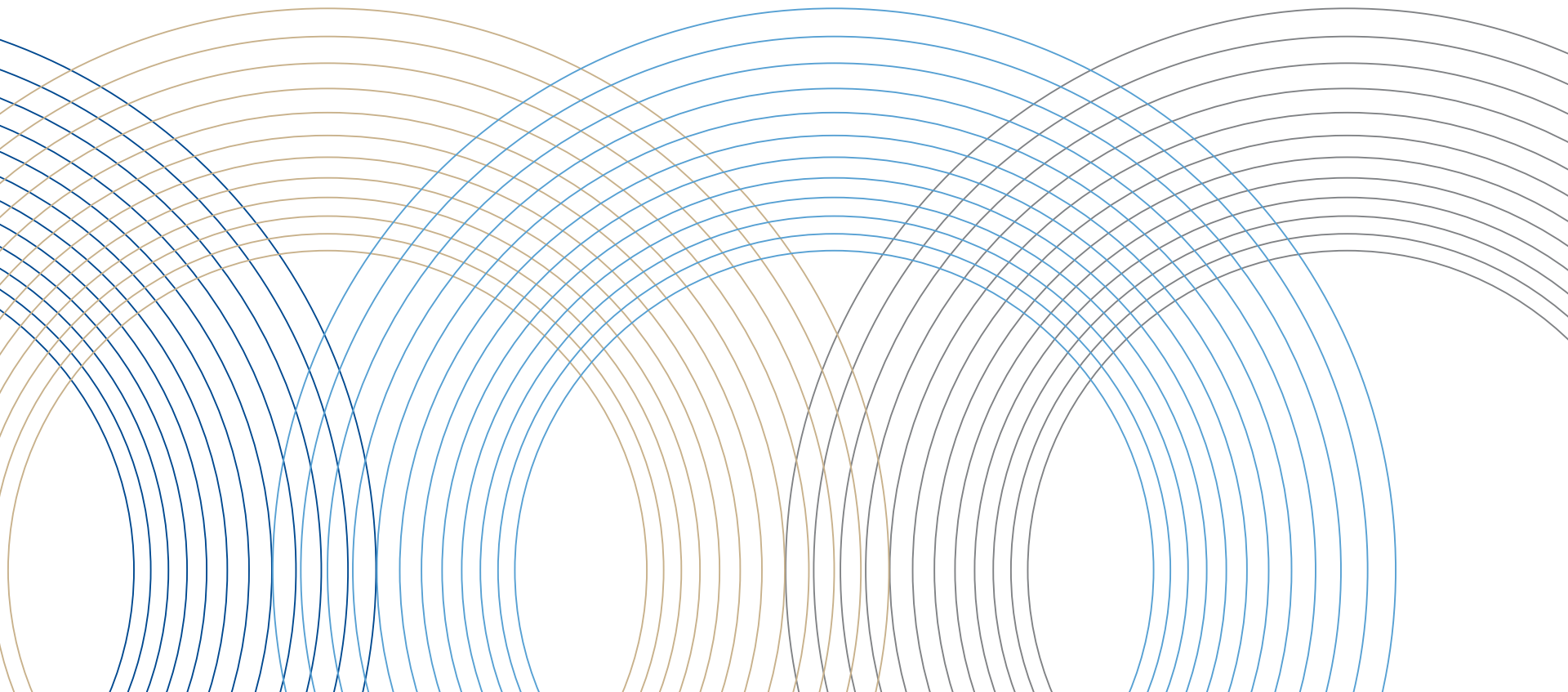
This is our battle: the watershed we all share, and the fight to maintain a healthy environment, vibrant communities and a stable economy.

OUR BATTLE

STATE OF THE BATTLE RIVER AND SOUNDING CREEK WATERSHEDS REPORT 2011



ABOUT THE BATTLE RIVER WATERSHED ALLIANCE

The Battle River Watershed Alliance (BRWA) was created in 2006 as a non-profit society. Shortly after its formation, the BRWA was selected by Alberta Environment, under *Water for Life: Alberta's Strategy for Sustainability* (Government of Alberta 2003), as the designated Watershed Planning and Advisory Council (WPAC) for the Battle River and Sounding Creek watersheds within Alberta.

Under Alberta's Water for Life strategy, Watershed Planning and Advisory Councils have a mandate to lead in watershed planning, develop best management practices, foster stewardship activities within the watershed, report on the state of the watershed and educate users of the water resource.

The BRWA works in partnership with communities, watershed stewardship groups, all four orders of government (municipal, provincial, federal and First Nations), industry, academia, environmental organizations and residents to promote the health and sustainable management of the land and water resources of the Battle River and Sounding Creek watersheds using the best science and social science available.

We exist to have a watershed that sustains all life by using sound knowledge, wisdom, and wise actions to preserve our watershed for future generations.

BATTLE RIVER WATERSHED ALLIANCE

TABLE OF CONTENTS

ACKNOWLEDGMENTS

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Government of Alberta ■

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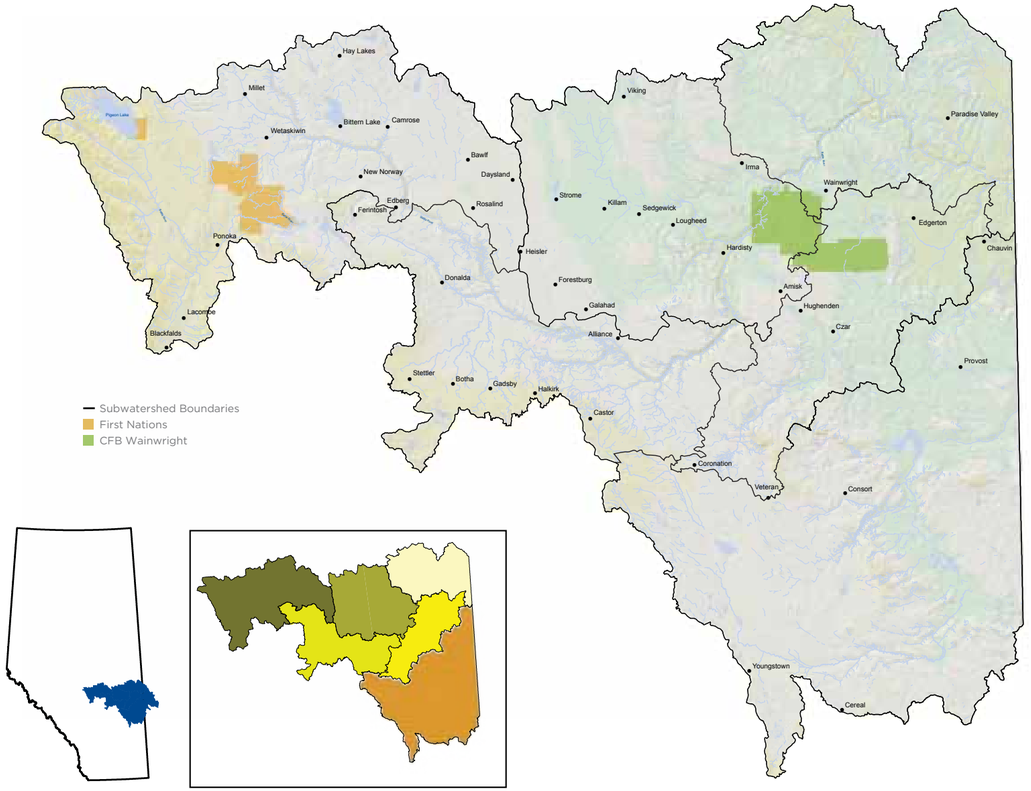
THE BATTLE RIVER AND SOUNDING CREEK
WATERSHEDS

The Battle River Watershed Alliance planning boundaries encompass the Alberta portions of the Battle River and Sounding Creek watersheds. The Battle River watershed is made up of five subwatersheds: Bigstone, Iron Creek, Paintearth, Blackfoot and Ribstone. The Sounding Creek watershed is considered as a single unit. Note: The background colours on the large map represent terrain relief.



WHAT IS A
WATERSHED?

A watershed is an area of land that catches precipitation, such as snow or rain, and drains it to a common place, such as a marsh, stream, river or lake. The boundaries of a watershed are known as drainage divides (i.e. the high point of land between adjoining watersheds). Precipitation falling along these drainage divides will ultimately become part of different watersheds.

Other terms that are used to describe a watershed are drainage basin, catchment basin or area, and river basin.

While the Battle River and Sounding Creek watersheds receive their names from the waterways that traverse their lengths, these watersheds are greater than their rivers and streams. A watershed encompasses its rivers and streams, yes, but also the lakes, wetlands, farmlands, parklands, grasslands, people and communities which fall within its boundaries.

A healthy, sustainable watershed is a place where community well-being is supported by a strong economy and a healthy environment. A healthy watershed provides us with what we need to live, contributing to the overall health of the environment and the quality of life of the people who live within its boundaries.

Municipalities rely on our watersheds for drinking water, household use, business and industry. A healthy watershed contributes not only to water quality, but also to the quality of life of local residents and visitors alike.

Farmers and ranchers rely on the water systems of our watersheds to irrigate crops for food, to feed and water livestock, and to maintain their agricultural operations.

Industries rely on our watersheds for power generation and oilfield injection.

Residents rely on the lakes, rivers, streams, wetlands and other natural areas of our watersheds for household water use, fishing, boating, swimming and other recreational activities. A healthy, vibrant watershed provides us with beautiful landscapes in which to live, work and play.

Watersheds are also home to a diversity of plant species and provide critical habitat for many wildlife species. The natural lands, wetlands, and riparian areas of our watersheds make them extremely rich and diverse landscapes.

Photo Opposite Page:
The intersection of land and water. Agricultural lands are essential sources of food. Wetlands provide many ecological services and functions.

A watershed's health impacts our environment AND our economy. Today we recognize that our communities benefit from various ecological functions or services that are not normally factored into measures of economic activity such as gross domestic product (GDP). These services are referred to as "ecological goods and services" (EG&S). Healthy ecosystems and watersheds help sustain air and water quality, provide clean drinking water, sequester carbon, produce food, decompose wastes, and support and enhance quality of life. All of these are critical factors in our economic and social well-being; therefore, every action we take has an enormous influence on the present and future state of our watershed, our economy, and our communities.

THE BATTLE RIVER AND SOUNDING CREEK

WATERSHEDS

DEFINING OUR BOUNDARIES

The North Saskatchewan River Basin is one of the major watersheds of Alberta. The Battle River and Sounding Creek watersheds are sub-basins of this watershed, making up about 40 percent of its total area. Both the Battle River and Sounding Creek watersheds extend into Saskatchewan. The Battle River Watershed Alliance focuses its work on the Alberta portions of these watersheds.

The Battle River watershed is an important watershed in east-central Alberta and western Saskatchewan, and is a tributary of the North Saskatchewan River. Covering over 25,000 square kilometres, the Alberta portion of the Battle River watershed is entirely within the province's settled "White Zone" and is characterized by productive agricultural communities that span the Parkland, Grassland, Boreal and Foothills Natural Regions.

With its headwaters originating at Battle Lake, the Battle River traverses central Alberta and extends east into Saskatchewan, where it flows into the North Saskatchewan River at Battleford, Saskatchewan.

The Battle River watershed is further subdivided into five sub-watersheds: Bigstone, Paintearth, Iron Creek, Blackfoot and Ribstone.

Like the Battle River watershed, the Sounding Creek watershed extends from east-central Alberta into west-central Saskatchewan. Its Alberta portion covers an area of about 10,000 square kilometres. Sounding Creek begins its journey near Hanna, Alberta and flows into Sounding Lake. It is believed that outflow from Sounding Lake into Eyehill Creek has occurred only once or twice in the last 50 or more years (Figliuzzi 2011). From Sounding Lake, Eyehill Creek flows northeast until it reaches Manito Lake in Saskatchewan. This lake has a prehistoric spillway to the Battle River, but no outflow has been observed since European settlement (Partners FOR the Saskatchewan River Basin 2009).

A SPECIAL PLACE

Unlike most of Alberta's major rivers, which are continuously fed by melting mountain snowpack and glaciers, the Battle River and Sounding Creek watersheds are entirely prairie fed. Their modest water supply is derived solely from local surface water runoff (from rain storms and spring melt), groundwater flow, and supply from tributaries, lakes and reservoirs. Because water availability and the natural flow of rivers and streams can vary widely from year to year, managing this watershed presents unique challenges. Land use practices also have a much greater impact on surface water quality because contaminants, harmful or otherwise, move slowly across the landscape.

The topography within the Battle River and Sounding Creek watersheds is predominantly flat, with large tracts of land that are considered 'non-contributing'; this means the water that falls as snow or rain collects in small lakes and wetlands, where it will eventually infiltrate into the ground or evaporate before it ever reaches the Battle River or Sounding Creek.

WHO RELIES ON OUR WATERSHED

In 2006, about 122,500 people lived in the Battle River and Sounding Creek watersheds. Though this area of Alberta is often considered to be a predominantly rural landscape, our watersheds are becoming increasingly urban. In 2006, half of the population lived in the watersheds' cities and towns, with almost a quarter (22.3%) living in the cities of Camrose and Wetaskiwin and another third (33.1%) living in towns. An additional 12.1% of the population lived in villages, summer villages, or on Native reserves. The balance (32.5%) lived in rural areas.

From 2001 to 2006, the number of people living in urban areas increased by about 8%, while the number living in rural areas decreased by about 4%. The only subwatershed which experienced substantial population growth over this time period was Bigstone, with an increase of 8%. The populations of the Paintearth and Blackfoot subwatersheds increased by less than 0.4% each, while the Sounding Creek watershed and the Iron Creek and Ribstone subwatersheds experienced decreases in population. The greatest decrease occurred in Ribstone (-5%). Overall, between 2001 and 2006 the population of the Battle River and Sounding Creek watersheds increased by about 4% (Watrecon 2010).

Table 1 – Value of Economic Activity (GDP) and Ecosystem Services (EG&S) in our watersheds ($ millions)

SUB-BASIN	ECONOMIC ACTIVITY (GDP)	ECOSYSTEM SERVICES (EG&S)	TOTAL VALUE	PERCENT FROM ECONOMIC ACTIVITY
Bigstone	$5,192.2	$1,470.1	$6,662.30	77.9%
Paintearth	$1,073.7	$696.5	$1,770.20	60.7%
Iron Creek	$1,081.5	$477.6	$1,559.10	69.4%
Ribstone	$497.3	$483.0	$980.30	50.7%
Blackfoot	$918.5	$435.5	$1,354.00	67.8%
Sounding Creek	$959.5	$1,490.6	$2,350.10	36.6%
TOTAL	$9,622.8	$5,053.5	$14,676.29	65.6%

DID YOU KNOW?

The Battle River is about 1100 km in length. It flows across Alberta for about 800km before reaching the Saskatchewan border. The combined length of Sounding and Eyehill Creeks is about 420 km.

HOW DO WE BENEFIT FROM A HEALTHY WATERSHED?

A report on the "Economic Activity and Ecosystem Services in the Battle River Basin" (Anielski and Watrecon 2011) estimated the monetary value of goods and ecological services in the Battle River and Sounding Creek watersheds at $5.05 billion per year. Economic activity in our watersheds was estimated at $9.62 billion per year (GDP). See table 1 for more details.

These results give us an idea of the significant benefits we receive from the multitude of resources and processes that are provided to us by natural ecosystems within our watersheds. It makes sense that we should value, protect, and care for these natural spaces that provide us with so much.

RURAL AND URBAN: DEFINED

For the purposes of this report, "rural" refers to areas outside of any city, town, village, summer village, or Native reserve.

"Urban" refers to any city, town, village, summer village, or Native reserve.

THE BATTLE RIVER AND SOUNDING CREEK

WATERSHEDS HISTORY

People have lived in the Battle River and Sounding Creek watersheds for thousands of years. But the history of this area did not begin with the occupation of these lands by the indigenous peoples of the time. It began geologically with the retreat of the glaciers and the vast amount of escaping waters that carved the river channels and gouged the valleys. This glacial retreat created a rich and biodiverse landscape, into which the nomadic peoples of the day migrated.

BEFORE THE EUROPEANS ARRIVED:

Prior to the arrival of Europeans in Alberta, the area surrounding the Battle River was inhabited by various First Nations groups, including the Blackfoot, Cree, Gros Ventres, and Assiniboine (Stoney) peoples (MacGregor 1976). These groups interacted with each other through a complex combination of trade, warfare and diplomacy (Binnema 2001). Here in the plains and parklands of Alberta they lived amidst the beautiful landscape of the Battle River valley and the surrounding areas, sustaining themselves with the produce of the land and by hunting the buffalo that roamed the land in vast numbers.

THE ARRIVAL OF EUROPEANS:

European exploration of the Battle River watershed began in the 1700s. Anthony Henday made his inaugural tour through the area in 1754. As trading posts were constructed along the North Saskatchewan River, increasing numbers of traders and surveyors entered the area, travelling around and through the Battle River valley. Many who travelled through the area and interacted with the First Nations peoples who lived there gained a strong impression of the esteem in which these people held the land on which they lived (MacGregor 1976).

EXPANDING TRADE:

As the fur trading industry became increasingly important in the area in the early 1800s, a trade relationship was created between the Hudson's Bay Company and the First Nations groups with which the company traded. However, the 1800s were also a time of increasing hardship for the First Nations peoples of the prairies as the buffalo were eradicated and disease and starvation spread. In 1876, Treaty No. 6 was signed, which gave control of a large area of land across central Alberta and Saskatchewan (including the Battle River area) to the emerging government of Canada.

EUROPEAN SETTLEMENT:

In the mid-1800s, John Palliser led an expedition to Western Canada to gather information about the land for the British government. His primary goal was to determine if the prairies were suitable for agriculture. In 1883, Dominion government surveyors began staking out farming land along the Battle River. By then, homesteads were already springing up along the Battle River and across the surrounding landscape. Government plans for the occupation and agricultural use of the prairies were underway. It is from these beginnings that the agricultural legacy of this area began (MacGregor 1976).

WHAT'S IN A NAME?

The Battle River derives its name from the Cree name for the river. Journals from the 18th century also refer to the river as the "fighting river". At the time of European contact and settlement, warfare and conflict were a part of life on the prairies for the numerous groups of people living here. Any number of conflicts may have contributed to the naming of this river as the Battle.

The Blackfoot Nation had its own name for the river, meaning "little" or "half" river. Because the Battle River is not fed by glacial waters, it is indeed a little river when compared to rivers whose headwaters are in the mountains.

The Stoney people also had their own name for the river. At this time, the BRWA does not know the English translation of this name.

Photo Opposite Page:
Ferries and horse-drawn wagons were two early forms of transportation in our watersheds.

A HEALTHY WATERSHED FOR ALL:

PROTECTING BIODIVERSITY

IDENTIFYING AND PROTECTING CRITICAL AREAS FOR THE CONSERVATION OF BIOLOGICAL DIVERSITY IS CRITICAL.

The UN Convention on Biological Diversity (United Nations 1992) calls for the establishment of protected areas for the conservation of biological diversity. In addition, the Seventh Meeting of the Conference of the Parties to the Convention on Biological Diversity established a target to conserve or protect at least 10% of each of the world's ecological regions (United Nations 2004). Another target arising out of this meeting was that areas of particular importance to biodiversity be protected.

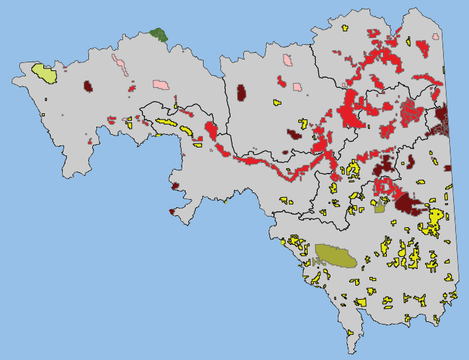
Only about 0.6% of the Battle River watershed and 0.5% of the Sounding Creek watershed are protected in some way (AENV 2010). For the purpose of this report, protected areas may include any of the following (as defined by the Government of Alberta): ecological reserves, crown reservations, wilderness areas, provincial and national parks, heritage rangelands, natural areas and recreation areas. Our watersheds are very much human-dominated landscapes, with agricultural lands comprising about three-quarters of the land base and linear developments, such as roads, railways and pipelines, crisscrossing the landscape. These factors contribute to the fragmentation and degradation of natural ecosystems and habitats, and as such contribute to a weakening of the overall biodiversity and ecological integrity of our watersheds.

The Government of Alberta has developed an inventory of Alberta's "environmentally significant areas" (Fiera Biological Consulting 2009). These are places in Alberta that have been identified as areas that are important to the long-term maintenance of biological diversity, soil, water, or other natural processes. Together, these areas make up about 20% of our watersheds.

Currently, designation as an environmentally significant area does not provide any legal protection to these areas. Formal protection or management may be necessary to ensure that the biodiversity and ecological integrity of these areas is protected into the future.

THE IMPORTANCE OF BIODIVERSITY

Biodiversity describes the variety of life on earth and is essential to our quality of life. We rely on biodiversity to provide us with a number of essential ecological goods and services including food, waste treatment, climate regulation and clean air and water. We also benefit economically from biodiversity – fisheries, forestry and wildlife-related recreation are an integral part of our economy. High levels of biodiversity are also associated with greater ecosystem stability. The more intact or undisturbed an ecosystem is the more likely it will be able to support a diversity of plant and animal species; the more diverse an ecosystem is, the better able it is to cope with environmental stresses, such as floods and droughts.



A HEALTHY WATERSHED FOR ALL:

FISH AND WILDLIFE

FISH IN THE BATTLE RIVER WATERSHED

Fish are an important component of a healthy watershed, and good indicators of the health of the aquatic ecosystem. A fish-based Index of Biological Integrity (IBI) study was carried out on the Battle River in 2006 and 2007 (Stevens and Council 2008). Of the 19 species of fish known to occur historically in the Battle River, 14 species were captured during this study.

Overall, the Battle River received an IBI score of 42%, meaning the river has levels of poor fishing/species of concern and levels of no fishing/species at risk. The Battle River's fish are suffering due to various human activities and land use practices that affect water quality and the overall health of our aquatic ecosystems.

As might be expected, better water quality was linked to higher IBI scores. Specifically, more species were found in river sections with lower concentrations of phosphorus and nitrogen. In addition, higher IBI scores were observed where there was less upstream cropland cover.

The study also showed a strong link between fish populations and human land-use patterns, specifically road networks. For areas along the river where road densities were low, there was an increased abundance of carnivorous fish such as walleye, northern pike, and burbot. Healthy populations of carnivorous fish indicate a relatively healthy and diverse aquatic community. Where road densities were high, there was a higher proportion of omnivorous fish such as white sucker and fathead minnow. As river water quality and health declines, the proportion of omnivorous fish increases.

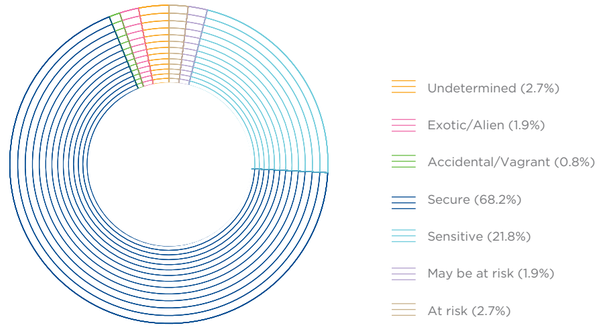
PROTECTING THE ANIMALS THAT CALL OUR WATERSHEDS HOME

How we live, work and play on the landscape has many impacts on our water supply, our watersheds, and our quality of life. Our actions also affect the various other creatures who call this place home. Many of the wildlife species who live in our watersheds are dependent on dwindling resources such as wetland and riparian habitats, native grasslands, and other undeveloped areas, and as such are suffering as a result of increased development, habitat loss and degradation, and other land use changes.

Alberta Fish and Wildlife records show that over 250 wildlife species (fish, mammals, amphibians and birds) have inhabited the Battle River and Sounding Creek watersheds in recent years (Prescott 2010). Of these species, 2.7% are currently classified as "at risk", 1.9% as "may be at risk", and 21.8% as "sensitive" in Alberta, according to Alberta Sustainable Resource Development's "General Status of Alberta Wild Species 2010" report (Government of Alberta 2011).

Fish and wildlife species may be indicative of the overall health of our watersheds; the interconnectedness of life tells us that the impacts we have on even one species may have much farther reaching impacts on the web of life as a whole. The biological integrity and diversity of our watersheds is essential to the health of our environment and our society.

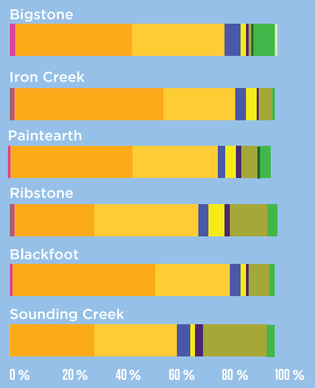
FIGURE 1 – STATUS OF ALBERTA WILD SPECIES FOUND IN OUR WATERSHEDS



LAND COVER AND LAND USE

While much of the landscape of the Battle River and Sounding Creek basins is used for agricultural purposes, the agriculture, forestry, fishing and hunting industry accounts for only about 6% of the GDP. The prime driver of economic activity is the mining and oil and gas extraction industry, accounting for almost half of the GDP of our watersheds (Anielski and Watrecon 2011).

FIGURE 2 – PERCENTAGE OF TOTAL LAND COVER AND LAND USE



SEE LEGEND ON PAGE 15

DID YOU KNOW...

Unlike the water that goes down your drain to the sewer, water that flows into storm drains may not be treated and filtered for pollutants. In such cases, this water, along with any contaminants it may carry, flows directly into our lakes, rivers and streams. Check with your local community to see what happens to the water that flows into your storm sewers!

HOW HEALTHY IS OUR WATERSHED, REALLY?

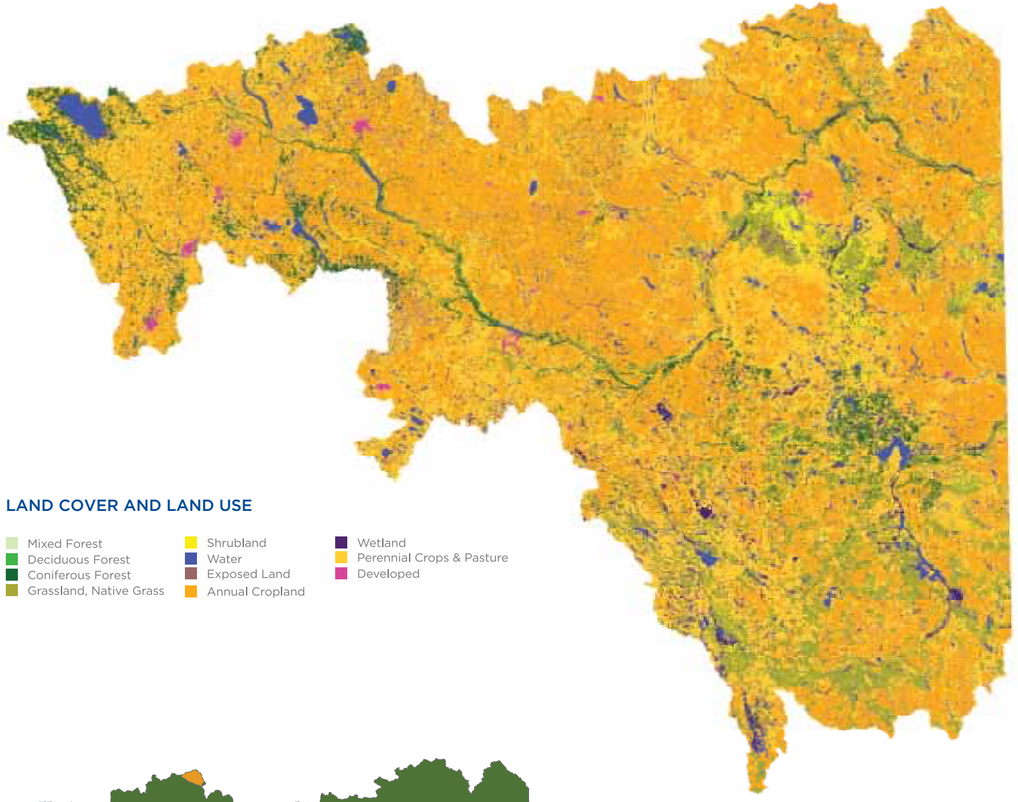
The Battle River and Sounding Creek watersheds span over 35000 square kilometres of diverse landscapes and communities in Alberta. These diverse landscapes include four Natural Regions and six Natural Subregions: the Foothills (Lower Foothills), Boreal Forest (Central Mixedwood, Dry Mixedwood), Parkland (Central Parkland) and Grassland (Northern Fescue, Dry Mixedgrass), illustrated on page 15 (bottom) (Strong and Leggat 1992).

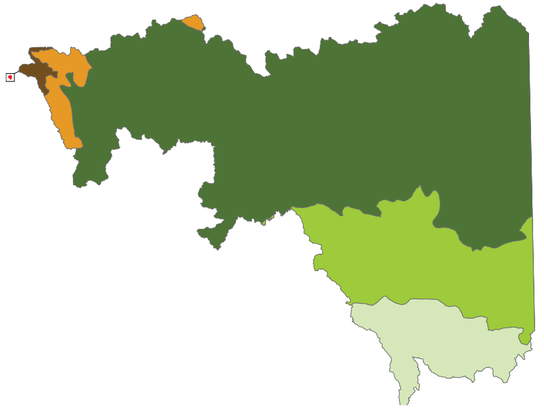
Land use practices in our watersheds have greatly modified the natural landscape. In particular, agriculture has long been of great importance in our watersheds. Today, about three-quarters of our land base is comprised of annual and perennial crop and pasture lands (AAFC 2001). While agriculture is an integral component of our economic wellbeing, it has had a very real impact on our watersheds.

Figure 2 and the map on page 15 (top) provide a visual representation of land cover in our watersheds (AAFC 2001).

Other land uses also have an impact on our watershed. Many factors, such as population growth and increased development, result in increased pressures on our land and water resources. For example, increased demands on our water supplies from industry, municipalities and agriculture contribute to water quantity issues. Water quality may be impacted when harmful substances reach our rivers, lakes and streams from a variety of sources, including storm water runoff from our communities.

Road networks, power lines, railroads, pipelines and oil and gas wells crisscross and dot the landscape, resulting in habitat fragmentation, land alteration and increased human presence in our watersheds. Recreational lands provide fun outdoor opportunities at the same time as they may also increase human impact in those areas.





WHY REPORTING MATTERS

It's an old but useful phrase: to know where you're going, you need to know where you've been. That's the purpose of building a comprehensive State of the Watershed report.

This report provides a snapshot of the health and sustainability of the Alberta portions of the Battle River and Sounding Creek watersheds, looking at various indicators of watershed health such as surface and groundwater quality and quantity, land use, wetland and riparian health, biodiversity and the status of fish and wildlife species, and more. Other indicators included here look at social and economic well-being, that is, our quality of life and the health and wellbeing of our communities and economy.

Using this report as a benchmark, the next step is to develop a watershed management plan that will outline the steps required to improve the sustainability of our watersheds. The information presented here will directly support these watershed management planning efforts in the Battle River and Sounding Creek watersheds.

This report will also be complimented by technical reports on the natural and cultural history of the Battle River and Sounding Creek watersheds. These technical reports will provide a more in-depth look at the various components that form the natural, social and economic landscape of our watersheds. As they are finalized, these reports will be made available on our website: **www.battleriverwatershed.ca**.

INFORMATION GAPS

In addition to telling us what we know about the Battle River and Sounding Creek watersheds, this report also tells us what we don't know. Watersheds are complex systems, and our understanding of the Battle River and Sounding Creek watersheds is by no means complete. Information gaps include:

- Lack of long-term water quality monitoring in the Sounding Creek watershed and along portions of the Battle River
- Limited water quality monitoring related to pesticides and emerging pollutants such as pharmaceuticals.
- Lack of long-term water quality monitoring in the Sounding Creek watershed
- Lack of comprehensive wetland inventories for all subwatersheds
- Limited inventories and knowledge of the presence, abundance and status of fish and wildlife species in the Battle River and Sounding Creek watersheds
- Limited knowledge of ground water quantity, quality, recharge rates and use in the Battle River and Sounding Creek watersheds
- Limited riparian health monitoring over time; limited riparian health assessments in the Sounding Creek watershed and Ribstone subwatershed.
- Limited airshed management zone coverage in our watersheds. As such, long-term air quality monitoring is limited.
- Limited understanding of how air quality may affect the land and water resources of our watersheds.

Photo Opposite Page:
A welcome first sign of spring, the prairie crocus is native to these lands and is generally confined to unbroken, native prairie soils.

HOW DO WE MEASURE

WATERSHED SUSTAINABILITY?

Sustainability refers to the extent to which a society can establish balance, through actions and decisions, between environmental, social, and economic values. Doing so requires tradeoffs. Prioritizing economic development may mean placing a lesser focus on maintaining a healthy environment, and vice versa. Both a healthy environment and a stable economy may promote social and community well-being.

The following approach to measuring watershed sustainability seeks to capture these tradeoffs.

A TWO-FOLD APPROACH TO MEASUREMENT

Our aim in measuring watershed sustainability is to measure our relative effectiveness at achieving sustainability in the Battle River and Sounding Creek watersheds. We do this by studying a core set of indicators that can be used to look at different aspects of sustainability separately, but also in combination. In this way, we can compare subwatersheds over time and based on different aspects of sustainability to better examine our overall progress toward sustainability.

1. MEASURING RISK TO SUSTAINABILITY

One way we measure the sustainability of each subwatershed is by using a risk scale, which reports on whether the condition of specific indicators presents a low, moderate or high risk to watershed sustainability. Thus, where sufficient data is available (as indicated by an "*"), indicators are rated using the following rating system:

Conditions present low risk to watershed sustainability

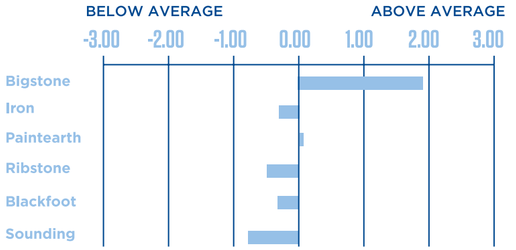
Conditions present moderate risk to watershed sustainability

Conditions present high risk to watershed sustainability

2. MEASURING DEVIATIONS FROM AVERAGE

A major challenge of bringing together different types of information is that they are measured using different units and on different scales. To confront this challenge, we standardized data by measuring the distance from average for each indicator (the -3 to +3 range represents standard deviations from the average). This allows us to see if a given indicator in a particular subwatershed is more or less than the average compared to other subwatersheds. Note that an "above average" rating does not necessarily mean "better".

WATER WELL DENSITY



As an example, if we know the average water well density in the Battle River and Sounding Creek watersheds, we can compare this average to the density of water wells in individual subwatersheds. In this instance, we see that the Bigstone subwatershed has an above average density of water wells.

In the broader context of watershed management, measuring deviations from average allows us to visualize the relative sustainability of our subwatersheds and start to have conversations about potential watershed management decisions that could help to improve the overall sustainability of our watersheds.

For example, due to the fact that wells (water, oil and gas, or otherwise) are potential sources of groundwater contamination, areas with above average well densities may be given additional attention in watershed management discussions and decisions. Of course, proper management and maintenance of wells across our watersheds is also an important watershed management consideration.

As another example, for those subwatersheds that have above average densities of roads and other linear developments (pipelines, powerlines, etc.), management actions could be put in place to mediate the effects of those developments. Similarly, where riparian health is most compromised (as shown in a score that is below average), riparian area management could become a priority.

By understanding where deviations from average exist, we can better prioritize our focus to improve management responses.

INDICATORS FOR

WATERSHED SUSTAINABILITY

Indicators have been divided into two categories: environmental sustainability and socio-economic sustainability. A third category, actions for sustainability, will be developed in the future to look at the ways in which stewardship actions contribute to a more sustainable watershed.

ENVIRONMENTAL SUSTAINABILITY INDICATORS

SURFACE WATER

Surface Water Allocations: This indicator shows to what extent surface water resources are currently allocated in our watersheds by reporting on the total volume of licensed allocations. For more information on this indicator, see pages 33-35 (AENV 2010).

***Water Quality:** Water quality is an important component of healthy watersheds and aquatic ecosystems. Water quality scores are based on water quality index (WQI) values for nutrients, bacteria, and metals. These values come from water quality monitoring that was carried out at eleven sites along the Battle River in 2004-2005. In addition, the water quality section (page 38-39) looks at the following water quality parameters: total phosphorus, total nitrogen, total ammonia, nitrite, bacteria, dissolved oxygen and pH (AENV 2011a; Teichreb 2011).

Water quality was rated as follows:

WQI SCORE 81-100% – LOW RISK TO WATERSHED SUSTAINABILITY

WQI SCORE 46-80% – MODERATE RISK TO WATERSHED SUSTAINABILITY

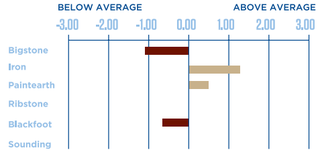
WQI SCORE 0-45% – HIGH RISK TO WATERSHED SUSTAINABILITY

The Water Quality Index is rated on a percentage scale from 0 to 100, 0 representing the poorest water quality and 100 representing the best water quality. An above average rating represents better water quality.

This data represents water quality monitoring carried out along the Battle River mainstem. Because the Battle River does not flow through the Ribstone subwatershed and the Sounding Creek watershed, these watersheds are not included in the above graphs. Although irregular, scattered water quality monitoring has taken place over the years in these watersheds, no long-term monitoring exists. In order to gain a better understanding of water quality in these regions, long-term monitoring is essential.

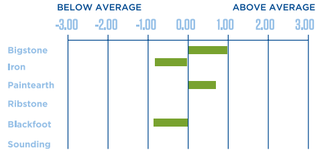
The Battle River near Battle Lake.

WATER QUALITY INDEX, NUTRIENTS



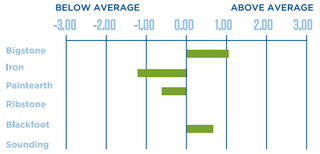
The Iron Creek subwatershed had a high score of 62.7% (lower nutrient levels), while Bigstone had a low score of 41.3% (higher nutrient levels). The average was 51.0%.

WATER QUALITY INDEX, BACTERIA



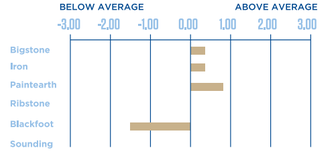
Bigstone had a high score of 89.8% (lower bacteria levels), while the Iron Creek subwatershed had a low score of 82.6% (higher bacteria levels). The average was 85.9%.

WATER QUALITY INDEX, METALS



Bigstone had a high score of 96.1% (lower metal levels), while the Iron Creek subwatershed had a low score of 82.1% (higher metal levels). The average was 89.4%.

WATER QUALITY INDEX, OVERALL



Overall water quality was poorest in the Blackfoot subwatershed (73.9%) and best in the Paintearth subwatershed (76.3%). The average was 75.4%.

River Flow Quantity Index: This index describes the difference between the natural flow regime for the Battle River and the actual flows recorded every year. See page 32 for information on this indicator (AENV 2011b).

***Deviation from natural flow:** This indicator shows the extent to which recorded flows of the Battle River deviate from natural flow values. Record flows can them be compared to the Battle River instream flow need (IFN) (AENV 2010). It has been estimated that a 15% reduction to the Battle River's natural flow is the allowable limit for water diversion. For more information on this indicator, see page 36.

This indicator was rated as follows:

<10% REDUCTION IN NATURAL FLOW – LOW RISK TO WATERSHED SUSTAINABILITY

10-15% REDUCTION IN NATURAL FLOW – MODERATE RISK TO WATERSHED SUSTAINABILITY

>15% REDUCTION IN NATURAL FLOW – HIGH RISK TO WATERSHED SUSTAINABILITY

GROUNDWATER

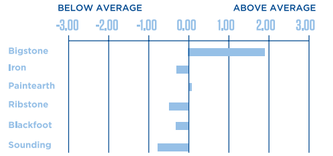
Groundwater Allocations: This variable reports on annual licensed groundwater allocations and compares this to annual groundwater recharge. This indicator is discussed in further detail on page 37 (AENV 2010).

Groundwater Well Density: This indicator reports on groundwater well density (wells per square kilometre) (IHS Energy (Canada) Ltd 2010). Areas with higher well densities will have greater potential impacts to groundwater quantity and quality.

Coalbed Methane Wells: This indicator reports on coalbed methane well density (wells per square kilometre). The potential for methane gas to escape and migrate from a coalbed methane well to nearby aquifers and water well supplies is a concern for some Albertans, although to-date no problems have been found based on field evidence or complaint investigations.

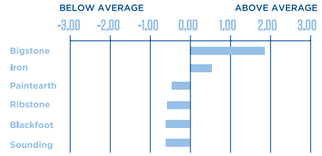
Oil and Gas Activity: This indicator reports on oil and gas well density (wells per square kilometre) (AENV 2010). Oil and gas activity may impact surface and groundwater quantity and quality, the intactness of habitats, and more.

GROUNDWATER WELL DENSITY



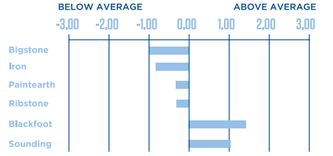
Groundwater well densities range from 3.2 wells per square kilometre in Bigstone to 0.7 wells per square kilometre in the Sounding Creek watershed. Average water well density in the BRWA's planning area is 1.4 wells per square kilometre.

COALBED METHANE WELL DENSITY



Coalbed methane well densities are fairly low in our watersheds, with the highest densities occurring in Bigstone (0.2 wells per square kilometre). Average well density in the BRWA's planning area is 0.04 wells per square kilometre.

OIL AND GAS WELL DENSITY



Oil and gas well densities range from 2.1 wells per square kilometre in Blackfoot to 1.4 wells per square kilometre in Bigstone. Average oil and gas well density in the BRWA's planning area is 1.7 wells per square kilometre.

While we have a clear understanding of well densities in our watersheds, we do not have a clear understanding of what density of wells would present a low, moderate and high risk to watershed sustainability.

Proper well maintenance and other precautionary actions are essential to reducing the risks associated with well development. Further research and discussion is required to determine what well densities will be considered acceptable and appropriate in our watersheds.

INDICATORS FOR

WATERSHED SUSTAINABILITY

BIODIVERSITY

***Fish-based Index of Biological Integrity:** This indicator assesses river conditions and the health of aquatic ecosystems using a multi-metric index that reflects important ecosystem components, including habitat and trophic guild composition and the healh and abundance of fish species. IBI scores from 0-100% (Stevens and Council 2008).

IBI scores were rated as follows:

71-100% - LOW RISK TO WATERSHED SUSTAINABILITY

41-70% - MODERATE RISK TO WATERSHED SUSTAINABILITY

0-40% - HIGH RISK TO WATERSHED SUSTAINABILITY

Habitat Fragmentation, average patch size: This indicator measures habitat fragmentation by looking at average "patch" size. A "patch" represents an area of land covered by a single land cover type. The most notable effect of habitat fragmentation is the reduction in average patch size, and habitat fragmentation is related to habitat degradation and species loss.

Status of Species: This indicator classifies species of the Battle River and Sounding Creek watersheds according to the following categories: At Risk, May be at Risk, Sensitive, Secure, Undetermined, Not Assessed, Exotic/Alien, Extirpated/Extinct, and Accidental/Vagrant (see Terms section for definitions of these categories) (Government of Alberta 2011; Prescott 2010). The proportion of species within each category may then be determined. For more information on this indicator, see page 13.

***Protected Areas:** This indicator measures protected areas as a percentage of the total area of each subwatershed; this represents the extent to which areas important for conserving biodiversity, cultural heritage, scientific research, recreation, natural resource maintenance, and other values are protected from incompatible uses (Spatial Data Warehouse Ltd. 2010). At the same time, we recognize that the achievement of ecological integrity within protected areas is dependent not only on their designation as a protected area or park, but also on the management decisions carried out within that protected area.

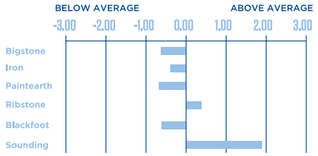
Protected areas were rated as follows:

>10% OF SUBWATERSHED PROTECTED IN SOME WAY – LOW RISK TO WATERSHED SUSTAINABILITY

5-10% OF SUBWATERSHED PROTECTED – MODERATE RISK TO WATERSHED SUSTAINABILITY

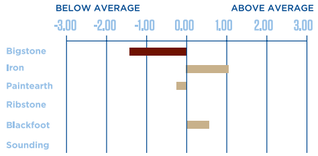
<5% OF SUBWATERSHED PROTECTED – HIGH RISK TO WATERSHED SUSTAINABILITY

AVERAGE PATCH SIZE



Average patch size in the Sounding Creek watershed is 32 hectares. In contrast, Paintearth has the smallest average patch size, at about 8 hectares. Average patch size over the BRWA's planning area is 14.4 hectares

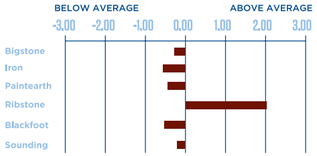
INDEX OF BIOLOGICAL INTEGRITY



Bigstone had the lowest IBI score (35%), while the Iron Creek subwatershed had the highest (54%). The average IBI score over the BRWA's planning area was 42%.

The "Index of Biological Integrity" study looked at fish data for the Battle River mainstem only. As such, subwatersheds that the Battle River does not flow through could not be assigned an IBI score.

PROTECTED AREAS



About 3% of Ribstone's land area is contained in protected areas. In comparison, the Iron Creek subwatershed contains the smallest area of protected lands, at 0.02% of its land area. Overall, about 0.6% of the BRWA's planning area is protected.

LAND COVER AND LAND USE

Land Cover: This indicator provides a picture of land cover and land use by measuring the total area of land that falls into each of the following categories: water, exposed land, developed/built-up, shrubland, wetland, grassland (native), annual crops, perennial crops and pasture, coniferous forest, deciduous forest and mixed forest (AAFC 2001; Spatial Data Warehouse Ltd. 2010). By comparing different land uses and vegetation cover, it is possible to determine the proportion of land having very low and very high anthropogenic (human) impact.

Land cover was rated according to the amount of land in a natural, or "undeveloped", state. Natural land cover consists of land covered by water, shrublands, wetlands, native grasslands and forests. Developed land includes annual and perennial crop and pasture land, exposed (bare) ground, urban areas, and otherwise built-up lands (such as roads).

***Linear Development:** This indicator measures linear development density (km/km2). Linear development refers to all oil and gas pipelines, power lines, railway lines, roads, cutlines and trails that crisscross the landscape (Spatial Data Warehouse Ltd. 2010; IHS Energy (Canada) Ltd. 2010). Linear disturbances may impact water quality, water quantity, intactness of natural areas and habitats, biodiversity and the health of wetlands and riparian areas.

For the purpose of reporting on the state of our watersheds, we looked specifically at road densities, as road densities have been shown to provide an accurate picture of the ecological and biological integrity of a landscape.

Linear development was rated as follows:

0.0-0.5 KM/KM2 – LOW RISK TO WATERSHED SUSTAINABILITY; MOST SPECIES INTACT

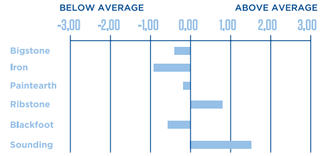
0.6-1.0 KM/KM2 – MODERATE RISK TO WATERSHED SUSTAINABILITY; MORE-SENSITIVE SPECIES MAY BE LOST

1.0-1.5 KM/KM2 – HIGH RISK TO WATERSHED SUSTAINABILITY; BOTH MORE-SENSITIVE AND LESS-SENSITIVE SPECIES MAY BE LOST

> 1.5 KM/KM2 – LARGELY ARTIFICIAL OR HUMAN DOMINATED LANDSCAPE

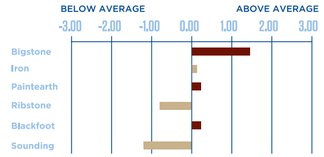
Wetland Area: Wetlands serve many valuable functions in a watershed, but wetland loss has been substantial throughout Alberta and beyond (Ducks Unlimited Canada 2004). This indicator looks at the change in wetland area over time. In Alberta's White Zone, high resolution, historic and current aerial photography is typically used to determine the change in wetland area over time, and is referred to as a "comprehensive" or "drained" wetland inventory. However, such a wetland inventory has only been completed for the Iron Creek subwatershed and select areas of the Bigstone subwatershed. Wetland inventories should be carried out for the Sounding Creek watershed and the remaining subwatersheds of the Battle River. As this data does not currently exist, the "deviations from average" approach to indicator measurement looks at the relative area of land covered by wetlands in each subwatershed.

NATURAL LAND COVER



Natural or "undeveloped" land cover ranges from a low of 15% of the land base in the Iron Creek subwatershed to a high of 37% in the Sounding Creek watershed. Overall, natural lands make up about 25% of the BRWA's planning area.

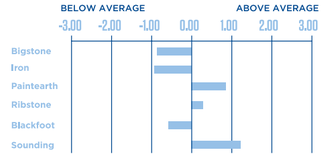
LINEAR DEVELOPMENT - ROADS



Road densities are highest in Bigstone, at 1.3 km of roads per square kilometre of land. Road densities are lowest in the Sounding Creek watershed, at 0.7 km of roads per square kilometre of land. Average road density in the BRWA's planning area is 0.98 km of roads per square kilometre.

Road densities have been shown to be closely linked to IBI scores (see page 13).

WETLAND AREA



When looking at wetland area as a percentage of total subwatershed area, 3% of the Sounding Creek watershed contains wetlands, whereas only 0.5% of the Iron Creek subwatershed contains wetlands. On average, 1.6% of the BRWA's planning area is covered by wetlands.

INDICATORS FOR WATERSHED SUSTAINABILITY

LAND COVER AND LAND USE

***Riparian Health:** Riparian areas are those green zones of vegetation around our wetlands, lakes, rivers and streams, and are capable of supporting incredibly ecologically diverse ecosystems. Riparian health was determined through aerial and ground-based riparian health assessments (Teichreb and Walker 2008; Cows and Fish 2010).

Aerial riparian health assessments were carried out in 2007 and 2008 for Battle Lake and Pigeon Lake, as well as the entire Alberta portion of the Battle River. In addition, Cows and Fish has completed on-the-ground riparian health assessments for various sections of the Battle River, as well as lakes and streams throughout the Battle River and Sounding Creek watersheds. Based on these assessments, an overall score out of 100% was assigned to each subwatershed.

Riparian health was rated as follows:

80-100% - LOW RISK TO WATERSHED SUSTAINABILITY

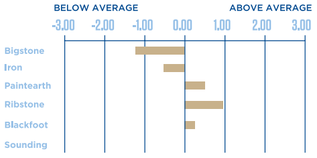
49-79% - MODERATE RISK TO WATERSHED SUSTAINABILITY

0-49% - HIGH RISK TO WATERSHED SUSTAINABILITY

Manure Application: This indicator measures the amount of manure applied in our watershed (tonnes per hectare). Manure application may contribute to such impacts as nutrient loading, an increased number of pathogens and odour (Statistics Canada 2007).

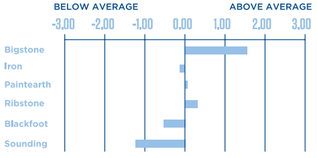
Most watersheds have their headwaters in pristine mountain regions. In the Battle River watershed, this is not the case. The Bigstone subwatershed, which includes our headwaters, contains 63% of the population of our watersheds. It is also home to the highest livestock densities, road densities and manure application rates.

RIPARIAN HEALTH



Riparian health was greatest in Ribstone (70.0%) and poorest in Bigstone (59.2%). For more information on riparian areas, see pages 40-41.

MANURE APPLICATION



Manure application was greatest in Bigstone (4.3 tonnes per hectare) and lowest in the Sounding Creek watershed (1.3 tonnes per hectare). On average, manure application is 2.7 tonnes per hectare in the BRWA's planning boundaries.

SOCIO-ECONOMIC SUSTAINABILITY INDICATORS

***Community Well-being Index:** The Community Well-being (CWB) Index is a composite indicator which combines census data on income, education, housing and labour force participation to produce "well-being" scores for individual communities. A community's CWB index score is a single number that can range from a low of 0 to a high of 100 (AANDC 2010). For a detailed description of how each of the index components (income, education, housing and labour force) is rated, please visit the *Aboriginal Affairs and Northern Development Canada* website.

It should be noted that "well-being" may mean different things to different people. There are many factors that may be used to describe well-being and some indicators of well-being are easier to measure than others. Census data records a limited number of variables and as such is not able to capture all aspects of well-being. That being said, the CWB index does provide us with some insight into the well-being of our communities.

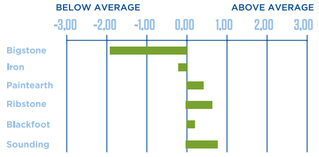
CWB scores were rated as follows:

71-100% - LOW RISK TO WATERSHED SUSTAINABILITY

41-70% - MODERATE RISK TO WATERSHED SUSTAINABILITY

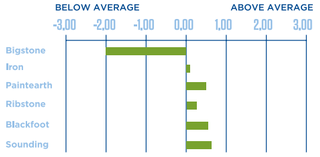
0-40% - HIGH RISK TO WATERSHED SUSTAINABILITY

COMMUNITY WELL-BEING OVERALL



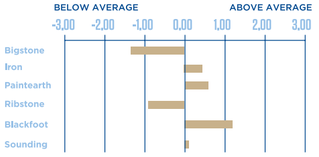
Bigstone had the lowest overall CWB score (74.7%), while Sounding Creek had the highest (80.0%).

INCOME



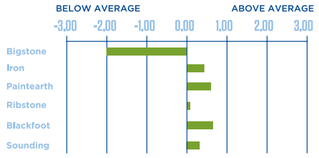
It is interesting to note that although Bigstone accounts for over half of the economic output of our watersheds (as measured by GDP), it has the lowest per capita GDP (GDP per person).

EDUCATION



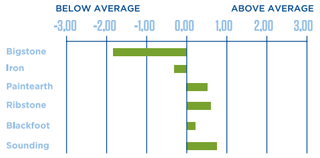
Bigstone had the lowest education score, at 45.2%. Blackfoot had the highest education score, at 51.6%.

HOUSING



Bigstone had the lowest overall CWB score (74.7%), while Sounding Creek had the highest (80.0%).

LABOUR FORCE



Bigstone had the lowest labour force score, at 83.9%. The Sounding Creek watershed had the highest score, at 92.8%.

INDICATORS FOR
WATERSHED SUSTAINABILITY

COMMUNITY WELL-BEING INDEX

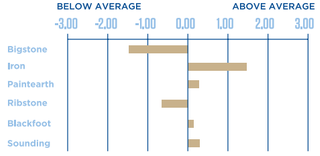
CWB scores for the Bigstone subwatershed are consistently lower than all the other subwatersheds. This result may seem surprising given that the subwatershed is home to three cities and about two-thirds of the total population of the Battle River and Sounding Creek watersheds. However, Bigstone is also home to five First Nations Reserves, which have the lowest overall community well-being scores. The overall CWB score for First Nations Reserves in Bigstone is 46.2%; the overall CWB score for Bigstone, not including First Nations Reserves, is 81.1%. Equitable distribution of resources and fair treatment of all citizens is an essential component of economic and social well-being and the overall sustainability of our watersheds.

CWB SCORES (%)

	INCOME	EDUCATION	HOUSING	LABOUR FORCE ACTIVITY	OVERALL
PAINTEARTH	85.5	49.9	94.5	92.0	79.2
IRON CREEK	83.8	49.7	93.9	89.3	77.8
BIGSTONE	74.7	45.2	85.4	83.9	74.7
RIBSTONE	84.4	46.3	92.6	92.3	78.7
BLACKFOOT	85.8	51.6	94.6	91.0	79.7
SOUNDING CREEK	86.2	48.8	93.5	92.8	80.0
BIGSTONE (without First Nations Reserves)	86.5	52.0	94.6	90.7	81.1
First Nations Reserves	39.0	24.8	57.8	63.4	46.2

Social Well-being: This report looks at urban area proximity to protected areas as an indicator of social well-being (Spatial Data Warehouse Ltd. 2010). Recreational opportunities provided by parks and protected areas that are close at hand contribute to the health and wellbeing of our communities.

URBAN AREA DISTANCE FROM THE PROTECTED AREA

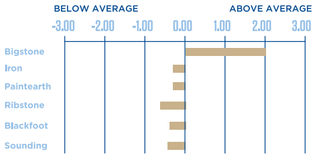


For this indicator, an "above average" rating means that there is a greater distance, as the crow flies, from urban areas to protected areas.

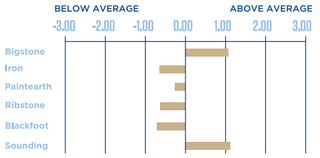
On average, protected areas in Bigstone are 14 km from urban centres. In contrast, people in the Iron Creek subwatershed are an average of 37 km from protected areas. On average, urban areas in our watersheds are 25 km from protected areas.

Economic Well-being: As a preliminary measure of economic well-being, this report measures both gross domestic product (GDP) and ecological goods and services (EG&S) (Anielski and Watrecon 2011).

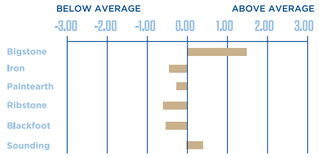
GDP



EG&S



GDP AND EG&S



For subwatershed-specific GDP and EG&S numbers, see page 9.

The following is a list of indicators that were not included in this report, but which may be explored in the future.

Surface Water Indicators

- *Lake Water Trophic Status:* This variable is an indication of the overall level of productivity in a lake, using chlorophyll as a proxy.
- *Status of Lake Levels:* This variable shows the status of individual lake levels from year to year.

Groundwater Indicators

- The intersection of wells and otherwise developed areas with groundwater vulnerability data, indicating areas more sensitive to potential contamination.
- Groundwater quality monitoring: measuring concentrations of methane gas and nitrate in groundwater

Land Cover and Land Use Indicators

- Soil Salinity: This indicator would measure the area and proportion of land affected by dryland salinity and irrigation salinity.
- Use of agricultural pesticides: This variable would measure the use of pesticides in agriculture and the change in use patterns over time.

Air Quality Indicators

In addition to our land and water resources, the air we breathe is also an integral component of the health of our watersheds. For example, air pollutants such as nitrogen oxides and sulphur dioxide may contribute directly to the health of our land and water resources through acidic deposition and the formation of acid rain.

Socio-Economic Indicators

Indicators of social well-being that may be measured in the future include: recreation opportunities, life expectancy, and crime, suicide and drug addiction rates.

Indicators of economic well-being that may be measured in the future include: GDP vs. disposable income, investment (government expenditures, major projects, etc.), per capita waste disposal, per capita energy consumption and energy use per unit of GDP.

Actions for Sustainability Indicators

Indicators that may be measured in the future include: well reclamation efforts, membership in stewardship groups, number of land conservation agreements, waste diversion (eg. recycling and composting) programs, and more.

THE NUMBERS

The following table outlines the numbers used to calculate deviations from average. Community and economic well-being numbers are described elsewhere in the report and are not included here.

	BIGSTONE	IRON CREEK	PAINTEARTH	RIBSTONE	BLACKFOOT	SOUNDING CREEK
SURFACE WATER						
Water Quality Index (%)						
Nutrients	41.3	62.7	54.4		45.7	
Bacteria	89.8	82.6	88.5		82.7	
Metals	96.1	82.1	86.0		93.5	
Overall	75.8	75.8	76.3		73.9	
GROUNDWATER						
Groundwater Well Density (wells/km2)	3.2	1.1	1.4	0.9	1.1	0.7
Coalbed Methane Well Density (wells/km2)	0.2	0.07	0.01	0.002	0	0.0007
Oil and Gas Well Density (wells/km2)	1.4	1.5	1.6	1.6	2.1	2.0
BIODIVERSITY						
Index of Biological Integrity (%)	35.3	53.8	44.2		50.1	
Protected areas (% of total area)	0.4	0.02	0.2	3.3	0.07	0.5
Average Patch Size (hectares)	8.8	10.9	8.2	18.0	8.8	31.8
LAND COVER AND LAND USE						
Natural Land Cover (% of total area)	19.4	14.8	21.4	30.2	17.8	36.7
Wetland Area (% of total area)	0.6	0.5	2.4	1.8	0.9	2.8
Linear Development - Roads (km/km2)	1.28	1.00	1.02	0.81	1.02	0.73
Riparian Health (%)	59.2	62.7	67.7	70.0	66.4	
Manure Application (tonnes/hectare)	4.3	2.5	2.7	3.0	2.1	1.3
SOCIAL WELL-BEING						
Urban area distance from protected area (km)	13.7	36.9	27.5	20.2	26.5	27.6

INDICATORS FOR

WATERSHED SUSTAINABILITY

Fencing off water bodies and waterways is one way to help maintain healthy riparian areas.

Ultimately, it is up to watershed residents to determine what they want their watershed to look like. Watershed residents will have to determine what are considered “acceptable” and “unacceptable” risks to watershed sustainability. These decisions may require tradeoffs between environmental, social and economic values, and will determine what environmental, social and economic conditions are considered acceptable and desirable.

To give an example of these potential tradeoffs, let’s look at riparian areas. Cattle can cause damage to riparian areas. From an economic perspective, fencing off riparian areas requires an investment of time and money. From an ecological perspective, fencing off riparian areas helps to promote healthier riparian areas, which in turn promotes better water quality, wildlife habitat, and more.

The choice is yours. It is our hope that the information and indicators presented in this report will help to guide and inform these conversations.

We know human activity is changing our watershed. Measuring water quantity and quality is useful for determining how our actions on the land are impacting our water systems. The health of our wetlands and riparian areas is closely tied to these issues. As such, these indicators are now explored in more detail.

WATER QUANTITY

WATER QUALITY

WETLANDS AND RIPARIAN HEALTH

WATER QUANTITY

Having enough water in our streams, rivers, lakes and wetlands is essential to sustaining healthy aquatic systems. But more than this, healthy aquatic systems ensure a sustainable, safe and secure water supply for our communities, now and into the future (Government of Alberta 2001). As such, it is important that we remain mindful of the limited water resources available to us, and plan our actions accordingly.

The rivers and streams of the Battle River watershed have flows that vary considerably on an annual and seasonal basis (Optimal Solutions 2010). These flows are affected by natural long-term changes in climate and short-term seasonal weather patterns. The flow regime of our watersheds has also been influenced by human use of water and by various land use changes and practices. Today, water is allocated and withdrawn for a variety of purposes, including municipal, industrial and agricultural uses. According to the most recent assessment of the Alberta River Flow Quantity Index, long-term flows in the Battle River (based on the 10-year index average from 2000-2009) are below the normal natural flow (AENV 2011b).

In general, peak flows for the Battle River occur during the months of April and May, corresponding with annual snow melt and spring rains. The lowest flows are observed in the fall and winter. Annual flow volumes of the Battle River may vary greatly from year to year.

Climate change may also impact our watersheds in the future. Precipitation levels at Camrose for both snow and rain showed a decline from 1971-2001. Precipitation and water quantity in the Battle River watershed are directly related; apart from groundwater supplies, our watershed is dependent on the water we receive from the sky in the form of snow or rain. As precipitation levels decrease, natural flows in the Battle River may also be expected to decrease over time.

Figure 3 shows the mean monthly natural and recorded flows for the Battle River averaged for the years 1980-2004. Natural flow is the quantity of water that would have been recorded under natural conditions prior to human interference or anthropogenic impacts, while recorded flow is the quantity of water actually observed. Figure 4 shows the natural annual variability in the Battle River's flow from 1912 to 2008, compared to the average annual natural flow for those years of about 276,000 cubic decameters and Battle River watershed surface water licenses (AENV 2010).

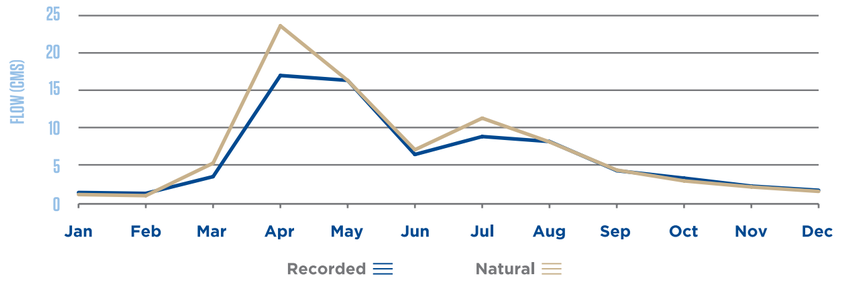


FIGURE 3 – MEAN MONTHLY NATURAL AND RECORDED FLOW (CMS: CUBIC METRES PER SECOND) FOR THE BATTLE RIVER, NEAR THE ALBERTA-SASKATCHEWAN BORDER (1980-2004)

SURFACE WATER QUANTITY

When speaking about water allocations, it is important to distinguish between licensed water allocation and licensed water use or consumption. Licensed water allocation refers to the total volume of water that may be diverted from a given water source by a license holder. Licensed water use refers to the amount of water that may be permanently removed from the aquatic ecosystem by a license holder.

In terms of surface water allocation, the Battle River is over allocated. In an average year, the natural flow of the Battle River amounts to about 276,000 cubic decametres per year. In 2010, about 750,000 cubic decametres of surface water were allocated in the Battle River watershed (AENV 2010).

About 90% of this water is allocated to ATCO Power for use at the ATCO Power Battle River Coal-Fired Generating Station (located in the Paintearth subwatershed). Almost all of this water is returned to the Battle River after use. The water required for the generating station is stored in the Forestburg Reservoir, which was created in 1954 by a 12 metre high dam located on the Battle River.

In terms of surface water use, about 60,000 cubic decametres of water were approved for use in 2004. Battle River flows have been as low as 52,893 cubic decametres in 1930 and as high as 1,282,252 cubic decametres in 1974 (AENV 2010). In particularly dry years, such as that experienced in 1930, there may not be enough water in the Battle River to meet the present needs of water users.

Under the Master Agreement on Apportionment (1969), Alberta must ensure that 50% of the Battle River's water reaches Saskatchewan.

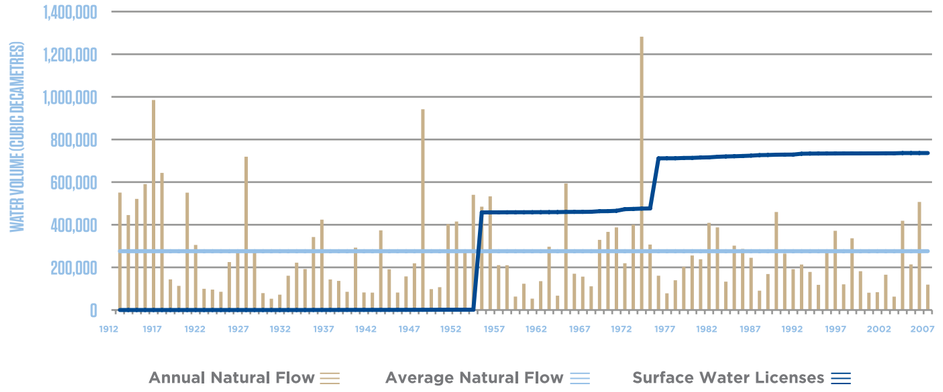


FIGURE 4 – ANNUAL NATURAL FLOW OF THE BATTLE RIVER NEAR THE AB-SK BORDER, COMPARED TO THE BATTLE RIVER AVERAGE NATURAL FLOW AND BATTLE RIVER WATERSHED SURFACE WATER LICENSES.

WHAT'S A CUBIC DECAMETRE, ANYWAYS?
A cubic decametre is the volume of a cube that has a side length of 10 metres. An Olympic-size swimming pool holds about 2.5 cubic decametres. This means that, on average, the amount of water that flows through the Battle River every year could fill over 100,000 swimming pools!

WATER QUANTITY

Our knowledge about water quality and quantity in the Sounding Creek watershed is very limited. This is an important data gap to address in the future. Even in the Battle River watershed, where more information is available, our knowledge is still incomplete. This information focuses on what we do know of water quality and quantity in the Battle River and Sounding Creek watersheds.

The charts below show the amount of surface water allocated to various uses in the Battle River watershed (AENV 2010). ATCO Power's water allocation is contained within the "commercial" category.

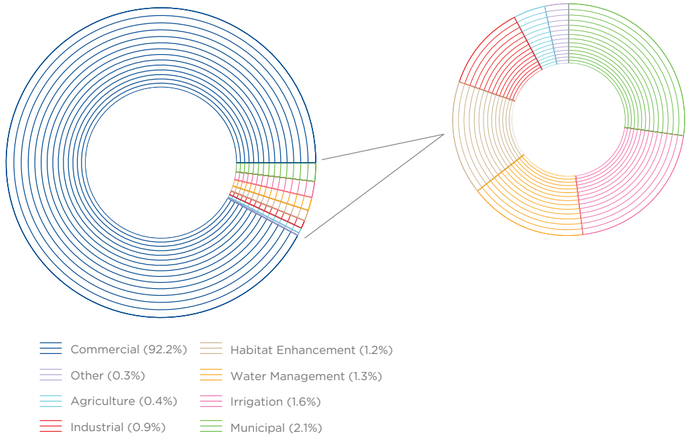


FIGURE 5 – SURFACE WATER ALLOCATION IN THE BATTLE RIVER WATERSHED

In 2010, about 26,000 cubic decametres of water were allocated in the Sounding Creek watershed (AENV 2010). Currently, it is unclear how much surface water is present in the Sounding Creek watershed. We also don't know what the average annual naturalized flow volume is for either Sounding Creek or Eyehill Creek (Figliuzzi 2010; Hopkinson 2001). As such, it is difficult to gauge the sustainability of our current use and management of surface water resources in the Sounding Creek watershed.

DID YOU KNOW?

The amount of surface and groundwater allocated in the Battle River and Sounding Creek watersheds does not take into account unlicensed domestic or household water use. Under Alberta's Water Act, Albertans owning or occupying land adjacent to surface water or under which groundwater exists may withdraw up to 1,250 cubic meters of water per year for domestic or household use without requiring a license. In addition, water rights in the form of registrations for traditional agriculture use allow applicants to withdraw up to 6,250 cubic meters of water per year without a license for the purpose of raising animals or applying pesticides to crops.

The chart below shows the proportion of surface water allocated to various uses in the Sounding Creek watershed (AENV 2010). Note that municipal surface water use is negligible, due to the fact that many communities rely on groundwater resources.

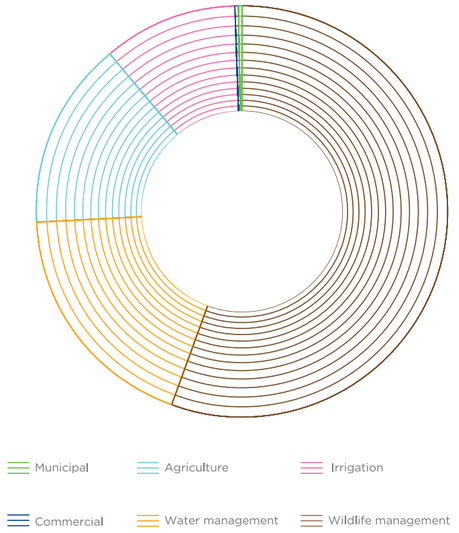


FIGURE 6 – SURFACE WATER ALLOCATION IN THE SOUNDING CREEK WATERSHED

Table 2 – 2010 maximum annual licensed surface water allocation (cubic decametres) for each watershed/subwatershed and percent of total annual allocation

	MAXIMUM ANNUAL LICENSED SURFACE WATER ALLOCATION	% TOTAL ANNUAL ALLOCATION
Bigstone	24,296	3.1
Iron Creek	13,337	1.7
Paintearth	703,906*	90.4
Ribstone	8,128	1.0
Blackfoot	2,848	0.4
Sounding Creek	26,157	3.4
Total Annual Allocation	778,672	100

*As described on page 33, most of this water is allocated to ATCO Power for use at their coal-fired generating station.

DID YOU KNOW?

When looking at total licensed surface water allocations for the Battle River watershed, about 273% of the average annual flow of the Battle River is allocated. About 22% of the Battle River's average annual flow is allocated for use or consumption.

WATER QUANTITY

INSTREAM FLOW NEEDS

Instream flow needs refers to the minimum amount of water a river or stream needs to maintain a healthy, functioning river ecosystem and sustain the life within it (Instream Flow Council 2004).

To benchmark healthy flow rates, a measure called an instream objective (IO) is used. The purpose of this IO is to minimize the impacts of water withdrawals during times of decreased water availability. If water levels drop below the IO, people with water licenses subject to the IO must stop withdrawing water until flows return to levels above the IO.

The Battle River's instream objective is 50/25. This means that from April 1 to Oct 31, a flow target of 50 cubic feet per second is considered to be the minimum acceptable flow; from Nov 1 to March 31, this number drops to 25 cubic feet per second.

Water licenses issued prior to 1992 are not subject to the IO (AENV 2010). As such, the IO does not ensure that a given amount of water will remain in the river, as senior license holders not subject to the IO can withdraw water regardless of flows, provided they do not impact the ability of someone downstream with a more senior license to withdraw water.

Discussions are underway to establish water conservation objectives for the Battle River watershed (Government of Alberta 2004). A Water Conservation Objective (WCO) defines the quantity and quality of water to remain in a river or other body of water for the protection of that water body and its aquatic environment (section 1 of Alberta's Water Act). Ideally, WCOs set for waterways in the Battle River watershed will reflect the instream flow needs of those waterways.

It has been estimated that in order to meet the instream flow need for the Battle River, the natural flow should not be reduced by more than 15%. Based on flow data for the years 1912-2008, the Battle River's natural annual flow was reduced by less than 10% about 27% of the time (26 years), by between 10-15% about 28% of the time (27 years), and by more than 15% about 45% of the time (44 years) (AENV 2010).

Table 3 – 2010 maximum annual licensed groundwater allocation (cubic decametres) for each watershed/subwatershed and percent of total annual allocation

	MAXIMUM ANNUAL LICENSED GROUNDWATER ALLOCATION	% TOTAL ANNUAL ALLOCATION
Bigstone	8,346	48
Iron Creek	2,313	13
Paintearth	812	5
Ribstone	2,051	12
Blackfoot	2,054	12
Sounding Creek	1,796	10
Total Annual Allocation	17,372	100

WATER LICENSE PRIORITY: FITFIR

In Alberta, water license priority is based on seniority (also referred to as "first in time, first in right" or FITFIR). Each license or registration is given a priority number that corresponds to the date that the application was received. The earlier the date, the more senior the license. During times of water shortage, senior license holders are entitled to their allocation of water before more junior water license holders, regardless of the purpose of water use.

GROUNDWATER QUANTITY

Groundwater is found beneath the surface of the earth and exists in soil pores and in the fractures of rock formations. Groundwater sources are more commonly called aquifers; these deposits of water are fed from above ground, purified, and returned to the surface through springs, wetlands or wells.

In 2010, about 15,600 cubic decametres of groundwater were allocated in the Battle River watershed. Municipal and agricultural uses accounted for about 80% of total allocations, with industrial, commercial and other uses accounting for the remainder (AENV 2010).

In the same year, about 1,800 cubic decametres were allocated in the Sounding Creek watershed. Here, municipal and agricultural uses accounted for about 90% of total allocations (AENV 2010).

The charts below show the proportion of ground water allocated to various uses in the Battle River and Sounding Creek watersheds. Table 3 shows groundwater allocation by watershed/subwatershed.

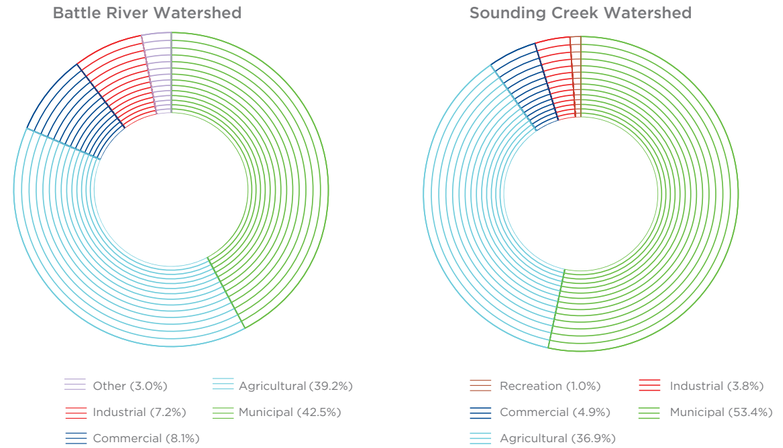


FIGURE 7 – GROUNDWATER ALLOCATION IN THE BATTLE RIVER AND SOUNDING CREEK WATERSHEDS

Although we know how much groundwater is allocated, we don't have a clear picture of how much groundwater is actually used every year, especially when unlicensed withdrawals are taken into account (see "Did You Know?" section on page 34). We also don't know how much groundwater we have in the first place, or the rate at which groundwater recharge occurs, or the quality of our groundwater resources (Parks 2006). Thus, it is difficult to gauge the sustainability of our current use and management of groundwater resources. These are significant gaps in our knowledge that should be addressed in order to ensure ongoing, sustainable access to this resource.

WATER QUALITY

Apart from residential water quality monitoring, no long-term water quality monitoring takes place in the Sounding Creek watershed. It is important to address this data gap in order to learn about potential water quality issues in this watershed.

Where do the nutrients come from?

Excess nutrients may enter waterbodies and waterways through runoff and erosion from agricultural land. Household sources of nutrients may include lawn fertilizers, septic systems and cleaning supplies such as dishwashing and laundry detergents. Landfills and industrial and municipal sewer and wastewater systems may also contribute phosphorus and nitrogen to our water systems.

The Alberta River Water Quality Index (AENV 2011a) reports on water quality at two locations along the Battle River: 1) Battle River at Highway 53 and 2) Battle River at Driedmeat Lake, both in the Bigstone subwatershed. Based on water quality testing at these locations in 2008/09, the Battle River received an overall rating of fair, meaning that federal and provincial guidelines for metals, nutrients, bacteria and pesticides were sometimes exceeded by moderate amounts, with water quality occasionally departing from desirable levels.

Nutrients appear to pose the greatest threat to water quality in the Battle River, with nutrient levels receiving a rating of *marginal* in 2007/08 and poor in 2008/09.

Table 4 – Alberta River Water Quality Index Scores, 2007-2009

2008-2009

RIVER LOCATION	SUB-INDEX VALUES (0-100)				OVERALL INDEX
	Metals	Nutrients	Bacteria	Pesticides	
Battle River at Hwy 53	90	31	72	93	72
Battle River at Driedmeat Lake	91	29	100	78	75

2007-2008

RIVER LOCATION	SUB-INDEX VALUES (0-100)				OVERALL INDEX
	Metals	Nutrients	Bacteria	Pesticides	
Battle River at Hwy 53	97	60	71	83	78
Battle River at Driedmeat Lake	91	29	91	64	73

96-100	**Excellent** Guidelines almost always met; best quality
81-95	**Good** Guidelines occasionally exceeded, but usually by small amounts; threat to quality is minimal
66-80	**Fair** Guidelines sometimes exceeded by moderate amounts; quality occasionally departs from desirable levels
46-65	**Marginal** Guidelines often exceeded, sometimes by large amounts; quality is threatened, often departing from desirable levels
0-45	**Poor** Guidelines almost always exceeded by large amounts; quality is impaired and well below desirable levels; worst quality

Surface water quality monitoring from 2004-2005 for eleven stations along the Battle River confirms these ratings. Canadian Water Quality Guidelines for phosphorus were exceeded more than 50% of the time at all stations and 100% of the time at seven of the stations. Guidelines for nitrogen were also exceeded more than 50% of the time at all but one of the stations (Teichreb 2011).

Other water quality issues of concern include low levels of dissolved oxygen, as well as pH levels and fecal coliform counts that sometimes exceed guidelines.

Table 5 – Compliance with Surface Water Guidelines, December 2004 - October 2005

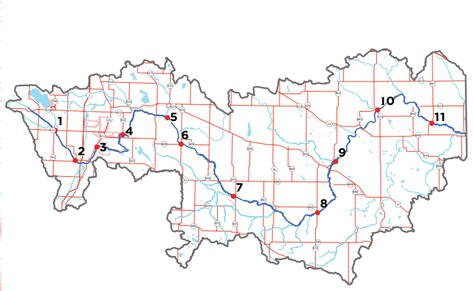
		STN. 1 HWY 611	STN. 2 ABOVE PONOKA	STN. 3 BELOW PONOKA	STN. 4 HWY 822	STN. 5 ABOVE DRIEDMEAT L.	STN. 6 BELOW DRIEDMEAT L.	STN. 7 BIGKNIFE PP	STN. 8 HWY 872	STN. 9 HWY 881	STN. 10 HWY 41	STN. 11 HWY 897
NUTRIENTS	**GUIDELINE (MG/L)**											
Total phosphorus	aquatic life (0.05)	100	100	100	100	100	100	100	75	63	67	89
Total nitrogen	aquatic life (1)	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)	0	0	22	11	0	0	0	0	0	0	0
BACTERIA	**GUIDELINE (#/100 ML)**											
Fecal coliforms	irrigation (100)	20	27	10	0	0	30	0	30	40	20	10
	recreation (200)	10	0	0	0	0	20	10	10	0	10	10
PHYSICAL	**GUIDELINE**											
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

Canadian Water Quality Guidelines exceeded more than 50% of the time
Canadian Water Quality Guidelines exceeded up to 50% of the time
Canadian Water Quality Guidelines never exceeded

NUTRIENTS: WHAT'S THE BIG DEAL?

Nutrients, such as phosphorus and nitrogen, are essential building blocks of life. One key feature of nutrients is that they help plants to grow. While this is beneficial on the land, plant growth in water can be very harmful to aquatic ecosystems. Excess nutrient levels may lead to excessive aquatic plant and algae growth, also known as "algal blooms". Algae blooms can lead to severe fluctuations in dissolved oxygen levels. Fish and other aquatic organisms depend on this dissolved oxygen to live, and decreased oxygen levels increase the stress of these organisms. Excessive aquatic plant growth can also clog water intake pipes, interfere with recreational activities, and lead to increased water treatment costs. The decay of plant material may also result in bad odours and a bad taste in drinking water.

WATER QUALITY MONITORING STATIONS



WETLANDS AND RIPARIAN HEALTH

Table 6 – Riparian health assessment scores, based on aerial videography results (except Ribstone, based on Cows and Fish data)

	RIPARIAN HEALTH SCORE (%)	HEALTH CATEGORY
Bigstone	59.2	FAIR
Iron Creek	62.7	FAIR
Paintearth	67.7	FAIR
Ribstone	70.0	FAIR
Blackfoot	66.4	FAIR
Sounding Creek	NO DATA	

Examples of healthy (top) and unhealthy (bottom) riparian areas

The health of wetlands and riparian areas is closely linked to issues of water quality, water quantity, and biodiversity.

Essentially, a 'wetland' is any area that is wet for at least part of the year. Wetlands are places where enough water collects to support aquatic plants and processes.

A 'riparian area' is the critical buffer between a body of water and the land beside it. In other words, riparian areas include things like river or stream banks, shorelines, and the edges of wetlands.

Healthy wetlands and riparian areas and the lush vegetation they support play a key role in purifying our water through filtering and reducing surface water runoff from surrounding uplands and trapping sediment and sediment-associated pollutants such as nutrients, pesticides and bacteria (see Table 7). They also work to store water, which helps mediate the effects of both floods and drought. This water storage capacity also results in an increased amount of water that filters through the soil and into groundwater systems (Ducks Unlimited Canada 2004).

Wetlands and riparian areas also support high levels of biodiversity. Almost two-thirds of Canada's rare and endangered species and over 80% of Alberta's bird species rely on riparian areas for all or part of their life cycle (Cows and Fish 2002). Wetlands are among the most productive ecosystems in the world and are second only to rainforests in the level of biodiversity that they harbour!

Table 7 – Range of percent retention for nitrogen, phosphorus, sediment, coliforms and pesticides in natural wetlands (Ducks Unlimited Canada, 2004)

	RETENTION (%)
Nitrogen • Nitrate	UP TO 87%
• Ammonium	UP TO 76%
Phosphorus	UP TO 94%
Sediment	UP TO 98%
Coliforms (constructed wetlands)	UP TO 99%
Pesticides	<1 DAY - SEVERAL MONTHS[1]

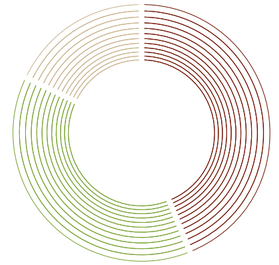
[1] *Time for residues to decrease by 50%*

UNFORTUNATELY, OUR WETLANDS AND RIPARIAN AREAS ARE SHOWING SIGNS OF STRESS.

Research suggests that wetland loss throughout the Battle River and Sounding Creek watersheds is significant and ongoing and represents a threat to the health and function of these watersheds. In 2005, a comprehensive drained wetland inventory was completed for the entire Iron Creek subwatershed. This inventory showed that in 2005 only 33% of the pre-1963 wetland area remained intact in the Iron Creek subwatershed. An inventory of select regions of the Bigstone subwatershed showed that in these regions only 18% of the pre-1963 wetlands remained intact in 2003. Annual wetland loss in the settled areas of Alberta has been estimated at between 0.3% and 0.5% of remaining wetland area (Alberta Water Council 2008).

Riparian areas are also suffering as a result of various land use practices. In 2007 and 2008, aerial videography was carried out for the entire Alberta length of the Battle River (Teichreb and Walker 2008). Essentially, this aerial videography used video footage captured via low-level flights to assess the health and integrity, or ecological condition, of the riparian areas of the Battle River. On average, 39% of the Battle River's riparian areas were rated as good/healthy, 18% as fair/moderately impaired and 43% as poor/highly impaired (see Figure 8). Table 6 shows a summary of riparian health by subwatershed, based on aerial videography results (with the exception of the Ribstone subwatershed, based on Cows and Fish data) (Teichreb and Walker 2008; Cows and Fish 2010).

FIGURE 8 – AERIAL VIDEOGRAPHY RIPARIAN HEALTH ASSESSMENT SCORES FOR THE BATTLE RIVER MAINSTEM



39% Good
18% Fair
43% Poor

GOOD/HEALTHY
80-100%
Little or no impairment to any riparian functions

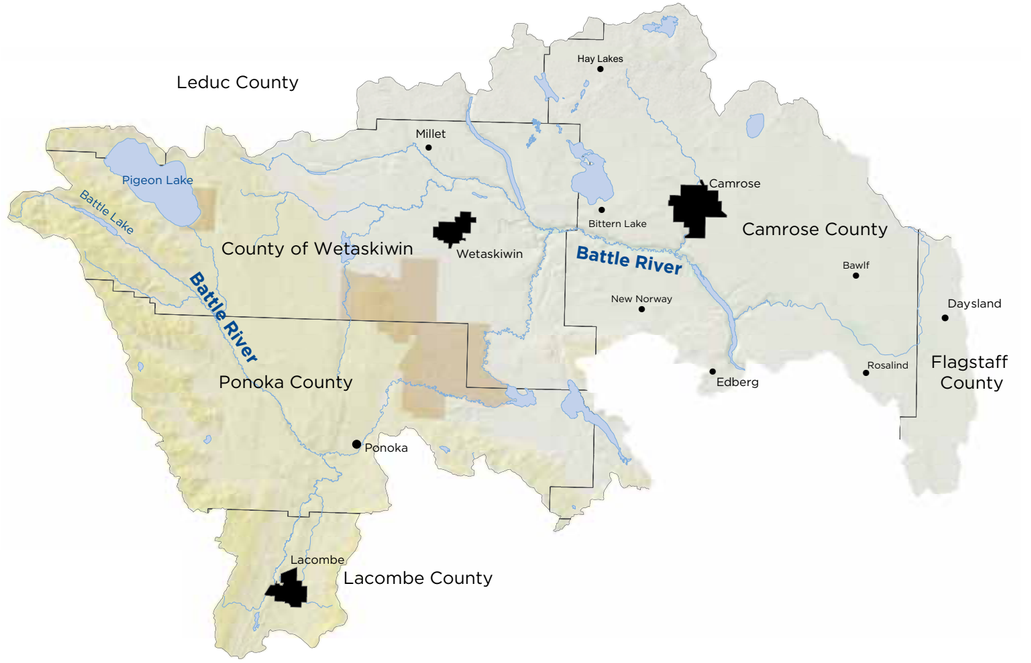
FAIR/MODERATELY IMPAIRED
49-79%
Some impairment to riparian functions

POOR/HIGHLY IMPAIRED
<49%
Severe impairment to riparian functions

A CLOSER LOOK

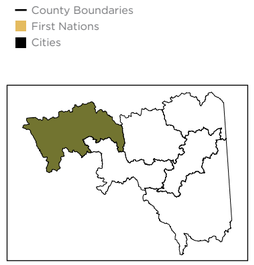
The following sections provide an overview of the Sounding Creek watershed and each of the five subwatersheds of the Battle River watershed.

BIGSTONE
SUBWATERSHED



Bigstone is the western-most subwatershed of the Battle River watershed. It is also home to the headwaters of the Battle River, which originates at Battle Lake. In terms of both area and population, it is the largest watershed.

Bigstone encompasses about 7250 square kilometres. In 2006 Bigstone had a population of about 77,000 people, which represents about two-thirds of the population of the Battle River and Sounding Creek watersheds (Watrecon 2010). Bigstone also accounts for 54% of economic output in these watersheds, at $5.19 billion per year (Anielski and Watrecon 2011). Despite this, per capita gross domestic product (GDP per person) in Bigstone is the lowest of all the Battle River subwatersheds and the Sounding Creek watershed.



In terms of employment, less than 20% of the workforce was employed in agriculture and other resource-based industries in 2006. Understandably, the proportion of Bigstone's rural population employed in these industries was greater, accounting for between 44 and 58 percent of rural employment. The majority of the workforce was employed in service industries (Watrecon 2010).

Bigstone contains portions of the counties of Camrose, Flagstaff, Lacombe, Leduc, Ponoka and Wetaskiwin. Its three cities, Camrose, Lacombe and Wetaskiwin, account for nearly 50% of the subwatershed's population. About a quarter of Bigstone's population lives in rural areas. Also located within its borders are the First Nations' reserves of Louis Bull 138B, Samson 137, Samson 137A, Ermineskin 138, Montana 139, and Pigeon Lake 138A (tan shading on map).

The Bigstone subwatershed is located within the Dry Mixed Wood and Central Parkland natural subregions of Alberta. As such, it contains the largest portion of the Battle River and Sounding Creek watersheds' coniferous (57%), deciduous (41%) and mixed (72%) forests (AAFC 2001). These forests contribute significantly to the carbon sequestration capacity of our watersheds.

80.5% of Bigstone's land area is developed in the sense that it is devoted to agricultural land uses (annual and perennial crop and pasture land; 78.9%) and otherwise developed land (urban development, roads, etc.; 1.6%). In the larger context of the total area of the Battle River and Sounding Creek watersheds, Bigstone contains 40% of the settled and built-up lands (urban development, highways, etc.), though it comprises only 20% of the total land area of these watersheds (AAFC 2001).

Based on preliminary estimates, Bigstone is second only to the Sounding Creek watershed in the ecological goods and services it provides. The value of these services amounts to $1.47 billion per year (Anielski and Watrecon 2011).

THE BIGSTONE SUBWATERSHED IS HOME TO:

3 major dams and 29 minor dams

57 freshwater springs

24 "Environmentally Significant Areas" covering an area of about 430 square kilometres (about 6% of the subwatershed)

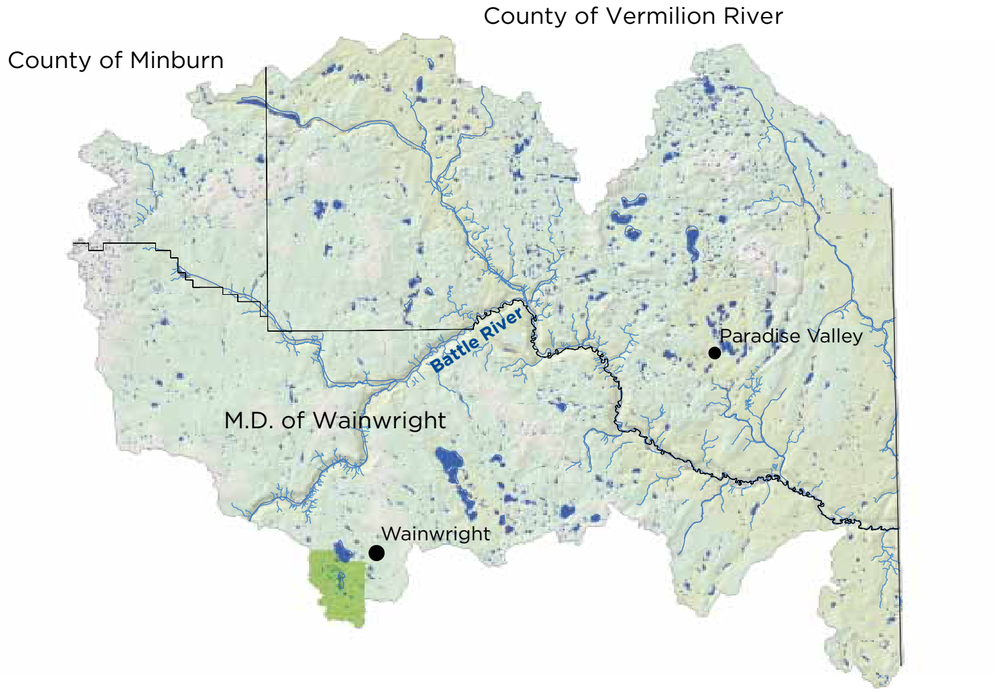
9,260 KM of roads, 385 km of railway lines, and 310 km of power lines

4 Crown reservations, 2 provincial parks, 3 recreation areas and 4 natural areas, which together comprise about 0.4% of the subwatershed

5,000 active oil and gas wells and 7000 km of oil and gas pipelines

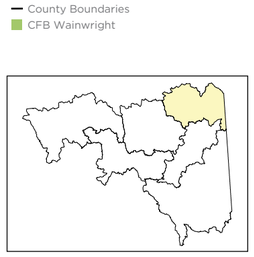
440-570 MM annual precipitation
(based on records from 1970-2000)

BLACKFOOT
SUBWATERSHED



The Blackfoot subwatershed is located within the Central Parkland natural subregion of Alberta. It is the most north-eastern subwatershed and encompasses an area of about 4320 square kilometres. Blackfoot's boundaries encompass portions of the County of Minburn, the County of Vermilion River, and the M.D of Wainwright.

In 2006, just over 10,300 people, or about 8% of the population of the Battle River and Sounding Creek watersheds, called Blackfoot home. The majority (52.6%) of these people lived in Wainwright, while 45.6% lived in rural areas. The balance lived in Paradise Valley (Watrecon 2010). The eastern portion of the Canadian Forces Base at Wainwright is also located within this subwatershed, encompassing an area of about 40 square kilometres.



Non-basic industries such as retail trade, health care and social services, and business services account for more than 60% of employment in the Blackfoot subwatershed. The agriculture and resource-based industries account for about 27% of the subwatershed's employment; however, this percentage reached 46% in the County of Minburn, 44% in the MD of Wainwright and just under 40% in the County of Vermilion River (Watrecon 2010). This translates into land use that is dominated by annual and perennial crop and pasture land. With 82% of its land area devoted to agricultural land uses (81%) and otherwise developed land (1%), it is the second most developed subwatershed (AAFC 2001).

The Battle River Trestle Bridge, located near Wainwright, Alberta.

The value of economic activity in the Blackfoot subwatershed was $918.5 million in 2007. However, Blackfoot generated the lowest value of ecological goods and services, at $435.5 million per year (Anielski and Watrecon 2011).

THE BLACKFOOT SUBWATERSHED IS HOME TO:

2 Crown reservations, which comprise just 0.07% of the subwatershed

4,425 KM of roads, 70 km of railway lines, and 175 km of power lines

41 minor dams

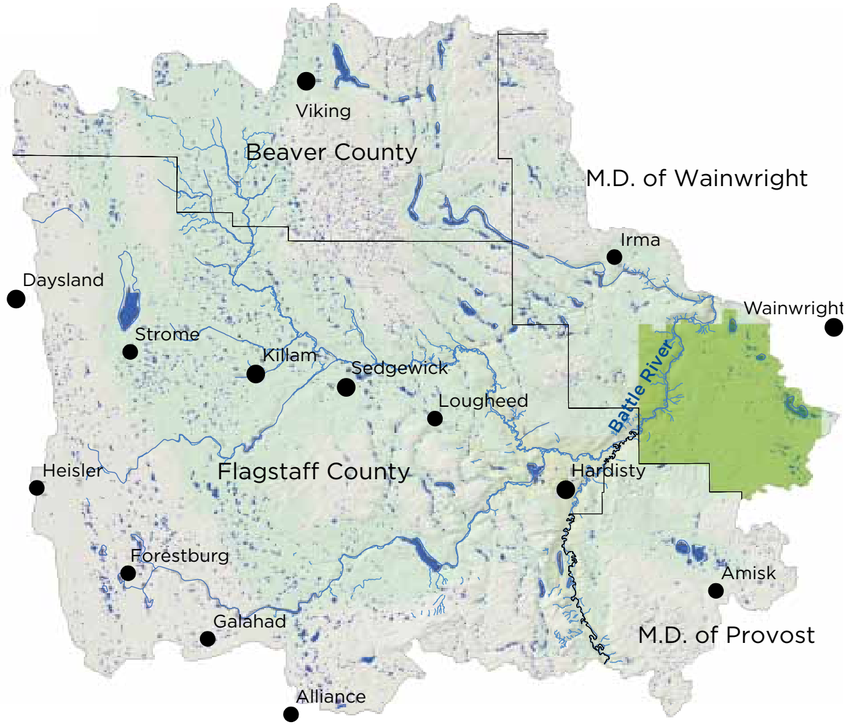
15 freshwater springs

16 "Environmentally Significant Areas" covering an area of about 650 square kilometres (about 15% of the subwatershed)

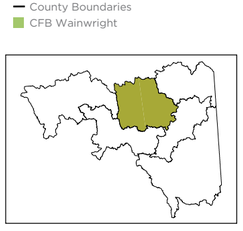
6,195 active oil and gas wells and about 4720 km of oil and gas pipelines

390-436 MM annual precipitation
(based on records from 1970-2000)

IRON CREEK
SUBWATERSHED



With a population of about 11,300 people, the Iron Creek subwatershed is home to roughly 9% of the people of the Battle River and Sounding Creek watersheds. Communities within this subwatershed include Viking, Killam, Forestburg, Sedgewick, Hardisty, Irma, Strome and Lougheed. The Iron Creek subwatershed contains portions of Beaver County, the County of Minburn, Flagstaff County, the M.D. of Provost, and the M.D. of Wainwright. Nearly half of the population lives in rural areas, with the remainder living in the subwatershed's various towns and villages (Watrecon 2010).



The Iron Creek subwatershed covers an area of over 5540 square kilometres within the Central Parkland natural subregion of Alberta. It is the most developed subwatershed in terms of land area devoted to agricultural land uses (83.6%) and otherwise developed lands (0.7%) (AAFC 2001). In 2006, agriculture and other resource-based industries accounted for about 35% of the subwatershed's employment. Health care and social services, business services and other service industries also accounted for a substantial portion of employment (Watrecon 2010).

The Viking Ribstones, located south-east of Viking, Alberta.

After Bigstone, the Iron Creek subwatershed contributes the greatest economic output, as measured by GDP ($1.08 billion in 2007). However, the Iron subwatershed contributes only $477.6 million worth of ecosystem goods and services every year, which is one of the lowest ecological values observed in the Battle River and Sounding Creek watersheds (Anielski and Watrecon 2011).

THE IRON CREEK SUBWATERSHED IS HOME TO:

6 major dams and 78 minor dams

10 freshwater springs

16 "Environmentally Significant Areas" covering on area of nearly 600 square kilometres (about 10% of the subwatershed)

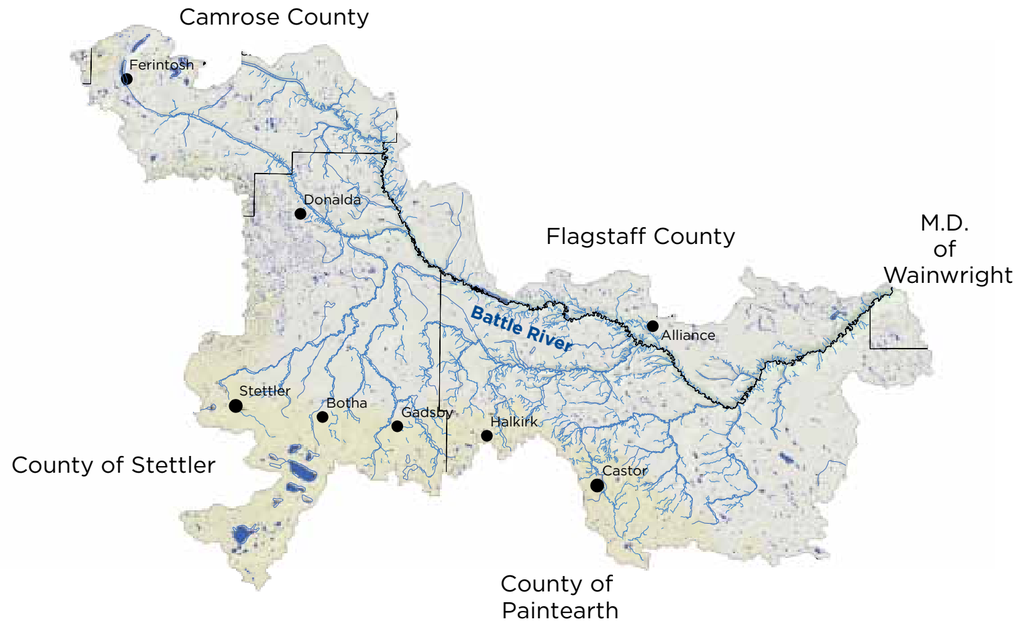
5,540 KM of roads, 190 km of railway lines and 375 km of power lines

1 Crown reservation, which comprises just 0.02% of the subwatershed

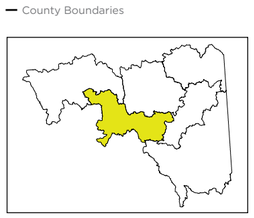
4,625 active oil and gas wells and 5495 km of oil and gas pipelines

415-445 MM annual precipitation
(based on records from 1970-2000)

PAINTEARTH
SUBWATERSHED



With a population of about 12,200 people, Paintearth is home to 10% of the population of the Battle River and Sounding Creek watersheds. Nearly half of these people live in Stettler, with the balance living in rural areas and smaller communities that dot the landscape (Watrecon 2010). Paintearth contains portions of Camrose County, the County of Paintearth, the County of Stettler, the County of Wetaskiwin, Flagstaff County and the M.D. of Wainwright. It is also home to the Forestburg Reservoir and the ATCO Power Battle River Coal-Fired Generating Station,



Paintearth is roughly 4700 square kilometres in size. 79% of Paintearth's land area is devoted to agricultural land uses (78%) and otherwise developed lands (1%). With the majority of its land area located in the Central Parkland natural subregion, Paintearth also contains nearly 30% of the Battle River watershed's coniferous forest, 15% of its deciduous forest, and 19% of its mixed forest. These forested lands account for about 6% of the subwatershed's total area (AAFC 2001). A small portion of the Paintearth subwatershed is in the Northern Fescue Grassland natural subregion.

ATCO Power Battle River Coal-Fired Generating Station.

In 2006, about 30% of Paintearth's workforce was employed in agriculture and other resource-based industries. Retail trade, health care, and business and other services also accounted for a large portion of employment (Watrecon 2010).

Economic activity was valued at $1.07 billion in 2007 which is roughly the same as that of the Iron Creek subwatershed. At the same time, Paintearth contributed slightly more ecological goods and services than the Iron Creek subwatershed, at $696.5 million per year (Anielski and Watrecon 2011).

THE PAINTEARTH SUBWATERSHED IS HOME TO:

4 major dams, 325 minor dams and 2 water control devices

22 freshwater springs

12 "Environmentally Significant Areas" covering an area of over 500 square kilometres (about 10% of the subwatershed)

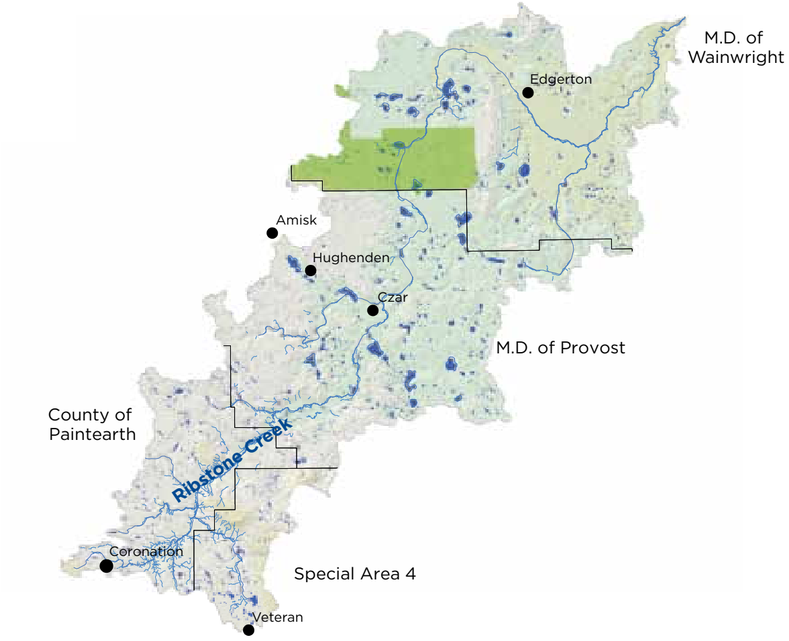
4,840 KM of roads, 265 km of railway lines, and 270 km of power lines

2 Crown reservations, 1 recreation area, and 1 provincial park, which together comprise just 0.2% of the subwatershed

4,050 active oil and gas wells and 4095 km of oil and gas pipelines

410-490 MM annual precipitation (based on records from 1970-2000)

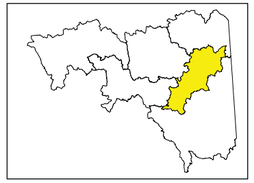
RIBSTONE
SUBWATERSHED



About 4,420 people, or about 4% of the people of the Battle River and Sounding Creek watersheds, call the Ribstone subwatershed home. Almost 60% of the population live in the rural parts of the subwatershed, while another 23% live in the town of Coronation (Watrecon 2010). Other communities in this subwatershed include Edgerton, Hughenden, Veteran and Czar. Ribstone contains portions of the County of Paintearth, the M.D. of Provost, the M.D. of Wainwright and Special Area 4.

With the exception of the Sounding Creek watershed, Ribstone is the least developed subwatershed, with 68.6% of its land area devoted to agricultural land uses and 0.5% to otherwise developed lands. Ribstone contains 22% of the shrubland of the Battle River and Sounding Creek watersheds (AAFC 2001). It is also the smallest subwatershed, covering an area of about 3700 square kilometres in the Central Parkland natural subregion of Alberta.

— County Boundaries
■ CFB Wainwright



With 40% of its workforce working in agriculture or other resource-based industries, Ribstone is second only to the Sounding Creek watershed in the proportion of its workforce that is employed in these industries. In the M.D. of Provost and the County of Paintearth, over 50% of the workforce is employed in these industries. Service industries, most notably business, health care and social services, also contribute a great deal to employment (Watrecon 2010).

Ribstone contributes the least amount of economic activity, valued at $497.3 million in 2007. Ecological goods and services account for another $483 million per year (Anielski and Watrecon 2011).

THE RIBSTONE SUBWATERSHED IS HOME TO:

3 major dams and 81 minor dams

17 freshwater springs

13 "Environmentally Significant Areas" covering an area of over 800 square kilometres (about 22% of the subwatershed)

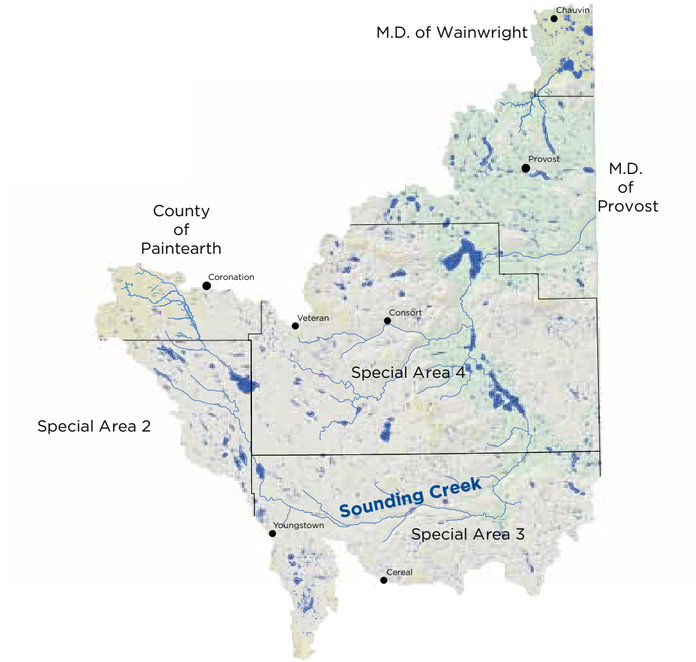
3,035 KM of roads, 145 km of railway lines and 210 km of power lines

2 crown reservations, 1 natural area and 1 ecological reserve, which together comprise about 3% of the subwatershed

3,465 active oil and gas wells and 3330 km of oil and gas pipelines

410-490 MM annual precipitation (based on records from 1970-2000)

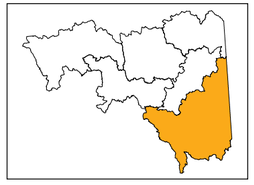
SOUNDING CREEK
WATERSHED



The Sounding Creek watershed covers an area of over 10,300 square kilometres; however, with a population of only 7,300, it is home to just 6% of the population of the Battle River and Sounding Creek watersheds. About half of the residents of the watershed live in rural areas, while the other half live in urban areas, such as Provost, Chauvin and Youngstown (Watrecon 2010). The Sounding Creek watershed contains portions of the County of Paintearth, the M.D. of Provost, the M.D. of Wainwright, and Special Areas 2, 3 and 4.

The Sounding Creek watershed is located predominantly in the Northern Fescue and Dry Mixedgrass Grassland natural subregions of Alberta. It is unique in that it is essentially a closed basin. Though there is a prehistoric spillway from Manito Lake (Saskatchewan) to the Battle River, no outflow has been observed since European settlement (Partners FOR the Saskatchewan River Basin 2009). This watershed is also unique in that it contains portions of Special Areas 2, 3 and 4. These areas were established under the Special Areas Act in 1938 due to extreme hardship of the drought years of the 1930s.

— County Boundaries



By area, the Sounding Creek watershed is home to 31% of the water and 50% of the wetlands found within the Alberta portion of our watersheds. It also contains an incredible 63% of the Battle River and Sounding Creek watersheds' native grassland (AAFC 2001). It is not surprising that, compared to the subwatersheds of the Battle River watershed, the Sounding Creek watershed provides the greatest value of ecological goods and services, providing nearly $1.5 billion worth every year! In comparison, the Sounding Creek watershed contributes the second lowest value of economic activity, at $859.5 million in 2007 (Anielski and Watrecon 2011).

Compared to the Battle River's subwatersheds, the Sounding Creek watershed is the least developed, with approximately 63% of its land area devoted to agricultural land uses (AAFC 2010). However, agriculture and other resource-based industries account for about 45% of the watershed's employment, a greater proportion than in any of the Battle River's subwatersheds. In addition, average GDP per capita is higher than that of each of the 5 subwatersheds of the Battle River. Nearly 80% of the Sounding Creek watershed's GDP comes from employment in basic industries, such as agriculture, oil and gas, utilities, construction and manufacturing. Mining and oil and gas extraction alone accounts for 63% of economic activity in the Sounding Creek watershed (Anielski and Watrecon 2011; Watrecon 2010).

THE SOUNDING CREEK WATERSHED IS HOME TO:

8 major dams and 250 minor dams and 1 water control device

34 freshwater springs

18 "Environmentally significant areas" covering an area of over 2000 square kilometres (about 20% of the watershed)

7,560 KM of roads, 295 km of railway lines and 200 km of power lines

2 Provincial parks, 3 crown reservations, and 1 natural area, which together comprise 0.5% of the watershed

12,190 active oil and gas wells and 11,045 km of oil and gas pipelines

PUTTING WORDS INTO ACTION.

A PATH FORWARD

As pressures on our watershed continue to mount, the need for decisive action grows. The issues of water quality and quantity management and monitoring need to be at the forefront of any discussions regarding the health and wellbeing of our economy, our environment and our communities. In preparing this report, many channels for action became apparent. Counties and municipalities can continue their work of implementing bylaws, policies and plans that take into account the overall health of our watersheds. Government at all levels can consider taking further action on important watershed issues such as the restoration and protection of wetlands and riparian areas, as well as the protection of key wildlife habitats and ecosystems. Watershed residents can learn more about their watershed, become engaged in these conversations, and take action in improving our watershed and ensuring its continued health.

PLANNING

The Battle River Watershed Alliance will continue to lead watershed planning in partnership with communities, landowners, governments and other key stakeholders within the Battle River and Sounding Creek watersheds. This report provides us with important baseline information that will support the development of a watershed management plan.

EDUCATION

This report is also an important tool for increasing watershed education and awareness. It will inform the BRWA's own education and outreach efforts, but we are all stewards of the Battle River and Sounding Creek watersheds and we encourage watershed residents to put this report to use! Share this information with others, whether with your local government, local agricultural producers, or your next door neighbour. Take this information into our schools, so that our children may begin to learn the value of the watershed they live in.

STEWARDSHIP

Local action and involvement on the part of individuals and communities is essential to watershed protection. Concerned residents should consider forming a local watershed stewardship group or becoming involved with one that already exists. For more information on stewardship groups currently active in our watersheds, visit the BRWA website at **battleriverwatershed.ca**. Also, consider becoming involved with these organizations (among others!) taking action on environmental issues in our watershed and beyond: Alberta Fish and Game Association, Water Matters, Nature Conservancy of Canada, Ducks Unlimited Canada, Cows and Fish, Alberta Conservation Association, Alberta Ecotrust, and the Alberta Stewardship Network.

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Base Data provided by Spatial Data Warehouse Ltd.

Well site Data and Raw Pipeline Data provided by IHS Energy (Canada) Ltd.

2001 Landcover Data provided by Agriculture and Agrifood Canada

Aerial videography: *carried out in the Battle River watershed in 2007 and 2008; used videography captured via low-level flights to assess the health and integrity, or ecological condition, of the riparian areas of the Battle River.*

Annual crop: *annually cultivated cropland and woody perennial crops. Includes annual field crops, vegetable, summer fallow, orchards and vineyards.*

Basin: *see watershed.*

Battle River watershed: *a subbasin of the North Saskatchewan River basin; comprised of five subwatersheds (Bigstone, Blackfoot, Iron, Paintearth, Ribstone).*

Biodiversity: *describes the variety of life on Earth. This variety may be found within one species (variety of genes), among various species (variety or number of species), or among ecosystems (variety or number of ecosystem types). High levels of biodiversity are associated with greater ecosystem stability.*

Carbon sequestration: *the process of removing carbon from the atmosphere and depositing it in a reservoir. For example, trees capture and store carbon through the process of photosynthesis.*

Contributing area: *the area in a drainage basin or watershed that contributes water to streamflow or recharge to an aquifer.*

Crown reservation: *a registered interest in land(s) by Parks and Protected Areas Division of the Government of Alberta, to which conditions to industrial activity may apply.*

Cubic decametre: *the volume of a cube that has a side length of 10 metres. Another commonly used measure of volume is the acre-foot, which is the volume of one acre of surface area to a depth of one foot.*

Dam: *a barrier constructed on a water body for water storage, control or diversion purposes.*

Developed land: *consists of annual and perennial crop and pasture land, exposed (bare) ground, urban areas, and otherwise built-up lands (such as roads).*

Drained wetland inventory: *high resolution, historic and current aerial photography is used to determine the change in wetland over time.*

Ecological Goods and Services: *(EG&S) ecological goods and services, also referred to as ecosystem services, are the benefits that people obtain, either directly or indirectly, from a multitude of resources and processes that are provided by natural ecosystems. Ecosystem services can be measured in ecological (biophysical) terms and they can also be translated into economic terms through valuation studies.*

Ecological Reserves: *preserve and protect natural heritage in an undisturbed state for scientific research and education. Ecological reserves contain representative, rare and fragile landscapes, plants, animals and geological features. The primary intent of this class is strict preservation of natural ecosystems, habitats and features, and associated biodiversity. Ecological reserves serve as outdoor laboratories and classrooms for scientific studies related to the natural environment. Public access to ecological reserves is by foot only; public roads and other facilities do not normally exist and will not be developed. Most ecological reserves are open to the public for low-impact activities such as photography and wildlife viewing.*

Environmentally Significant Areas (ESAs): *represent places in Alberta that are important to the long-term maintenance of biological diversity, soil, water, or other natural processes, at multiple spatial scales. They are identified as areas containing rare or unique elements in the province, or areas that include elements that may require special management consideration due to their conservation needs. ESAs do not represent government policy and are not necessarily areas that require legal protection, but instead are intended to be an information tool to help inform land use planning and policy at local, regional and provincial scales.*

FITFIR: *("first in time, first in right") In Alberta, water license priority is based on seniority (also referred to as "first in time, first in right" or FITFIR). Each license or registration is given a priority number that corresponds to the date that the application was received. The earlier the date, the more senior the license. Senior license holders are entitled to their allocation of water before more junior water license holders, regardless of the purpose of water use.*

General Status of Alberta Wild Species – Categories:

At Risk *Any species known to be at risk after formal detailed status assessment and legal designation as Endangered or Threatened in Alberta.*

May Be At Risk *Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment.*

Sensitive *Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.*

Undetermined *Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status.*

Not Assessed *Any species that has not been examined during this exercise.*

Exotic/Alien *Any species that has been introduced as a result of human activities.*

Extirpated/Extinct *Any species no longer thought to be present in Alberta (Extirpated) or no longer believed to be present anywhere in the world (Extinct).*

Accidental/Vagrant *Any species occurring infrequently and unpredictably in Alberta, i.e., outside its usual range.*

Gross domestic product (GDP): *refers to the market value of all final goods and services produced within a given area in a given period. It is often considered an indicator of a country's standard of living.*

Index of Biological Integrity (IBI): *index used for assessing the health of aquatic ecosystems. Through the IBI study carried out on the Battle River in 2006 and 2007, an IBI specific to the Battle River was developed.*

Instream Flow Needs: *This is the scientifically determined amount of water, flow rate, water level, or water quality that is required in a river or other body of water to sustain a healthy aquatic environment or to meet human needs such as recreation, navigation, waste assimilation, or aesthetics.*

Land use: *the human management and modification of the natural environment into built environments such as fields, pastures, and settlements*

Licensed water allocation: *Under a water license, the maximum allowable volume of water to be diverted from the aquatic ecosystem.*

Licensed water use: Under a water license, the maximum allowable volume of water to be permanently removed from the aquatic ecosystem.

Natural areas: *preserve and protect sites of local significance and provide opportunities for low-impact recreation and nature appreciation activities. Natural areas include natural and near-natural landscapes of regional and local importance for nature-based recreation and heritage appreciation. Natural areas are typically quite small; however, larger sites can be included in this class. Most natural areas have no facilities and in those that do, facilities are minimal and consist mainly of parking areas and trails.*

Natural Region: *extensive land mass (of the order of 20,000 km²) characterized by permanent geographic boundaries and a certain uniformity and individuality of climatic, topographical, geomorphological and biological conditions. Natural regions are comprised of smaller land masses called natural subregions.*

Non-contributing area: *the area in a drainage basin or watershed that does not contribute water to streamflow or recharge to an aquifer.*

Perennial crop and pasture: *periodically cultivated cropland. Includes tame grasses and other perennial crops such as alfalfa and clover grown alone or as mixtures for hay, pasture or seed.*

Protected areas: *For the purposes of this report, protected areas may include any of the following (as defined by the Government of Alberta): ecological reserves, crown reservations, wilderness areas, provincial and national parks, heritage rangelands, natural areas and recreation areas.*

Provincial Parks: *preserve natural heritage; they support outdoor recreation, heritage tourism and natural heritage appreciation activities that depend upon and are compatible with environmental protection. Provincial parks protect both natural and cultural landscapes and features. They are distinguished from wildland parks by their greater range of outdoor recreation facilities, the extent of road access, and the interpretive and educational programs and facilities that are available to visitors. Outdoor recreation activities that promote appreciation of a park's natural heritage and cultural features are encouraged. Provincial parks offer a variety of outdoor recreation opportunities and support facilities.*

Recreation Areas: *support outdoor recreation and tourism; they often provide access to lakes, rivers, reservoirs and adjacent Crown land. Recreation areas support a range of outdoor activities in natural, modified and man-made settings. They are managed with outdoor recreation as the primary objective. Some areas are intensively developed, while others remain largely undeveloped. Many recreation areas play a significant role in management of adjacent Crown lands and waters by localizing the impact of development and serving as staging areas.*

Riparian areas: *the lands adjacent to streams, rivers, lakes and wetlands, where vegetation and soils are strongly influenced by the presence of water.*

Rural: *refers to those areas outside of any city, town, village, summer village, or Native reserve.*

Sounding Creek watershed: *a subbasin of the North Saskatchewan River basin; falls within the planning boundaries of the Battle River Watershed Alliance.*

Sustainability: *meeting the needs of the present without compromisin g the ability of future generations to meet their needs.*

Topography: *the physical configuration of the surface of the land, including its elevation, slope and orientation.*

Undeveloped (natural) land: *consists of land covered by water, shrublands, wetlands, native grasslands and flowers.*

Urban: *refers to any city, town, village, summer village, or Native reserve.*

Water Conservation Objective (WCO): *As defined in Alberta's Water Act, a Water Conservation Objective is the amount and quality of water necessary for the: 1) protection of a natural water body or its aquatic environment, 2) protection of human needs such as recreation, navigation, and waste assimilation, and 3) management of fish and wildlife, which may include water necessary to maintain a particular rate of flow or water level.*

Water License: *A water license provides the authority for diverting and using surface water or groundwater. The license identifies the water source, the location of the diversion site, the amount of water to be diverted and used from that source, the priority of the "water right" established by the license, and the condition under which the diversion and use must take place.*

Watershed: *an area of land that catches precipitation, such as snow and rain, and drains it to a larger body of water, such as a marsh, lake, stream or river. May also be referred to as a drainage basin, catchment basin or area, or river basin. Subwatersheds drain smaller areas of land within the larger watershed.*

Wetland: *land having water at, near, or above the land surface, or which is saturated with water long enough to promote wetland or aquatic processes.*

BATTLE RIVER
WATERSHED ALLIANCE

STATE OF THE WATERSHED REPORT FOR THE BATTLE RIVER AND SOUNDING CREEK WATERSHEDS 2011

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