (for example, managers will be encouraged to use off-site watering or other Best Management Practices).

As one of the recreational lakes in the Battle River watershed, it is important to acknowledge the potential pressures of development and tourism on the lakeshore and riparian areas. Much of the area around the lake within Camrose County is designated as a Watershed District. Most of the other riparian areas are protected, whether by provincial park or by conservation groups (Figure 15).

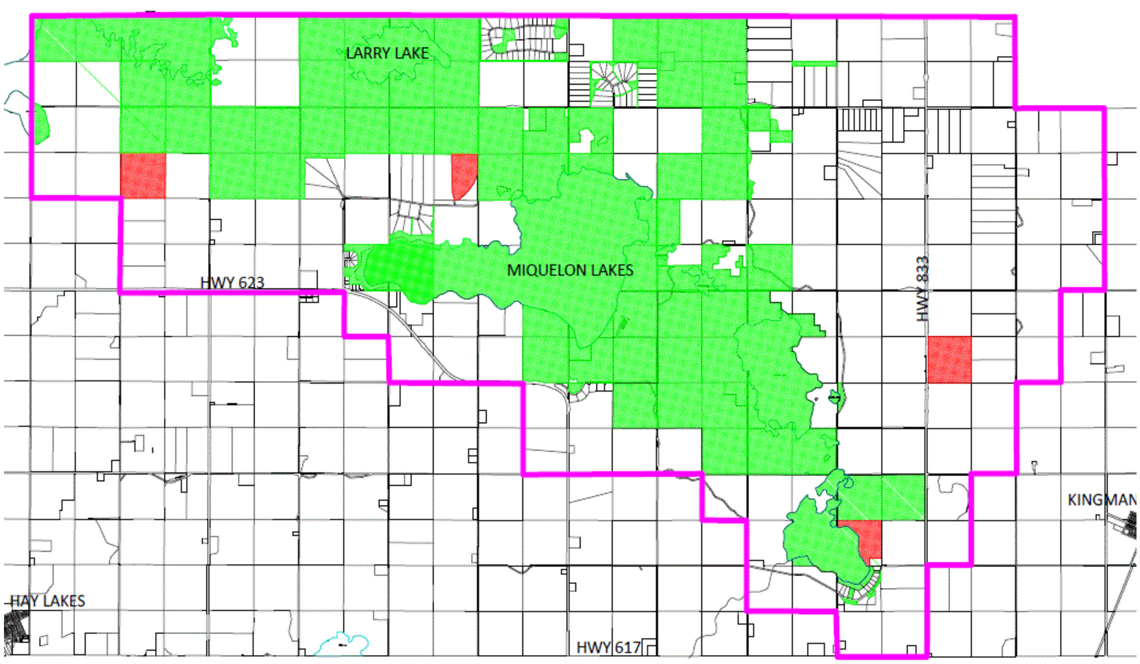

Figure 15. Miquelon Lakes planning area (pink) with lands with provincial protection (green) and land protected through a conservation agency (red).

Within the rest of Camrose County, no building site is permitted where it would be "subject more than a 1% annual risk of flooding" (Camrose County, 2014, p.25, Sec.618.2). In other words, within the 1:100 year flood plain. However, this does not restrict the removal of vegetation.

In their Land Use Bylaw 013-97, Ponoka County has defined "Flood Plain Districts". The purpose of these is to allow flood-prone land to be used productively while not permitting buildings and uses that could be damaged by flooding (Ponoka County, 2012). There is also further restriction about the types of buildings and infrastructure that are built near or within the 1 in 100 year flood mark.

> The 1 in 100 year flood level means that every year, there is a 1% chance that a certain flood level will be met or exceeded

Lacombe County Land Use Bylaw (Lacombe County, 2012) requires an environmental reserve or environmental reserve easement of not less than 30 metres (98 feet) in width from the high water mark of waterbodies and/or the top bank of watercourses to the lot line. No development or interference with natural riparian plants is allowed in this area. The setback is measured from the high water mark or top bank, even if current water levels are lower. Buffers should always include 1 in 100 year river floodplains, and 1 in 100 year lake flood levels.

5.2.2 Other Provinces

Several of the other provinces have developed policies or regulations. Some are more formal than others, and only some have legislative power.

The Government of British Columbia brought in the Riparian Areas Regulation under their *Fish Protection Act* (2006). This piece of legislation "is designed to provide local governments with legislated direction, adequate support, direction, and assurance that, with the exercise of due diligence, protection of fish and riparian fish habitat will be achieved" (Government of British Columbia, 2006, p. iii) in British Columbia.

The Atlantic Provinces have also developed documents regarding riparian beneficial management practices (BMPs) (Agriculture and Agri-Food Canada, 2006a, b).

These focus on potential beneficial management practices for riparian zone management in agricultural landscapes in Atlantic Canada.

In Ontario, there are several pieces of legislation and policy that inform riparian area management. The *Lakes and Rivers Improvement Act* (Ontario Ministry of Natural Resources, 2011) provides for the management, protection, preservation and use of and right to the waters of the lakes and rivers of Ontario, the land under them, and their shores and banks for both humans and non-human users.

6.0 Community

Riparian areas are important to many communities in the Battle River and Sounding Creek watersheds. Riparian areas were traditionally where many First Nations gathered, and where communities were settled. Not only were these areas important for gathering food, water, and building materials, but waterways were important transportation and trading routes.

Though some of these functions remain today, riparian areas have also become important recreation spots, and the site of some industry. There is also significant, and varied, societal values associated with riparian areas and the various services they provide. As a result, they remain significant sites of society and community.

6.1 Economics

Riparian areas are responsible for providing many services, many with economic value. Because the value of these lands varies substantially, a precise monetary value cannot be placed upon them (Clare & Sass, 2013; Kline, Alig, & Johnson, 2000; South Carolina, 2000). Impacts and systems analysis should be discussed and taken into consideration before buffers are set or development occurs.

As agriculture is a major economic driver in the Battle River Watershed, it is important to look at how riparian BMPs can be economically beneficial. Though some on-farm economic benefits exist, research has shown that it may not fully offset the costs of implementation primarily borne by the owners of non-urbanized agricultural, forest, and vacant lands at the edge or within urbanized areas (Environment Canada, 2013; Kline et al., 2000). Programs to compensate landowners or to provide economic incentives to establish buffers beyond their recommended minimum buffer width and implement further land use management BMPs should be considered (Clare & Sass, 2013; Kline et al., 2000; South Carolina, 2000).

6.2 Ecological Services

The value of ecological areas in terms of environmental valuation and ecological services is being heavily studied. However, the value of ecological goods and services has not been fully developed for the riparian area and riparian buffer zone. Primary consideration is given to the value of the provisioning services (natural resources) and the regulating services done by natural systems (filtering, producing oxygen, flood protection, growing food, etc.). However, there are also the cultural services like inspiration for art, recreation, etc. Ecosystems supply a variety of all these types of services.

Riparian areas are disproportionately abundant in ecosystem function and goods & services in respect to surface area (Capon, Chambers, MacNally, Naiman, Davies, Marshall, Pittock, Reid, Capon, Douglas, Catford, Baldwin, Stewardson, Roberts, Parsons, & Williams, 2013; Felipe-Lucia, Comín & Bennett, 2014). As a result, management decisions need to incorporate the preservation of a mixture of land-use types to ensure a mix of services and multiple benefits, including social, economic, and ecological (Capon et al., 2013, Felipe-Lucia, et al., 2014).

6.3 Community Capacity for Riparian Restoration

The capacity of a community to participate in riparian management and restoration was studied by Thomson and Pepperdine (2003) to better understand what is needed in a community for riparian restoration to occur. Their research underscores that money is not the only factor that is involved. Values and the ability to act are crucial pieces, and will vary with location and over time. These play into the many choices and challenges that will need to be addressed for sustainable riparian management.

Such capacity can be built, but involves long-term investment and work. The values that play into riparian restoration are ecological, societal, political, individual, as well as economic. All are important, but provide alternative approaches to values, and can influence the capacity a community has to act. Thomson and Pepperdine (2003) developed a tool that can be used to determine key issues in regards to capacity that need to be addressed or as a means of reporting current status. It can be used by decision-makers, policy developers, and other groups to develop a framework for policies and discussions about capacity building.

Communities with river or lake shore lands would benefit greatly by maintaining and restoring riparian habitats. There would be an increase the supply of ecosystem services that work to sustain the community, as well as increased the resilience of the floodplain ecosystem. Allowing for a mosaic of habitats would maximize synergies, and create synergies for cultural services, such as rural agri-tourism, preservation of local crops and livestock varieties, promote local products and services, create jobs, and help reduce rural emigration (Felipe-Lucia et al., 2014).

7.0 Ecology & Natural Areas

In Alberta, about 80% of all wildlife use riparian areas for all or part of their lifecycle (Fitch, Adams, & O'Shaughnessy, 2003). They are critical habitat on the prairie landscape. Riparian areas are also important for maintaining healthy fish and aquatic invertebrate populations through energy transfer, refugia, and temperature regulation.

An ecologically healthy waterbody does not need to be pristine to maintain function. However, some aspects of aquatic and riparian condition may have been degraded to provide for human use (Victoria Department of Natural Resources and Environment, 2002). In recent years, these challenges have become especially evident in regards to recreation and building on the floodplain. To determine synergies and facilitate good decision-making, riparian health assessments and consultation with riparian experts is needed.

7.1 Protected Areas, and Environmentally Significant Areas (ESAs)

Many of the ESAs in the Battle River and Sounding Creek watersheds are the areas surrounding waterbodies and watercourses (Figure 17), demonstrating the ecological importance of riparian areas within our watershed. Parks and protected areas are important spaces for many reasons, including protecting certain landscapes, wildlife species and habitat, natural regions, and culturally significant areas. As mentioned earlier, the provincial government has established the Mount Butte and South Battle Lake Natural Areas to protect approximately one third of the shoreline and riparian zones, as well as some of the upland habitat around Battle Lake. Though only 0.6% of the BRWA planning area is formally protected, other riparian and wetland areas are protected and conserved through other organizations with conservation easements, nature conservancies, and other land and habitat protection programs.

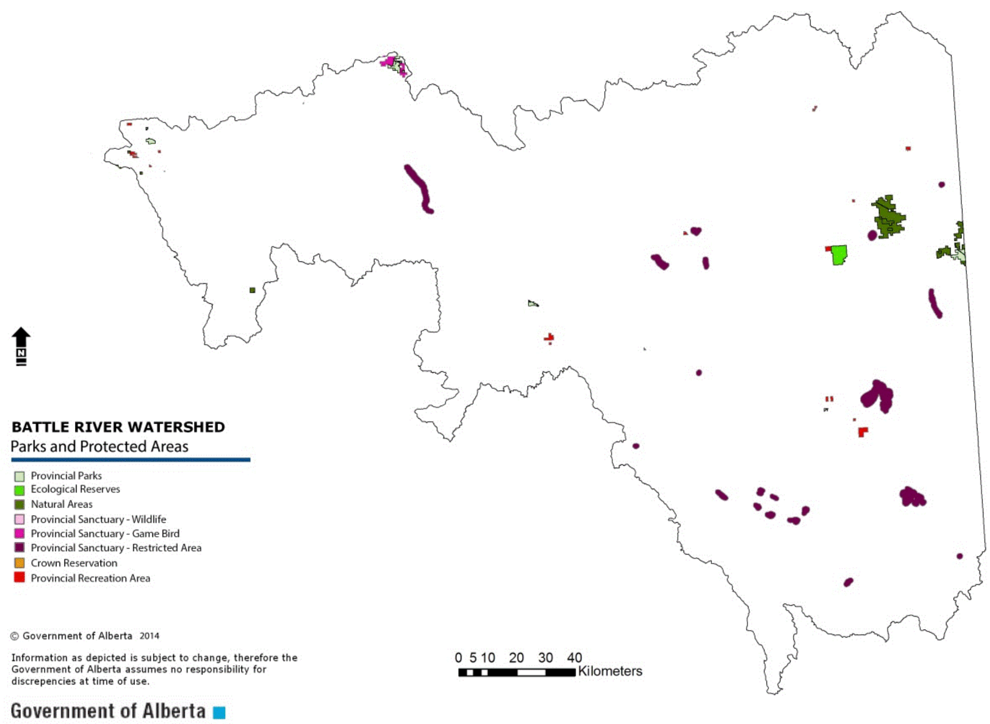

Figure 16. Parks and protected areas within the Battler River and Sounding Creek watersheds.

Parks and protected areas also provide important opportunities for recreation. These are important for tourism, a range of outdoor activities year-round, and our overall well-being.

Environmentally Significant Areas (ESAs) are defined as areas vital to the long term maintenance of biological diversity, physical landscape features and other natural processes within a regional context (Jennings & Reganold, 1991). ESAs are identified based on attributes such as ecological and hydrological function, unique habitats, species diversity and wildlife corridor function, unique geologic and geomorphologic features. Because ESAs are established on the basis of their attributes, they represent a range of diverse habitats and land features throughout the Battle River Watershed.

ESAs are an important tool for comparing landscapes in the watershed to determine their relative health. Because ESAs can provide a benchmark for assessing landscape health, managing on an integrated watershed-scale is most appropriate, rather than managing it in pieces according to the needs of individual stakeholders.

Many of the ESAs in the Battle River and Sounding Creek watersheds are the areas surrounding waterbodies and watercourses (Figure 17), demonstrating the ecological importance of riparian areas within our watershed.

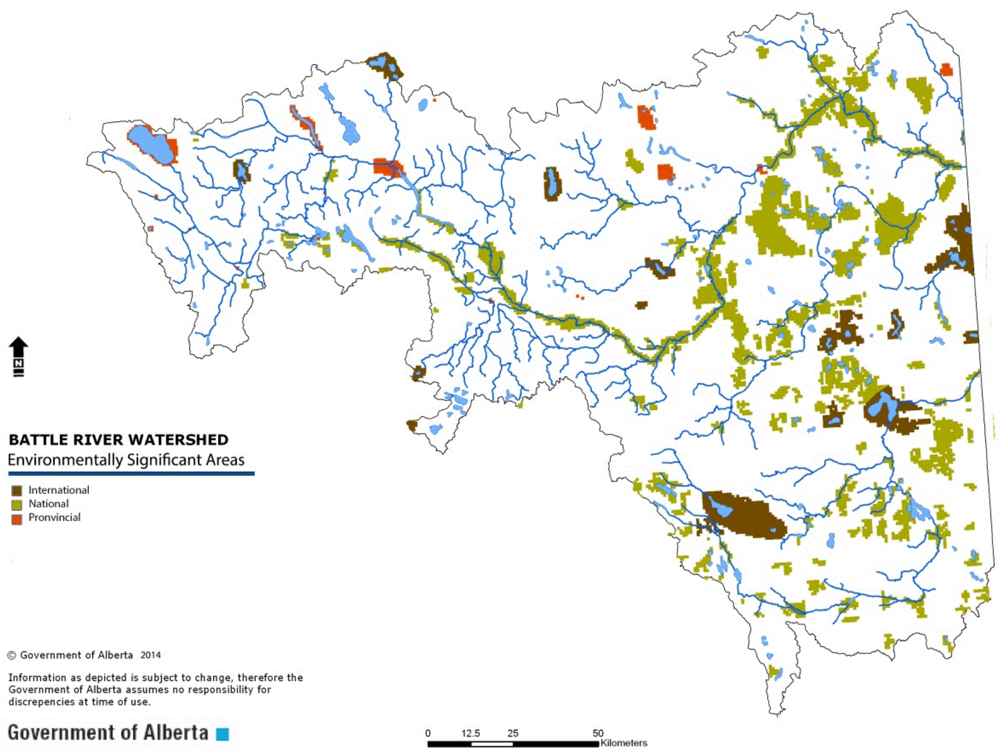

Figure 17. Environmentally significant areas within the Battler River and Sounding Creek watersheds.

Though these areas are important for both human and wildlife use, they are not always recognized or protected. ESAs are important to consider in understanding synergies, ecological services, and long-term planning.

7.2 Fish and Wildlife Habitat

Riparian areas are important sites for fish and wildlife habitat, as the presence of water is a fundamental element of habitat. Wildlife use riparian areas disproportionately more than any other habitat type, and some aquatic and semi-aquatic species may be found nowhere else. The water in the adjacent aquatic zone provides habitat for a variety of organisms, including invertebrates, fish, reptiles, amphibians, birds and mammals (Fitch & Adams, 1998). In Canada, almost two-thirds of all federally listed endangered, threatened and vulnerable species (including fish, mammals, birds, reptiles and amphibians, and plants) rely on riparian areas for at least part of their lifecycle. Almost one half of the listed species rely exclusively on riparian habitats for the majority of their lifecycle (Cows and Fish, 2000).

7.2.1 Fish Habitat

Fish habitat is protected under federal jurisdiction. Though there are many operations that are permitted without review from Department of Fisheries and Oceans (DFO), the *Fisheries Act* (1985) prohibits works or undertakings that could result in the harmful alteration, disruption or destruction of fish habitat. In addition, it also helps to protect fish from other threats to sustainability such as flow alteration, pollution, and aquatic invasive species (Department of Fisheries and Oceans [DFO], 1993).

Due to changes in the *Fisheries Act* in 2013, protection of fish and fish habitat has been limited to certain water bodies Section 35 of the revised *Fisheries Act* (1985) prohibits "any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery" (p.15), which is defined as "the death of fish or any permanent alteration to, or destruction of, fish habitat" (Fisheries Act, 1985, p.2)

Subsection 35(1) prohibition is applied to any activity that has the potential to cause *serious harm to fish.* These projects are likely to negatively impact the ability of the fish habitat to directly or indirectly support the life processes of fish or result in the death of fish (Fisheries and Oceans Canada, 2013). This regulation applies only to waterbodies where a "fishery" is present. A fishery is defined as:

> the area, locality, place or station in or on which a pound, seine, net, weir or other fishing appliance is used, set, placed or located, and the area, tract or stretch of water in or from which fish may be taken by the said pound, seine, net, weir or other fishing appliance, and also the pound, seine, net, weir, or other fishing appliance used in connection therewith (Fisheries Act, 1985, p.2).

As a result, it is implied that where no fishery recognized, no protection is provided. It is unclear if tributaries and other waterbodies within the watershed are protected.

Beyond the impacts mentioned above and chemical water quality properties (i.e. pH, nutrient loading), there are other significant influences of riparian areas and vegetation on fish habitat. Riparian areas have direct influence on the health of the aquatic habitat, and thus on fish health. Riparian areas and the instream aquatic habitat are both part of the Fisheries Sensitive Zone (FSZ) (Figure 18). Any development or alternation of this area could significantly impact fish health and fish habitat.

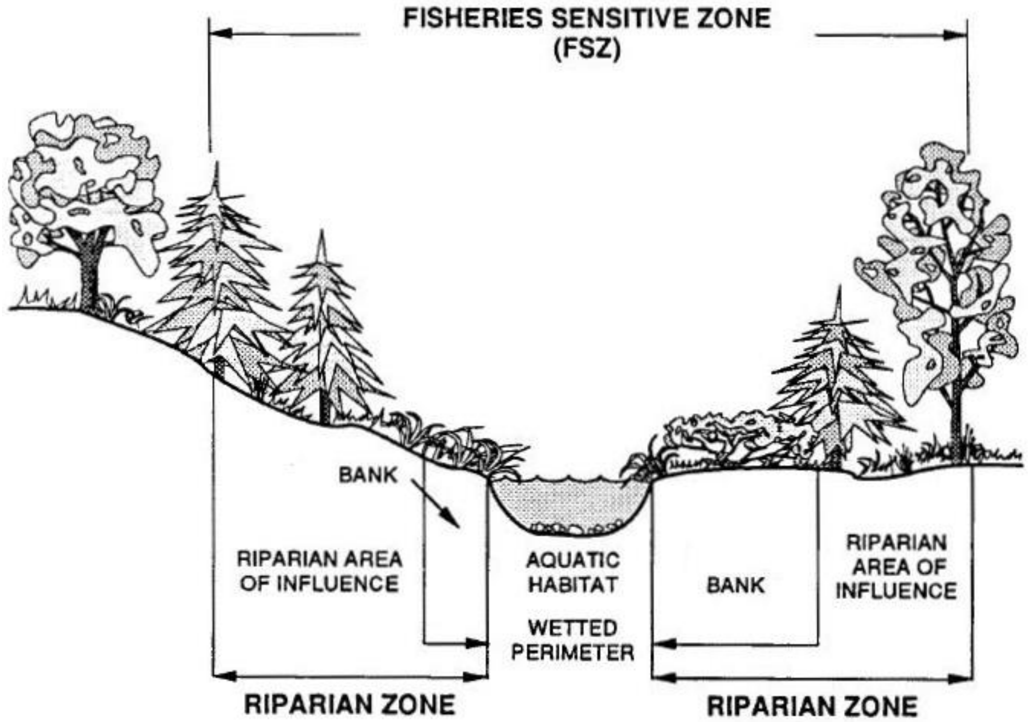

Figure 18. Riparian areas and fisheries sensitive zones (Copyright DFO, 1993).

Riparian areas provide much of the food in aquatic ecosystems directly by providing habitat for terrestrial insects that fall into the water becoming food items for fish. The organic matter from riparian vegetation provides a food source for many aquatic insects which become food items for fish. Large mature trees along a streambank or lakeshore provide a source of large organic debris for the aquatic environment and should be preserved (DFO, 1993). Riparian vegetation also influences bank stability, channel pattern, and the longitudinal profile, all linked to fish habitat (Fitch & Adams, 1998). Riparian vegetation also plays an important role by providing cover and shelter which reduces fish stress and losses from predation. Fallen dead trees and snags, eroded root structures and logs provide stream bed stability, cover, and habitat for young fish (DFO, 1993).

Density and height of the riparian vegetation influences the amount of light reaching the water surface, thus impacting water temperatures and dissolved oxygen saturation levels of streams. A developed tree canopy provides consistent shading which regulates water temperature and rates of fluctuation, creating an insulating microclimate. This ultimately reduces stress on fish populations and improves fish habitat quality. (DFO, 1993).

7.2.2 Wildlife Habitat

As edge habitats, riparian areas contrast with surrounding land use and vegetation and are utilized by many wildlife species. Riparian areas along river systems act as greenspace corridors for the larger species, essential for dispersion, migration, and carrying out life-cycle needs. In areas with habitat loss and fragmentation from a variety of causes (i.e. recreation, industry, agriculture), riparian areas become more important as wildlife habitat for many species (Crooks, 2002; Staicer, 2005).

Within the Battle River and Sounding Creek watersheds, there are 14 Important Bird Areas (IBAs), three of which are shared with Saskatchewan (Important Bird Areas Canada, 2015). Though IBAs are not legally protected in Canada (unlike in Europe), they often overlap with designated protected areas. Two of our IBAs have ESA status, and three are, either in part or entirety, in a provincial park (Campbell, Rowell, & Yakimovich, 2014). As with the ESAs, most of the IBAs in our watershed are associated with waterbodies and their surrounding land.

8.0 Water Supply

Riparian areas play an important role in the maintenance of both water quality and quantity. They are often sites of ground water and surface water interactions, and the filtering and storing of both. Because of these interactions with groundwater, infiltration sites should be identified and protected from development and other human impacts.

8.1 Water Quality

Land use is a crucial piece of watershed health in the Battle River watershed. Though riparian areas are important sites of water quality and quantity maintenance, their ability to mitigate impacts of inappropriate land use on the aquatic environment may be decreasing.

Water quality is impacted by many factors, including the health of riparian areas. The United States Environmental Protection Agency (2005) states that "riparian areas play a significant role in protecting water quality and reducing adverse water quality impacts associated with non-point source pollution" (p.1). Surrounding land use, riparian land cover vegetation type (headwaters and local), and buffer width are significant factors are strong indicators of water quality (Dodds & Oakes, 2011).

The efficiency of riparian areas to manage water quality issues, especially as they pertain to excess nutrient levels, seems to be highly variable, depending on the research, the nutrients involved, and the land use. Research from Alberta and other Prairie Provinces demonstrates that the majority of surface water runoff in Alberta's agricultural regions occurs during spring snowmelt, when the capacity of riparian areas to capture and treat this runoff is lowest (Anderson, 1999; Casson, Olson, Little, & Nolan, 2008; Paterson et al., 2006; Corriveau, Chambers, Yates, & Culp, 2011; Olson & Kalischuk, 2011). Utilizing other nutrient management strategies, such as described by Skinner (2013), in conjunction with buffer strips may compensate for these inefficiencies.

Along the mainstem of the Battle River, there are 11 water quality monitoring stations. These monitor nutrient levels, dissolved oxygen, coliform levels, and pH. (Figure 19).

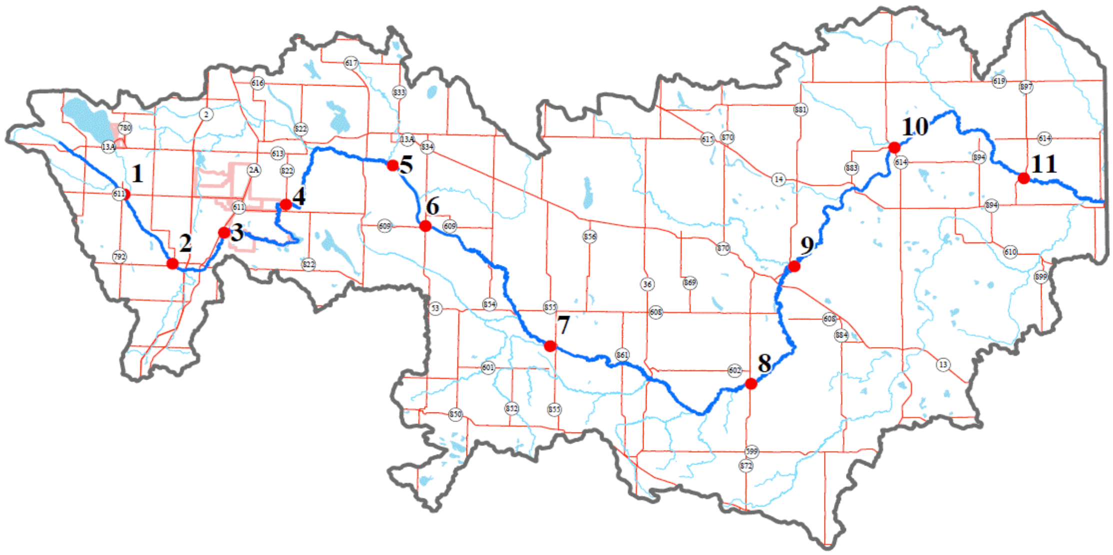

Figure 19. Battle River water quality monitoring stations (2004-2005). Long-term water quality monitoring stations are located at number 2 and 5.

Water quality issues are a significant issue for the Battle River, its tributaries, and many lakes in the watershed (Skinner, 2013). Water quality monitoring results from 2005 revealed high levels of phosphorus and nitrogen in the Battle River mainstem (Table 6). Significant water quality issues at Station 6 helped to identify a potential project area for riparian implementation (Ferry Point Reach Riparian Restoration Program).

Table 6: Water quality compliance with surface water quality guidelines, December 2004 – October 2005 (Alberta Environment, 2005)

Parameter	Guideline	Station Number										
		1	2	3	4	5	6	7	8	9	10	11
Total Phosphorus	Aquatic life (0.05 mg/L)	100	100	100	100	100	100	100	75	63	67	89
Total Nitrogen	Aquatic life (1 mg/L)	33	67	78	89	90	100	89	75	75	33	44
Total ammonia	Aquatic life (calc.)	0	0	11	11	10	0	0	0	0	0	0
Nitrite	Aquatic life (0.06 mg/L)	0	0	22	11	0	0	0	0	0	0	0
Fecal Coliforms	Irrigation (100 per	20	27	10	0	0	30	0	30	40	20	10

Parameter	Guideline	Station Number										
		1	2	3	4	5	6	7	8	9	10	11
	100 mL)											
Fecal Coliforms	Recreation (200 per 100 mL)	10	0	0	0	0	20	10	10	0	10	10
Dissolved Oxygen	Aquatic life (>5.0 mg/L)	0	18	30	10	27	40	30	0	20	30	30
pH	Aquatic life (6.5-8.5)	0	0	40	40	27	50	10	0	0	0	0
(red)	Canadian Water Quality Guidelines exceeded more than 50% of the time											
(yellow)	Canadian Water Quality Guidelines exceeded up to 50% of the time											
(green)	Canadian Water Quality Guidelines never exceeded											

8.2 Water Quantity

As interfaces between terrestrial and aquatic systems, riparian health around watercourses and waterbodies impacts issues related to water quantity - drought, flood, surface water, and groundwater.

8.2.1 Flooding

Riparian areas are important in regards to mitigating and managing flooding and excess water. Healthy riparian areas provide opportunity for water infiltration and use by the land and plants, so less goes into waterbodies and watercourses as direct surface runoff. As well, for the water already in the watercourse, riparian areas slow the water down, reducing erosion and other impacts of fast-moving water.

Though flooding is not often a huge concern for the Battle River, there have been major flood events in the past. Severe flooding in 1974 caused a lot of damage to agricultural land and bridges. The river and some of its larger tributaries do flow through communities where flooding could be a concern. As previously mentioned, some communities where the river does flow though have implemented BMPs as they apply to flood plain development.

As a result of the 2013 flooding in southern Alberta, the challenges and issues of developing in the floodplain and insurance claims for these developments are being investigated. Policies are being put in place to by government and insurance groups to discourage development in these areas, as well as to promote restoration and conservation of riparian areas.

As mentioned earlier, the initiative set up by the Alberta government to promote and strengthen the “non-structural” (wetlands and riparian areas) methods of flood mitigation is slowly gaining ground. The *Watershed Resiliency and Restoration Program* (WRRP) (AESRD, 2014b) aims to improve natural watershed functions in order to build greater long-term resiliency to droughts and floods through restoration and conservation of degraded or lost wetlands, riparian areas, and floodplains, education, and stewardship, and research and data. Increasing nature’s ability to reduce the intensity, magnitude, duration, and effects of flooding and drought on a watershed level is a critical element in mitigating the long-term environmental, social and economic impacts of severe natural events (AESRD, 2014b). Though the program indicates that this program applies to “priority areas”, work will be done with WPACs.

8.2.2 In-stream Flow Needs

In watercourses, in-stream flow needs (IFNs) are important to maintain healthy aquatic ecosystems. IFNs can be generally described as the quantity, timing, and quality of water flows required to sustain freshwater and other associated ecosystems’ processes (such as fisheries, riparian areas, and channel maintenance), and the human livelihoods and well-being that benefit us directly or indirectly (Ko & Donahue, 2012).

In the Battle River mainstem, there have been measurable reductions in recruitment of riparian species observed, and at current rates, likely insufficient to support the riparian community over the long-term (AESRD, 2014a). As a result, the riparian condition has become highly vulnerable to impacts of local land management. By establishing an IFN based flow regime, the predicted impact would be an improved ability to support all processes key to the long term sustainability of the aquatic ecosystem, and recruitment in riparian area specifically (AESRD, 2014a).

As questions about water quantity come to the fore with increasing urban population, development, and climate change, having healthy riparian areas will help mitigate the impacts, and increase the resilience and adaptive capacity of our ecosystems, communities, and well-being (Capon et al., 2014).

9.0 Land Use

Land use within the riparian area can significantly alter the health and functionality of those areas. Stevens and Council (2008) suggest that rapid growth in urban, agriculture, and energy sectors and their infrastructure that modify the landscape and drainage has compromised the ecological integrity of riparian areas.

Though riparian areas do help buffer against some effects of some inappropriate land uses, riparian areas are often overwhelmed by the intensity of the impacts and become ineffective. On the Canadian Prairies, healthy riparian areas are unable to cope with intensive land use practices (Corriveau et al., 2011), resulting in reduced water quality and increased nutrient loads. Unlike other areas of North America with intensive agriculture, the most significant run-off event on Canadian Prairies is the spring melt (Corriveau et al., 2011). This plays a significant role in determining how riparian areas buffer and are able to absorb upland run-off.

9.1 Agriculture

As agriculture is the dominant land use in the Battle River and Sounding Creek watersheds, this is an important element to discuss. Because agroecosystems cover a large portion of the watershed, they should be managed to provide multiple ecosystem services, and not only for provisioning services (Felipe-Lucia et al., 2014).

Riparian areas are responsible for the production of an average of 4126 Kg/ha of forage in one growing season in central Alberta (DeMaere, 2005). As such, they are incredibly important for livestock producers. Many BMPs regarding remote watering sites, grazing and stocking management, and well as tillage practices, have been established by various organizations (Alberta Agriculture and Food, 2007; Fitch et al., 2003) in regards to stewardship of the land and agricultural practices.

Much of the discourse surrounding riparian areas pertains to the impact of some agriculture practices on riparian health. Water quality issues stemming from sediment erosion, nutrient loading, and loss of riparian vegetation as a result of improper land use are challenges that need to be addressed. Yet it is important to acknowledge that agriculture does not need to be contrasted with healthy ecological functioning of riparian areas. Cows and Fish (Fitch et al., 2003) promotes the idea that it "is possible to sustain livestock production, maintain biodiversity and care for water quality" (p. i).

Alternative Land Use Services (ALUS) also works across Canada to "create a healthy landscape that sustains agriculture, wildlife and natural spaces for all Canadians" (Alternative Land Use Services (ALUS), n.d.). ALUS is a community-based program, delivered by farmers, that "provides support to farmers and ranchers to enhance and maintain nature's benefits" (ALUS, n.d.), giving landowners a per-acre payment for augmenting wetlands, creeks and marginal farmland. Currently, three counties in Alberta and a few individuals are using it to promote riparian improvement and conservation.

Programs such as the Environmental Farm Plan, Growing Forward 2, and other government-driven initiatives play an important role in promoting riparian maintenance and restoration on the agricultural landscape.

9.2 Urban Development

Urban development within the riparian area and floodplain can result in significant loss of property, infrastructure, and life. The June 2013 flooding in southern Alberta is an example of how destructive and costly it can be to have unhealthy riparian areas.

In the urban setting, riparian buffers work to decrease the rate of runoff reaching the water bodies and reduce the sediment, nutrient, and pollutant loading to the water resource (South Carolina, 2000). However, standard urban development has significant impact on nearby water bodies. Streams and rivers adjacent to urban areas often have greater sediment loads as compared to many other land use settings.

As mentioned earlier on, there are a number of counties or municipalities within Alberta and Battle River watershed that have developed bylaws and policies to restrict development or removal of trees and shrubs within the riparian area or floodplain, as well as the creation of formal environmental reserves.

In some communities, issues related to beavers and their influence on infrastructure and other use of the riparian area arise. Apart from learning to live with other species and managing human use of the riparian area to be flexible to beaver activity, working with the beavers can be mutually beneficial. Further information and discussion on this topic can be found later in this report.

9.3 Natural Resource Extraction

The Battle River Valley is an area rich with natural resources. Coal and gravel have historically been extracted from the area, and are still currently extracted in many parts of the watershed. As many of these operations may occur near watercourses, regulations and bylaws on ensuring riparian areas and buffers are maintained are important.

9.3.1 Gravel Mining

Gravel mining is prevalent throughout the Battle River and Sounding Creek watersheds (Figure 20). As such, this is an important area to address in regards to riparian areas management. As many gravel extraction pits are in or near waterbodies and river valleys, how gravel mines operate can impact water quality as well as erosion of banks and coulees.

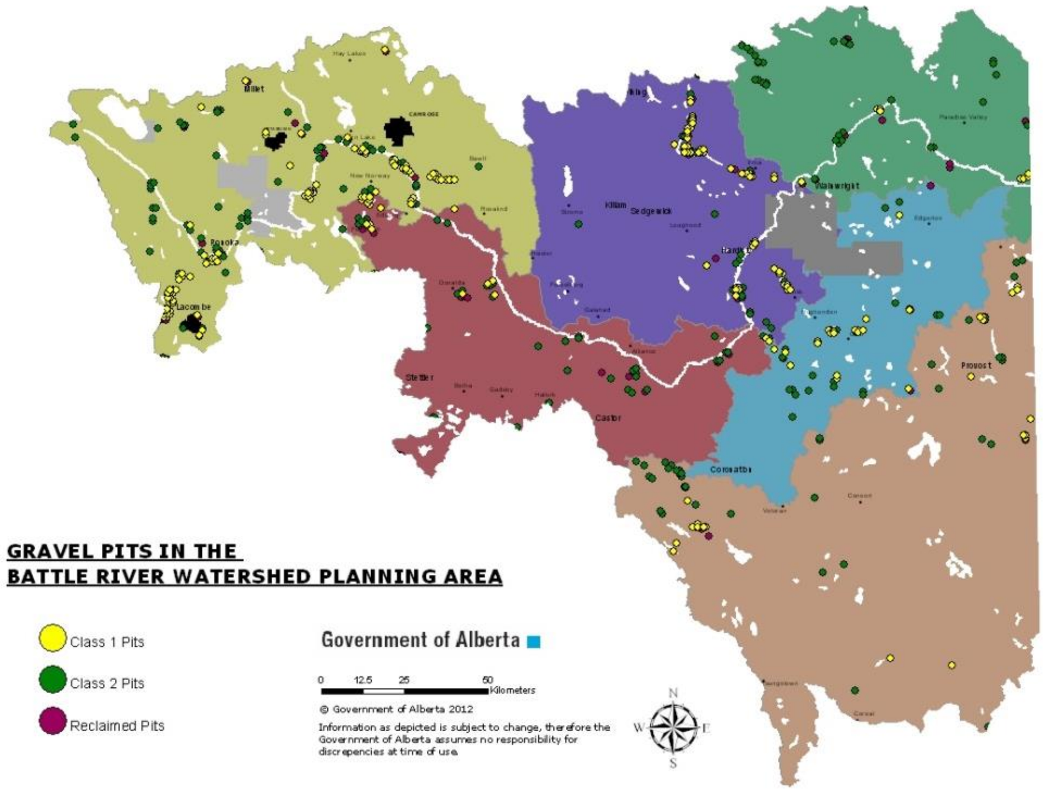

Figure 20. Gravel pit locations in the Battle River and Sounding Creek watersheds.

Currently, there are more than 20 municipal, provincial and federal Acts, Policies and Regulations that govern gravel and other aggregate extraction activities in Alberta (Alberta Sand & Gravel Association (ASGA), 2015). Applications under both provincial (Alberta Environment, 2004) and municipal (i.e. Camrose County, 2014), consideration of using vegetated buffers for water quality, surrounding vegetation, and wildlife habitat is highly recommended. Erosion control (recommended as vegetation), in regards to preventing siltation of water bodies, is a required part of all plans (Alberta Environment, 2004).

9.3.2 Coal Mining and Oil & Gas

Though no regulations have been located pertaining directly to coal mining and oil & gas development in riparian areas, the Alberta Energy Regulator (AER) (2013) identified maintaining riparian habitat structure, and protecting the "complex biological structure and processes" (p.43) in all operations.

Setbacks from waterbodies and watercourses for operations on Crown land have been established, and are dependent upon watercourse and waterbody classification (Alberta Energy Regulator [AER], 2013). Though these setbacks are not required for private lands, they are recommended as "good management practices" (AER, 2013, p.7).

9.4 Linear Disturbance

Linear disturbance refers to human disturbances that designed in more or less a straight line. This includes all oil and gas pipelines, power lines, railway lines, roads, cutlines, and trails that crisscross the landscape (Figure 21).

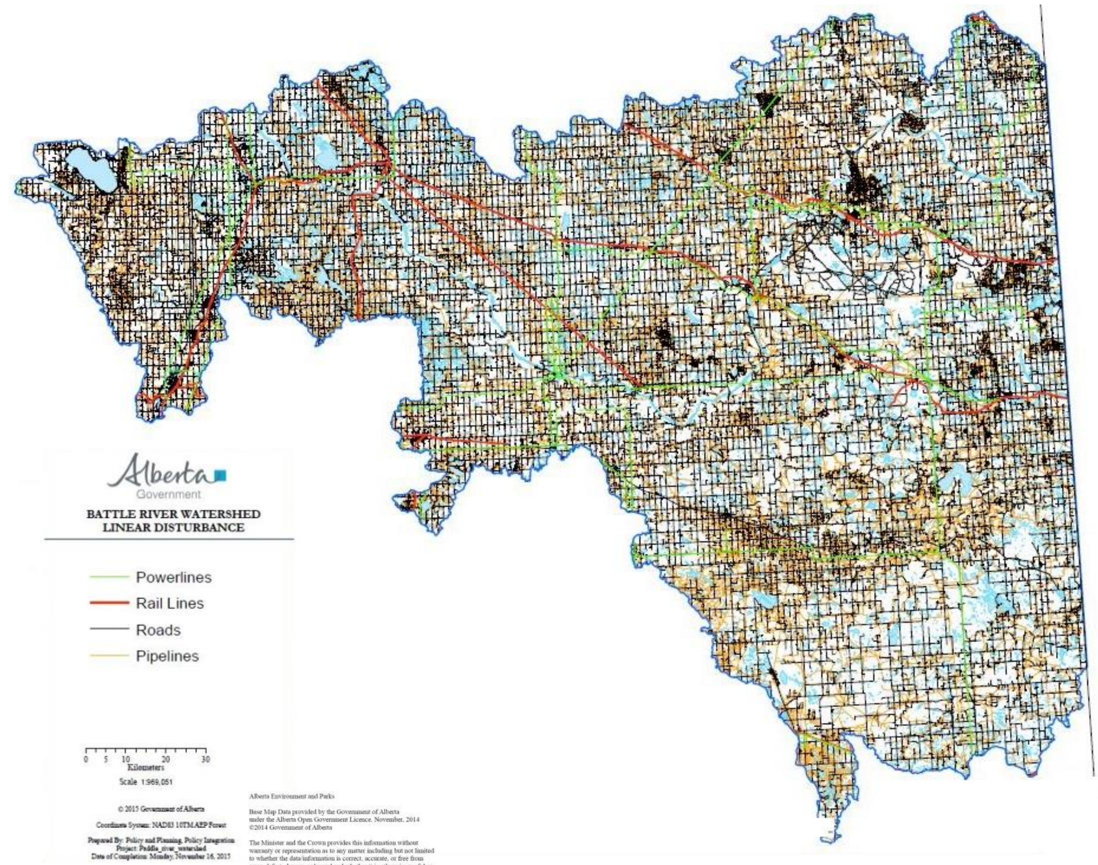

Figure 21. Linear disturbance in the Battle River and Sounding Creek watersheds.

Alberta Environment and Parks (then Alberta Environment) *Code of Practice for Watercourse Crossings* (2013b) outlines how to avoid or minimize the potential harmful effects of developing watercourse crossings (i.e. bridges) within a water body. As well, the *Code of Practice for Pipelines and Telecommunication Lines Crossing a Water Body*

(AEP, 2013a). The conditions that need to be followed are based on the watercourse's classification. Fish habitat is mentioned, but refers only to the aquatic habitat. There are currently no guidelines related to riparian areas and these type of disturbances in either of these documents. However, access roads and pipelines are not permitted to parallel within 200 meters of any permanent waterbodies or riparian area (except for crossings) (AER, 2013).

In 2008, Stevens and Council examined the relationship between fish index of biological integrity (IBI) and land use. Though other land use factors were shown to impact fish IBI, Steven and Council exposed a strong link between basin road density and the index of biological integrity of fish assemblages. Higher road densities appear to negatively influence the integrity of fish assemblages. According to the study, this can occur even where road density is 0.7 km/km^2. The average road density of the BR & SC watersheds is 0.98 km/km^2, ranging from 1.3 km/km^2 (Bigstone sub-watershed) to 0.7 km/km^2 (Sounding Creek sub-watershed) (BRWA, 2011).

9.5 Recreation

Recreation is an important aspect of understanding the context of land use of riparian areas. Outside of provincially designated areas, little management of recreation exists. Though much of the riparian areas of the Battle River and Sounding Creek watersheds are on private or municipal land, opportunities can be made for public access.

One significant challenge to recreation management in riparian areas is the use of off-highway vehicles (OHVs). This is a challenge that many environmental organizations face around the province. OHVs can be used with low impact, and some trails exist. However, in many watersheds, they have damaged many sensitive areas, including riparian areas of both lotic and lentic waterbodies. Much of the issue lies in the culture framework of OHV operators, and how this type of recreation is portrayed in media.

Though several provinces have legislation regarding the operation of OHVs, few places have regulations or bylaws that prohibit the use of OHVs in wetlands, riparian areas, in-stream habitat, and other sensitive areas. The Government of Ontario (*Ontario*

Highway Traffic Act, 2015, O. Reg. 135/15) does prohibit this, as well as any operation of the OHV that would cause "harm, injury or damage, either directly or indirectly, to any property, flora or fauna," or result in any "alteration, disruption or destruction to the natural environment, including erosion damage or degradation" [s. 23 (2,3)].

Another way recreation has impacted riparian areas is the pressure of development around lakes. These issues arise as more people want permanent residences (homes or cottages) by our limited number of lakes, and few understand how to develop and maintain properties to ensure healthy lakes. In 2012, AESRD released *Stepping back from the Water*, a document outlining beneficial management practices for new development near water bodies. In addition, Nature Alberta delivers the *Living By Water* program that facilitates one-on-one consultation with waterfront residents to determine environmentally-friendly practices on their property to help maintain shoreline and water health (Nature Alberta, 2015). Consultations occur all over Alberta, and are on a volunteer basis.

10.0 Riparian Health, Management, and Restoration

10.1 Riparian Health Assessments

Riparian health assessments and inventories are vital in understanding current riparian health issues and identifying management and restoration needs. To obtain a broader scope of riparian area status, aerial videography works well, and has been used several times in Alberta. Site-specific assessments performed by Cows and Fish help with specific concerns and can provide site-specific management/restoration possibilities.

10.1.1 Aerial Videography

Low-level aerial videography can be used effectively to provide a broad scale riparian health and integrity assessment, and to develop a visual understanding of the landscape, land use, and development at and around the site (Stewart, Reedyk, Franz, Fromradas, Hilliard, & Hall, 2011; Teichreb & Walker, 2008). These types of surveys are able to achieve rapid and cost-effective riparian assessments over large areas, while maintaining an acceptable level of assessment. Aerial videography can be successfully used with manned or unmanned air vehicles (UAV or drone) (North Saskatchewan Watershed Alliance (NSWA), 2015).

Using the geo-referenced aircraft position data, aerial videography, and a modified scorecard (first developed by the Alberta Conservation Association), the health and integrity of river riparian areas can be assessed and given an overall rating of Good/Healthy, Fair/Moderately Impaired, or Poor/Highly Impaired. This rating corresponds to a percentage of the maximum possible score (Table 7).

Table 7. Description of Aerial Videography Riparian Health Categories

Health Category		***Score Ranges***
Good/Healthy	(green)	*80-100%*
Fair/Moderately Impaired	(yellow)	*49-79%*
Poor/Highly Impaired	(red)	*<49%*

The scorecard consists of seven questions reflective of the important ecological services that a 'healthy' riparian area would provide to the ecosystem (Appendix A).

10.1.2 Cows and Fish Health Assessment

Riparian health assessments/inventories, like those done by Cows and Fish, are detailed field examination of the vegetative, soil and hydrological parameters of a particular riparian area. Subsequent to data collection, a derived riparian health assessment score is assigned to each site. This rating is expressed as a percentage, as well as a health category, namely *healthy*, *healthy but with problems*, or *unhealthy* (Table 8).

Table 8. Description of Cows and Fish Riparian Health Categories.

Health Category		***Score Ranges***	***Description***
Healthy	(green)	*80-100%*	Little to no impairment to any riparian functions
Healthy, but with problems	(yellow)	*60-79%*	Some impairment to riparian functions due to management or natural causes
Unhealthy	(red)	*<60%*	Severe impairment to riparian functions due to management or natural causes

Assessments are done using the more detailed inventory form or one of the field workbooks (Ambrose, Ehlert, & Spicer-Rawe, 2009; Fitch, Adams, & Hale, 2009) for lotic or lentic systems, dependent upon the water body type (Appendix B and C). These ground-based assessment methods are more likely give a more precise and robust measurement of riparian health due to a more intensive and complete set of assessment criteria. However, due to this intensive nature, such assessments are most easily carried out over relatively small areas. Using the stratification process for site selection to represent longer reaches, a larger area can be evaluated.

Riparian health assessments, before and after restoration actions, are integral parts of some of the riparian policies and strategies mentioned in this report (City of Calgary, 2013; Rocky View County, 2009).

10.2 Management

Many riparian area management approaches and tools have been suggested from different organizations around the world. Wherever possible, the management and restoration of riparian land should assist in restoration, maintenance of healthy rivers (and other waterbodies) and landscapes, and the protection of cultural and social values (Victoria Department of Natural Resources and Environment, 2002).

10.2.1 Framework

Some research and documents out of Australia suggest creating a management framework to help manage implementation priorities and decisions. To develop a management framework in which all riparian stakeholders are encouraged to manage the land to protect and/or restore the functions of the riparian area, consideration should be given to these elements:

1. Establish a clear set of goals and objectives for watersheds, with clear priorities, tools to provide guidance and measurement of progress toward objectives, and targets for riparian protection and restoration;
2. An acknowledged partnership approach between all riparian stakeholders;
4. Mechanisms to encourage and facilitate riparian stakeholders to manage their land in accordance with the goals and objectives; and
5. A common understanding in the community of the importance of riparian land (Victoria Department of Natural Resources and Environment, 2002).

In establishing priorities and targets for riparian protection and restoration, the full range of benefits will be identified and considered. These include benefits to the biodiversity of riparian and in-stream habitats, economic values, ecological goods and services, infrastructure assets, as well as social, cultural, and recreational values.

10.2.2 Buffers and Setbacks

The purpose of buffers and setbacks from water bodies is to create areas that are controlled for development or alterations, allowing natural vegetation and processes near water bodies to remain as healthy and functional as possible, as well as to protect private property from possible flooding and loss of land due to stream erosion and bank instability. Buffers and setbacks from riparian areas appear in different areas, and have varied means of delineation. Depending on the management goals of a watercourse, waterbody, or watershed, the width of buffer strips may vary.

Some policies, regulations, and bylaws stipulate buffer width and the type of setbacks required in relation to waterbody type, geology and geography, industry type and land use purposes. However, enforcement and application of these is not uniform.

Various methods for determining buffers or setbacks are site-specific and land-use specific, making them inappropriate to apply on a more regional or watershed scale. Setbacks on a broader scale can be delineated using aerial videography as described above. Riparian assessments such as those provided by Cows and Fish would be more localized. As well, the field manual created by Agriculture and Agri-Food Canada on buffer designs (Stewart, et al., 2010) is more site-specific, but is designed for landowners to do their own assessment.

Another more site specific method is the Riparian Setback Matrix Model (RSMM) (White & Gray, 2007). This method has been incorporated into the Lakeland County (Lac La Biche) Land Use Bylaw, and other counties are developing similar approaches. The RSMM delineates the width of an ER based on the slope of the land, height of banks, groundwater influence, soil type, and vegetative cover (Appendix D). If no vegetation exists, the ER is determined from the edge of water (White & Gray, 2007). AESRD (2012) guidelines pertaining to setbacks and buffers incorporate similar factors.

Buffer width will vary according to what extent the strip is meant to be established for wildlife habitat. Different wildlife groups have different habitat requirements that dictate the size of buffer strip. The standard 20m or 30m buffer strip contributes minimally to wildlife habitat, except for small rodents and shrews. Most amphibians ideally require at least 50 m (Hannon, et al., 2002), though for the Northern Leopard Frog (*Lithobates pipiens*) it extends to 100m (Government of Alberta, 2011). Songbirds, avian raptors, ungulates, and mammalian carnivores (species ranging in size from cougar to weasel) all require much larger buffers, ranging between 100-400m (AESRD, 2012; Environment Canada, 2013; Hannon, et al., 2002). Species at Risk and other sensitive species may have specific recommendations.

10.3 Restoration Approaches

A number of techniques exist to help restore riparian areas. Most restoration projects include many different techniques, often combining "hard" structural approaches and "soft" bioengineering approaches (Brown, 2013). Depending on the issue, terrain, soils, weather/climate, size, and land use, different techniques are more appropriate. All have varying levels of success, and have varying levels of adaptive capacity (Capon et al., 2013). Few monitoring or evaluation studies have been conducted on restoration projects.

Restoration in urban areas often requires different techniques to address the challenges of development and protection on infrastructure and property than more rural options. As there are more potential constraints on space, access, and infrastructure limitations in urban settings, more "hard" techniques may be necessary.

10.3.1 Bioengineering

Bioengineering (sometimes referred to as soil bioengineering) is a method of bank stabilization using living woody and herbaceous materials with organic and inorganic materials to increase the strength and structure of the soil. Structures using natural materials utilize the regeneration of tree cuttings and production of roots that bind the stream bank together. Though more often applied to lotic systems, bioengineering can be used to treat a wide variety of unstable or eroding shoreline or bank. Some common methods are live staking, wattle fencing, and brush layers (Alberta Conservation Association, 2014; Bentrup & Hoag, 1998; Polster, 2002; Cows and Fish, 2003; Donat, 1995).

Bioengineering methods have gained popularity as they offer a more ecologically acceptable way of bank stabilization that still complies with the land use and safety requirements. They can be used on their own or in combination with other shoreline or bank engineering techniques (Donat, 1995; Polster, 2002). For most biological restoration approaches, using natural species where possible is preferred (Cows and Fish, 2003; Greater Wellington Regional Council, 2008).

The most common "soft" approach taken for riparian restoration involves tree planting. This is often used in agricultural areas in conjunction with exclusion fencing (short term or long term), and alternative water systems in livestock operations that border lakes or rivers and streams. As livestock can damage the soil and consume or trample the vegetation in riparian areas that maintain the stability of the bank, limiting livestock presence in these areas and planting some the important plants can help re-establish the riparian vegetation, and allow the ecosystem to regain shape and function.

10.3.2 Wetland restoration

Wetlands, though policy-wise are often separate from riparian areas, should also be considered in addressing the issue of riparian management. They are ecologically connected, and perform many similar functions. Maintaining existing wetlands in floodplains through conservation easements or other means is essential in helping maintain riparian health and function. Restoration of wetlands, through wetland restoration agencies, is an important element of restoring riparian function. The new Alberta Wetland Policy (Government of Alberta, 2013) informs implementation and actions to maintain and restore wetlands vital to a sustainable land use.

Wetlands and their management in the Battle River watershed will be covered in more detail in our ongoing work through our watershed management plan.

10.4 Beavers and Riparian Management

Benefits of beavers for riparian areas and aquatic ecosystems, and management strategies are numerous. The beaver's role in creating and sustaining water and riparian areas has been extensively researched in the last couple decades. As a keystone species, the beaver can significantly manipulate their environment. This can create opportunities for humans as studies suggest beaver-regulated rivers and ponds increase flood and drought mitigation and resilience (Hood & Bayley, 2008).

The beaver's ability to create channels that distribute water far beyond the waterbody's edge and dams that hold water and sediment fosters the creation of healthy wetland and riparian areas (Hood & Bayley, 2008). Though much maligned by some for flooding effects of beaver ponds, appropriate land use for long-term benefit can allow for co-existence and is essential for sustainability. A beaver management matrix for agricultural producers was developed by Cows and Fish (2013) to be a tool for decision-making about potential concerns and opportunities regarding beavers on their land.

Restoring beavers can be a sensitive issue when it comes to managing their impacts. Techniques have been developed to facilitate beaver dam construction where the least amount of perceived negative impacts. A documentary on the Canadian Broadcasting Corporation (CBC) program *The Nature of Things* (Canadian Broadcasting Corporation (CBC), 2013) highlights some of these methods, as well as the research into the benefits of beavers.

10.5 Implementation - Ferry Point Reach Riparian Restoration Program

The Ferry Point Reach Riparian Restoration program is based on funding from government and non-government partners. It is part of a pilot for the Growing Forward 2 Agricultural Watershed Enhancement program aimed at working with watershed groups to find landowners who are interested and willing to participate in riparian restoration on their land. The Ferry Point Reach Riparian Restoration program got its name from a historical spot along the river near a lot of the restoration projects.

The rationale for choosing this location as the first reach to address stems from results of water quality monitoring, and the fish IBI (Index of Biological Integrity) study (Stevens & Council, 2008). Both the water quality (Station 6, see Table 5) and IBI study identified this reach in particular as problematic (Figure 22).

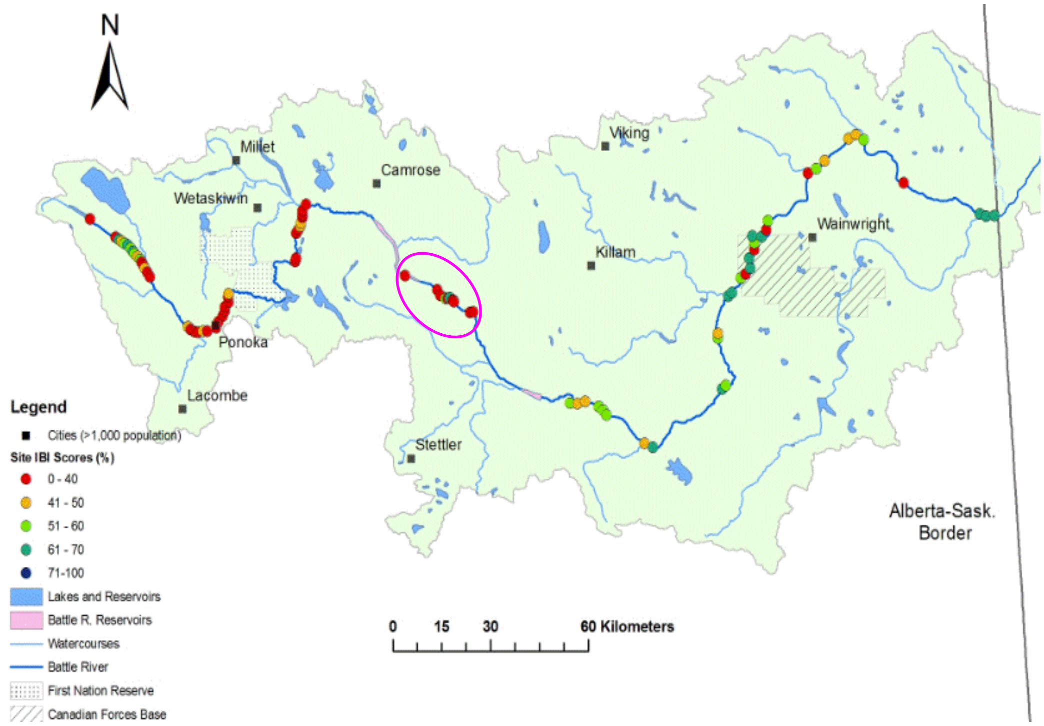

Figure 22. Study sites along the Battle River for the fish-based Index of Biological Integrity (IBI) and their IBI score. Circled reach indicates problem area and site selected for restoration project.

The participants in the summer 2013 portion of the program all had riparian health assessments completed by Cows and Fish. In 5 years, a re-assessment of the project sites will be done.

The program has had numerous participants and funders. The projects range from exclusion fencing to help re-establish vegetative buffer, to creating a variety of alternative water source systems like solar pumps and new dugouts. A total of 9 projects were completed by the end of summer 2014. An overview of the projects completed can be found in the accompanying *Ferry Point Reach Riparian Restoration Program Project Journal* (Stanley & Specht, 2014).

11.0 Conclusion

11.1 Recommendations

In much of the literature, many ways are presented on how to management human actions in regards to riparian areas. They include various forms of mitigation for flood and drought, incentive programs, proactive planned adaptation, and various legislation and policy suggestions. Many of these suggestions should be applied within landscape/watershed-level policies and plans, as well as at the municipal level.

In their report about habitat quantity, Environment Canada (2013) provides recommendations regarding the width of riparian buffers, percent of stream length with natural cover, and the amount of impervious surfaces (urban development) within a watershed. All these impact the health and structure of riparian areas. Though this report focuses on watercourses, similar applications can be made to waterbodies.

Recommendation for an Alberta-wide strategy or policy toward riparian management have been suggested by the Alberta Water Council (2013; Clare and Sass, 2012). In addition, some "alternative" tools for management are presented that use social and economic tools to address the multi-faceted perspective on riparian areas and their management. Work done in the United States surrounding riparian buffers suggests that different protection programs and mechanisms may need to be considered or developed for different land uses and land types (South Carolina, 2000).

As riparian areas appear to be significant habitat for a variety of species, especially the degree to which many Species at Risk use riparian areas, it would be prudent to promote good stewardship of riparian areas in order to protect and enhance the populations of many species (Cows and Fish, 2000). Using habitat or ecosystem level conservation strategies increases effectiveness/efficiency of conservation efforts rather than focusing on individual species (Saab & Rich, 1997).

In the *Approved Water Management Plan for the Battle River Basin* (AESRD, 2014a), it recommends that a riparian areas monitoring and restoration strategy should be developed within two years of the approval of the Water Management Plan for the Battle River Basin. AESRD (2014a) also suggests that the development and application of the riparian areas monitoring and restoration strategy should be done as joint work by the Government of Alberta and the designated Watershed Planning and Advisory Council for the Battle River Basin (currently the Battle River Watershed Alliance). The implementation of the strategy would be a shared responsibility, including all watershed stakeholders. This could incorporate many of the adaptive strategies outlined in the literature and in the report.

The collaborative development of a joint provincial and municipal policy regarding floodplain development is important to help minimize the impact of flooding events. Within this framework, incentives for not developing or penalties for developing in the floodplain/riparian management area could be tools that help reduce the human infrastructure damage, as well as help maintain the ecological infrastructure.

At a site-specific level in the Battle River watershed, Cows and Fish (Spicer-Rawe et al., 2010) developed a series of beneficial management practices for the various riparian components.

Table 9. Suggested beneficial management practices for the Battle River Watershed from Spicer-Rawe et al., 2010, p.24-25.

Riparian Health Component	Beneficial Management Practices
Vegetative Cover of Streambanks, Shorelines and Riparian Area	• Native plant communities require rest from grazing or other disturbances during the growing season to regrow, reduce the amount of bare ground and to out-compete disturbance-caused and invasive plants for nutrients and water • Other human activities such as recreation, transportation and industrial development should be managed to preserve native plant communities
Invasive and Disturbance-caused Plants	• Grazing strategies should consider distribution, timing, and stocking rates that fall within the carrying capacity of pasture units. Proving rest during the growing season, skim grazing and time-controlled grazing management practices can be applied as a means to reduce the potential for invasive and disturbance-caused plants. • Other land-use management plans (eg. industrial, transportation, extraction) should have reclamation plans and sites should be monitored closely until reclamation is complete • Recreational use
Tree & Shrub Establishment and	• Water management strategies should include maintenance of natural flows necessary for healthy riparian ecosystems

Regeneration	• Maintain existing preferred tree and shrub communities (eg. poplars, willows, dogwood) and prevent the increase of browsing-resistant shrub communities (eg. snowberry, rose) • Provide adequate rest from continuous browse pressure to promote regeneration of existing preferred tree and shrub communities and sustain future reproduction and establishment • Attention to grazing management options such as distribution, timing, rotation and stocking rate should maintain and increase preferred trees and shrubs • Other land uses should also strive to maintain native woody plant communities and consider appropriate timing and intensity of use in riparian forests
Streambanks & Shorelines: Root Mass Protection & Physical Alterations	• Livestock management should consider avoiding streambank and floodplain areas when they are saturated • Maintain and/or re-establish natural flow patterns and meander cycles to allow more periodic flooding and sediment deposition on the floodplain where it can begin to restore alterations to the soil • Leaving a buffer between crops and riparian area will help maintain streambank vegetation.
Bare Ground & Physical Alterations to Entire Riparian Area	• Good distribution of livestock throughout riparian areas, effective rest during the growing season and avoiding grazing during vulnerable periods (eg. early spring) to maintain well vegetated and stable riparian areas. Use of off-stream watering systems to improve livestock distribution and limit direct access to stream channel. • Maintain environmental reserves, where present, and refrain from human development and activity within these zones • Cropping practices limit disturbance within ecological riparian boundary and if possible, leave a buffer between crop and riparian area.
Stream Channel Incisement, Stability & Artificial Removal or Addition of Water	• Maintain and increase the amount of vegetation with deep-binding root mass along river and streambanks through the successful regeneration of preferred trees and shrubs, and maintenance of native graminoid communities • Maintain and/or re-establish natural flow patterns and meander cycles • Maintain and restore wetlands within the watershed to trap and store water and reduce impacts from flooding.

Though many of these focus on rural and riverine situations, some can be applied anywhere, and highlight the need to maintain what we have, and manage how humans live on the land.

11.2 Summary

Over the next century, riparian ecosystems will likely play crucial roles in determining the vulnerability and resilience of natural and human systems to climate change, as well as capacity of these systems to adapt. Additionally, riparian ecosystems themselves are likely to become highly vulnerable to climate change and land use impacts. However, given the critical role of riparian ecosystem functions in landscapes, as well as the strong links between riparian ecosystems and human well-being, considerable means, motives and opportunities for strategically planned adaptation to climate change exist. The need for planned adaptation and management of and for riparian ecosystems will be strengthened as the importance of many riparian ecosystem functions, goods and services grows with a changing climate. Consequently, riparian ecosystems are likely to become the focus of significant adaptation worldwide (Postel, 2008; Capon et al., & Williams, 2013).

It is in the best interest of all watershed stakeholders to be proactive in managing the use of and impacts to our riparian areas. Discussion about challenges, mitigation, and adaptation must be undertaken to ensure riparian areas are able to maintain their function and value.

12.0 References

Agriculture and Agri-Food Canada. (2006)a. Beneficial management practices for riparian zones in Atlantic Canada. Charlottetown, Prince Edward Island: Island Nature Trust. Retrieved from http://www.islandnaturetrust.ca/wp-content/uploads/2010/04/Beneficial-Management-Practices-for-Riparian-Zones-in-Atlantic-Canada1.pdf

Agriculture and Agri-Food Canada. (2006)b. Best management practices for riparian zones in Newfoundland and Labrador. Charlottetown, Prince Edward Island: Island Nature Trust. Available at http://www.nr.gov.nl.ca/nr/publications/agrifoods/

Agriculture and Agri-Food Canada. 2010. *Best management practices – featuring Robocow*. Retrieved from http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1185800728980&lang=eng

Alberta Agriculture and Food. (2007). *Remote pasture water systems for livestock*. Retrieved from http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11857/$file/400_716%28c30%29.pdf?OpenElement

Alberta Conservation Association. (2014). *Riparian conservation: A landowner guide*. Available at http://www.ab-conservation.com/go/default/index.cfm/programs/land/riparian-conservation-project/

Alberta Energy Regulator. (2013). *Integrated standard and guidelines – Enhanced Approval Process (EAP)*. Available from http://aep.alberta.ca/forms-maps-services/enhanced-approval-process/eap-manuals-guides/default.aspx

Alberta Environment. (2004). *A guide to the code of practice for pits*. Edmonton, Alberta: Queens Printer. Available at http://aep.alberta.ca/lands-forests/land-industrial/legislation-guidelines.aspx

Alberta Environment. 2005. *Battle River Watershed Atlas*. Alberta Environment, prepared for Nov. 19, 2005 workshop.

Alberta Environment and Sustainable Resource Development. (2012). *Stepping back from the water: A beneficial management practices guide for new development near water bodies in Alberta's settled region*. Calgary, Alberta: Government of Alberta. Available at http://environment.alberta.ca/04100.html

Alberta Environment and Sustainable Resource Development. (2013)a. *Code of practice for pipeline and telecommunications lines crossing a water body*. Edmonton, Alberta: Queens Printer. Available from http://esrd.alberta.ca/water/legislation-guidelines/water-codes-of-practice.aspx

Alberta Environment and Sustainable Resource Development. (2013)b. *Code of practice for watercourse crossings.* Edmonton, Alberta: Queens Printer. Available from http://esrd.alberta.ca/water/legislation-guidelines/water-codes-of-practice.aspx

Alberta Environment and Sustainable Resource Development. (2014)a. *Approved water management plan for the Battle River basin (Alberta)*. Alberta Environment and Sustainable Resource Development Planning Report. Available at http://www.qp.alberta.ca/documents/orders/orders_in_council/2014/714/2014_299.html

Alberta Environment and Sustainable Resource Development. (2014)b. *Watershed resiliency and restoration program*. Government of Alberta. Available at http://esrd.alberta.ca/water/programs-and-services/watershed-resiliency-and-restoration-program.aspx

Alberta Sand & Gravel Association (ASGA). (2015). *Regulation*. Available at http://www.asga.ab.ca/resources-regulation.asp

Alberta Water Council. (2013*). Riparian land conservation and management report and recommendations.* Alberta Water Council: Edmonton, Alberta. Available from http://www.albertawatercouncil.ca/Publications/tabid/59/Default.aspx

Alternative Land Use Services. (n.d.). *Vision*. Retrieved from http://alus.ca/vision/

Ambrose, N., Ehlert, G., & Spicer-Rawe, K. (2009). *Riparian health assessment for lakes, sloughs, and wetlands - Field Workbook Second Edition*. Modified from Fitch, L., B. W. Adams, and G. Hale, 2001. Riparian Health Assessment for Streams and Small Rivers - Field Workbook. Cows and Fish program. Graphcom Printers Ltd: Lethbridge, Alberta. Available from http://www.cowsandfish.org/publications/management.html

AMEC Earth & Environmental (2004*). Instream flow incremental methodology scoping study Battle River basin*. Prepared for Alberta Environment. Calgary, Alberta: Townsend Environmental Consulting

Anderson, A.M. (1999). *Water quality of the Battle River: Technical report*. Alberta Environment Technical Report #W9901. 287 pp. Retrieved from http://environment.gov.ab.ca/info/library/5807.pdf

Atkinson, M. M., & Coleman, W.D. (1992). Policy networks, policy communities and the problems of governance. *Governance* 5(2), 154-180. doi: 10.1111/j.1468-0491.1992.tb00034.x

Battle River Watershed Alliance. (2011). *Our battle: State of the Battle River and Sounding Creek watersheds report 2011*. Camrose Alberta: Battle River Watershed Alliance.

Battle River Watershed Alliance. (2012)a. *Battle River watershed management planning process: Phase two terms of reference February 2012.* Camrose Alberta: Battle River Watershed Alliance.

Battle River Watershed Alliance. (2012)b. *Battle River policy committee terms of reference February 2012*. Camrose Alberta: Battle River Watershed Alliance.

Brown, K.B. (2013). *Urban stream restoration practices: An initial assessment*. Retrieved from http://www.civil.uwaterloo.ca/cive770/papers/restoration_methods/urban_stream_restoration.pdf

Campbell, E., Rowell, P., & Yakimovich, K. (2014). *BirdLife IBA important bird areas Alberta guide 2014.* Nature Alberta. Available at http://naturealberta.ca/wp-content/uploads/2013/02/PDF-of-IBA-Guide-for-electronic-copies.pdf

Camrose County. (2012). *Miquelon Lake area structure plan*. Produced by Scheffer Andrew Ltd. Retrieved from https://camrosecounty.civicweb.net/Documents/DocumentDisplay.aspx?Id=18532

Camrose County, By-law No 1142 Land Use Bylaw. August 26, 2014.

Canadian Broadcasting Corporation(CBC). (2013). *The beaver whisperers.* Retrieved from http://www.cbc.ca/beaverwhisperer/

Capon, S.J., Chambers, L.E., MacNally, R., Naiman, R.J., Davies, P., Marshall, N., Pittock, J., Reid, M., Capon, T., Douglas, M., Catford, J., Baldwin, D.S., Stewardson, M., Roberts, J., Parsons, M., & S.E. Williams. (2013). Riparian ecosystems in the 21st century: Hotspots for climate change adaptation? *Ecosystems* 16(3): 359-381. doi: 10.1007/s10021-013-9656-1

Casson, J.P., Olson, B.M., Little J.L., & Nolan, S.C. (2008). *Assessment of environmental sustainability in Alberta's agricultural watersheds project, volume 4: Nitrogen loss in surface runoff*. Alberta Agriculture and Rural Development, Lethbridge, AB. 71 pp. Available at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr12647

City of Calgary. (2013). *Riparian strategy: Sustaining healthy rivers and communities*. Retrieved from http://www.calgary.ca/UEP/Water/Documents/Water-Documents/Sunnyside_Riparian_Strategy.pdf?noredirect=1

City of Grande Prairie. (2012). *Mapping of environmental reserve (ER) and science based setbacks for ER*. Prepared by O2 Planning + Design. Retrieved from http://www.cityofgp.com/index.aspx?page=1526

Clare, S., & Sass, G. (2012). *Riparian lands in Alberta: Current state, conservation tools, and management approaches*. Edmonton, Alberta: Fiera Biological Consulting Ltd. Available from http://www.albertawatercouncil.ca/LinkClick.aspx?fileticket=8e-3QdH48yU%3D&tabid=150

Coleman, W. D. & Skogstad, G. (Eds.). (1990). *Policy communities and public policy in Canada*. Toronto: Copp Clark Pitman.

Corriveau, J., Chambers, P.A., Yates, A.G., & Culp, J.M. (2011). Snowmelt and its role in the hydrologic and nutrient budgets of prairie streams. *Water Science & Technology* 64.8, 1590-1596. doi: 10.2166/wst.2011.676

Cows and Fish (n.d.). *Ecology & Function*. Accessed April 15, 2014. http://www.cowsandfish.org/riparian/ecology.html

Cows and Fish. (2000). *Riparian areas and endangered species: A summary of the use of riparian habitats by species at risk in Canada* (Report No. 008). Retrieved from http://www.cowsandfish.org/publications/reports.html

Cows and Fish. (2003). *Growing restoration: Natural fixes to fortify streambanks.* http://www.cowsandfish.org/pdfs/growing_restoration_en.pdf

Cows and Fish. (2013). *An overview of beaver management for agricultural producers*. Alberta Riparian Habitat Management Society: Lethbridge, Alberta. http://www.cowsandfish.org/pdfs/Beaver-Matrix-FINAL.pdf

Christiansen D. 1977. *Battle River basin study*. Alberta Environment. Background Information Report #8.

Crooks, K. (2002). Relative sensitivities of mammalian carnivores to habitat fragmentation. *Conservation Biology* 16(2), 488–502.

DeMaere, C. (2005). *A survey to determine forage production of riparian areas in the central parkland natural subregion of Alberta*. Cows and Fish Alberta Riparian Habitat Management Program Report No. 021 Retrieved from http://www.cowsandfish.org/publications/documents/RiparianForageProductionSurvey2003report021.pdf

Department of Fisheries and Oceans. (1993). *Land development guidelines for the Protection of aquatic habitat*. Available at http://www.dfo-mpo.gc.ca/Library/165353.pdf

Dodds, W.K., & Oakes, R.M. (2006). Controls on nutrients across a prairie stream watershed: Land use and riparian cover effects. *Environmental Management* 37(5), 634–646. doi: 10.1007/s00267-004-0072-3

Donat, M. 1995. *Bioengineering techniques for streambank restoration. A review of central European practices*. Province of British Columbia. Ministry of Environment, Lands and Parks, and Ministry of Forests. Watershed Restoration Project Report No. 2:86p. Available at http://www.for.gov.bc.ca/hfd/library/ffip/Donat_M1995.pdf

Environment Canada. (2013). How much habitat is enough? 3rd ed. Environment Canada, Toronto, Ontario. Available at http://ec.gc.ca/Publications/default.asp?lang=En&xml=1B5F659B-B931-4F37-A988-3DD73DF656B7

Felipe-Lucia, M. R., Comín, F.A., & Bennett, E.M. (2014). Interactions among ecosystem services across land uses in a floodplain agroecosystem. *Ecology and Society* 19(1): 20. doi: 10.5751/ES-06249-190120

Fisheries Act, Revised Statutes of Canada (1985, c. F-14). Retrieved from the Justice Laws website: http://laws-lois.justice.gc.ca/eng/acts/f-14/

Fisheries and Oceans Canada. (2013). *Fisheries Protection Policy Statement*. Available at http://www.dfo-mpo.gc.ca/pnw-ppe/pol/index-eng.html

Fitch, L., & Adams, B.W. (1998). Can cows and fish co-exist*? Canadian Journal of Plant Science*, 78(2), 191-198. doi: 10.4141/P97-141

Fitch, L., Adams, B.W., & Hale, G. (2009). *Riparian health assessment for streams and small rivers - field workbook, 2nd Ed*. Lethbridge, Alberta: Cows and Fish Program. 94 pages. Retrieved from http://www.cowsandfish.org/publications/assessment.html

Fitch, L., Adams, B., & O'Shaughnessy, K. (2003). *Caring for the green zone: Riparian areas and grazing management – Third Edition*. Cows and Fish. Graphcom Printers Ltd.: Lethbridge, AB. Available from http://www.cowsandfish.org/publications/management.html

Fitch, L., & Ambrose, N. (2003). *Riparian areas: A user's guide to health*. Cows and Fish. Graphcom Printers Ltd.: Lethbridge, Alberta. Available from http://www.cowsandfish.org/publications/management.html

Government of Alberta. (2003). *Water for Life: Alberta's Strategy for Sustainability*. Government of Alberta. (Publication No. 1/955). Edmonton, Alberta: Alberta Environment. Retrieved from http://www.waterforlife.alberta.ca/01548.html

Government of Alberta. (2011). *Recommended land use guidelines for protection of selected wildlife species and habitat within grassland and parkland natural regions of Alberta*. Available at http://esrd.alberta.ca/fish-wildlife/wildlife-land-use-guidelines/default.aspx

Government of Alberta. (2013). *Alberta Wetland Policy*. Available at http://www.waterforlife.alberta.ca/01533.html

Government of British Columbia. (2006). *Riparian areas regulation implementation guidebook.* Ministry of Water Land and Air Protection. Available from http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/riparian_areas.html

Greater Wellington Regional Council. (2008). *Mind the stream: A guide to looking after streams in the Wellington region.* Greater Wellington Regional Council Land Management. Retrieved from http://www.gw.govt.nz/assets/council-publications/Mind%20the%20stream%20booklet%20Full.pdf

Haag, J., Logan, M., & White, J. (2010). *Developer's guide to the riparian setback matrix model for the Municipal District of Foothills #31*. Prepared for the Municipal District of Foothills. Edmonton, Alberta: *Aquality* Environmental Consulting Ltd. Available from http://www.mdfoothills.com/residents/planning/environment/riparian_setbacks.html

Hannon, S.J., Paszkowski, C.A., Boutin, S., DeGroot, J., Macdonald, S.E., Wheatley, M., & Eaton, B.R. (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. doi: 10.1139/X02-092

Hood, G.A. and S.E. Bayley. (2008). Beaver (*Castor canadensis*) mitigate the effects of climate on the area of open water in boreal wetlands in western Canada. *Biological Conservation* 141, 556-567.

Important Bird Areas Canada. (2015). Information at your fingertips. Available at http://www.ibacanada.ca

Jennings, M.D., and J.P. Reganold. (1991). A theoretical basis for managing environmentally sensitive areas. *Environmental Conservation* 18, 211-218. doi:10.1017/S0376892900022128

Kay, P., Edwards, A.C., & Foulger, M. (2009). A review of the efficacy of contemporary agricultural stewardship measures for ameliorating water pollution problems of key concern to the UK water industry. *Agricultural Systems*, 99(2), 67-75. doi: 10.1016/j.agsy.2008.10.006

Kline, J.D., Alig, R.J., & Johnson, R.L. (2000). Forest owner incentives to protect riparian habitat. *Ecological Economics* 33, 29–43.

Ko, J., & Donahue, W.F. (2012). *Maintaining healthy aquatic ecosystems: Operational and Policy Recommendations for Instream Flow Needs*. Canmore, Alberta: Water Matters Society of Alberta. Retrieved from http://www.water-matters.org/pub/470

Lac La Biche County. (2012). Lac La Biche County land use bylaw no. 12-024. Retrieved from http://www.laclabichecounty.com/files/labiche/bylaw_12_024_land_use_bylaw_no_maps.pdf

Lacombe County. (2012). *June 2012 - Riparian Areas*. Retrieved from http://www.lacombecounty.com/index.php/faq/623-june-2012-riparian-areas

Lee, K.N. (1993). *Compass and gyroscope: Integrating science and politics for the environment*. Washington, DC: Island Press.

Lovell, S.T., & Sullivan, W.C. (2006). Environmental benefits of conservation buffers in the United States: Evidence, promise, and open questions. *Agriculture, Ecosystems and Environment*, *112*, 249-260. doi: 10.1016/j.agee.2005.08.002

Mills, B., & Scrimgeour, G. (2004). *The effectiveness of aerial videography to characterize lakeshore condition.* Data Report (D-2005-017). Edmonton, Alberta: Alberta Conservation Association. Available from http://www.ab-conservation.com/go/default/custom/uploads/reportseries2/Efctiv-Aerial-Videogrphy-Chrctrize-LS-Cond.pdf

Mitchell, B. (1997). *Resource and environmental management.* Waterloo, ON.: Longman Press.

Nature Alberta. (2015). *Living by water*. http://naturealberta.ca/programs/living-by-water/

North Saskatchewan Watershed Alliance (NSWA). (2015). Riparian health assessment of Wabamun Lake: An aerial assessment using an unmanned air vehicle (UAV). Prepared for the Wabamun Watershed Management Council, Edmonton, AB. Available from https://www.nswa.ab.ca/content/riparian-health-assessment-wabamun-lake

Olson, B.M., Kalischuk, A.R. (eds.). (2011). *Nutrient beneficial management practices evaluation project 2007 to 2012: 2010 progress report*. Alberta Agriculture and Rural Development, Lethbridge, AB. 370 pp. Available at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw11955

Ontario Highway Traffic Act, 2015, O. Reg. 135/15 Operation of off-road vehicles on highways. Available from http://www.ontario.ca/laws/regulation/030316#BK35

Ontario Ministry of Natural Resources (2011). *Lakes and rivers improvement act administrative guide*. Retrieved from http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@water/documents/document/stdprod_088408.pdf

Paterson, B.A., Olson, B.M., & Bennett, D.R. (2006). *Alberta soil phosphorus limits project, Volume 1: Summary and recommendations*. Alberta Agriculture, Food and Rural Development, Lethbridge, AB. 82 pp. Available at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag11864

Polster, D.F. (2002). *Soil bioengineering techniques for riparian restoration.* In: Proceeding of the 26th Annual British Columbia Mine Reclamation Symposium, Dawson Creek, September 2002. Retrieved from http://www.creditvalleyca.ca/wp-content/uploads/2011/02/2002-polster.pdf

Postel, S.L. (2008). The forgotten infrastructure: Safeguarding freshwater ecosystems. *Journal of International Affairs* 61, 75-90. Retrieved from http://www.glerl.noaa.gov/seagrant/ClimateChangeWhiteboard/Resources/Uncertainty/Mac1/postel08.pdf

Rocky View County. (2009). *Interim background report for riparian land conservation and management policy*. Retrieved from http://www.aref.ab.ca/resourcelibrary/documents/Riparian%20Interim%20Background%20Report.pdf

Rocky View County. (2014). *Riparian setbacks policy*. Available at http://www.rockyview.ca/BuildingPlanning/PlansUnderReview/RiparianSetbacksPolicy.aspx

Saab, V.A. & Rich, T.D. (1997). Large-scale conservation assessment for neotropical migratory land birds in the Interior Columbia River Basin. U.S. Department of Agriculture Forest Service, Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-399.

Sauchyn, D., Diaz, H., & Kulshreshtha, S. (2010). Conclusion. In D. Sauchyn, H. Diaz, & S. Kulshreshtha (Eds.), *The new normal: The Canadian Prairies in a changing climate* (pp. 353-361). Regina, Saskatchewan: Canadian Plains Research Center.

Scrimgeour, G.J., & Wicklum, D. (1996). Aquatic ecosystem health and integrity: Problems and potential solutions. *Journal of the North American Benthological Society*, 15(2), 254-261.

Simonson, J. (2010). *Using aerial videography to assess riparian areas in southern Alberta*. Edmonton, Alberta: Alberta Environment. Retrieved from http://www.environment.gov.ab.ca/info/library/8273.pdf

Skogstad, G. (2005). *Policy networks and policy communities: Conceptual evolution and governing realities*. University of Toronto, Toronto, Ontario. Prepared for the Workshop on "Canada's Contribution to Comparative Theorizing" Annual Meeting of the Canadian Political Science Association University of Western Ontario, London, Ontario. Retrieved from http://www.cpsa-acsp.ca/papers-2005/Skogstad.pdf

South Carolina. (2000). *Final report of the statewide task force on riparian forest buffers*. Columbia, S.C.: Center for Environmental Policy, Institute of Public Affairs, University of South Carolina. Retrieved from http://media.clemson.edu/public/restoration/carolina%20clear/toolbox/sctaskforcebuffersreport.pdf

Spicer-Rawe, K. (2005). *Riparian health inventory report Camrose Creek & Mirror Lake project area.* Red Deer, Alberta: Cows and Fish – Alberta Riparian Habitat Management Society.

Spicer-Rawe, K., O'Shaughnessy, K., & Bach, N. (2010). *Battle River watershed riparian areas and health summary*. Red Deer, Alberta: Cows and Fish – Alberta Riparian Habitat Management Society.

Staicer, C. (2005). *The role of riparian buffers in forest bird conservation* (Report No. RES04-09). Report for the Nova Forest Alliance. Available at http://novascotia.ca/natr/wildlife/habfund/projects-2005.asp

Stanley, N., & Specht, E. (2014). *Ferry Point reach riparian restoration program project journal*. Battle River Watershed Alliance. Available from

Stevens, C., & Council, T. (2008). *A fish-based index of biological integrity for assessing river condition in central Alberta*. Technical Report T-2008-001. Produced by the Alberta Conservation Association, Sherwood Park and Lethbridge, Alberta, Canada. 29 pp.

Stewart, A., Reedyk, S., Franz, B., Fromradas, K., Hilliard, C., & Hall, S. (2010). *Field manual on buffer design for the Canadian prairies*. Agri-Environment Services Branch, Agriculture and Agrifood Canada. Available from http://publications.gc.ca/site/eng/387724/publication.html

Stewart, A., Reedyk, S., Franz, B., Fromradas, K., Hilliard, C., & Hall, S. (2011). A planning tool for design and location of vegetative buffers on watercourses in the Canadian prairies. *Journal of Soil and Waters Conservation* 66(4). 97A-103A. doi:10.2489/jswc.66.4.97A

Stranberg, R. (2005). *Technical Report: Print media survey of the eastern Canadian droughts of 2001 and 2002.* Ottawa, Ontario: Adaptation and Impacts Research Division (AIRD) Environment Canada. Retrieved from http://www.src.sk.ca/images/Technical%20Report%20-%20Print%20Media%20Survey%20Eastern%20Canada.pdf

Teichreb C., & Walker, G. (2008). *Aerial videographic health and integrity assessment of the riparian management area for selected reaches of the Battle River.* Alberta Environment Technical Report. Available from http://www.battleriverwatershed.ca/publications

Thomson, D., & Pepperdine, S. (2003). *Assessing community capacity for riparian restoration*. Canberra, Australia: Land & Water Australia. Available from http://lwa.gov.au/products/pn30385

Victoria Department of Natural Resources and Environment. (2002). *Healthy rivers healthy communities & regional growth: Victorian river health strategy*. McLaren Press: Melbourne, Australia. http://www.water.vic.gov.au/__data/assets/pdf_file/0007/9862/Victorian-River-Health-Strategy-2002un.pdf

United States Environmental Protection Agency. (2005). *National management measures to protect and restore wetlands and riparian areas for the abatement of nonpoint source pollution*. Washington, DC: U.S. EPA. Retrieved from http://water.epa.gov/polwaste/nps/wetmeasures/#10

White, J., & Gray, M. (2007). *The riparian setback matrix model*. Prepared for Lakeland County. Edmonton, Alberta: *Aquality* Environmental Consulting Ltd.

Appendix A

Aerial Videography Riparian Management Area Health and Integrity Assessment Scorecard (from Teichreb & Walker, 2008**)**

Modified by Walker Environmental to include consideration for naturally occurring areas that do not allow plant growth in questions 1 and 3 and removal of question 8.

This scorecard follows the general health and integrity approach described in Scrimgeour and Wicklum (1996). The scorecard, applied to low altitude (< 200 ft.) aerial videography, delivers a rapid, **"coarse filter"** assessment of riparian management area **health and ecological function** on individual polygons that can be summarized to describe the health and integrity of the entire lake. This information can be used to direct conservation and management activities at those human actions negatively impacting the health or integrity in the riparian management area.

Assessment Questions and Scoring.

1. 85% or more of the polygon area is covered with vegetation of any kind? (Polygon area does not include area covered by water).

Yes____ (2 points) **No_____** (0 points) Nat_____(1 point)

2. Cattails and bulrushes are visibly growing in the littoral zone adjacent to the polygon area? (Identifying immature bulrush and cattail stands may be difficult. On some lakes these species do not grow because of site and/or climate conditions. It is important you know this prior to deciding if their absence is natural or human caused).

Dense to Medium ____ (1 point), **Medium to Sparse ____** (0.5 points), **None ____** (0 points)

3. Woody plants like willow, birch or poplar cover 15% or more of the polygon area? (In some cases riparian areas do not have the potential for woody plants because of soil chemistry and other factors, i.e., saline and drainage. In some cases woody plants do not meet this threshold because of site and successional reasons).

Yes____ (1 point) **No_____** (0 points) Nat_____ (.5 point)

4. Within the 15% woody zone, what is the abundance of woody plants? (If the answer to Question 3 is no, this question receives 0 points)

Dense to Medium ____(1 point) or **Sparse to Medium ____** (0.5 points)

5. 35% or more of the polygon shows visual signs of human caused removal or alteration of vegetation? (e.g., includes conversion of native vegetation to lawn grass, mowing, grazing, cutting of woody vegetation, etc.).

Yes____ (0 points) **No**_____ (2 points)

6. 35% or more of the polygon shows visual signs of human caused physical alteration? (e.g., addition or removal of sand or rock, harrowing beaches, retaining walls, boat houses, decks, patios, walking or ATV trails, cattle activity, etc.)

Yes____ (0 points) **No**_____ (3 points)

7. What picture does most of the polygon look like?

Picture A? ___ (1 point) **Combination of A and B?**___ (0.5 points) **Picture B?**___ (0 points)

Total possible points = 11 .

Actual points (sum from questions above) = _____.

<u>Summary of Question Scores</u>

If the score is **8.0 or more** it is likely the Riparian Management Area is **healthy**.

If the score is **6.0 to 8.0** it is likely the Riparian Management Area is **moderately impaired**.

If the score is **6 or less** it is likely the Riparian Management Area is **highly impaired**.

Additional aerial videography scoring method was developed through then Alberta Environment (Simonson, 2010) by combining methods from Cows and Fish and Alberta Conservation Association.

Appendix B

Riparian health inventory and assessment (survey) methodology utilized by Cows and Fish for lotic systems (from Spicer-Rawe et al., 2010).

This description of riparian health parameters is based on the Alberta Lotic Wetland Health (Survey) User Manual as created by Ecological Solutions Group LLC (2009).

Some factors on the evaluation will not apply on all sites. For example, sites without potential for woody species are not rated on factors concerning trees and shrubs. Vegetative site potential can be determined by using a key to site type (e.g., Thompson and Hansen 2001, 2002, 2003, or another appropriate publication). On severely disturbed sites, vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position.

Most of the factors rated in this evaluation are based on ocular estimations. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories are broad, evaluators do need to calibrate their eye with practice. It is important to remember that a health rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as in the collective experience of an array of riparian scientists, range professionals, and land managers.

The evaluator must keep in mind that this assessment form is designed to account for most sites and conditions in the applicable region. However, rarely will all the questions seem exactly to fit the circumstances on a given site. Therefore, try to answer each question with a literal reading. If necessary, explain anomalies in the comment section. Each factor below will be rated according to conditions observed on the site. The evaluator will estimate the scoring category and enter that value on the score sheet. The riparian health score for streams and small rivers (survey) is based on 11 basic parameters pertaining to riparian health

1. Vegetative Cover of Floodplain and Streambanks. Vegetation cover helps to stabilize banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation (Platts and others 1987). On most streams the area of the channel bottom is excluded from the polygon. (***Note:*** *The whole channel width extends from right bankfull stage to left bankfull stage; however we need to include the lower banks in all polygons, therefore consider for exclusion ONLY the relatively flat and lowest area of the channel—the "bottom."*) This allows data to be collected on the riparian area while excluding the aquatic zone, or open water, of the stream. The aquatic zone is the area covered by water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of perennial wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails), *Scirpus* species (bulrushes), *Carex* species, and other perennial graminoids.

In many systems, large portions of the channel bottom may become exposed due to seasonal irrigation use, hydroelectric generation, and natural seasonal changes such as are found in many prairie ecosystems. In these cases, especially the prairie streams, the channel bottom may have varying amounts of herbaceous vegetation, and the channel area is ***included*** in the polygon as area to be inventoried. Typically these are the “pooled channel” stream type that has scour pools scattered along the length, interspersed with reaches of grass, bulrush, or sedge-covered channel bottom. If over half (>50%) the channel bottom area has a canopy cover of persistent vegetation cover (perennial species), taken over the entire length of the polygon as a whole, then it qualifies for inclusion within the inventoried polygon area. If then you are in doubt whether to include the channel bottom in the polygon, then leave it out, but be sure to indicate this in the comment section. This is important so that future assessments of the polygon will be looking at the same area of land.

The evaluator is to estimate the fraction of the polygon covered by plant growth. Vegetation cover is ocularly estimated using the canopy cover method (Daubenmire 1959).

Scoring:
6 = More than 95% of the polygon area is covered by live plant growth.
4 = 85% to 95% of the polygon area is covered by live plant growth.
2 = 75% to 85% of the polygon area is covered by live plant growth.
0 = Less than 75% of the polygon area is covered by live plant growth.

2. Invasive Plant Species (Weeds). Invasive plants (weeds) are alien species whose introduction does or is likely to cause economic or environmental harm. Whether the disturbance that allowed their establishment is natural or human-caused, weed presence indicates a degrading ecosystem. While some of these species may contribute to some riparian functions, their negative impacts reduce overall site health. This item assesses the degree and extent to which the site is infested by invasive plants. The severity of the problem is a function of the density/distribution (pattern of occurrence), as well as canopy cover (abundance) of the weeds. In determining the health score, all invasive species are considered collectively, not individually. A weed list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). Space is provided on the form for recording weed species counted. Include both woody and herbaceous invasive species. ***Leave no listed species field blank, however;*** enter “0” to indicate absence of a value. (A blank field means the observer forgot to collect the data; a value means the observer looked.)

The site's health rating on this item combines two factors: weed density/distribution class and total canopy cover. A perfect score of 6 out of 6 points can only be achieved if the site is weed free. A score of 4 out of the 6 points means the weed problem is just beginning (i.e., very few weeds and small total canopy cover [less than 1%]). A moderate weed problem gets 2 out of 6 points. It has a moderately dense weed plant distribution (a class between 4 and 7) and moderate total weed canopy cover (between 1% and 15%). A site scores 0 points if the density/distribution is in class 8 or higher, or if the total weed canopy cover is 15% or more.

2a. Total Canopy Cover of Invasive Plant Species (Weeds). The evaluator must evaluate the total percentage of the polygon area that is covered by the combined canopy of all plants of all species of invasive plants. Determine which rating applies in the scoring scale below.

Scoring:
3 = No invasive plant species (weeds) on the site.
2 = Invasive plants present with total canopy cover less than 1% of the polygon area.
1 = Invasive plants present with total canopy cover between 1% and 15% of the polygon area.
0 = Invasive plants present with total canopy cover more than 15% of the polygon area.

2b. Density/Distribution Pattern of Invasive Plant Species (Weeds). The observer must pick a category of pattern and extent of invasive plant distribution from the chart below (Figure 3) that best fits what is observed on the polygon, while realizing that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches the view of the polygon.

Scoring:
3 = No invasive plant species (weeds) on the site.
2 = Invasive plants present with density/distribution in categories 1, 2, or 3.
1 = Invasive plants present with density/distribution in categories 4, 5, 6, or 7.
0 = Invasive plants present with density/distribution in categories 8, or higher.

CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several sporadically occurring plants	
7	A few patches	
8	A few patches plus several sporadically occurring plants	
9	Several well spaced patches	
10	Continuous uniform occurrence of well spaced plants	
11	Continuous occurrence of plants with a few gaps in the distribution	
12	Continuous dense occurrence of plants	
13	Continuous occurrence of plants associated with a wetter or drier zone within the polygon.	

Figure B 1. Weed density distribution class guidelines

NOTE: Prior to the 2001 season, the health score for weed infestation was assessed from a single numerical value that does not represent weed canopy cover, but instead represents the fraction of the polygon area on which weeds had a well established population of individuals (i.e., the area infested).

3. Disturbance-Increaser Undesirable Herbaceous Species. A large cover of disturbance-increaser undesirable herbaceous species, native or exotic, indicates displacement from the potential natural community (PNC) and a reduction in riparian health. These species generally are less productive, have shallow roots, and poorly perform most riparian functions. They usually result from some disturbance, which removes more desirable species. Invasive species considered in the previous item are not reconsidered here. As in the previous item, the evaluator should state the list of species considered. A partial list of undesirable herbaceous species appropriate for use in Alberta follows. A list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2001]). The evaluator should list any additional species included.

Antennaria spp. (pussy-toes) *Hordeum jubatum* (foxtail barley) *Potentilla anserina* (silverweed)

Brassicaceae (mustards) *Plantago* spp. (plantains) *Taraxacum* spp. (dandelion)
Bromus inermis (awnless brome) *Poa pratensis* (Kentucky bluegrass) *Trifolium* spp. (clovers)
Fragaria spp. (strawberries) ________________________________
____

Scoring:
3 = Less than 5% of the site covered by disturbance-increaser undesirable herbaceous species.
2 = 5% to 25% of the site covered by disturbance-increaser undesirable herbaceous species.
1 = 25% to 50% of the site covered by disturbance-increaser undesirable herbaceous species.
0 = More than 50% of the site covered by disturbance-increaser undesirable herbaceous species.

4. Preferred Tree and Shrub Establishment and/or Regeneration. (*Skip this item if the site lacks potential for trees or shrubs; for example, the site is a herbaceous wet meadow or marsh.*) Not all riparian areas can support trees and/or shrubs. However, on those sites where such species do belong, they play important roles. The root systems of woody species are excellent bank stabilizers, while their spreading canopies provide protection to soil, water, wildlife, and livestock. Young age classes of woody species are important for the continued presence of woody communities not only at a given point in time but into the future. Woody species potential can be determined by using a key to site type (Thompson and Hansen 2001, 2002, 2003, etc.). On severely disturbed sites, the evaluator should seek clues to potential by observing nearby sites with similar landscape position. *(**Note:*** Vegetation potential is commonly underestimated on sites with a long history of disturbance.)

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus catharticus* [European/common buckthorn], and *Tamarix* species [salt cedar]) are excluded from the evaluation of establishment and regeneration. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-intense grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus catharticus* [European/common buckthorn], and *Tamarix* species [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. ***FOR EXAMPLE:*** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

For shrubs in general, seedlings and saplings can be distinguished from mature plants as follows. For those species having a mature height generally over 1.8 m (6.0 ft.), seedlings and saplings are those individuals less than 1.8 m (6.0 ft.) tall. For species normally not exceeding 1.8 m (6.0 ft.), seedlings and saplings are those individuals less than 0.45 m (1.5 ft.) tall or which lack reproductive structures and the relative stature to suggest maturity. (***Note:*** Evaluators should take care not to confuse short stature resulting from intense browsing with that due to young plants.)

Scoring: *(If the site has no potential for trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA. If the evaluator is not fairly certain potential exists for preferred trees or shrubs, then enter NC and explain in the comment field below.)*
6 = More than 15% of the total canopy cover of preferred trees/shrubs is seedlings and/or saplings.
4 = 5% to 15% of the total canopy cover of preferred trees/shrubs is seedlings and/or saplings.
2 = Less than 5% of the total canopy cover of preferred tree/shrubs is seedlings and/or saplings.
0 = Preferred tree/shrub seedlings and saplings absent.

5a. Browse Utilization of Available Preferred Trees and Shrubs. (*Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh, or all woody plants have already been removed.*) Livestock and/or wildlife browse many riparian woody species. Excessive browsing can eliminate these important plants from the community and result in their replacement by undesirable invaders. With excessive browsing, the plant loses vigour, is prevented from flowering, or is killed. Utilization in small amounts is normal and not a health concern, but concern increases with greater browse intensity.

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus catharticus* [European/common buckthorn], and *Tamarix* species [salt cedar]) are excluded from the evaluation of utilization. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-intense grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus catharticus* [European/common buckthorn], and *Tamarix* species [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. ***FOR EXAMPLE:*** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

Consider as available all tree and shrub plants to which animals may gain access and that they can reach. For tree species, this means mostly just seedling and sapling age classes. When estimating degree of utilization, count browsed second year and older leaders on representative plants of woody species normally browsed by ungulates. Do not count current year's use, because this would not accurately reflect actual use when more browsing can occur later in the season. Browsing of second year or older material affects the overall health of the plant and continual high use will affect the ability of the plant to maintain itself on the site. Determine percentage by comparing the number of leaders browsed or utilized with the total number of leaders available (those within animal reach) on a representative sample (at least three plants) of each tree and shrub species present. Do not count utilization on dead plants, unless it is clear that death resulted from over-grazing. ***Note:*** If a shrub is entirely mushroom/umbrella shaped by long term intense browse or rubbing, count utilization of it as heavy.

Scoring: (*Consider all shrubs within animal reach and seedlings and saplings of tree species. If the site has no woody vegetation [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.*)
3 = None (0% to 5% of available second year and older leaders of preferred species are browsed).
2 = Light (5% to 25% of available second year and older leaders of preferred species are browsed).

1 = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed).
0 = Heavy (More than 50% of available second year and older leaders of preferred species are browsed).

5b. Live Woody Vegetation Removal by Other Than Browsing. Excessive cutting or removing parts of plants or whole plants by agents other than browsing animals (e.g., human clearing, cutting, beaver activity, etc.) can result in many of the same negative effects to the community that are caused by excessive browsing. However, other effects from this kind of removal are direct and immediate, including reduction of physical community structure and wildlife habitat values. ***Do not include natural phenomena such as natural fire, insect infestation, etc. in this evaluation.***

Removal of woody vegetation may occur at once (a logging operation), or it may be cumulative over time (annual firewood cutting or beaver activity). This question is not so much to assess long term incremental harvest, as it is to assess the extent that the stand is lacking vegetation that would otherwise be there today. Give credit for re-growth. Consider how much the removal of a tree many years ago may have now been mitigated with young replacements.

Four non-native species or genera are excluded from consideration here because these are aggressive, invasive exotic plants that should be removed. They are *Elaeagnus angustifolia* (Russian olive), *Rhamnus cathartica* (common buckthorn), *Caragana arborescens* (common caragana), and *Tamarix* species (salt cedar).

Determine the extent to which woody vegetation (trees and shrubs) is lacking due to being physically removed (i.e., cut, mowed, trimmed, logged, cut by beaver, or otherwise removed from their growing position). The timeframe is less important than the ecological effect. Time to recover from this kind of damage can vary widely with site characteristics. The objective is to measure the extent of any damage remaining ***today*** to the vegetation structure resulting from woody removal. We expect that the woody community will recover over time (re-grow), just as an eroding bank will heal with re-growing plant roots.
This question simply asks "How much woody material is still missing from what should be here?" The amount of time since removal doesn't really matter, if re-growth has been allowed to progress. If 20 years after logging, the site has a stand of sapling spruce trees, then it should get partial re-growth credit, but not full credit, since the trees still lack much of their potential habitat and ecological value. (***NOTE:*** In general, the more recent the removal, the more entirely it should be fully counted; and conversely, the older the removal, the more likely it will have been mitigated by re-growth.)

This question is really looking at volume (three dimensions) and not canopy cover (two dimensions). For example, if an old growth spruce tree is removed, a number of new seedlings/saplings may become established and could soon achieve the same canopy cover as the old tree had. However, the value of the old tree to wildlife and overall habitat values is far greater than that of the seedling/saplings. It will take a very long time before the seedlings/saplings can grow to replace all the lost habitat values that were provided by the tall old tree. On the other hand, shrubs, such as willows, grow faster and may replace the volume of removed plants in a much shorter time. Answer this question by estimating the percent of woody material that is missing from the site due to having been removed by human action. Select a range category from the choices given that best represents the percent of missing woody material.

Scoring: (*If the site has no trees or shrubs **AND** no cut plants or stumps of any trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.*)
3 = None (0% to 5% of live woody vegetation expected on the site is lacking due to cutting).
2 = Light (5% to 25% of live woody vegetation expected on the site is lacking due to cutting).
1 = Moderate (25% to 50% of live woody vegetation expected on the site is lacking due to cutting).
0 = Heavy (More than 50% of live woody vegetation expected on the site is lacking due to cutting).

6. Standing Decadent and Dead Woody Material. (*Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh.*) The amount of decadent and dead woody material on a site can be an indicator of the overall health of a riparian area. Large amounts of decadent and dead woody material may indicate a reduced flow of water through the stream (de-watering) due to either human or natural causes. De-watering of a site, if severe enough, may change the site vegetation potential from riparian species to upland species. In addition, decadent and dead woody material may indicate severe stress from over browsing. Finally, large amounts of decadent and dead woody material may indicate climatic impacts, disease and insect damage. For instance, severe winters may cause extreme die back of trees and shrubs, and cyclic insect infestations may kill individuals in a stand. In all these cases, a high percentage of dead and decadent woody material reflects degraded vegetative health, which can lead to reduced streambank integrity, channel incisement, and excessive lateral cutting, besides reducing production and other wildlife values.

The most common usage of the term ***decadent*** may be for over mature trees past their prime and which may be dying, but we use the term in a broader sense. We count decadent plants, both trees and shrubs, as those with 30% or more dead wood in the upper canopy. In this item, scores are based on the percentage of total woody canopy cover which is decadent or dead, not on how much of the total polygon canopy cover consists of dead and decadent woody material. Only decadent and dead standing material is included, not that which is lying on the ground. The observer is to ignore (not count) decadence in poplars or cottonwoods which are decadent ***due to old age*** (rough and furrowed bark extends substantially up into the crowns of the trees) (species: *Populus deltoides* [plains cottonwood], *P. angustifolia* [narrow-leaf cottonwood], and *P. balsamifera* [balsam poplar]), because cottonwoods/poplars are early seral species and naturally die off in the absence of disturbance to yield the site to later seral species. The observer is to consider (count) decadence in these species if apparently caused by de-watering, browse stress, climatic influences, or parasitic infestation (insects/disease). The observer should comment on conflicting or confounding indicators, and/or if the cause of decadence is simply unknown (*but not due to old age*).

Scoring: (*If site lacks potential for woody species, replace both Actual and Potential Scores with NA.*)
3 = Less than 5% of the total canopy cover of woody species is decadent and/or dead.
2 = 5% to 25% of the total canopy cover of woody species is decadent and/or dead.
1 = 25% to 50% of the total canopy cover of woody species is decadent and/or dead.
0 = More than 50% of the total canopy cover of woody species is decadent and/or dead.

7. Streambank Root Mass Protection. Vegetation along streambanks performs the primary physical functions of stabilizing the soil with a binding root mass and of filtering sediments from overland flow. Few studies have documented depth and extent of root systems of plant species found in wetlands. Despite this lack of documented evidence, some generalizations can be made. All tree and shrub species are considered to have deep, binding root masses. Among wetland herbaceous species, the first rule is that annual plants lack deep, binding roots. Perennial species offer a wide range of root mass qualities.
Some rhizomatous species such as the deep rooted *Carex* species (sedges) are excellent bank stabilizers. Others, such as *Poa pratensis* (Kentucky bluegrass), have only shallow roots and are poor bank stabilizers. Still others, such as *Juncus balticus* (wire rush), are intermediate in their ability to stabilize banks. The size and nature of the stream will determine which herbaceous species can be effective. The evaluator should try to determine if the types of root systems present in the polygon are in fact contributing to the stability of the streambanks.

In situations where you are assessing a high, cut bank (usually on an outside bend), the top may be upland, but the bottom is riparian. Do not assess the area that is non-riparian. In cases of tall, nearly vertical cut banks, assess the bottom portion that comes in contact with floodwaters. Omit from consideration those areas where the bank is comprised of bedrock, since these neither provide binding root mass, nor erode at a perceptible rate.

Note: Rip-rap does not substitute for, act as, or preclude the need for deep, binding root mass.

Since the kind and amount of deep, binding roots needed to anchor a bank is dependent on size of the stream, use the following table as a general guide to determine width of a band along the banks to assess for deep, binding roots. This is a “rule of thumb” for guidance that requires only estimated measurements.

Stream Size (Bankfull Channel Width)	Width of Band to Assess for Deep, Binding Roots
Rivers (Larger Than 30 m [>100 ft.])	15 m (50 ft.)
Large Streams (Approx. 5-30 m [16-100 ft.])	5 m (16 ft.)
Small Streams (Up To Approx. 5 m [16 ft.])	2 m (6 ft.)

Scoring:
6 = More than 85% of the streambank has a deep, binding root mass.
4 = 65% to 85% of the streambank has a deep, binding root mass.
2 = 35% to 65% of the streambank has a deep, binding root mass.
0 = Less than 35% of the streambank has a deep, binding root mass.

8. Human-Caused Bare Ground. Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 6 cm (2.5 in). Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground—these do not erode nor allow weeds sites to invade. Bare ground caused by human activity indicates a deterioration of riparian health. Sediment deposits and other natural bare ground are excluded as normal or probably beyond immediate management control. Human land uses causing bare ground include livestock grazing, recreation, roads, and industrial activities. The evaluator should consider the causes of all bare ground observed and estimate the fraction that is human-caused.

Stream channels that go dry during the growing season can create problems for polygon delineation. Some stream channels remain unvegetated after the water is gone. On most streams the area of the channel bottom is excluded from the polygon. (***Note:*** *The whole channel width extends from right bankfull stage to left bankfull stage; however we need to include the lower banks in all polygons, therefore consider for exclusion ONLY the relatively flat and lowest area of the channel—the “bottom.”*) This allows data to be collected on the riparian area while excluding the aquatic zone, or open water, of the stream. The aquatic zone is the area covered by water and lacking persistent emergent vegetation. Persistent emergent vegetation consists of perennial wetland species that normally remain standing at least until the beginning of next growing season, e.g., *Typha* species (cattails), *Scirpus* species (bulrushes), *Carex* species, and other perennial graminoids.

In many systems, large portions of the channel bottom may become exposed due to seasonal irrigation use, hydroelectric generation, and natural seasonal changes such as are found in many prairie ecosystems. In these cases, especially the prairie streams, the channel bottom may have varying amounts of herbaceous vegetation, and the channel area is ***included*** in the polygon as area to be inventoried. Typically, these are the "pooled channel" stream type that has scour pools scattered along the length, interspersed with reaches of grass, bulrush, or sedge-covered channel bottom. If over half (>50%) the channel bottom area has a canopy cover of persistent vegetation cover (perennial species), taken over the entire length of the polygon as a whole, then it qualifies for inclusion within the inventoried polygon area. If you are in doubt whether to include the channel bottom in the polygon, then leave it out, but be sure to indicate this in the comment section. This is important so that future assessments of the polygon will be looking at the same area of land.

Scoring:
6 = Less than 1% of the polygon is human-caused bare ground.
4 = 1% to 5% of the polygon is human-caused bare ground.
2 = 5% to 15% of the polygon is human-caused bare ground.
0 = More than 15% of the polygon is human-caused bare ground.

9. Streambank Structurally Altered by Human Activity. Altered streambanks are those having impaired structural integrity (strength or stability) usually due to human causes. These banks are more susceptible to cracking and/or slumping. Count as streambank alteration such damage as livestock or wildlife hoof shear and concentrated trampling, vehicle or ATV tracks, and any other areas of human-caused disruption of bank integrity, including rip-rap or use of fill. The basic criterion is any disturbance to bank structure that increases erosion potential or bank profile shape change. One large exception is lateral bank cutting caused by stream flow, even if thought to result from upstream human manipulation of the flow. The intent of this item is to assess only direct, on-site mechanical or structural damage to the banks. Each bank is considered separately, so total bank length for this item is approximately twice the reach length of stream channel in the polygon (more if the stream is braided). ***NOTE:*** Constructed streambanks (especially those with rip-rap) may be stabilized at the immediate location, but are likely to disrupt normal flow dynamics and cause erosion of banks downstream. The width of the bank to be considered is proportional to stream size. The table below gives a conceptual guideline for how wide a band along the bank to assess.

Stream Size (Bankfull Channel Width)	Width of Band to Assess for Bank Alteration
Rivers (Larger Than 30 m [>100 ft.])	4 m (13 ft.)
Large Streams (Approx. 5-30 m [16-100 ft.])	2 m (6 ft.)
Small Streams (Up To Approx. 5 m [16 ft.])	1 m (3 ft.)

Scoring:
6 = Less than 5% of the bank is structurally altered by human activity.
4 = 5% to 15% of the bank is structurally altered by human activity.
2 = 15% to 35% of the bank is structurally altered by human activity.
0 = More than 35% of the bank is structurally altered by human activity.

10. Human Physical Alteration to the Rest of the Polygon. Within the remainder of the polygon area, outside the stream bank area that was addressed in the previous question, estimate the amount of area that has been physically altered by human causes. The purpose of this question is to evaluate physical change to the soil, hydrology, etc. as it affects the ability of the natural system to function normally. Changes in soil structure will alter infiltration of water, increase soil compaction, and change the amount of sediment contributed to the water body. Every human activity in or around a natural site can alter that site. This question seeks to assess the accumulated effects of all human-caused change. Count such things as:

- **Soil Compaction.** This kind of alteration includes livestock-caused hummocking and pugging, recreational trails that obviously have compacted the soil, vehicle and machine tracks and ruts in soft soil, etc.
- **Plowing/Tilling.** This is disruption of the soil surface for cultivation purposes. It does not include the alteration of drainage or topographic pattern, which are included in the **Topographic Change** category.
- **Hydrologic Change.** Include in this category any area that is physically affected by removal or addition of water for human purpose. The physical effects to look for are erosion due to reduced or increased water, bared soil surface that had water cover removed, or flooded area that normally supports a drier vegetation type.
- **Human Impervious Surface.** This includes roofs, hardened surfaces like walkways and roads, boat launches, etc.
- **Topographic Change.** This is the deliberate alteration of terrain and/or drainage pattern for human purposes. It may be for aesthetic (landscaping) or other reasons, including such structures as water diversions ditches and canals.

Scoring:
3 = Less than 5% of the polygon is altered by human causes.
2 = 5% to 15% of the polygon is altered by human causes.
1 = 15% to 25% of the polygon is altered by human causes.
0 = More than 25% of the polygon is altered by human causes.

11. Stream Channel Incisement (Vertical Stability). An incised stream channel has experienced vertical downcutting of its bed. Incisement can lower the water table enough to change vegetation site potential. It can also increase stream energy by reducing sinuosity, reduce water retention/storage, and increase erosion. A stream becomes critically incised when downcutting lowers the channel bed so that the two-year flood event cannot overflow the banks. Some typical downcutting indicators are:

a) Headcuts;
b) Exposed cultural features (pipelines, bridge footings, culverts, etc.);
c) Lack of sediment deposits;
d) Exposed bedrock; and
e) A low, vertical scarp at the bank toe on the inside of a channel bend.

A severe disturbance can initiate downcutting, transforming the system from one having a high water table, appropriate floodplain, and high productivity to one of degraded water table, narrow (or no) active floodplain, and low productivity.

These stages of incisement can be categorized in terms of Schumm's stages of incised channel evolution
(Schumm and others 1984). The following indicators, taken together, collectively will enable the observer to assess severity of channel incisement:

Channel bed downcutting**—**Look for headcuts, lack of bed load sediment and exposed bedrock, a low vertical scarp at tow of bank along straight reaches and inside curves, hanging culverts and exposed cultural features.

Limited access to floodplain by flood flows of 1 to 3 year frequency**—**Look for a lack of sediment deposits and debris deposits on lower floodplain elevations.

Widening of the incised channel**—**Look for lateral cutting and sloughing of the high banks. This is one of the early steps in the healing process on a severely incised channel. Initially, the downward bed erosion forms a narrow, deep channel that often resembles a gully. Flood waters in such a channel normally cannot deposit, but can only erode and transport, sediment; therefore the narrow incisement must be widened to provide lateral space for a new floodplain to form. This lateral cutting also supplies the sediment that may be deposited at the bottom to begin the formation of a new floodplain.

New floodplain formation within the incised channel**—**Look for small depositional bars and low, flat areas near the channel. These will increase in width and length, as the healing process proceeds. Look especially for perennial vegetation becoming established on these depositional features, as it is the vegetation that secures the newly gained floodplain increments. The relative width of the active floodplain (the lowest level, the one that is most frequently flooded) determines to what extent an incisement has healed. Remember that floodplain width is inversely proportional to stream gradient, so that higher gradient (B stream type) channels typically have narrow floodplains (typically less than one bankfull channel width), and C and E stream type have wide to very wide floodplains (typically greater than one bankfull channel width).

A top rating is given to un-incised channels from which the normal 1-2 year high flow can access a well formed floodplain. These can be meandering meadow streams (E stream type) and wide valley bottom streams (C stream type) which access floodplains much wider than the stream channel, or they may be mountain and foothill streams in V-shaped valleys which have narrow floodplains limited by topography or bedrock. These latter types are usually armoured (well-rocked) systems with highly stable beds and streambanks that are not susceptible to downcutting (typically mountain and foothill streams of A and B stream types). The lowest rating goes to entrenched channels (F or G stream types) where even medium high flows which occur at 5-10 year intervals cannot over-top the high banks. Intermediate stages may be either improving or degrading, and may reflect slightly incised channels that are not yet downcut so badly that some flood stages still cannot access the floodplain, or they may be old incisements that are now healing and rebuilding a new floodplain in the bottom of the ravine.

Because a channel can be incised in any of several stages, the observer is to examine the channel in the polygon for indicators of the degree of channel bed grade stability and stage of incisement, as illustrated in Figure 4. Figure 4 adapts the Schumm channel evolution model to show a generalized schematic of stages through which a channel progresses from destabilization and downcutting to healing and reestablishment of a new floodplain. Actual sites will often have characteristics that are difficult to match with the generalized drawings in Figure 4. However, make a "best fit" call for category of incisement based on available evidence. If the indicators are confusing and inconclusive, choose the higher (less incised) indicated category. Explain your call in the comment field, and be sure to provide photo documentation of evidence on severely incised channels.

The following table defines incisement severity categories in terms of Schumm's model of channel evolution stages, as adapted by Rosgen (2006). Note that with destabilizing disturbance and subsequent change to remove disturbance, a channel may progress through predictable stages of incisement and healing, returning again ultimately to a functional, stable system.

Health Assessment Scoring	Incisement Class	Schumm's Channel Evolution Stages	Rosgen Types Included	Description of Incisment Situation
9	None	A	A, B, C, E	Channel is vertically stable and not incised; 1-2 year high flows can begin to access a floodplain appropriate to stream type. Active downcutting is not evident. Any old incisement is characterized by a broad floodplain in which perennial riparian vegetation well established. This category includes a variety of stream types in all land forms and substrates. The floodplain may be narrow or wide, depending on the

				type of stream, but the key factor is vertical stability. The system may have once incised, and later become healed and is now stable again, with a new floodplain appropriate to its stream type. In this case, the erosion of the old gully side walls will have ceased, and stabilized. A mature, or nearly mature, vegetation community will occupy much of the new valley bottom.
6	Slight	B/D	C, F, G	This category contains both degrading and healing stages. In either case, the extent of incisement is minimal. In Stage B, the channel is just beginning to degrade, and a 2 year flood event may still access some floodplain, partially or in spots. Downcutting is likely progressing. In Stage D, the system is healing. Downcutting should have ceased at this stage. A new floodplain should be well established with perennial vegetation, although it may not be as wide as the stream type needs. This is indicated by ongoing lateral erosion of high side walls of the original incisement, as the system continues to widen itself at its new grade level.
3	Moderate	B/D	C, F, G	This category also contains both degrading and healing stages. In both cases, the extent of incisement is significant. In Stage B, the channel has downcut to a level that floods of the 1-5 year magnitude cannot reach a floodplain. Downcutting is likely still progressing, but the channel may already look like a gully. In Stage D, the system has only just begun to

				heal. A small floodplain along the new curves in the gully is forming, and perennial vegetation is starting to colonize new sediment features. The high side walls of the gully are actively eroding as the system widens, and much of the fallen materials is being incorporated along the bottom.
0	Severe	C	F, G	The worst case category, where there is no floodplain in the bottom of a deep entrenchment, and small-to-moderate floods cannot reach the original floodplain level. Downcutting may still be in progress. High side wall banks may have begun to collapse and erode into the bottom, but high flows typically just wash this material directly through the system, with none of it being trapped to build new floodplain. At this stage, the system has lost practically all of its riparian function and habitat value.

Appendix C

Riparian health inventory and assessment (survey) methodology utilized by Cows and Fish for lentic systems (from Spicer-Rawe et al., 2010).

This description of riparian health parameters is based on the Alberta Lentic Wetland Health (Survey) User Manual as created by Ecological Solutions Group LLC. (2009).

Some factors on the evaluation will not apply on all sites. For example, sites without potential for woody species are not rated on factors concerning trees and shrubs. Vegetative site potential can be determined by using a key to site type (e.g., Thompson and Hansen 2001, 2002, 2003, or another appropriate publication). On severely disturbed sites, vegetation potential can be difficult to determine. On such sites, clues to potential may be sought on nearby sites with similar landscape position.

Most of the factors rated in this evaluation are based on ocular estimations. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories are broad, evaluators do need to calibrate their eye with practice. It is important to remember that a health rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation are somewhat subjective and are not grounded in quantitative science so much as in the collective experience of an array of riparian scientists, range professionals, and land managers.

Each factor below will be rated according to conditions observed on the site. The evaluator will estimate the scoring category and enter that value on the score sheet.

1. Vegetative Cover of the Polygon. Around lentic water bodies vegetation cover helps to stabilize shorelines, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, reduce the rate of evaporation (Platts and others 1987), and contributes primary production to the ecosystem. This question focuses on how much of the entire polygon area is covered by standing plant growth. Item 8 below assesses the amount of human-caused bare ground. Although there is some overlap between these two items, the bare ground to be counted in item 8 is strictly limited in definition, whereas all unvegetated area not inundated by water is counted in this item. The only area within the polygon exempt from consideration here is area covered by water, including water between emergent plants such as cattails and bulrushes. Areas such as boat docks, hardened pathways, and artificial structures are counted as unvegetated along with any bare ground, downed wood, and other plant litter. The rationale is that all such unvegetated areas contribute nothing to several of the important lentic wetland functions.

The evaluator is to estimate the fraction of the polygon covered by plant growth. Vegetation cover is ocularly estimated using the canopy cover method (Daubenmire 1959).

Scoring:
6 = More than 95% of the polygon area is covered by live plant growth.
4 = 85% to 95% of the polygon area is covered by live plant growth.
2 = 75% to 85% of the polygon area is covered by live plant growth.
0 = Less than 75% of the polygon area is covered by live plant growth.

2. Invasive Plant Species (Weeds). Invasive plants (weeds) are alien species whose introduction does or is likely to cause economic or environmental harm. Whether the disturbance that allowed their establishment is natural or human-caused, weed presence indicates a degrading ecosystem. While some of these species may contribute to some riparian functions, their negative impacts reduce overall site health. This item assesses the degree and extent to which the site is infested by invasive plants. The severity of the problem is a function of the density/distribution (pattern of occurrence), as well as canopy cover (abundance) of the weeds. In determining the health score, all invasive species are considered collectively, not individually.

A weed list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). Some common invasive species are listed on the form, and space is allowed for recording others. Include both woody and herbaceous invasive species. ***Leave no listed species field blank, however;*** enter "0" to indicate absence of a value. (A blank field means the observer forgot to collect the data; a value means the observer looked.)

The site's health rating on this item combines two factors: weed density/distribution class and total canopy cover. A perfect score of 6 out of 6 points can only be achieved if the site is weed free. A score of 4 out of the 6 points means the weed problem is just beginning (i.e., very few weeds and small total canopy cover [less than 1%]). A moderate weed problem gets 2 out of 6 points. It has a moderately dense weed plant distribution (a class between 4 and 7) and moderate total weed canopy cover (between 1% and 15%). A site scores 0 points if the density/distribution is in class 8 or higher, or if the total weed canopy cover is 15% or more.

2a. Total Canopy Cover of Invasive Plant Species (Weeds). The observer must evaluate the total percentage of the polygon area that is covered by the combined canopy of all plants of all species of invasive plants. Determine which rating applies in the scoring scale below.

Scoring:
3 = No invasive plant species (weeds) on the site.
2 = Invasive plants present with total canopy cover less than 1% of the polygon area.
1 = Invasive plants present with total canopy cover between 1 and 15% of the polygon area.

0 = Invasive plants present with total canopy cover more than 15% of the polygon area.

2b. Density/Distribution Pattern of Invasive Plant Species (Weeds). The observer must pick a category of pattern and extent of invasive plant distribution from the chart below (Figure 2) that best fits what is observed on the polygon, while realizing that the real situation may be only roughly approximated at best by any of these diagrams. Choose the category that most closely matches the view of the polygon.

Scoring:
3 = No invasive plant species (weeds) on the site.
2 = Invasive plants present with density/distribution in categories 1, 2, or 3.
1 = Invasive plants present with density/distribution in categories 4, 5, 6, or 7.
0 = Invasive plants present with density/distribution in categories 8, or higher.

CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several sporadically occurring plants	
7	A few patches	
8	A few patches plus several sporadically occurring plants	
9	Several well spaced patches	
10	Continuous uniform occurrence of well spaced plants	
11	Continuous occurrence of plants with a few gaps in the distribution	
12	Continuous dense occurrence of plants	
13	Continuous occurrence of plants associated with a wetter or drier zone within the polygon.	

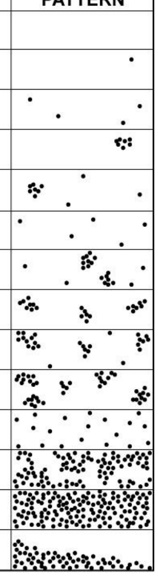

Figure C 1. Weed density distribution class guidelines

NOTE: Prior to the 2001 season, the health score for weed infestation was assessed from a single numerical value that does not represent weed canopy cover, but instead represents the fraction of the polygon area on which weeds had a well-established population of individuals (i.e., the area infested).

3. Disturbance-Increaser Undesirable Herbaceous Species. A large cover of disturbance-increaser undesirable herbaceous species, native or exotic, indicates displacement from the potential natural community (PNC) and a reduction in riparian health. These species generally are less productive, have shallow roots, and poorly perform most riparian functions. They usually result from some disturbance that removes more desirable species. Invasive species considered in the previous item are not reconsidered here. As in the previous item, the evaluator should state the list of species considered. A partial list of undesirable herbaceous species appropriate for use in Alberta follows. A list should be used that is standard for the locality and that indicates which species are being considered (i.e., *Invasive Weed and Disturbance-caused Undesirable Plant List* [Cows and Fish 2002]). The evaluator should list any additional species included.

Antennaria spp. (pussy-toes) *Hordeum jubatum* (foxtail barley) *Potentilla anserina* (silverweed)
Brassicaceae (mustards) *Plantago* spp. (plantains) *Taraxacum* spp. (dandelion)
Bromus inermis (awnless brome) Poa *pratensis* (Kentucky bluegrass) *Trifolium* spp. (clovers)
Fragaria spp. (strawberries) ____
____

Scoring:
3 = Less than 5% of the site covered by disturbance-increaser undesirable herbaceous species.
2 = 5% to 25% of the site covered by disturbance-increaser undesirable herbaceous species.
1 = 25% to 50% of the site covered by disturbance-increaser undesirable herbaceous species.
0 = More than 50% of the site covered by disturbance-increaser undesirable herbaceous species.

4. Preferred Tree and Shrub Establishment and/or Regeneration. (Skip this item if the site lacks potential for trees or shrubs; for example, the site is a herbaceous wet meadow or marsh.) Not all riparian areas can support trees and/or shrubs. However, on those sites where such species do belong, they play important roles. The root systems of woody species are excellent bank stabilizers, while their spreading canopies provide protection to soil, water, wildlife, and livestock. Young age classes of woody species are important for the continued presence of woody communities not only at a given point in time but into the future. Woody species potential can be determined by using a key to site type (Thompson and Hansen 2001, 2002, 2003). On severely disturbed sites, the evaluator should seek clues to potential by observing nearby sites with similar landscape position. (***Note:*** Vegetation potential is commonly underestimated on sites with a long history of disturbance.)

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus catharticus* [European/common buckthorn], and *Tamarix* species [salt cedar]) are excluded from the evaluation of utilization. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-intense grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus catharticus* [European/common buckthorn], and *Tamarix* species [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is that they are far more abundant on many sites than are species of greater concern (i.e., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. ***FOR EXAMPLE:*** A polygon may have *Symphoricarpos occidentalis* (buckbrush/ snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

For shrubs in general, seedlings and saplings can be distinguished from mature plants as follows. For those species having a mature height generally over 1.8 m (6.0 ft.), seedlings and saplings are those individuals less than 1.8 m (6.0 ft.) tall. For species normally not exceeding 1.8 m (6.0 ft.), seedlings and saplings are those individuals less than 0.45 m (1.5 ft.) tall or which lack reproductive structures and the relative stature to suggest maturity. (***Note:*** Evaluators should take care not to confuse short stature resulting from intense browsing with that due to young plants.)

Scoring: (*If the site has no potential for trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA. If the observer is not fairly certain potential exists for preferred trees or shrubs, then enter NC and explain in the comment field below.*)
6 = More than 15% of the total canopy cover of preferred trees/shrubs is seedlings and/or saplings.
4 = 5% to 15% of the total canopy cover of preferred trees/shrubs is seedlings and/or saplings.
2 = Less than 5% of the total canopy cover of preferred tree/shrubs is seedlings and/or saplings.
0 = Preferred tree/shrub seedlings and saplings absent.

5a. Browse Utilization of Available Preferred Trees and Shrubs. (*Skip this item if the site lacks trees or shrubs; for example, the site is a herbaceous wet meadow or cattail marsh, or all woody plants have already been removed.*) Livestock and/or wildlife browse many riparian woody species. Excessive browsing can eliminate these important plants from the community and result in their replacement by undesirable invaders. With excessive browsing, the plant loses vigour, is prevented from flowering, or is killed. Utilization in small amounts is normal and not a health concern, but concern increases with greater browse intensity.

Nine shrub genera or species (e.g., *Elaeagnus angustifolia* [Russian olive], *Symphoricarpos* species [buckbrush/snowberry], *Rosa* species [rose], *Crataegus* species [hawthorn], *Elaeagnus commutata* [silverberry/wolf willow], *Potentilla fruticosa* [shrubby cinquefoil], *Caragana* species [caragana], *Rhamnus catharticus* [European/common buckthorn], and *Tamarix* species [salt cedar]) are excluded from the evaluation of utilization. These are species that may reflect long-term disturbance on a site, that are generally less palatable to browsers, and that tend to increase under long-term moderate-to-intense grazing pressure; ***AND*** for which there is rarely any problem in maintaining presence on site. *Elaeagnus angustifolia* (Russian olive), *Caragana* species (caragana), *Rhamnus catharticus* [European/common buckthorn], and *Tamarix* species [salt cedar] are considered especially aggressive, undesirable exotic plants.

The main reason for excluding these plants is they are far more abundant on many sites than are species of greater concern (e.g., *Salix* species [willows], *Cornus stolonifera* [red-osier dogwood], *Amelanchier alnifolia* [Saskatoon serviceberry], and many other taller native riparian species), and they may mask the ecological significance of a small amount of a species of greater concern. ***FOR EXAMPLE:*** A polygon may have *Symphoricarpos occidentalis* (buckbrush/snowberry) with 30% canopy cover showing young plants for replacement of older ones, while also having a trace of *Salix exigua* (sandbar willow) present, but represented only by older mature individuals. We feel that the failure of the willow to regenerate (even though there is only a small amount) is very important in the health evaluation, but by including the buckbrush/snowberry and willow together on this polygon, the condition of the willow would be hidden (overwhelmed by the larger amount of buckbrush/snowberry).

Consider as available all tree and shrub plants to which animals may gain access and that they can reach. For tree species, this means mostly just seedling and sapling age classes. When estimating degree of utilization, count browsed second year and older leaders on representative plants of woody species normally browsed by ungulates. Do not count current year's use, because this would not accurately reflect actual use when more browsing can occur later in the season. Browsing of second year or older material affects the overall health of the plant and continual high use will affect the ability of the plant to maintain itself on the site. Determine percentage by comparing the number of leaders browsed or utilized with the total number of leaders available (those within animal reach) on a representative sample (at least three plants) of each tree and shrub species present. Do not count utilization on dead plants, unless it is clear that death resulted from over-grazing. ***Note:*** If a shrub is entirely mushroom/umbrella shaped by long term intense browse or rubbing, count utilization of it as heavy.

Scoring: (*Consider all shrubs within animal reach and seedlings and saplings of tree species. If the site has no woody vegetation [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.*)
3 = None (0% to 5% of available second year and older leaders of preferred species are browsed).
2 = Light (5% to 25% of available second year and older leaders of preferred species are browsed).
1 = Moderate (25% to 50% of available second year and older leaders of preferred species are browsed).
0 = Heavy (More than 50% of available second year and older leaders of preferred species are browsed).

5b. Live Woody Vegetation Removal by Other Than Browsing. Excessive cutting or removing parts of plants or whole plants by agents other than browsing animals (e.g., human clearing, cutting, beaver activity, etc.) can result in many of the same negative effects to the community that are caused by excessive browsing. However, other effects from this kind of removal are direct and immediate, including reduction of physical community structure and wildlife habitat values. ***Do not include natural phenomena such as natural fire, insect infestation, etc. in this evaluation.***

Removal of woody vegetation may occur at once (a logging operation), or it may be cumulative over time (annual firewood cutting or beaver activity). This question is not so much to assess long term incremental harvest, as it is to assess the extent that the stand is lacking vegetation that would otherwise be there today. Give credit for re-growth. Consider how much the removal of a tree many years ago may have now been mitigated with young replacements.

Four non-native species or genera are excluded from consideration here because these are aggressive, invasive exotic plants that should be removed. They are *Elaeagnus angustifolia* (Russian olive), *Rhamnus cathartica* (common buckthorn), *Caragana arborescens* (common caragana), and *Tamarix* species (salt cedar).

Determine the extent to which woody vegetation (trees and shrubs) is lacking due to being physically removed (i.e., cut, mowed, trimmed, logged, cut by beaver, or otherwise removed from their growing position). The timeframe is less important than the ecological effect. Time to recover from this kind of damage can vary widely with site characteristics. The objective is to measure the extent of any damage remaining ***today*** to the vegetation structure resulting from woody removal. We expect that the woody community will recover over time (re-grow), just as an eroding bank will heal with re-growing plant roots.
This question simply asks "How much woody material is still missing from what should be here?" The amount of time since removal doesn't really matter, if re-growth has been allowed to progress. If 20 years after logging, the site has a stand of sapling spruce trees, then it should get partial re-growth credit, but not full credit, since the trees still lack

much of their potential habitat and ecological value. (***NOTE:*** In general, the more recent the removal, the more entirely it should be fully counted; and conversely, the older the removal, the more likely it will have been mitigated by re-growth.)

This question is really looking at volume (three dimensions) and not canopy cover (two dimensions). For example, if an old growth spruce tree is removed, a number of new seedlings/saplings may become established and could soon achieve the same canopy cover as the old tree had. However, the value of the old tree to wildlife and overall habitat values is far greater than that of the seedling/saplings. It will take a very long time before the seedlings/saplings can grow to replace all the lost habitat values that were provided by the tall old tree. On the other hand, shrubs, such as willows, grow faster and may replace the volume of removed plants in a much shorter time. Answer this question by estimating the percent of woody material that is missing from the site due to having been removed by human action. Select a range category from the choices given that best represents the percent of missing woody material.

Scoring: (*If the site has no trees or shrubs* ***AND*** *no cut plants or stumps of any trees or shrubs [except for the species listed above to be excluded], replace both Actual Score and Possible Score with NA.*)
3 = None (0% to 5% of live woody vegetation expected on the site is lacking due to cutting).
2 = Light (5% to 25% of live woody vegetation expected on the site is lacking due to cutting).
1 = Moderate (25% to 50% of live woody vegetation expected on the site is lacking due to cutting).
0 = Heavy (More than 50% of live woody vegetation expected on the site is lacking due to cutting).

6. Human Alteration of Polygon Vegetation Community Composition. Human alteration of the vegetation is meant to include all changes to the plant community composition or structure on the polygon from human causes (e.g., logging, mining, roads, construction, or development) or by agents of human management (e.g., livestock). ***It is not meant to include transitory or short-term removal of plant material that does not alter long term plant community composition*** (i.e., grazing at carefully managed levels or wood cutting that does not change long term species composition of the community). Also include impacts caused by extreme concentrations of managed wildlife, rationale being that wildlife concentrations great enough to cause significant site damage are usually the result of human management choices. Beaver activities that alter vegetative communities will not be included in this question, but are included in the utilization question.

Of concern are the kinds of change that diminish or disrupt the natural wetland function of the vegetation. These include, but are not limited to, conversion of natural communities to lawns or hayfields (but not the actual mowing), changing plant community composition (e.g., causing replacement of willows with rose and buckbrush, woody species with herbaceous species, etc.), replacing native plants with tame plants, replacing deep rooted plants with shallow rooted plants, and/or replacing tall species with short species. In a case where the vegetation community is altered, due to removal of woody cover that allows conversion to a long term cover of a different kind of vegetation (i.e., cottonwoods/poplars are cut, and the site changes to a *Poa pratensis* [Kentucky bluegrass] cover), then the polygon gets a low score for both woody vegetation removal and for alteration of the vegetation community.

On polygons adjacent to water, remember that the polygon extends out to where the water is two metres deep. (***NOTE:*** Do not count the same area twice by including it as both a vegetative and a physical alteration, unless there clearly are both kinds of alteration. Decide into which category a particular effect should go. For example: A timber harvest may clear vegetation, but not necessarily cause physical damage on one area; while on another area it may cause both clearing of vegetation and disruption of the soil by heavy equipment.)

Scoring:
6 = Less than 5% of polygon vegetation community composition is altered by human activity.
4 = 5% to 15% of polygon vegetation community composition is altered by human activity.
2 = 15% to 35% of polygon vegetation community composition is altered by human activity.
0 = 35% or more of polygon vegetation community composition is altered by human activity.

7. Human Alteration of Polygon Physical Site. The purpose of this question is to assess physical change to the soil, bank/ shore integrity, hydrology, etc. as it affects the ability of the natural system to function normally. Changes in shore and bank contour and any change in soil structure will alter infiltration of water, increase soil compaction, and cause increased sediment contribution to the water body. Every human activity in or around a natural site can alter that site. This question seeks to assess the accumulated effects of all human-caused change.

Include all changes to the physical attributes of the site caused by human actions (e.g., logging, mining, housing development) or by agents of human management (e.g., livestock) and also any effects from concentrated wildlife use (Rationale being that wildlife concentrations great enough to cause significant site damage are usually the result of human management activities.) The kinds of physical change that diminish or disrupt the natural wetland functions on the site include, but are not limited to, hummocking, pugging, animal trails (livestock or wildlife), human roads, trails, buildings, landscaping, boat launches/docks, beach clearing and building, or rip-rapping of shores and banks. (***NOTE:*** *Do not count the same area twice by including it as both a* *vegetative and a physical alteration, unless there clearly are both kinds of alteration. Decide into which category a particular effect should go.* For example: A cottage owner may clear vegetation to gain a view of the lake without causing physical damage to one area; whereas, if he/she hauls in sand to enhance the beach, there may also be physical alteration of the same site.) This item is scored in two parts:

7a. Estimate the percentage of the polygon that is altered by human activities.

Scoring:
12 = Less than 5% of the polygon is physically altered by human activity.
8 = 5% to 15% of the polygon is physically altered by human activity.
4 = 15% to 35% of the polygon is physically altered by human activity.
0 = More than 35% of the polygon is physically altered by human activity.

7b. Estimate the severity of the alteration, *without regard to the portion of the polygon it might occupy.* Full score is given only to polygons with no physical alteration by human activity. Four categories of alteration severity are described here in terms of change to the site vegetation and hydrologic function. (***Note:*** *This call uses vegetation change to indicate degree of alteration, but the alteration must be physical in nature, not just vegetative change alone; e.g., disruption of soil, hydrology, topography, etc.*) Document the severity of alteration with photos and commentary.
Categories of severity are described below using conceptual guidelines. These guidelines are not comprehensive, but are intended as a relative scale by which the observer can judge his/her site. Every case is different, and there is no absolute measuring stick to apply. Use the following comparative descriptions to choose a category of alteration on your site:

- ***None***—No human-caused physical alteration observed on the polygon.
- ***Slight***—Physical site integrity is near natural. Human-caused alteration (including recovery from any past severe alterations) is apparent, but reflects minimal impact to plant communities and hydrological function in the altered areas (e.g., the plant community is little changed from that on nearby sites lacking physical alteration; any pugging and hummocking or other disruption of the soil profile is relatively shallow and is well vegetated with appropriate species).
- ***Moderate***—As compared with nearby unaltered sites, human-caused physical alteration on the polygon (including recovery from any past severe alterations) has noticeably altered the physical site integrity to the point that plant communities and hydrological function on the altered areas show visible impact. The plant community differs noticeably (by having introduced or missing components) from nearby sites that are on similar landscape position and that lack physical alterations. Pugging and hummocking or other disruption of the soil profile is moderate in depth and height of hummocks. Such alteration is either becoming re-vegetated with appropriate species, or is well covered with a mix of less desirable and appropriate species.

- ***Severe***—Human-caused physical site alteration on the polygon has compromised the physical integrity of the altered areas (even if only a small area is altered). Old alterations have not recovered and are still affecting the vegetation or hydrological functions (e.g., the plant community differs radically from nearby sites in similar position that lack physical alterations, reflecting altered hydrologic and/or soil conditions). Pugging and hummocking or other disruption of the soil profile is severe in depth of disturbance and/or height of hummocking. Alterations remain mostly bare of plant cover, or are becoming vegetated with invasive or undesirable species.

Scoring:
3 = ***No physical alterations*** to the site by human activity.
2 = Human alterations to the physical site are ***slight*** in effect.
1 = Human alterations to the physical site are ***moderate*** in effect.
0 = Human alterations to the physical site are ***severe*** in effect.

8. Human-Caused Bare Ground. Bare ground is exposed soil surface (not covered by plants, litter or duff, down wood, or rocks larger than 6 cm [2.5 in]). Hardened, impervious surfaces (e.g., asphalt, concrete, etc.) are not bare ground—these do not erode nor allow weeds sites to invade. Bare ground may result naturally from several processes (i.e., sedimentation, flood erosion, fire, tree fall, and exposure of lakebed by low water level), but that caused by human activity always indicates an impairment of wetland health. Exposed soil is vulnerable to erosion and is where weeds become established. Bare soil is not producing, nor providing habitat. Sediment deposits and other natural bare ground are excluded as normal and probably beyond management control. Human land uses often causing bare ground include livestock grazing, recreation, off road vehicle use, and resource extraction activities. After considering the causes of all bare ground on the site, the evaluator must estimate what percent of the site (polygon) area is human-caused bare ground.

Scoring:
6 = Less than 1% of the polygon is human-caused bare ground.
4 = 1% to 5% of the polygon is human-caused bare ground.
2 = 5% to 15% of the polygon is human-caused bare ground.
0 = 15% or more of the polygon is human-caused bare ground.

9. Degree of Artificial Withdrawal or Raising of Water Level. Although water levels naturally fluctuate on a seasonal basis in most systems, many wetland systems are affected by human-caused (artificial) additions or withdrawals. This artificial change of water level rarely follow a temporal regime that maintains healthy native wetland plant communities. The result is often a barren band of shore exposed or inundated for much of each growing season. This causes shore material to destabilize, and often provides sites for weeds to invade. Such conditions are extremely detrimental to healthy riparian function.

Not all lentic wetlands evaluated with this form will have surface water potential, but any wetland may have its water table degraded by draining, pumping, or diverting its surface or subsurface supply. On such lentic wetlands as marshes and wet meadows, look for evidence of drainage ditching, pumping, and the interruption of normal surface drainage inputs by livestock watering dugouts, cross slope ditches, or dams upslope.

In this item the evaluator is asked to categorize the degree to which the system is subjected to artificially rapid or unnaturally timed fluctuations in water level. Reservoirs intended for storage of water for power generation, irrigation, and/or livestock watering typically exhibit the most severe effects, but water may be diverted or pumped from natural systems for many other reasons (domestic use, industrial use, livestock watering, etc.). This item requires the evaluator to make a subjective call by choosing as a "best fit" one of the categories of drawdown severity described below. (***Note:*** Be careful to consider the scale of the water body as it relates to the scale of change. Pumping a small dugout full of water for livestock might severely impact a 0.8 ha (2 ac) slough, but be negligible to a lake covering a section of land.) Be sure to document the grounds for your estimate here. If there is no way to know with any reasonable degree of certainty how much water is being added or removed, it may be better to describe the situation and to "zero out" this item (not answer it). During periods of drought lakebeds become exposed, and often exhibit wide zones of almost barren shore. ***The evaluator must be careful not to attribute this natural phenomenon unfairly to a human activity.***

Severity Categories of Lentic Water Level Manipulation

Not Subjected The water body, or wetland, is not subjected to artificial water level change (e.g., drawdown, addition, stabilization, etc.).
This category may include very small amounts of change that cause no detectible fluctuation in water level.
Minor The water body or wetland is subject to no more than minor artificial water level change. The shore area remains vegetated, and withdrawal of water is limited or slow enough that vegetation is able to maintain growth and prevent soil exposure. A relatively narrow band affected by the water level fluctuation may support only annual plants.
Moderate The water body or wetland is subject to moderate quantities, speed and/or frequency of artificial water level change. Where water is removed, it is done in a way that allows pioneer plants to vegetate at least half of the exposed area resulting from drawdown. Where water is added, some flooding may occur at levels or times not typical to the area/season.
Extreme The water body or wetland is subjected to extreme changes in water level due to volume (extent), speed and/or frequency of artificial water addition or removal. Frequent or unnatural levels of flooding occur where water is added, including extensive

flooding into riparian and/or upland areas; or no natural annual drawdown is allowed to occur. In extreme artificial drawdown situations, a wide band of exposed bottom remains unvegetated.

Scoring:
9 = The water body, or wetland, is ***not subjected*** to artificial water level change.
6 = The degree of artificial water level change is ***minor.***
3 = The degree of artificial water level change is ***moderate.***
0 = The degree of artificial water level change is ***extreme.***

Appendix D

How to Use the Riparian Setback Matrix (from Haag, Logan, & White, 2010)

The amount of Environmental Reserve (ER) will be determined by using the Riparian Setback Matrix Model. Environmental Reserve will be determined at several sites along the water's edge. The area dedicated as ER will vary across the site. Some areas will require more ER and others will require less. The dedicated ER will vary throughout the parcel of land depending on slope of the land, height of any banks present, groundwater influence, soil type and vegetative cover.

The amount of property bordering the water's edge will also affect how Environmental Reserve is determined. To start using the Riparian Setback Matrix, setback points will need to be established. The number of points used to determine Environmental Reserve will vary based on area.

1. Establish the number and location of setback points required.

1.1. Whereas the location of the point will be:

1.1.1. At the point where vegetation (living or dead) characteristic of an aquatic environment changes to that of upland vegetation. This vegetation includes but is not limited to; Sedges, Bulrushes, Cattails and Willows.

1.1.2. If no vegetation exists, the setback point will be determined from the current edge of water.

1.1.3. Whereas the length of land bordering the water body, stream or wetland is:

1.1.3.1. **Greater than 200 meters** – The outside setback point will be no more than 100 meters from the property line along the water body, stream or wetland. The subsequent setback points will be equally spaced no more than 200 meters apart.

1.1.3.2. **200 meters to 50 meters** – Two (2) setback points will be required equal distance apart and equal distance from each property line.

1.1.3.3. **Less than 50 meters** – One (1) setback point will be required at the discretion of the Municipal District of Foothills. Please contact MD Foothills administration to determine the location of this setback point.

2. **Slope of the land** must be determined by a legal land surveyor at each of the setback points. From each setback point, determine the slope of the land perpendicular to the water body, stream or wetland. The setback distance for slope is calculated as follows:

2.1. If the slope is **<5%,** the setback distance requirement is 10 m.

2.2. If the slope is **5-9.9%,** the stated % the setback distance will be 10 m + 1 m for every 1 % increase in slope after the minimum.

2.3. If the slope is **10-15%**, consult with MD of Foothills administration to determine if a geotechnical survey will be required.

2.4. If the slope is ≥ **15 %,** then a geological survey is required. The total setback required for this site will be determined by a registered professional. The determined setback must take into account the slope, height of bank, groundwater influence, soil type and vegetative cover. Setback requirements will be subject to the approval of the subdivision authority.

2.5. Record slope, under measured slope in Step 1 and enter the calculated distance adjustment in the TOTAL Box in Step 1.

2.6. If the determined setback is greater than or equal to 75 m, skip to step 6; otherwise, continue to step 3.

3. **Height of Bank** must be determined by a legal land surveyor at each of the setback points. From each setback point, determine the height of bank perpendicular to the water body, stream or wetland. NOTE: Height of bank will be determined at the same time as slope by the surveyor.

3.1. Put a check mark next to the appropriate bank height in Step 2.

3.2. Identify and enter the required distance adjustment in the TOTAL Box in Step 2.

3.3. If the required distance adjustment is 75 m you can stop here. The required distance adjustment for this site is 75 m. The Environmental Reserve allocation will be determined horizontally, perpendicular to the water body, stream or wetland from the setback point.

3.4. If the determined setback is greater than or equal to 75 m, skip to step 6; otherwise, continue to step 4.

4. Determine the **depth to the water table** for the site. This information can be obtained from a geotechnical report, or from local well data by a qualified hydrogeologist.

4.1. Put a check mark next to the appropriate groundwater depth in Step 3.

4.2. Identify and enter the required distance adjustment in the TOTAL Box in Step 3.

4.3. If the determined setback is greater than or equal to 75 m, skip to step 6; otherwise, continue to step 5.

5. Determine the **vegetation cover of each type** for the site.

5.1. From each setback point, determine the vegetation type perpendicular to the water body, stream or wetland, by creating a 1m x 10m plot.

5.2. Determine the percent of the plot that is grass, shrub, forested, cleared or impermeable.

5.3. Multiply the percentage of each vegetation cover class by the respective distance adjustment for each type.

5.4. Put the required adjusted distance beside the respective vegetation cover.

5.5. Add up the setback requirements from all vegetation cover types to obtain the total vegetation cover setback.

5.6. Continue to step 6.

6. **Determine the baseline setback** based on slope, bank height, groundwater depth, and vegetation cover.

   6.1. If any of the setbacks calculated from steps 2 – 5 are equal to 75 m, the baseline setback for that point is 75 m.

   6.2. Otherwise, the baseline setback is the maximum of the setbacks determined in steps 2 – 5.

7. Determine the **soil type and texture** for the site.

   7.1. The soil type and texture with respect to proportions of sand, silt, clay, organic material (peat), rocks and gravel should be determined by a qualified professional.

   7.2. Based on the percentages of each soil particle fraction, determine the soil texture category that the soil at the site falls into, and use this texture/type to determine the setback soil multiplier.

8. Multiply the distance obtained in step 6 by the soil multiplier determined in step 7. This is the final setback for the site.

9. **To establish Environmental Reserve**, determine setback distances from each setback point. Connect setback points. Setback to the property line will be done perpendicularly from the nearest determined setback point. (See diagram on Page 9 for clarification).

Example Setback Calculations

A parcel of land is situated with 75m of shoreline along a lake.

CALCULATING SLOPE SETBACKS

The measured slope at both survey sites on the parcel of land is 9%. This slope falls in the category that does not require a check with MD of Foothills administration. The setback distance will be 10 m + 4m for the additional 4% slope over 5% (10m + 4m = 14m).

CALCULATING BANK HEIGHT SETBACKS

The measured bank height at both survey sites on the parcel of land is 2 m. The setback distance calculated for bank height will be 10 m (all sites with bank heights less than 5 m are assigned a setback of 10 m).

CALCULATING GROUNDWATER DEPTH SETBACKS

Based on a hydrogeological study of the area, reviewed by a qualified hydrogeologist, the depth of the water table for the parcel of land is determined to be approximately 15 m. This places the depth in the 10-19.9 m depth category, and the resulting setback is 15 m.

CALCULATING VEGETATION SETBACKS

Plot 1 is covered by 20% grass & herbaceous vegetation, 30% shrubs, 40% forested, 10% bare ground, and 0% impermeable surfaces.

a. Forested (40% × 0.20)=8 m

b. Shrub (30% × 0.25) = 7.5 m

c. Grass & herbaceous (20% × 0.30) = 6 m

d. Bare ground (10% × 0.50)=5 m

e. Impermeable surfaces (0% × 0.60) = 0 m
TOTAL Vegetation Setback = (6 m + 7.5 m + 8 m + 5 m + 0 m) = 26.5 meters.

Plot 2 is covered by 20% forested, 0% shrub, 50% grass & herbaceous vegetation, 30% bare ground, and 0% impermeable surfaces.
a. Forested (20% × 0.20)=4 m

b. Shrub (0% × 0.25) = 0 m

c. Grass & herbaceous (50% × 0.30) = 15 m

d. Bare ground (30% × 0.50)=15 m

e. Impermeable surfaces (0% × 0.60) = 0 m

TOTAL Vegetation Setback = (4 m + 0 m + 15 m + 15 m + 0 m) = 34 meters.

CALCULATING SOIL TEXTURE MODIFICATION OF SETBACKS:
Plot 1 (same as Plot 1 above) found to be on a soil with 10% clay, 30% silt, and 60% sand, which corresponds to a sandy loam.
The soil multiplier for a sandy loam is 1.0.
Because the vegetation calculations yielded the largest calculated setback for the plot, the setback calculated for Plot 1 is (26.5 m × 1.0) = 26.5 m.

Plot 2 (same as Plot 2 above) found to be on a soil with 35% clay, 35% silt, and 30% sand, which corresponds to a clay loam.
The soil multiplier for a clay loam is 1.25.
Because the vegetation calculations yielded the largest calculated setback for the plot, the setback calculated for Plot 2 is (34 m × 1.25) = 42.5 m.

Vegetation Definitions
Grass & Herbaceous Plants: Any grass or non-woody vegetation (including grasses, forbs, rushes, sedges).
Shrub: Shrubs will be defined as woody plants differing from a tree by its low stature (>2m) and by generally producing several basal shoots instead of a single trunk. Tree seedlings (saplings) <2m will also be considered as shrubs.
Forested: A tree or group of trees with an average height of 2 m and an associated understory.
Cleared: An area where the soil is exposed. There may be sporadically occurring plants present.
Aquatic Vegetation: Plants that grow in water or in saturated soils (i.e. bulrushes, sedges, cattails, rushes, willows).
Upland Vegetation: Plants that grow away from the water in drier soils (i.e. aspen, birch, white spruce and pine trees; shrubs such as rose, mountain ash, juniper and Saskatoon; grasses such as fescue, common grass, wild rye and wheat grass).

This is our battle: the watershed we all share, and the fight to maintain a healthy environment, vibrant communities and a stable economy.

Battle River Watershed Alliance

Gateway Centre
4825 51 Street (2nd floor)
Camrose Alberta
T4V 1R9
1 888 672 0276

www.battleriverwatershed.ca

Connecting People to Place for Action