North Saskatchewan Watershed Alliance

Atlas of the North Saskatchewan River Watershed in Alberta

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The North Saskatchewan Watershed Alliance (NSWA) is a non-profit society whose purpose is to contribute to the protection of water quality, water supplies, ecosystem function and improved watershed health through the collaborative efforts of all stakeholders and interested individuals.

NSWA is guided by a Board of Directors composed of representatives of member organizations from within the watershed. It is the designated Watershed Planning and Advisory Council (WPAC) for the North Saskatchewan River under the Government of Alberta's *Water for Life Strategy*.

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Disclaimer

The maps in this Atlas were created by compiling, evaluating and displaying the best available data for the purpose of improving general awareness about the watershed. These maps are not appropriate for addressing site-specific issues.

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Atlas of the North Saskatchewan River Watershed in Alberta

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About the North Saskatchewan Watershed Alliance

The North Saskatchewan Watershed Alliance (NSWA) was incorporated in 2000 as a not-for-profit society and provides a forum for sharing information about the North Saskatchewan River Watershed (NSRW) in Alberta. The purpose of the NSWA is to generate knowledge and advice to support the protection of water quality and ecosystem functioning throughout the NSRW. The NSWA is guided by a Board of Directors composed of representatives of member organizations from within the watershed. It is the designated Watershed Planning and Advisory Council (WPAC) for the North Saskatchewan River (NSR) under *Water for Life: Alberta's Strategy for Sustainability*. To learn more about the NSWA please see our website at www.nswa.ab.ca.

About the NSWA Atlas Project

This Atlas contains information on several watershed themes. The content has been gathered from a number of sources, including technical studies prepared by the NSWA. The information is presented in an easy to understand, high level format and presents a broad overview of the NSRW, its natural attributes and the nature of human activities in the watershed. We hope the Atlas will broaden the understanding of watershed characteristics and will raise awareness about challenges associated with managing and protecting this watershed. Readers are encouraged to refer to original reference materials for a more in-depth discussion of data, issues and management initiatives.

Acknowledgments

Preparation of this atlas would have not been possible without the extensive support NSWA members and partners, who provided both data and funding for the project. The NSWA Board of Directors would like to thank the Alberta Beef Producers; Petro-Canada; Agriculture and Agri-Food Canada (AAFC); Alberta Ecotrust; the City of Edmonton and NSWA staff for their efforts, expertise and resources. The NSWA also acknowledges Alberta Environment and Sustainable Resource Development; Alberta Agriculture and Rural Development; EPCOR; the Energy Resources Conservation Board and the Alberta Geological Survey for use of data and information.

Graham Watt, NSWA Watershed Planner, and Candace Vanin, Land Use Specialist with Agriculture and Agri-Food Canada, led the project and developed the maps. Melissa Logan, David Trew and Billie Milholland assisted in developing the text for the atlas. Gordon Thompson, Tom Cottrell and Edward G. Hoyes provided editorial assistance.

Dedication

This Atlas is dedicated to Mr. Bill Fox of Elk Point, Alberta who has represented Alberta Beef Producers on the NSWA Board of Directors for over a decade.

His steadfast efforts in promoting awareness of environmentally sustainable agriculture have contributed greatly to a wider understanding of watershed management. Mr. Fox has been a driving force for the Atlas project.

"The quality and relevance of this watershed atlas underscores the valuable contribution the North Saskatchewan Watershed Alliance makes to public understanding of the importance of water to our economy, our environment and to our identity as Canadians."

Robert Sandford
EPCOR Chair of the Canadian Partnership
Initiative in support of the United Nations Water for
Life International Decade for Action

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Interaction Between Land and Water

The Hydrologic Cycle

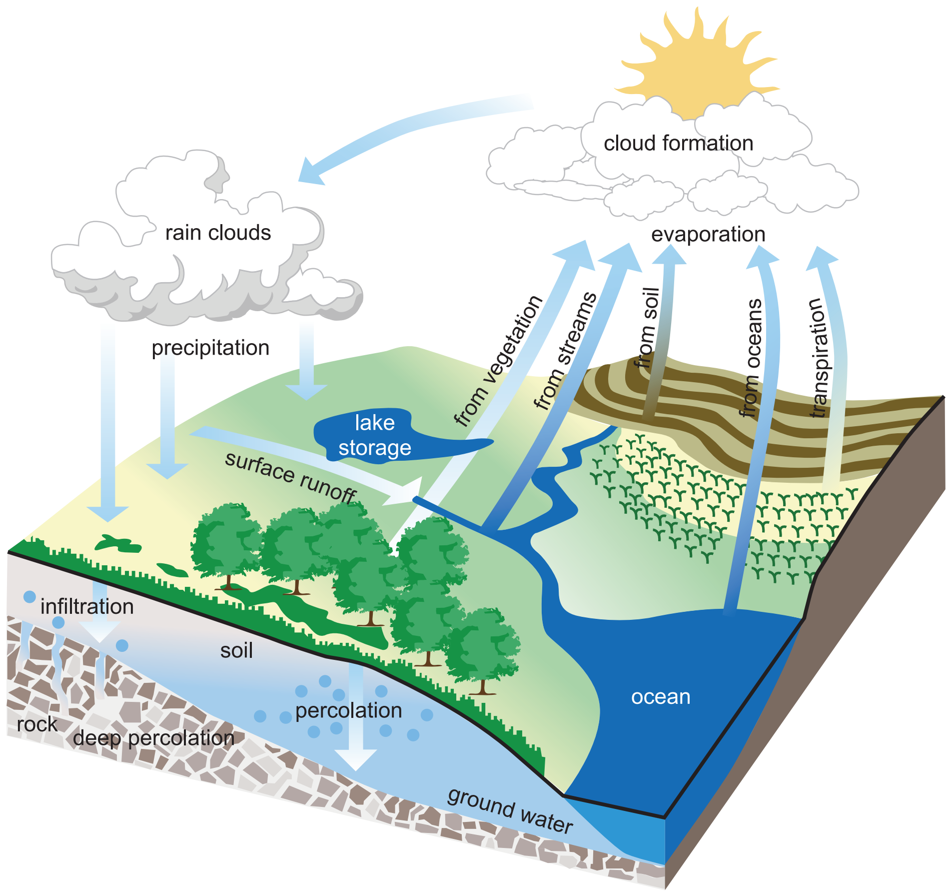
The hydrologic cycle is the continuous movement of water on, above and below the Earth's surface. The key components of this cycle are: precipitation; overland flow; infiltration to groundwater; transport and storage as surface water or groundwater; evaporation; and transpiration (see figure right). The cycle is ultimately driven by the effects of the sun's energy. Water changes states becoming liquid, gas (vapour) or solid (ice) at various points throughout the cycle. The hydrologic cycle affects climate. Evaporation removes heat from the environment, thereby cooling air temperature; condensation releases energy into the environment, thereby warming air temperature.

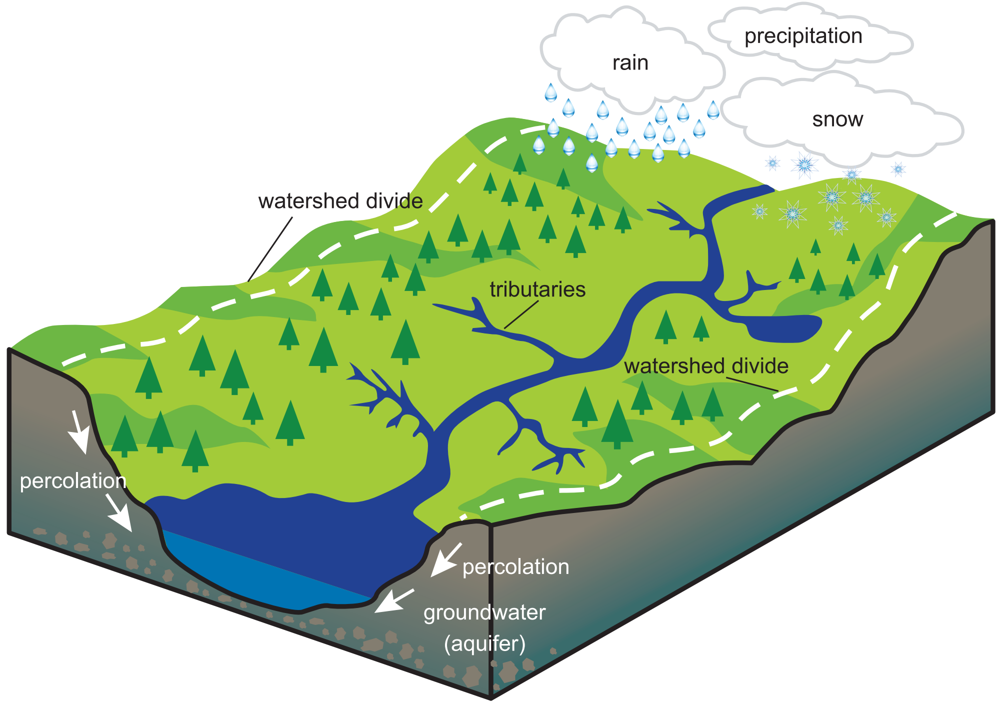
The total amount of water on earth and in the air never changes; the water we have on Earth today is the same water that was on the Earth billions of years ago. Oceans and others saline waters account for 97% of the water on the planet, and provide the largest amount of water to the atmosphere through evaporation. Fresh water accounts for 3% of the Earth's water supply (Atlas of Canada, 2009).

What is a Watershed?

We all have one thing in common: no matter where we live, we all live in a watershed. A watershed (also known as a drainage basin, river basin or catchment) is the area of land that catches precipitation and drains into a larger body of water, such as a river or lake. The boundaries of a watershed are defined by height of land or the elevation divide separating one watershed from another. Watersheds come in all sizes; they can be very large, spanning several provinces, or so small that they only encompass a small stream or wetland area. They cross municipal, provincial and national boundaries. They can be "open systems" -- those that eventually drain into an ocean, or "closed systems" -- those where water can only leave through evaporation or by percolating into groundwater.

Watersheds drain into other watersheds in a nested pattern, with smaller watersheds draining into larger watersheds. For example, a creek that flows into the Vermilion River (in east-central Alberta) has its own immediate watershed, but is also nested within the larger Vermilion River watershed, which in turn drains into the even larger North Saskatchewan River watershed (NSRW). Given the direct connection between watersheds, what we do within our own watershed can affect the water quality and water supply of all residents who live downstream from us.





Major Drainage Basins

In western Canada, all surface water flows either to the Pacific Ocean, Arctic Ocean, Hudson Bay or the Gulf of Mexico. The North Saskatchewan River watershed forms a small part of the much larger Hudson Bay watershed, which drains almost one third of Canada's land surface.

Beginning at the Saskatchewan Glacier in the Rocky Mountains, the North Saskatchewan River flows east through Alberta, joining the South Saskatchewan River near Prince Albert, Saskatchewan. Here these two rivers become the Saskatchewan River, which flows into Lake Winnipeg, and from there into Hudson Bay via the Nelson River (Map 1). Other Alberta rivers that form part of the Saskatchewan River watershed include the Battle, Red Deer, Bow, Oldman and the South Saskatchewan. The Saskatchewan River watershed is the fourth largest river system in North America.

Map 1. The Saskatchewan River Watershed

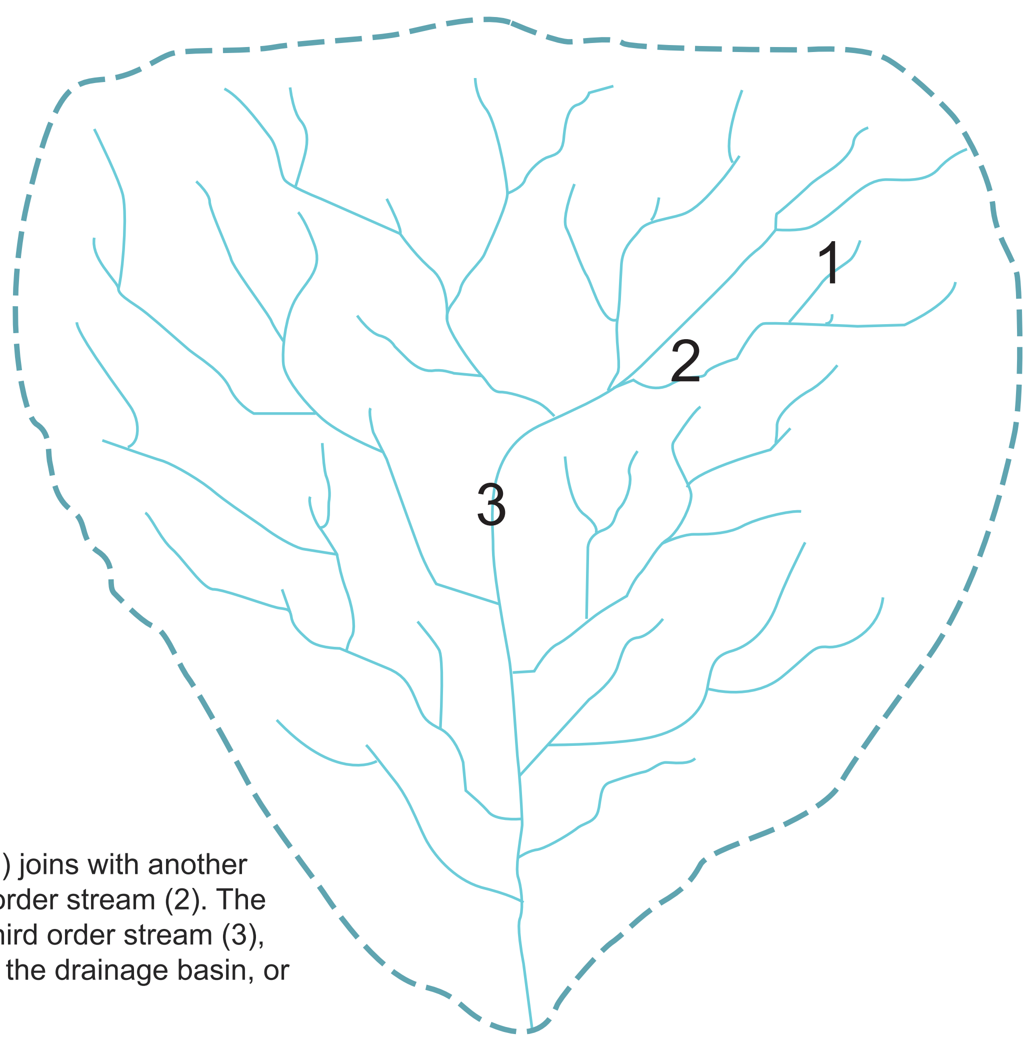
The North Saskatchewan River watershed, in light green, is part of the larger Saskatchewan River watershed, seen above. Map from Partners FOR the Saskatchewan River Watershed.

The North Saskatchewan River watershed encompasses over 57,000 km^2 of land within Alberta's borders and over 41,000 km^2 within Saskatchewan. The Battle River is a major tributary of the NSR and their confluence is near North Battleford, Saskatchewan, however the Battle River is considered separately for watershed management planning purposes.

Surface water bodies and riparian areas comprise about 11% of the total area of the North Saskatchewan River watershed. Permanent lakes cover an area of approximately 1,374 km^2 (2.4%) and temporary lakes cover approximately 461 km^2 (0.8%). Water features in the watershed include icefields, glaciers, rivers, reservoirs, lakes, wetlands, drainage districts, canals and oxbows.

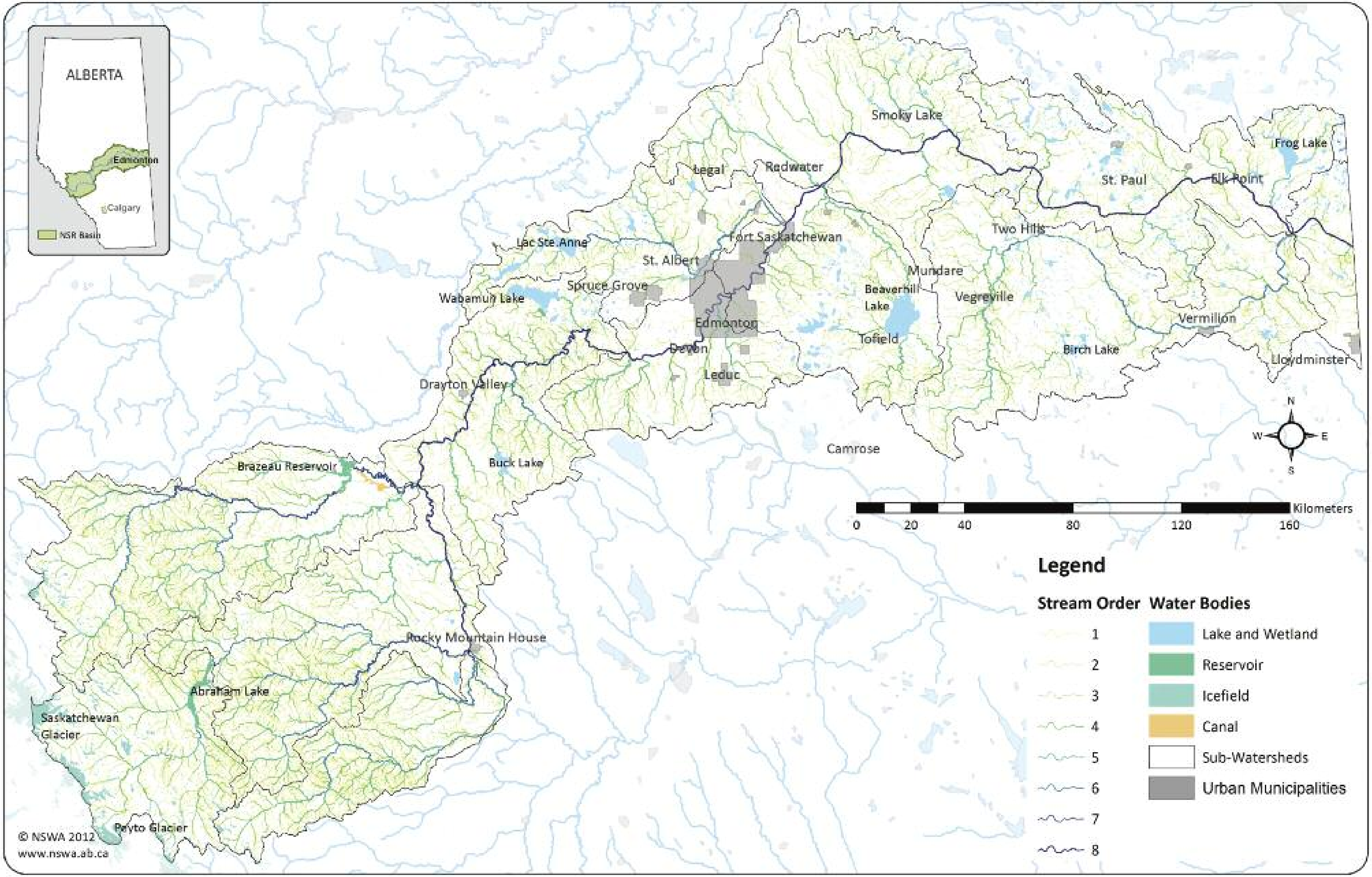
Stream Order

Hydrologists and ecologists use the concept of stream order to classify natural hierarchical patterns, as shown in the diagram below. The overall classification of stream order for the NSRW is illustrated on Map 2. A first-order stream is the smallest unbranched tributary. When two first-order streams join they form a second-order stream, and so on. The main stem of the North Saskatchewan River is considered an eighth-order stream, downstream from its confluence with the Clearwater River.



In this diagram, a first order stream (1) joins with another first order stream, to make a second order stream (2). The second order streams join to form a third order stream (3), and so on. The dotted line represents the drainage basin, or watershed.

Map 2. Surface Water Bodies and Stream Order in the North Saskatchewan River Watershed



Subwatersheds

Streams and watersheds form a nesting pattern, with smaller ones draining into larger ones. The smaller watersheds are known as “subwatersheds” or “subbasins”. Within the Alberta portion of the North Saskatchewan River watershed (Map 3) there are 12 subwatersheds as defined by the Water Survey of Canada (WSC). The Water Survey of Canada is a Federal agency responsible for the collection, interpretation and distribution of water resource data in Canada, and it maintains over 2,500 monitoring stations across the country.

Some NSR subwatersheds are defined by the natural drainage watershed of large tributaries (e.g. the Clearwater, Sturgeon and Vermilion Rivers). Other subwatershed boundaries include streams on both sides of the main stem of the river (e.g. Strawberry and Beaverhill subwatersheds). Boundaries for these subwatersheds were based on the location of the nearest WSC hydrometric stations. All subwatersheds contribute water volume to the North Saskatchewan River. Flowing water carries along natural materials as well as man-made materials that wash off the landscape. The transport of materials from subwatersheds is a major consideration in managing water quality in the mainstem of the North Saskatchewan River.

Watershed Components

All watersheds have a number of physical and biological components in common. These include surface water in lakes, streams and wetlands; groundwater contained in aquifers; riparian zones; and upland areas. In each watershed, these components vary in physical and biological structure, and in the functions they perform.

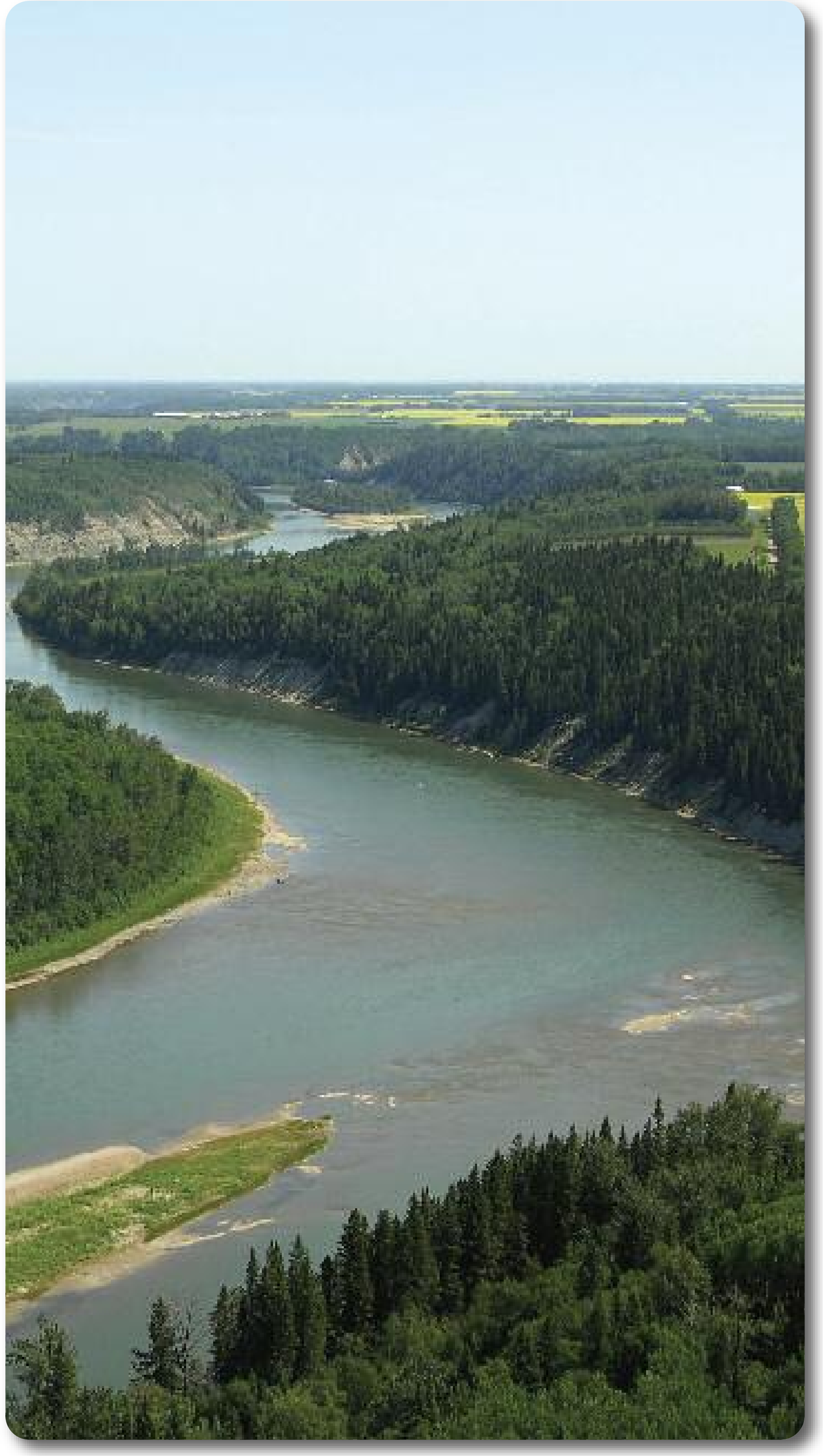
Lakes

Lakes in central Alberta are most often legacies of past glacial activity. The retreat of the glaciers 12,000 years ago left depressions and blocked waterways, which eventually filled with water. Lakes are defined as either nutrient poor (oligotrophic), moderately nutrient rich (mesotrophic), nutrient rich (eutrophic) or extremely nutrient rich (hypereutrophic). Many lakes in central Alberta are nutrient rich (eutrophic) due to the nature of the glacial till left behind after the glacial retreat. This till provides a soil base rich in nitrogen and phosphorus, which encourages plant and algae growth. Additional nutrient inputs resulting from human activities along shorelines and in the surrounding watershed have exacerbated this condition in many lakes.

An assessment of aquatic ecosystem health prepared by Alberta Environment and Sustainable Resource Development (AESRD) in 2006, identified 25 key recreational lakes in the NSR watershed. These lakes and their current trophic rankings (based on total phosphorus levels) are presented in the table on the next page.

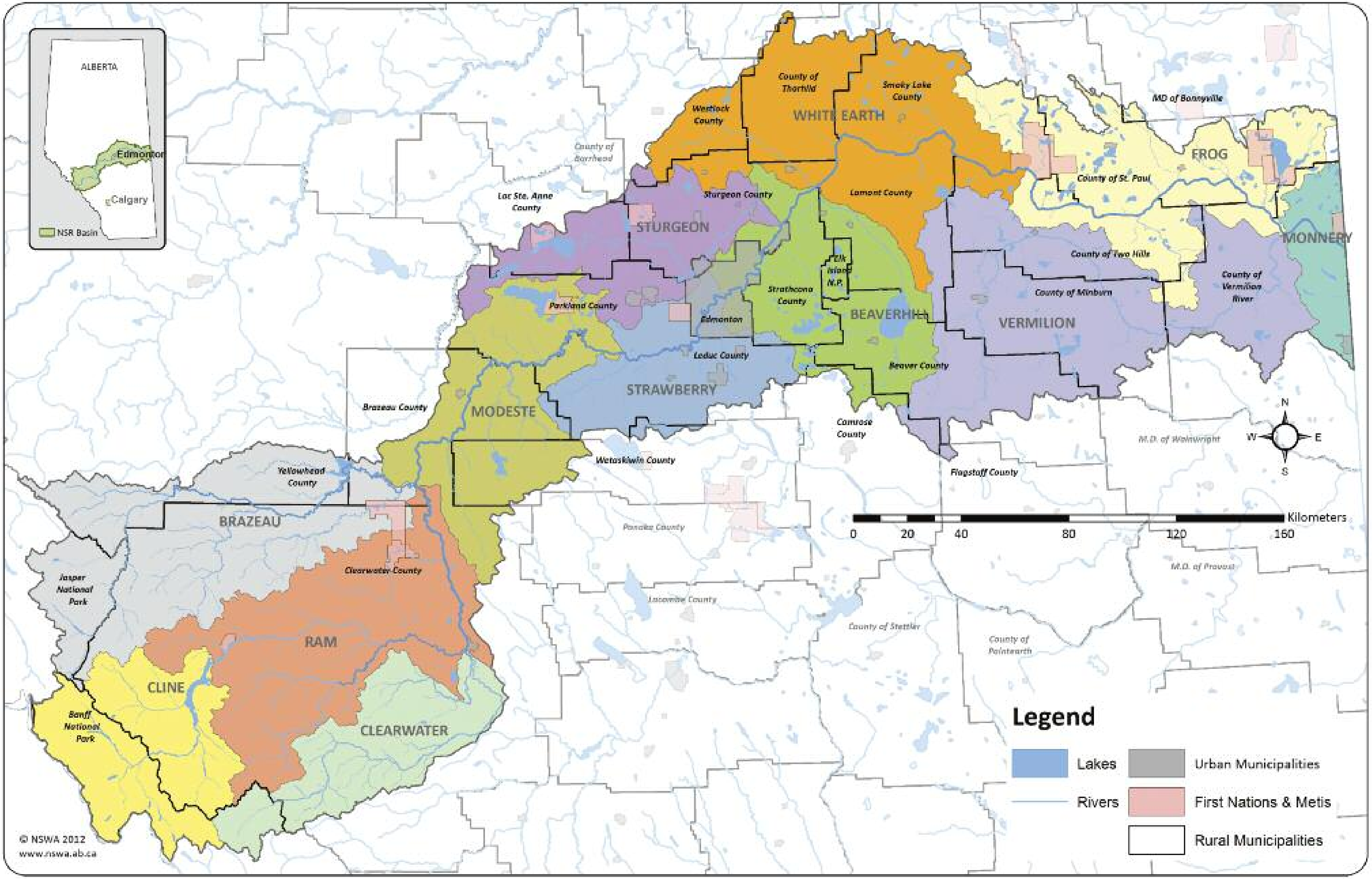
Algae and plant growth are often displeasing to recreational lake users. The presence of heavy cyanobacterial (blue-green algal) blooms in Alberta lakes is a now seen as a human health concern and beaches are sometimes closed as a result of a bloom. Heavy cyanobacterial blooms can also cause ecological consequences such as summertime fish kills and waterfowl mortalities. More information on lakes in the NSRW can be found at the Atlas of Alberta Lakes website, the Alberta Lake Management Society website, and the Alberta Environment and Sustainable Resource Development website.

Algal blooms such as this are common in Alberta lakes in late summer



Lake Name	Area (km^2)	Mean Depth (m)	Location	Trophic Status
Antler Lake	2.3	1.6	Dry Mixedwood Subregion	Hypereutrophic
Bonnie Lake	3.77	3.1	Dry Mixedwood Subregion	Eutrophic
Borden Lake	N/A	N/A	Dry Mixedwood Subregion	Eutrophic
Chicackoo Lake	0.26	4.7	Dry Mixedwood Subregion	Eutrophic
Cooking Lake	36.0	1.7	Dry Mixedwood Subregion	Hypereutrophic
Half Moon Lake	0.41	4.7	Dry Mixedwood Subregion	Eutrophic
Isle Lake	23.0	4.1	Dry Mixedwood Subregion	Hypereutrophic
Islet Lake	1.31	2.5	Dry Mixedwood Subregion	Hypereutrophic
Jackfish Lake	2.39	3.4	Dry Mixedwood Subregion	Eutrophic
Joseph Lake	6.68	2.4	Dry Mixedwood Subregion	Mesotrophic
Lac Saint Cyr	2.46	5.1	Dry Mixedwood Subregion	Eutrophic
Lac Ste. Anne	54.5	4.8	Dry Mixedwood Subregion	Eutrophic
Laurier Lake	6.42	4.0	Dry Mixedwood Subregion	Eutrophic
Matchayaw Lake	2.11	4.35	Dry Mixedwood Subregion	Hypereutrophic
Mons Lake	2.8	N/A	Dry Mixedwood Subregion	Mesotrophic
Sandy Lake	11.4	2.6	Dry Mixedwood Subregion	Hypereutrophic
Vincent Lake	7.28	5.7	Dry Mixedwood Subregion	Eutrophic
Wabamun Lake	81.8	6.3	Dry Mixedwood Subregion	Mesotrophic
Wizard Lake	2.48	6.2	Dry Mixedwood Subregion	Eutrophic
Big Lake	24	0.75	Central Parkland	Hypereutrophic
Spring Lake	0.80	1.9	Central Parkland	Eutrophic
Buck Lake	25.4	6.2	Lower Foothills	Eutrophic
Cow Lake	8.16	0.98	Lower Foothills	Mesotrophic
Crimson Lake	2.32	2.2	Lower Foothills	Mesotrophic
Swan Lake	1.44	6.0	Lower Foothills	Mesotrophic

Map 3. Subwatersheds and Municipal Boundaries in the North Saskatchewan River Watershed



Wetlands

Wetlands are areas of permanently or seasonally saturated soils that support the growth of aquatic plants. Wetlands may include shallow open water, bogs, fens, marshes, prairie potholes and northern muskegs. They contain some of the most biologically productive and diverse areas on the landscape. Many species of mammals depend on wetland habitats for food, escape cover or for breeding. These species include rodents (muskrat, beaver, mice and rabbits); ruminant animals (deer and moose), carnivores, and omnivores (coyotes and bears). Wetlands are critical habitat for many endangered species or species at risk in Canada. More than 200 bird species (including 45 species of waterfowl) and over 50 species of mammals depend on wetlands for food and habitat. One third of the species at risk listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) live in or near wetlands (COSEWIC, 2009).

Wetlands are called “nature's kidneys” because they act as natural physical and biological filtering systems. Research has demonstrated that some types of wetlands can trap or remove bacteria, nutrients, sediments and metals, and have carbon storage capabilities. Removal occurs when wetland vegetation absorbs nutrients, helping cycle them through the food chain. Other contaminants, such as metals, can attach (or adsorb) to plants and soil particles, and are thereby removed from the surface water flow. Wetland plants slow down flowing water, which causes sediment to settle out.

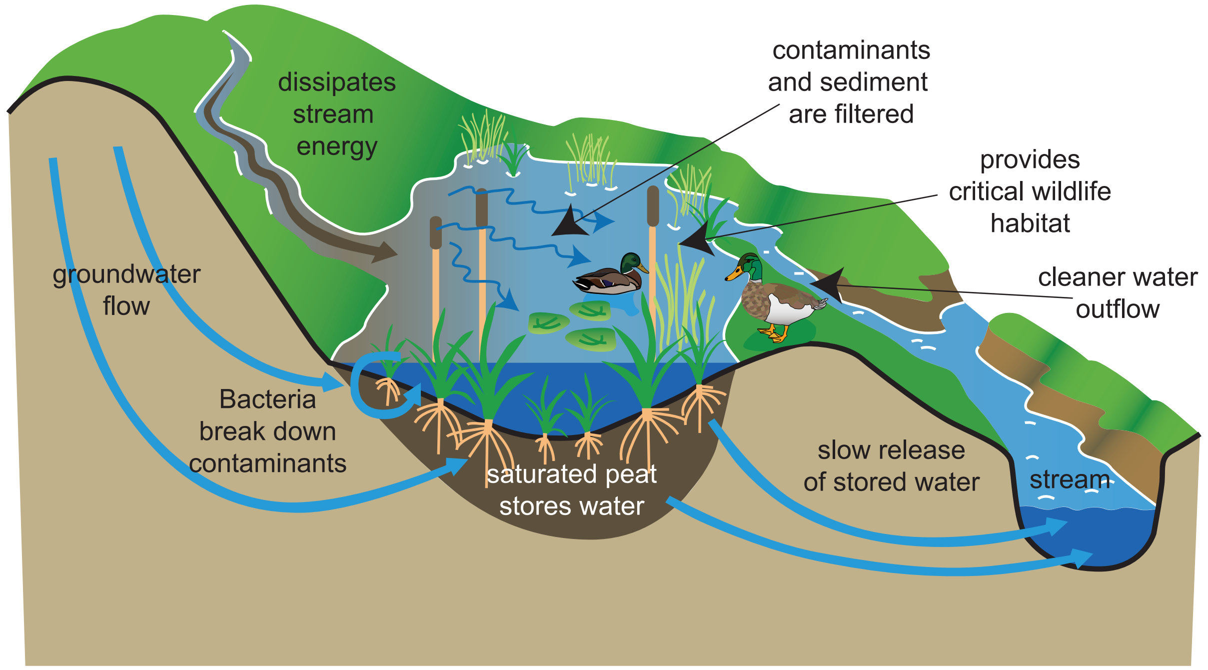
Given their ability to retain water, wetlands also provide a natural flood barrier that slows down peak inflows associated with spring runoff and summer storms. This watershed runoff is stored and released from a wetland during the remainder of the season. The more wetlands in a watershed, the higher the likelihood that serious water shortages and floods can be prevented. Wetlands can also serve as groundwater recharge areas, supplying water to aquifers and keeping groundwater levels up.

There are a number of different types of wetlands. In Canada, the Stewart and Kantrud method of wetland classification is most often used, which recognizes seven different wetland types ranging from temporary to permanent. The photos on the next page describes the seven classes of wetlands; it is important to note that the classes do not imply a level of importance (information provided by Ducks Unlimited Canada, 2010).

In the past, provincial government incentives were provided to drain wetlands on agricultural lands to encourage greater yields from field-crop production. As a result, the majority of wetlands in the settled areas of Alberta (the “White Area”) were drained or consolidated. Over 64% of wetlands have been lost in the White Area of the province (Wetlands Alberta, 2012). Today, the value of wetlands for the provision of ecosystem services, flood and drought protection is better understood. Land use planning and land management practices that encourage wetland protection or restoration are now included in government, NGO and industry-led incentive programs.

Limited wetland and drained wetland inventory work has been completed across the province by various agencies, including Alberta Environment and Sustainable Resource Development and Ducks Unlimited Canada. Within the North Saskatchewan River watershed, detailed wetland loss and wetland inventory work has been completed in the Vermilion subwatershed (Map 4). As illustrated on the map, there have been a considerable number of wetlands lost through drainage or consolidation, and a large number have undergone alterations due to development.

Diagram of wetland functions.



Agriculturally impacted wetlands

Class I – Ephemeral Wetlands

These wetlands typically have free surface water for only a short period of time after snowmelt or storm events in early spring. Because of the porous condition of the soils, the rate of water seepage from ephemeral wetlands is very rapid after thawing of the underlying frost seal. They may be periodically covered by standing or slow moving water. Water is retained long enough to establish some wetland or aquatic processes. They are typically dominated by vegetation such as Kentucky bluegrass, goldenrod and other wetland or low prairie species.

Class II – Temporary Wetlands

Class II wetlands are periodically covered by standing or slow moving water. They typically have open water for only a few weeks after snowmelt or several days after heavy storm events. Water seepage is fairly rapid, but surface water usually lingers for a few weeks after spring snowmelt and for several days after heavy rainstorms at other times of the year. Water is retained long enough to establish wetland or aquatic processes. They are dominated by wet meadow vegetation such as fine-stemmed grasses, sedges and associated forbs.

Class III – Seasonal Ponds and Lakes

Shallow marsh vegetation generally occurs in the deepest zone, which is usually dry by midsummer. They are typically dominated by emergent wetland grasses, sedges and rushes.

Class IV – Semi-Permanent Ponds and Lakes

Deep marsh vegetation is found in the central zone, and coarse emergent plants or submerged aquatics like cattails, bulrushes, and pondweeds are present. Class IV wetlands frequently maintain surface water throughout the growing season.

Class V – Permanent Ponds and Lakes

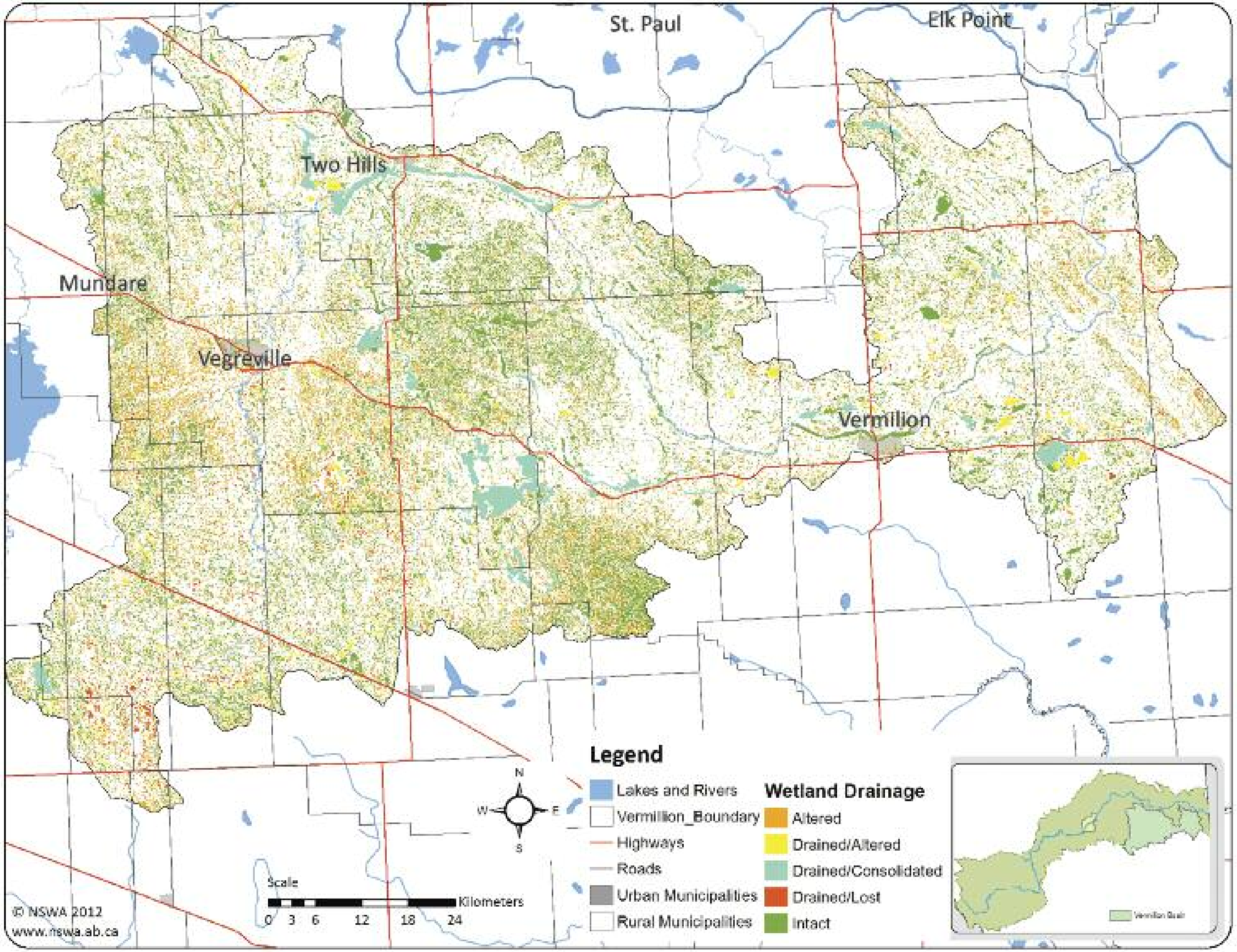
These wetlands have permanent open water in a central zone that is generally devoid of vegetation. Submergent plants may be present in the deepest zone, while emergent plants are found along the edges.

Class VI – Alkali Ponds and Lakes

Deep water is typically not permanently present. Alkali wetlands are characterized by a pH above 7 and a high concentration of salts. The dominant plants are generally very salt tolerant. These wetlands are especially attractive for shorebirds.

Class VII – Fen Ponds

Fen ponds are wetlands in which fen vegetation dominates the deepest portion of the wetland area. This wetland type often has wet meadow and low prairie vegetation present on the periphery. The soils are normally saturated by alkaline groundwater seepage. Fen ponds often have quaking or floating mats of emergent vegetation, which includes sedges, grasses and other herbaceous plants.



St. Paul
Elk Point
Two Hills
Mundare
Vegreville
Vermilion
Legend
Lakes and Rivers
Vermilion_Boundary
Highways
Roads
Urban Municipalities
Rural Municipalities
Wetland Drainage
Altered
Drained/Altered
Drained/Consolidated
Drained/Lost
Intact
N
W
E
S
Scale
0 3 6 12 18 24
Kilometers
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Groundwater

Groundwater exists below the Earth's surface in soils and rock formations. It also occurs in permafrost, soil moisture and deep geothermal water. Groundwater moves slowly, and can remain beneath the surface from a few years to millennia, as illustrated in the diagram below.

An **aquifer** is water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt). Water in an unconfined aquifer flows between the surface and the subsurface. Water in a confined aquifer is held underground by an impermeable layer, e.g. bedrock.

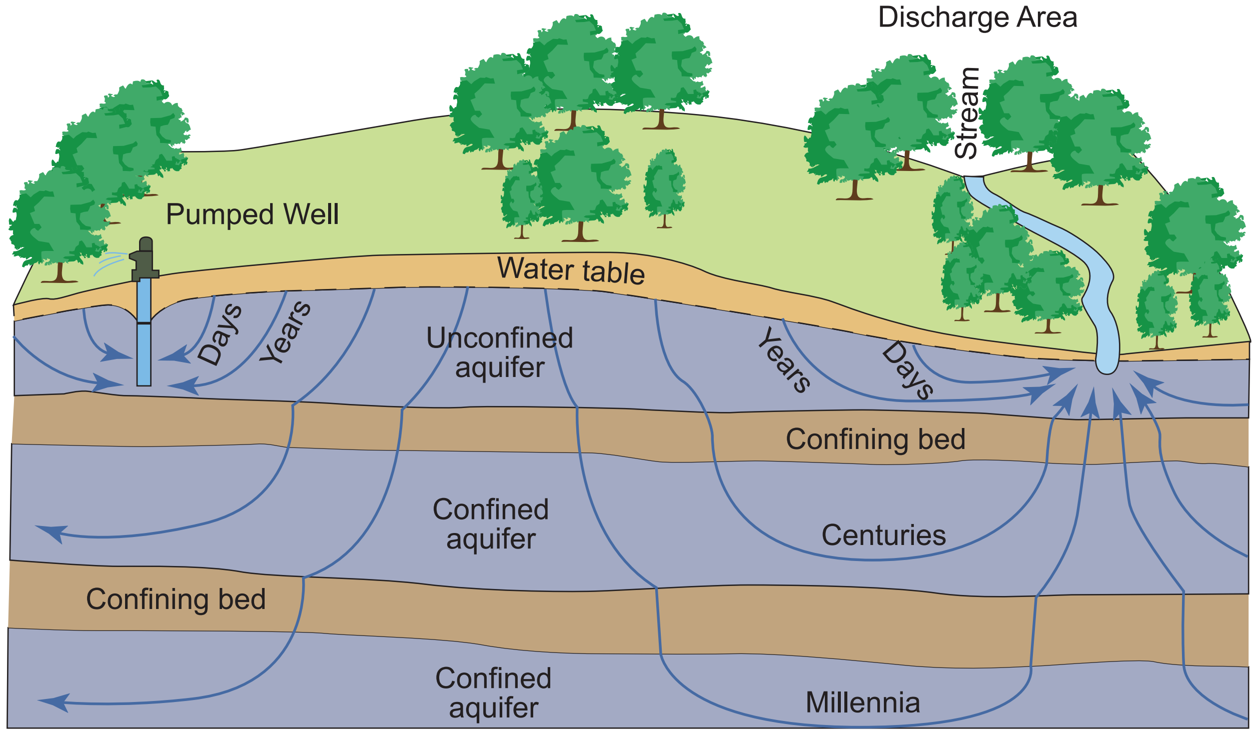
The **water table** is the region below ground where soil pores and voids in rock are saturated with water.

Groundwater comes to the surface through springs and seeps (**discharge** areas). This groundwater discharge accounts for most of the stream flow in rivers and streams in late fall and during winter in unregulated river systems in Alberta.

Surface water finds a way underground in places known as **recharge** areas. Activities on land in recharge areas need to be managed to avoid contamination of aquifers.

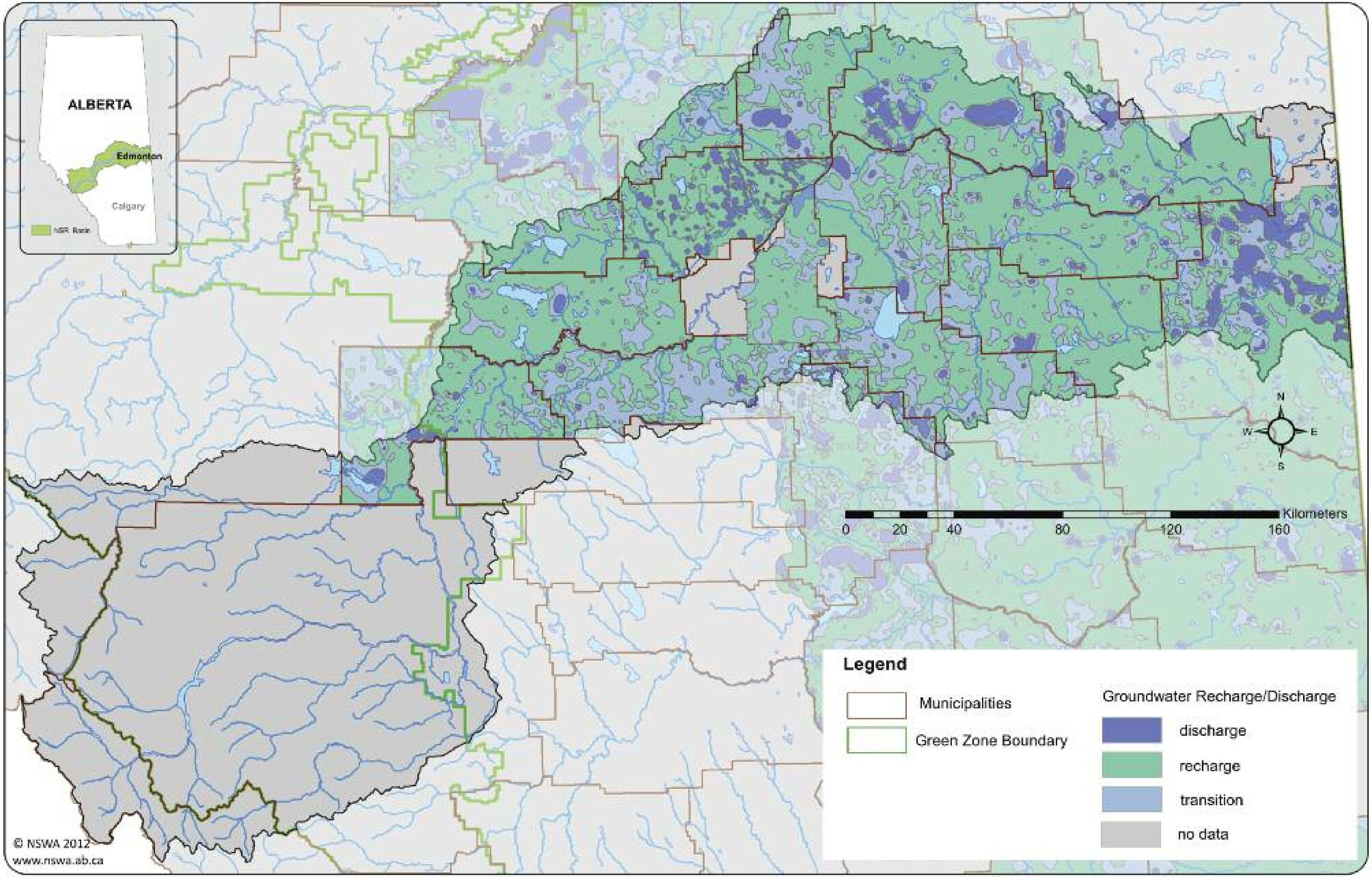
Most groundwater in Alberta comes from infiltration of surface water from rainfall and snowmelt. Seasonal recharge from surface water bodies when river and lake levels are high also makes a significant contribution to groundwater supplies.

The main discharge and recharge areas within the NSRW are illustrated in Map 5. There are significant data gaps in the headwaters region. Many municipalities have completed groundwater studies, and in 2011 the Alberta Geological Survey completed an Edmonton-Calgary corridor groundwater mapping study. More research is still required on this important resource.



This diagram shows the movement of groundwater and the scale of residence times that can be seen in groundwater supplies.

Map 5. Groundwater Recharge/Discharge Areas in the North Saskatchewan River Watershed



Riparian Areas

Riparian areas are transitional zones between water bodies and upland areas, where vegetation and soils are influenced strongly by the presence of water. **Lentic** riparian areas are those around standing water bodies (lakes and wetlands). **Lotic** riparian areas border flowing water. These areas make up a small portion of the landscape, but they support an extremely high level of plant and animal diversity ("biodiversity"). Riparian areas create important wildlife corridors between the aquatic environment and surrounding uplands. Over 80% of Alberta's wildlife species rely on riparian areas for all or part of their life cycle (Cows and Fish, 2011).

Other functions of riparian areas are similar to wetland functions and include:

- Limiting flood damage by maintaining bank stability, reducing erosion, and trapping sediment in abundant vegetation
- Physical and biological filtering of nutrients and contaminants from surface water
- Providing food, shade and shelter for fish and wildlife

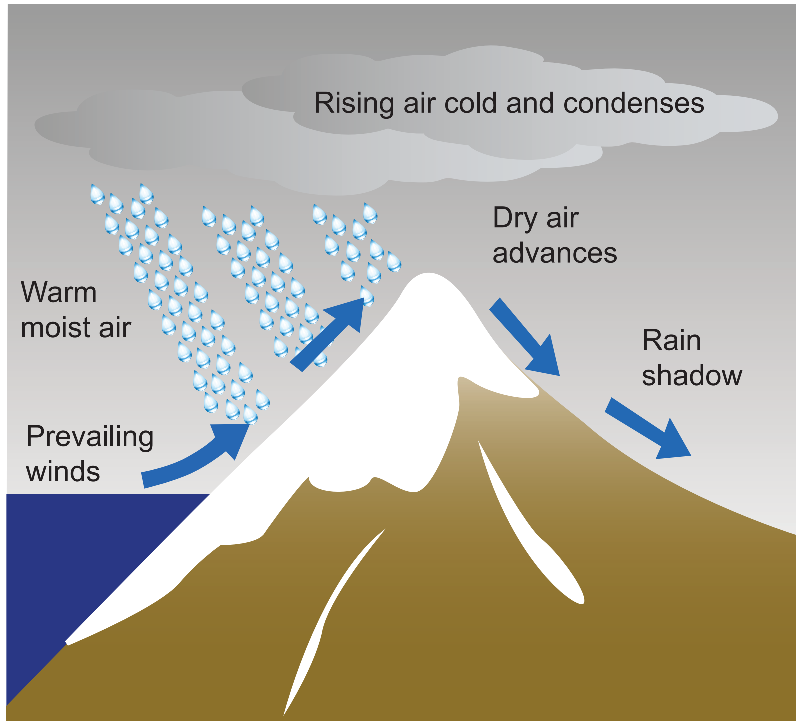
Riparian vegetation becomes woody debris. Debris in a waterbody provides shelter for fish and habitat for aquatic insects. In flowing water, this debris traps sediment and helps create structure (such as pools, riffles and runs) in the stream. Pools, riffles and runs are important components of a stream's ability to maintain healthy aquatic life.

Annual Precipitation, Evapotranspiration and Temperature

There is a wide variation in the mean annual precipitation across the NSRW. The Rocky Mountains form a barrier to the large-scale inflow of moist Pacific air. As moisture-laden air mass off the coast of British Columbia cools, it is forced upslope against the mountains, generating heavy precipitation. However, on the Alberta side of the Rockies, air mass is depleted of much of its moisture. It expands and warms as it moves down slope to the plains, resulting in reduced precipitation. This effect is known as a “rain shadow”.

Mean annual precipitation ranges from more than 1000 mm/year in the mountain areas to 400 mm/year in the arid eastern portions of the watershed (Map 6). Across most of the North Saskatchewan River watershed the average annual evaporation meets or exceeds the average annual precipitation. For example, mean annual precipitation in the Vegreville area is approximately 400 mm/year, while annual evaporative losses are more than 650 mm/year (Map 7), leaving a significant moisture deficit in the area. Surface runoff may only occur during heavy precipitation or following winters with heavy snow fall. In general, evaporation increases from west to east across the watershed.

Climate and weather data are collected through a network of climate stations maintained across Alberta by Environment Canada and the Alberta Climate Network (Alberta Environment and Sustainable Resource Development; Alberta Agriculture and Rural Development). Up-to-date information on climate can be found on the Drought Watch website administered by Agriculture & Agri-food Canada.



Rain shadow effect seen in the Rocky Mountain areas of the province.

Mean annual temperature in the North Saskatchewan River watershed varys considerably from west to east, from just 0.5-1.0 °C in the mountain regions to 3.0-3.5 °C in the Alberta Capital Region. The Alberta Capital Region is the “hot spot” in the watershed. Mean annual temperature decreases to 1.0-1.5 °C across the eastern portion of the watershed towards the Saskatchewan border. Maps 8 and 9 show the mean monthly temperatures for both July and January from 1960-1990. In January, the temperature is warmest in the mountain region due to the influence of warmer air from British Columbia, and is coolest in the eastern region of the NSRW near the Saskatchewan border. In July, however, the temperature is colder in the mid altitude mountain areas and warmer eastward to the Saskatchewan border. The July temperature map shows a slight increase in temperature in the highest mountain altitudes, immediately east of the British Columbia border.

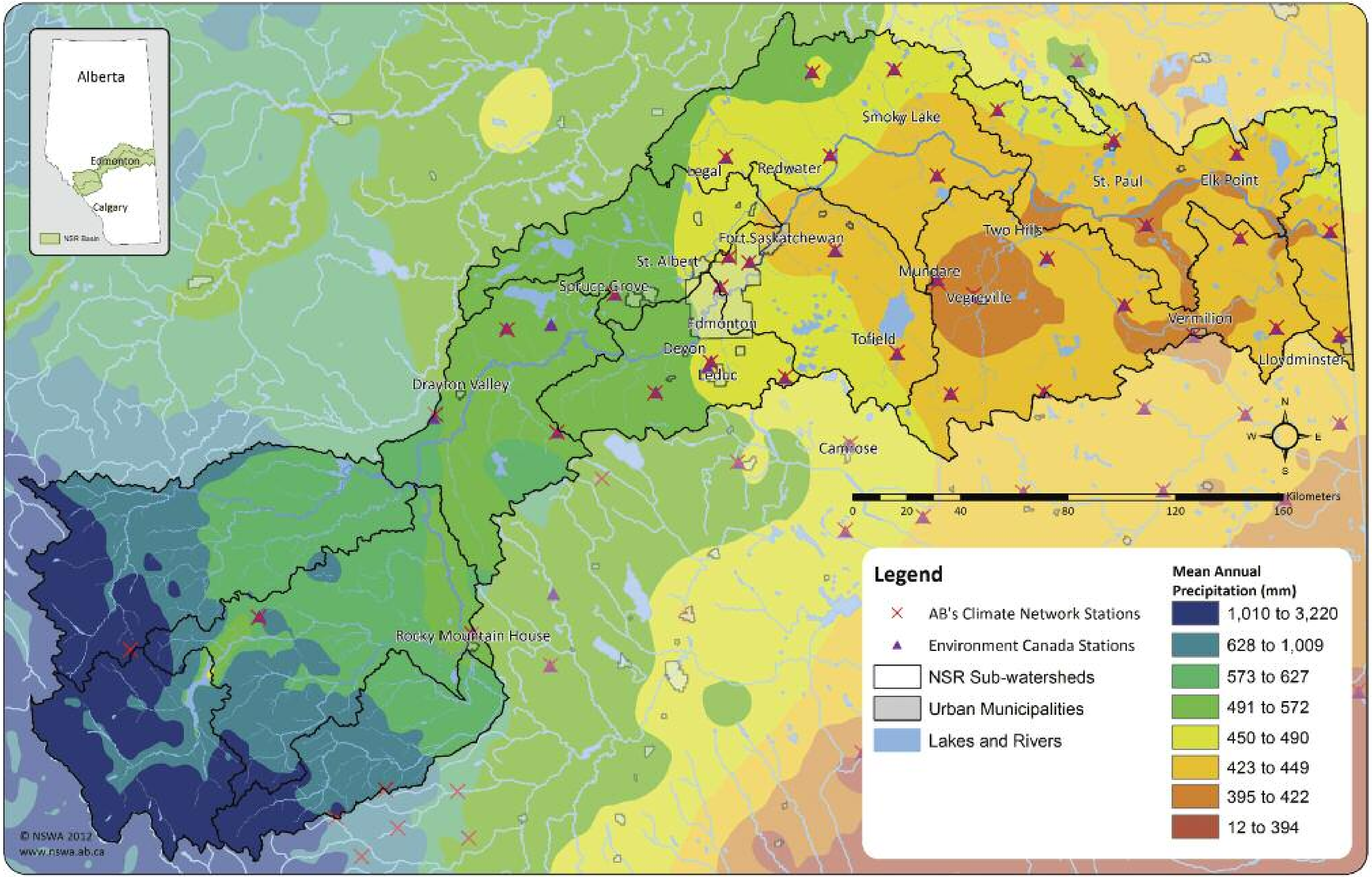
Transpiration

Transpiration is the movement of water within a plant and the subsequent loss of water from plant leaves in the form of vapour. Plants with deeper root systems can almost constantly transpire water through their leaves.

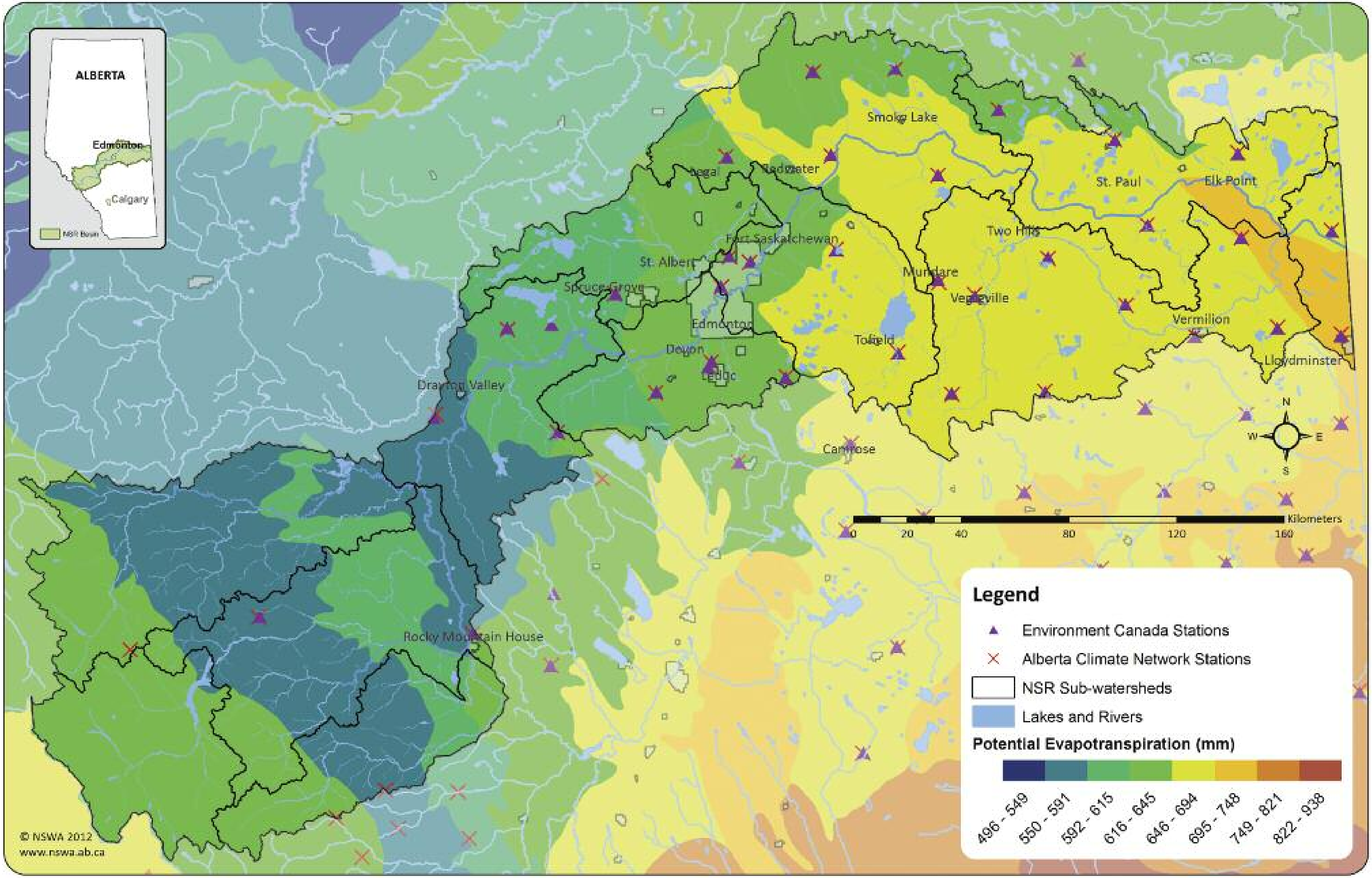
Evapotranspiration

Evapotranspiration is the sum of all water lost through evaporation and plant transpiration.

Map 6. Mean Annual Precipitation (1960 - 1990) in the North Saskatchewan River Watershed

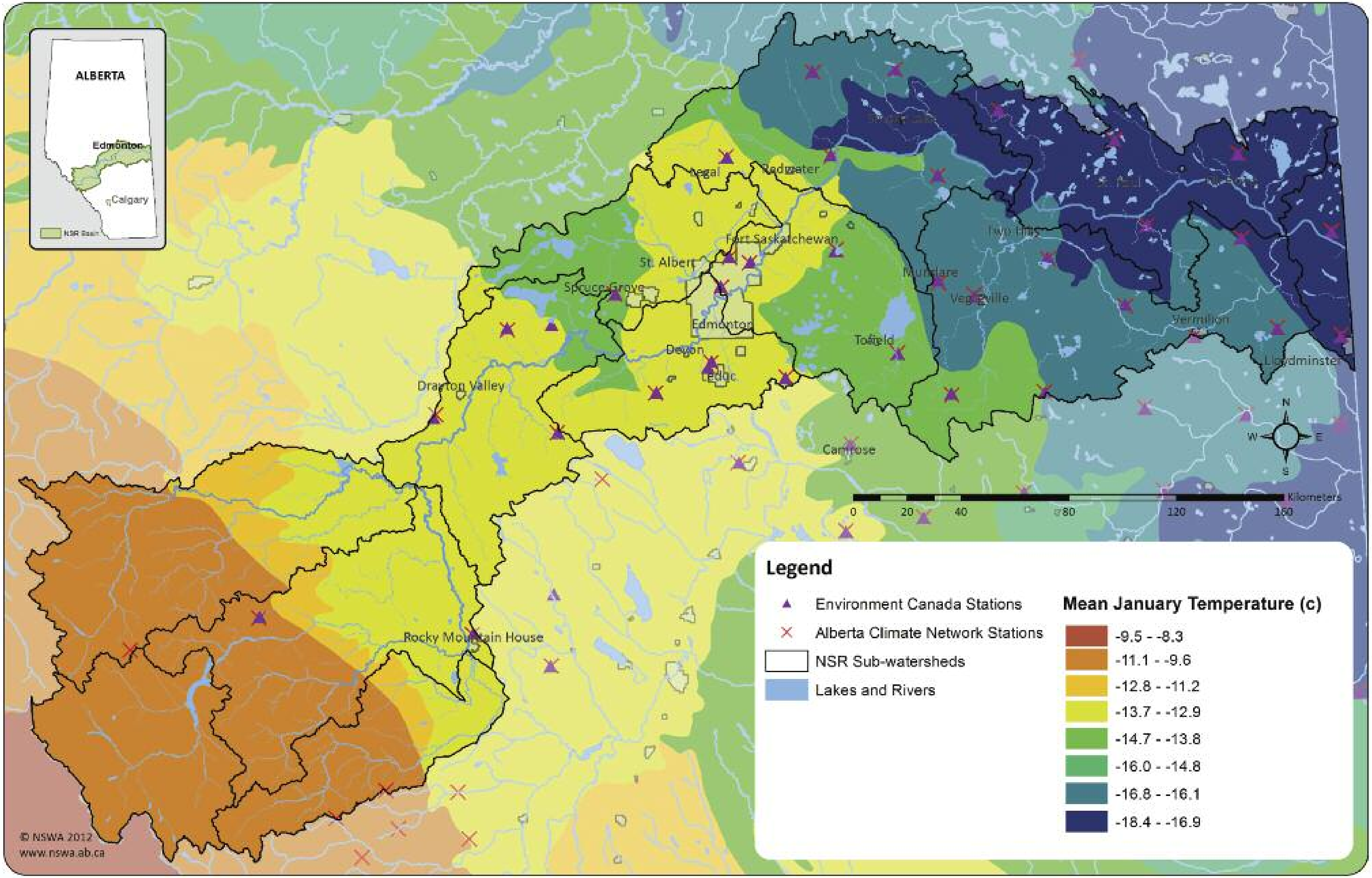


Map 7. Potential Evapotranspiration (1960 - 1990) in the North Saskatchewan River Watershed

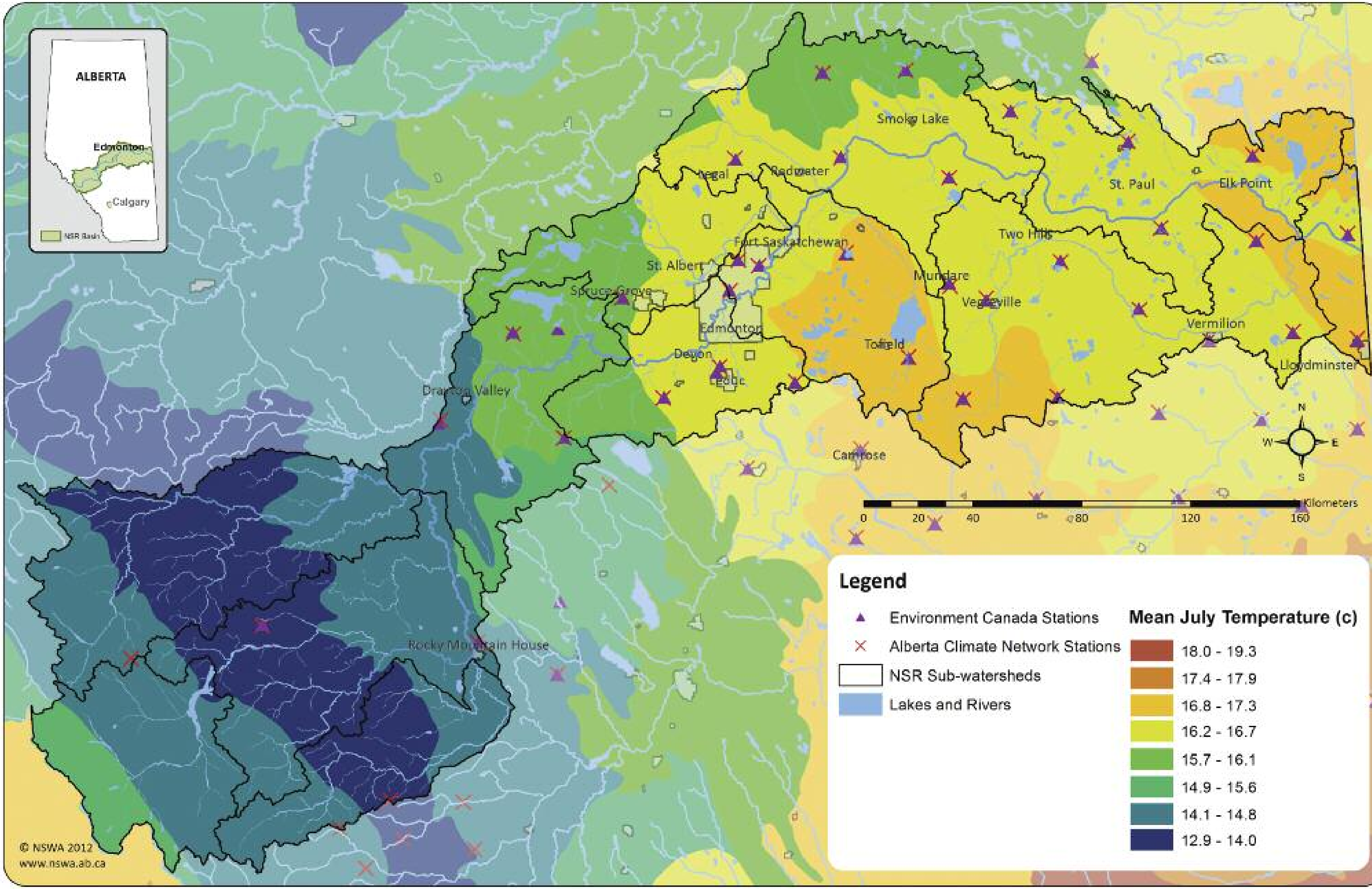


Map 8. Mean January Temperature (1960 - 1990) in the North Saskatchewan River Watershed

North Saskatchewan Watershed Alliance



Map 9. Mean July Temperature (1960 - 1990) in the North Saskatchewan River Watershed



Natural Subregions

The province is divided into Natural Regions and Subregions, based on landscape features, vegetation, climate, geology, wildlife distribution and topography. Subregions are defined by changes in vegetation, climate, elevation and other physical differences within a Natural Region. The province has a total of 6 Natural Regions and 21 Natural Subregions. There are 4 Natural Regions and 8 different Natural Subregions within the North Saskatchewan River watershed (see maps on pages 22 and 49).

The Natural Regions in the North Saskatchewan River watershed include the Rocky Mountain Natural Region, the Foothills Natural Region, the Boreal Forest Natural Region and the Parkland Natural Region. Each region displays variation in plant communities and landscape characteristics, as demonstrated in the photos to the right.

Landscapes in the Rocky Mountain Natural Region are mountainous, with vegetation ranging from coniferous forests in higher elevations to mixed forests and grasslands in valley areas. Exposed rock areas are common and annual temperatures are cool. This area includes the Alpine, Montane and Subalpine Subregions.

The Boreal Forest Natural Region is comprised of coniferous, deciduous and mixedwood forests. There are extensive wetlands across the landscape, and the climate is similar to the climate seen in the Rocky Mountain Natural Region. This Natural Region is the largest in the province, covering over half of the land mass.

The Foothills Natural Region includes the Upper and Lower Foothills Subregions. Coniferous forests are found on steep hills in the Upper region and deciduous and mixedwood forests are found on rolling hills in the Lower region.

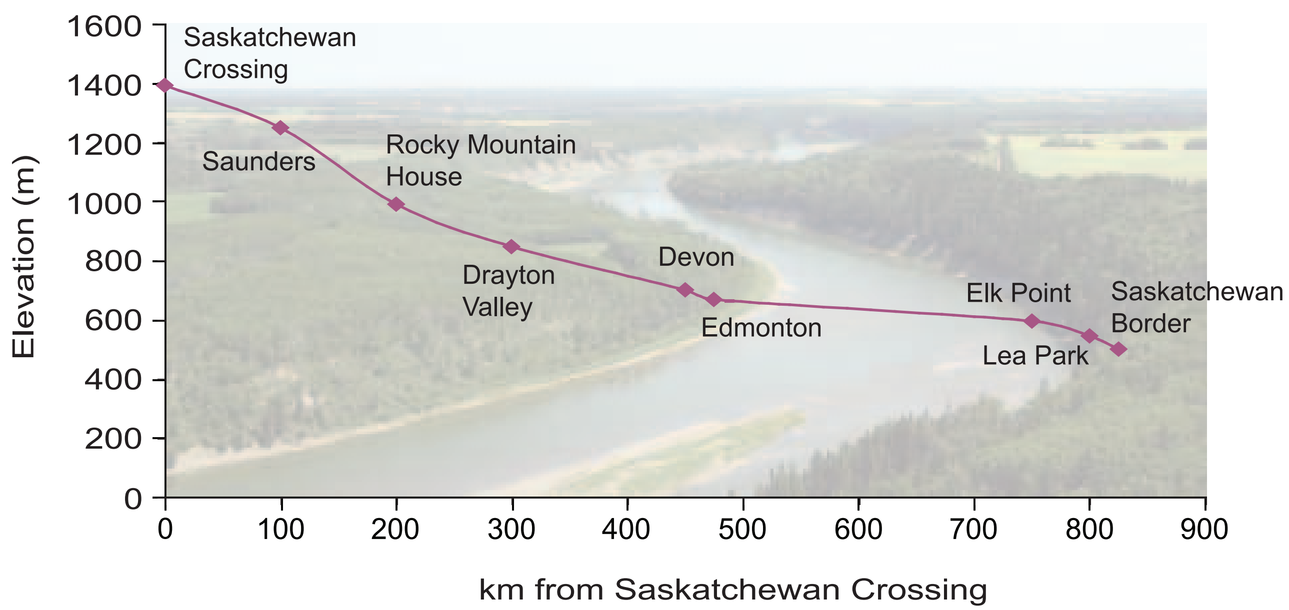
The Parkland Natural Region has largely been converted to agricultural lands and urban areas. Remnant areas of aspen and willow shrublands are mixed with native grasslands. It is a transition zone between the warmer Grasslands to the south and the cooler Boreal region to the north. Wetlands in this region are particularly significant for waterfowl populations.

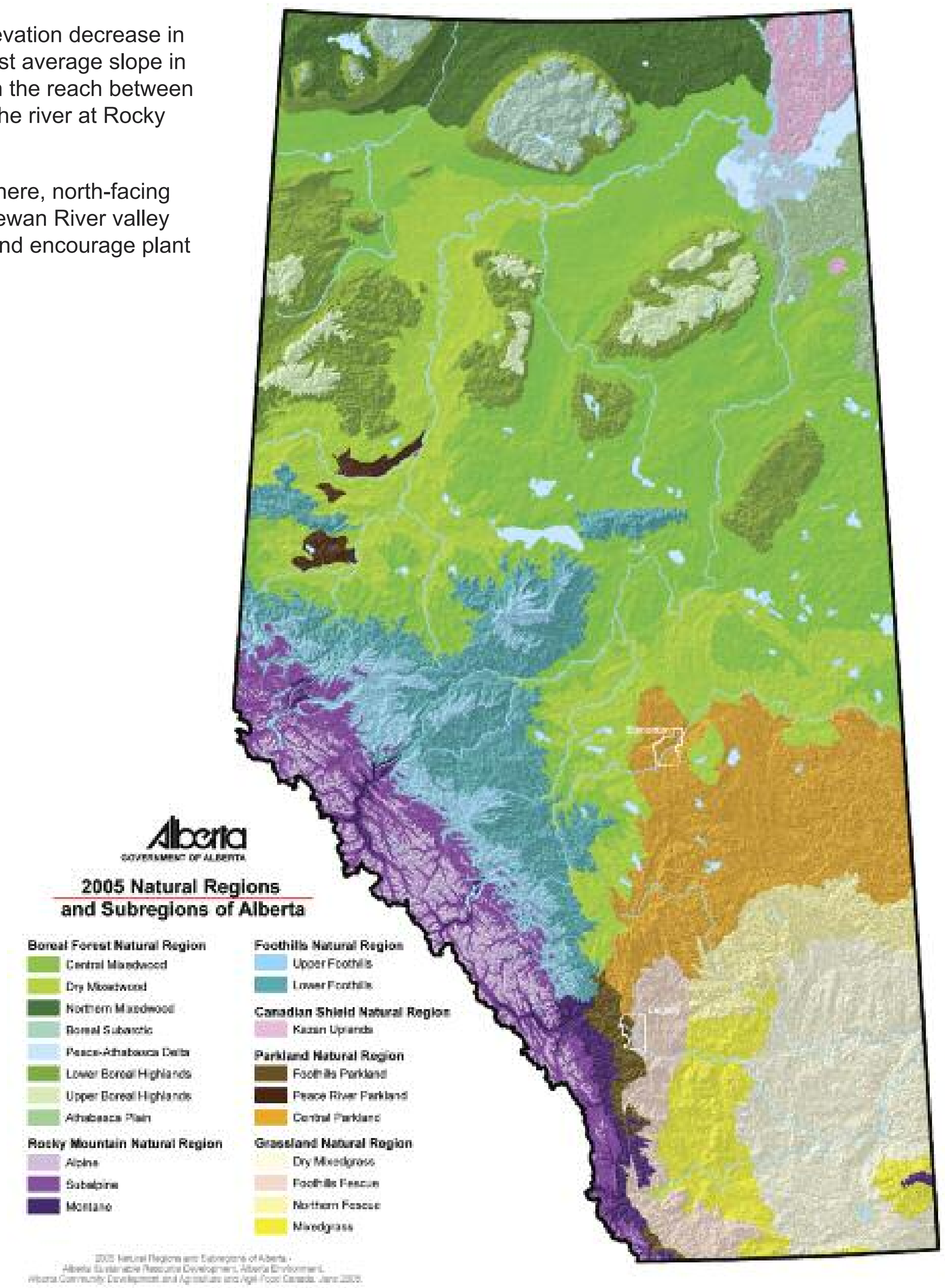
Topography

A topographic map represents features on the surface of the earth based on elevation. Map 10 and the figure below illustrate the elevation decrease in the watershed from west to east. The river drops in elevation a total of 890 meters, for an average gradient of 1.07 m/km. The highest average slope in the river occurs in the reach between Saskatchewan Crossing and Drayton Valley at 2.04 m/km. The lowest average slope occurs in the reach between Devon and the Saskatchewan border, at 0.63 m/km. Flow velocity in the river decreases as slope decreases. The mean velocity of the river at Rocky Mountain House is 1.37 m/s; it decreases to 1.16 m/s at Edmonton.

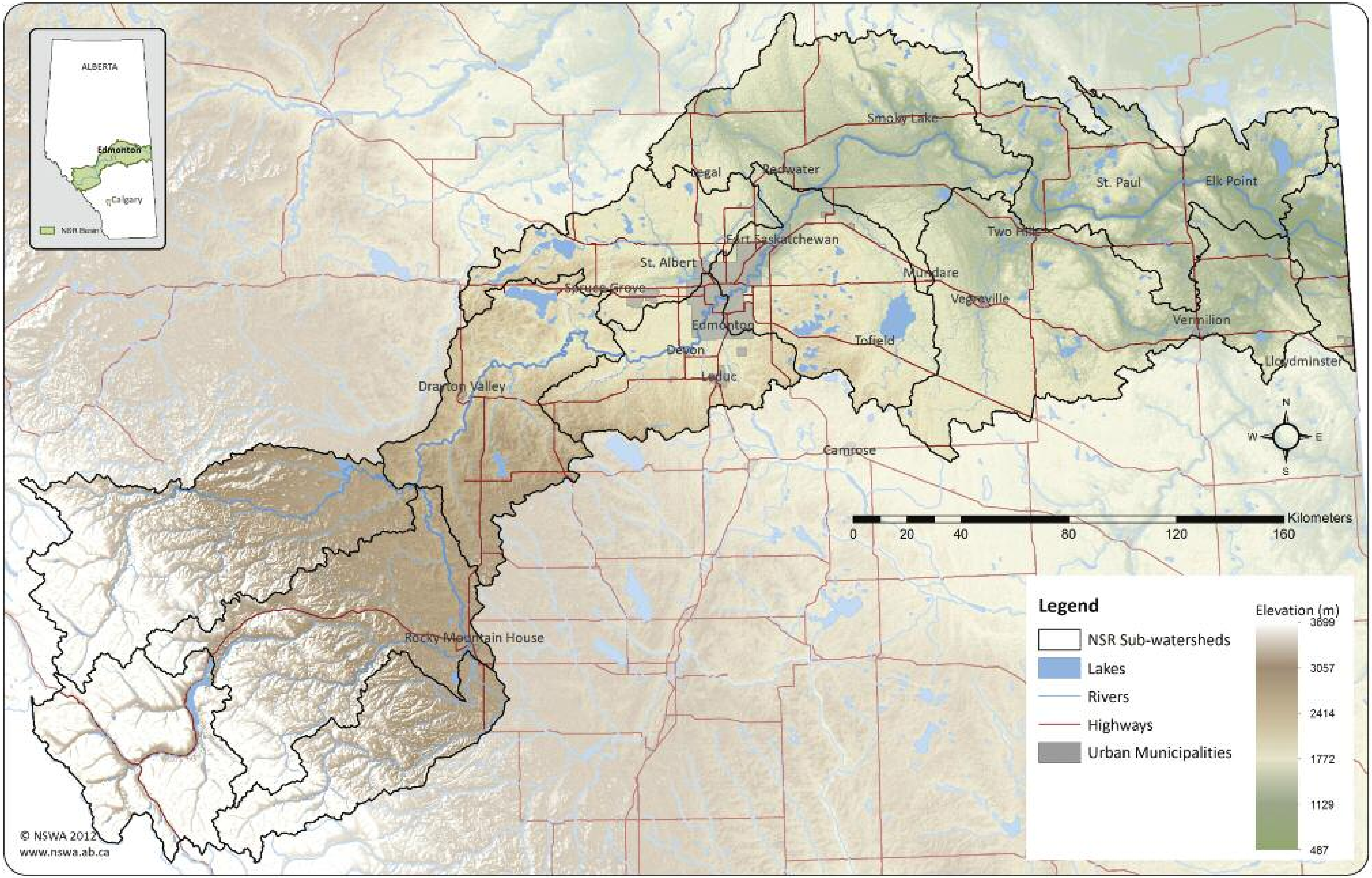
Topography affects the way water and air move across the land, and influences vegetation growth patterns. In the Northern Hemisphere, north-facing slopes receive less sunlight and as such, have higher soil moisture and encourage tree growth. For instance, in the North Saskatchewan River valley different tree species are frequently observed on the north versus south facing slopes. South facing slopes are naturally more arid and encourage plant species that prefer drier areas.

Elevation Changes across the North Saskatchewan River Watershed





Map 10. Topography in the North Saskatchewan River Watershed



Water Yield

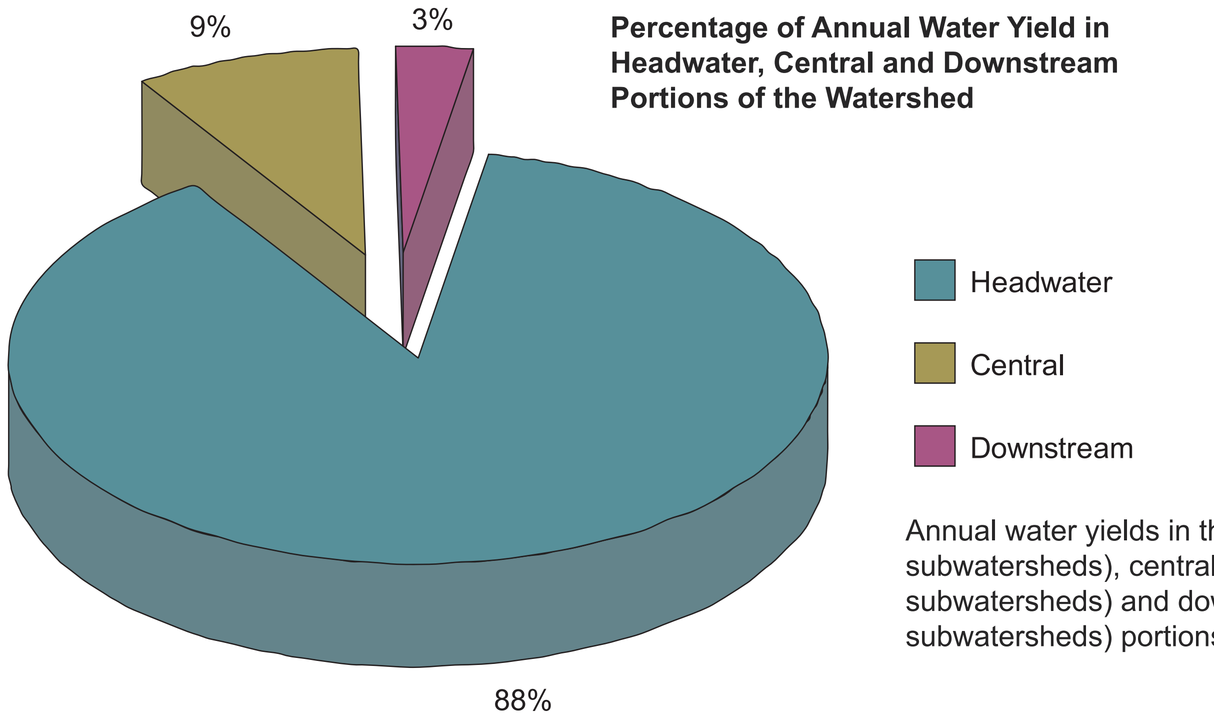
Factors affecting surface runoff include precipitation, amount and type of vegetation cover, slope, storage capacity of depressional areas (low wet areas where a significant amount of water ponds), landscape characteristics and anthropogenic (human) alterations. The subwatersheds of the North Saskatchewan River watershed vary widely in the amount of precipitation that runs off the surface of the land. This is known as water yield, which is the total amount of water flowing off a specific area in a defined time period.

The headwaters of mountain-fed prairie rivers are often referred to as the “water towers”, because they tend to provide the largest portion of total annual water yield generated within a watershed. This feature is shown in the pie charts, which illustrates the average annual percentage contribution of discharge from the headwater, central and downstream regions, as well as from the individual subwatersheds within the North Saskatchewan River watershed.

Subwatershed discharge is represented as a portion of total annual discharge of the North Saskatchewan River watershed. For instance, the four headwater subwatersheds (Cline, Ram, Clearwater, and Brazeau) together provide almost 90% (6,670 Mm^3) of the average annual discharge volume (7,510 Mm^3) of the North Saskatchewan River mainstem, as measured at the Saskatchewan border. The Cline subwatershed alone contributes 39% of the total watershed yield. On the other hand, central and downstream eastern subwatersheds of the North Saskatchewan River watershed contribute comparatively little runoff (9% and 3%, respectively).

Non-contributing areas are places in the watershed where surface runoff is stored within a small local area, and which do not contribute to the larger drainage network of the watershed except in extremely wet years. Examples of non-contributing areas include wetlands, shallow lakes with no outlets, perched basins, and areas with no outflow even under very wet conditions. The Prairie region, being relatively flat, contains many non-contributing areas that do not completely drain even in very wet years. Non-contributing areas may still contribute indirectly to water yield from subwatersheds through groundwater infiltration and discharge. The largest portions of non-contributing areas in the NSR watershed occur in the eastern portions of the watershed (Map 11).

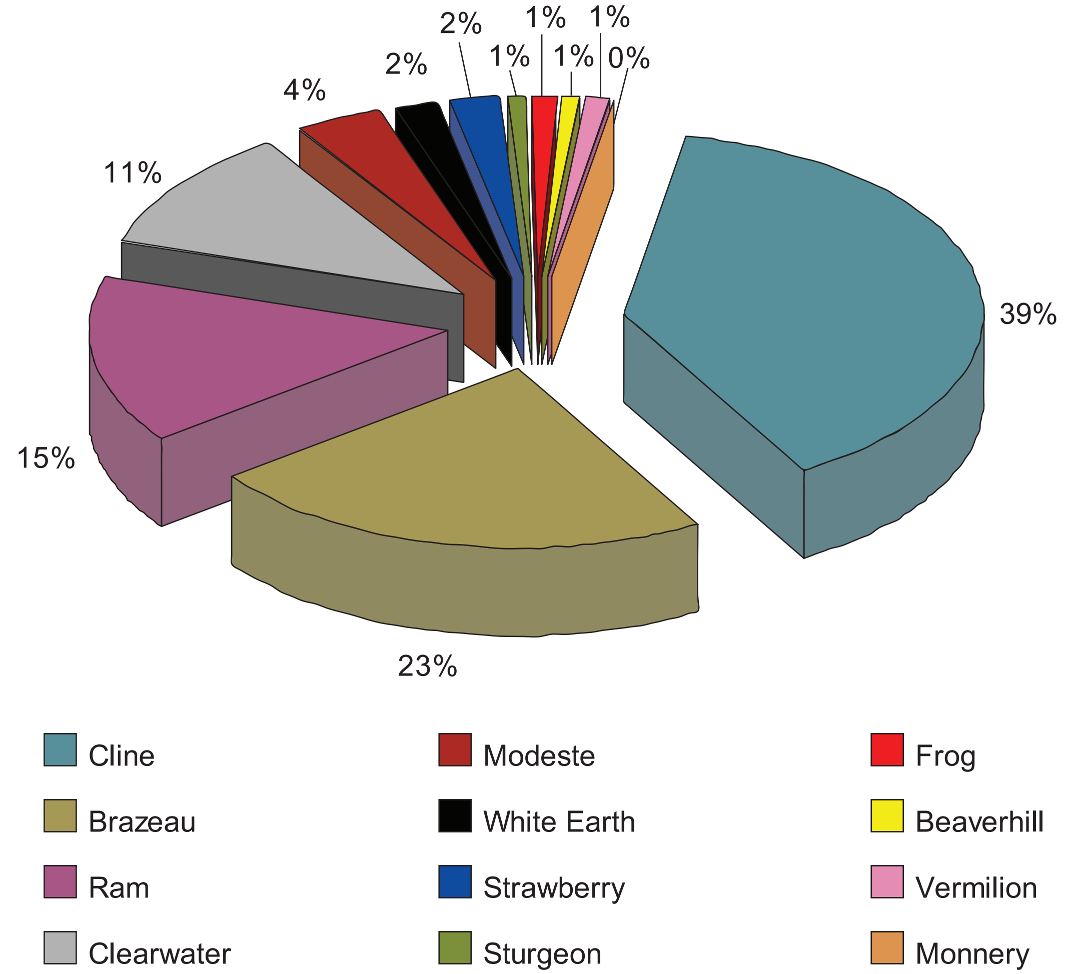
Percentage of Annual Water Yield in Headwater, Central and Downstream Portions of the Watershed



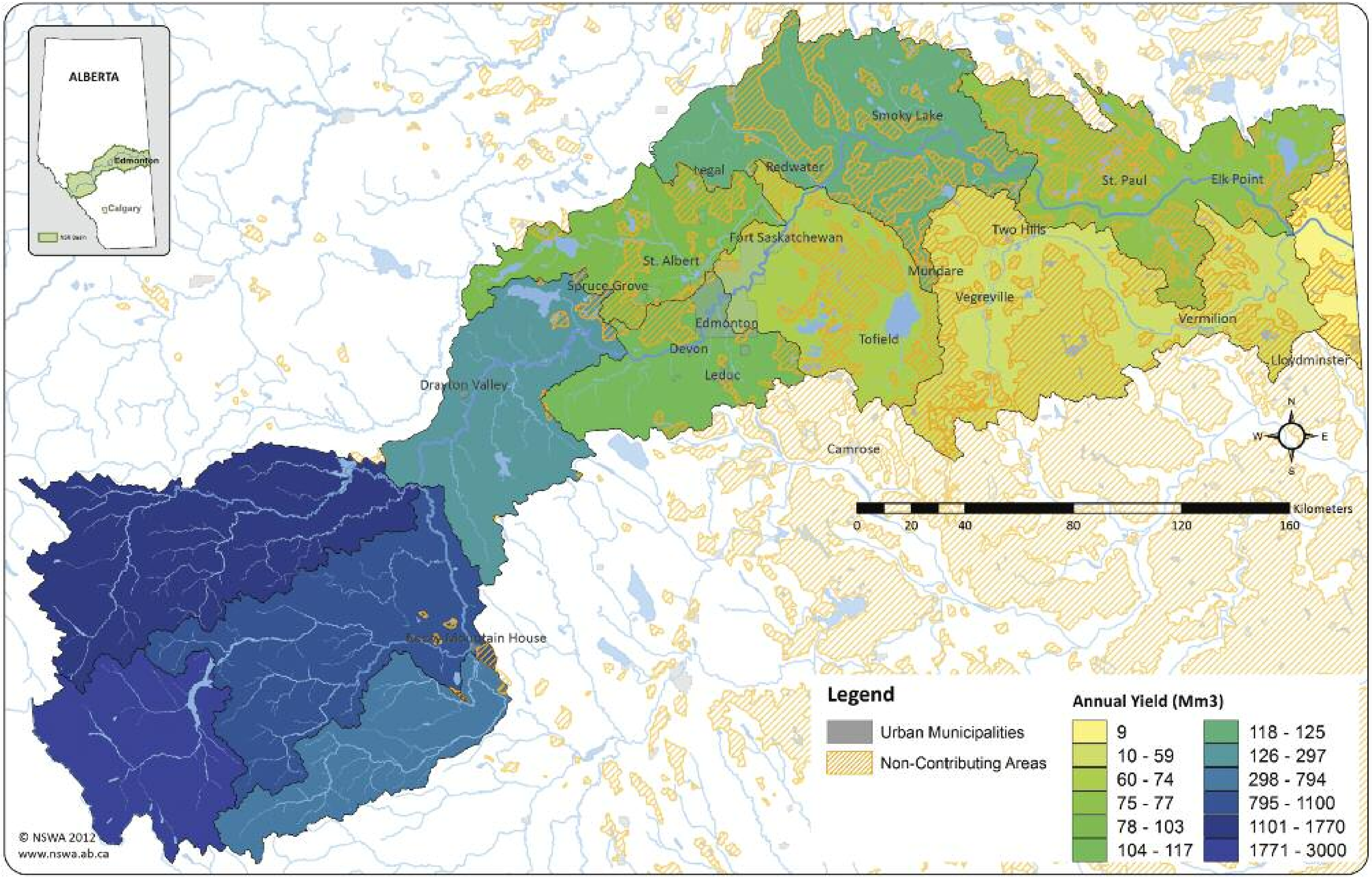
Annual water yields in the headwater (Cline, Brazeau, Ram and Clearwater subwatersheds), central (Modeste, White Earth, Strawberry and Sturgeon subwatersheds) and downstream (Frog, Beaverhill, Vermilion and Monnery subwatersheds) portions of the North Saskatchewan River watershed.

Percentage of Annual Water Yield per Subwatershed

Annual water yield for each subwatershed in the North Saskatchewan River watershed. The boxes in the legend indicate the headwater, central and downstream regions (left to right) in the watershed.



Map 11. Annual Subwatershed Water Yield in the North Saskatchewan River Watershed



Land Cover and Land Use

Land cover is defined as the biophysical features on the surface of the Earth, including water, vegetation, bare earth and built-up areas. Land cover information is obtained from aerial photographs, satellite imagery or field observations, and is classified into a number of categories.

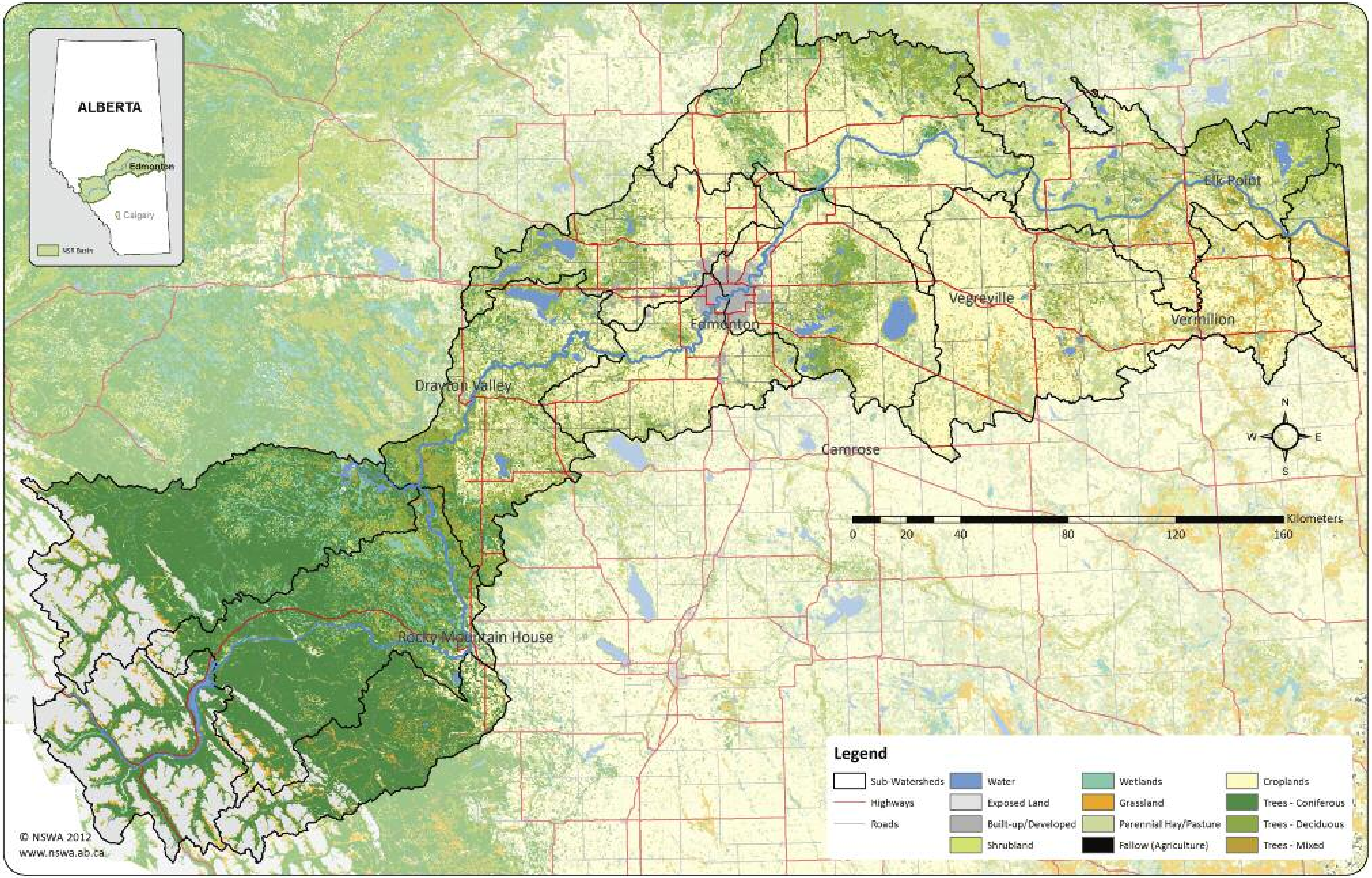
The term land cover is distinct from land use. The latter refers to the classification of human activities impacting a landscape. For example, land cover that is classified as deciduous forest may include several different land uses such as forestry, tourism-recreation (parks or protected areas) or grazing agriculture. Six major land use classifications are used in Canada: agriculture, forestry, energy/mining, tourism/recreation, transportation and urban development.

On Map 12, the predominant land cover types in the watershed range from coniferous and deciduous forests in the western headwaters region, to agricultural uses such as annual cropland, perennial cropland and pasture in the middle and eastern portions of the NSRW. There are some unique features in the watershed, including a rich spring fen (Wagner Bog), dune fields, old growth forests (foothills region) and coulees.

In the headwaters of the North Saskatchewan River watershed, the majority of lands falls within the Green Area (public lands) (*map to the right)*. Land uses in the Green Area are predominantly forestry, tourism/recreation, oil and gas exploration and development, with some urban/ residential land use. Central and downstream regions are in the White Area (private, or settled, lands) and almost all of the watershed's population lives in this zone. In the central region, the urban metropolitan areas of the Alberta Capital Region intermingle with agricultural land use, tourism/recreation use and oil and gas developments. The downstream region is predominantly under agricultural land use and oil and gas developments, with a small portion of urban development.

Public Lands General Classification Map

Map 12. Land Cover in the North Saskatchewan River Watershed



Population Density

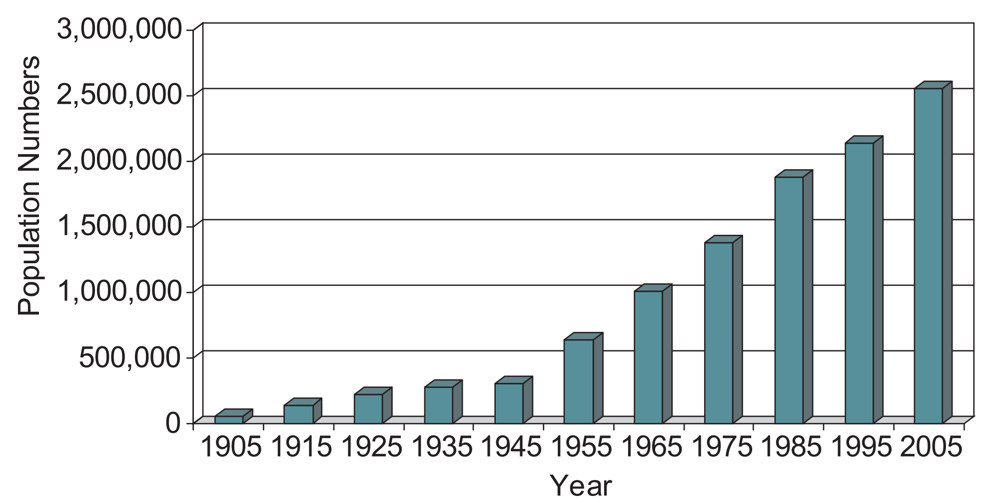
With over 1.2 million people, the North Saskatchewan River watershed is Alberta's most heavily populated major watershed. Map 13 depicts population density (the number of people per square kilometer, based on 2006 census data). The population density is categorized from very sparse (less than one person/km^2 in yellow) to highly dense (up to 12,000 people/km^2 in dark brown).

Note the high density (yellow to brown) of neighbourhoods in Edmonton and other urban centres, and the gradation of population from urban areas to surrounding rural areas. Population growth becomes less of a concern for watershed health when municipalities manage the impacts of development, by concentrating population in higher density nodes and utilizing low impact development (LID).

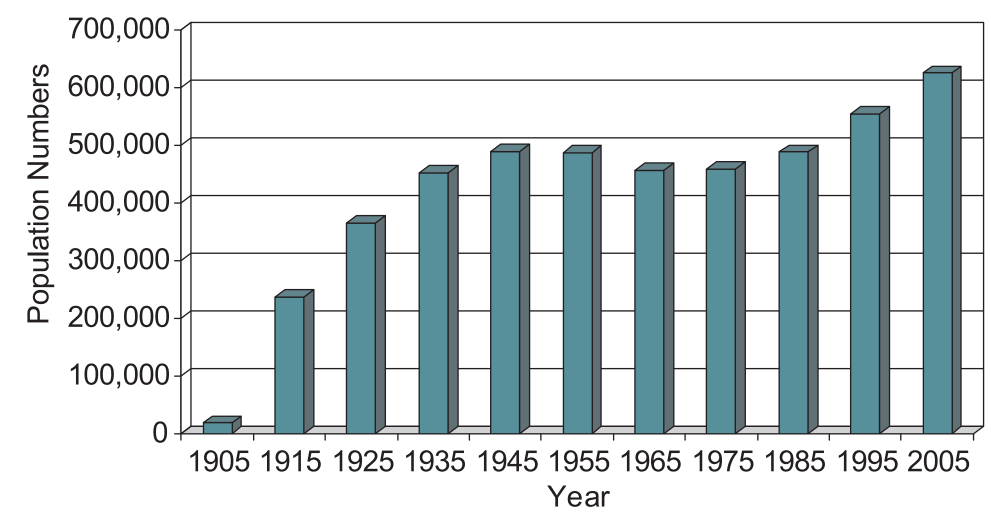
Rural residential development is a growing trend throughout the NSRW. Demands on local governments to supply services such as water, wastewater treatment and municipal infrastructure are increasing steadily due to this rapid growth. To accommodate population growth sustainably and strategically, regional growth management planning is a priority for the Alberta Capital Region. Initiatives to this end are led by the Capital Region Board, which is composed of 27 regional municipalities.

Significant population growth pressures in Alberta, particularly in urban areas result in increased recreational use in rural regions, particularly parks and protected areas. Activities such as random camping and ATV/Off-Highway Vehicle (OHV) use in riparian areas and waterways damage fish habitat and destroy natural vegetation. Invasive species are spread easily by unwashed ATV tires. Public education regarding the importance of trail systems and the environmental impacts of random camping, and ATV and OHV use, are key to preventing damage to sensitive areas.

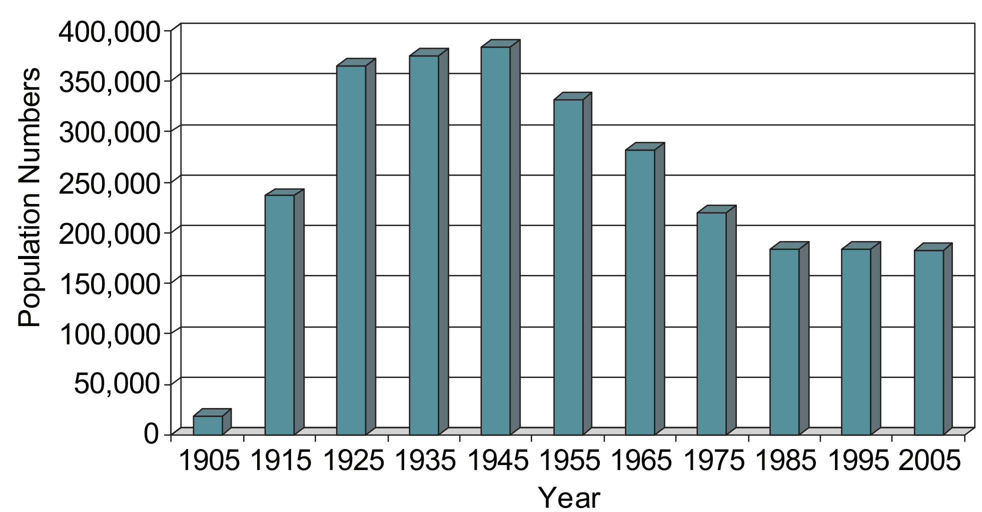
Provincial Urban Population



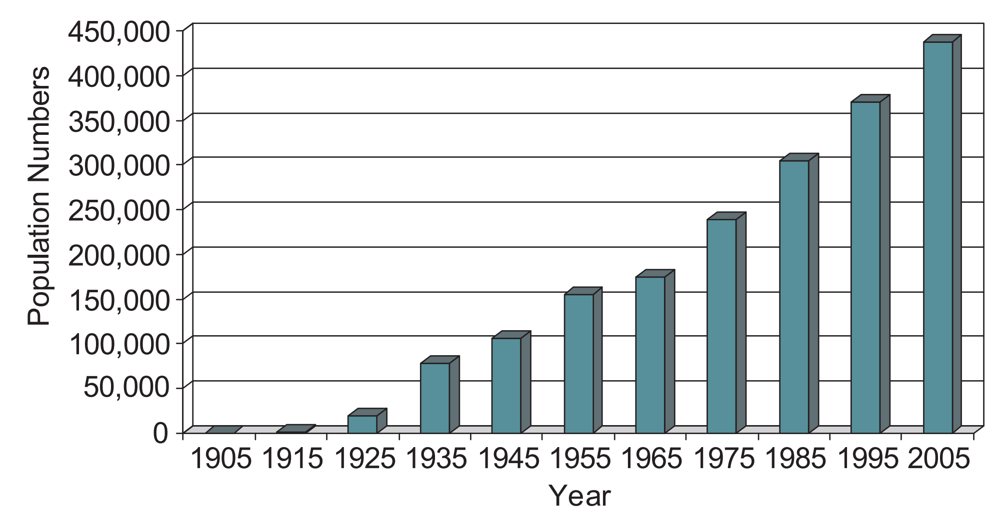
Provincial Rural Population



Provincial Farm Population



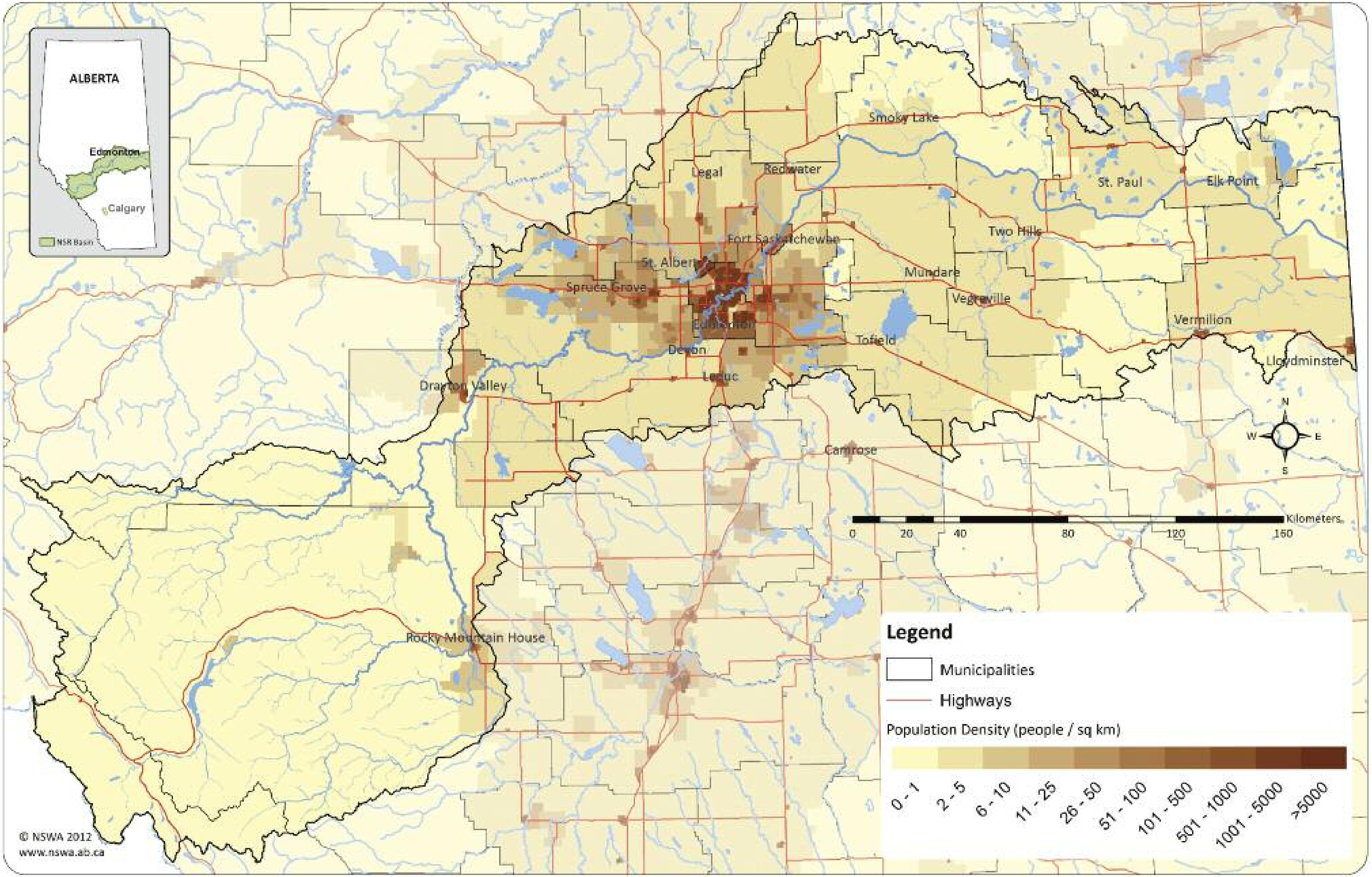
Provincial Acreage Population



As seen in the graphs above, urban populations have dramatically increased across Alberta in the last 100 years, while rural populations have remained fairly static. (Note: Provincial rural population numbers are the sum total of farm and acreage populations). The most interesting feature is the shift of the rural populations from farms to acreages; farm populations have nearly halved since their peak in 1945, while acreage populations have more than quadrupled in this same time period.

Scenes like this are common across Alberta, especially on long weekends. Extensive ATV and OHV damage has been caused in the lower headwater regions of the NSRW.

Map 13. Population Density (2006) in the North Saskatchewan River Watershed



Surface Water Licences

In Alberta, any person wishing to divert or use surface or non-saline groundwater, other than for domestic use, must obtain an Approval, Licence or Temporary Diversion Licence or comply with the Code of Practice established for certain exempted activities.

A licensed allocation is generally the maximum amount of water that an applicant expects will be required annually over the licensing period. The amount that is actually diverted and consumed in any particular year may be less than the full allocation. For example, in agricultural and irrigation settings, demand for water is typically lower during wetter years due to increased natural rainfall and surface runoff.

It is important to track how much water is used overall across thewatershed. Users who are licensed for large volumes are generally required to report how much water they have diverted, consumed and returned each year. Generally speaking, there is a significant difference between what has been allocated in the NSRW and what is actually consumed. Consumed, in this context, means water that is not returned to the river. Downstream users benefit from water that is returned to the river by upstream users. Smaller Licence holders may not be required to report the volumes of water that they use, and water use for domestic purposes is not licensed or reported.

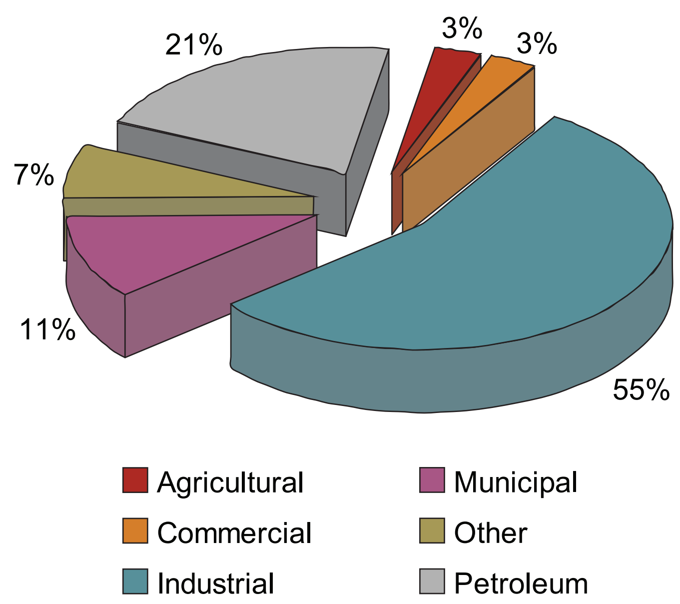
Alberta is required to leave 50% of the natural flow in the 5 major rivers flowing across the border into Saskatchewan, in order to ensure that Saskatchewan residents have water of sufficient quantity and quality to meet their needs, as per the Canada, Alberta, Saskatchewan, Manitoba *Master Agreement on Apportionment* (1969) as administered by the Prairie Provinces Water Board. This agreement prescribes similar obligations on waters flowing eastward from Saskatchewan into Manitoba.

Surface water withdrawal accounts for nearly 90% of water use in the North Saskatchewan River watershed. Almost all of this water use comes directly or indirectly from the North Saskatchewan River in the central region of the watershed. The pie chart to the right summarizes the water use in the watershed by sector, with the top two users being the industrial sector (55%) and the petroleum sector (21%).

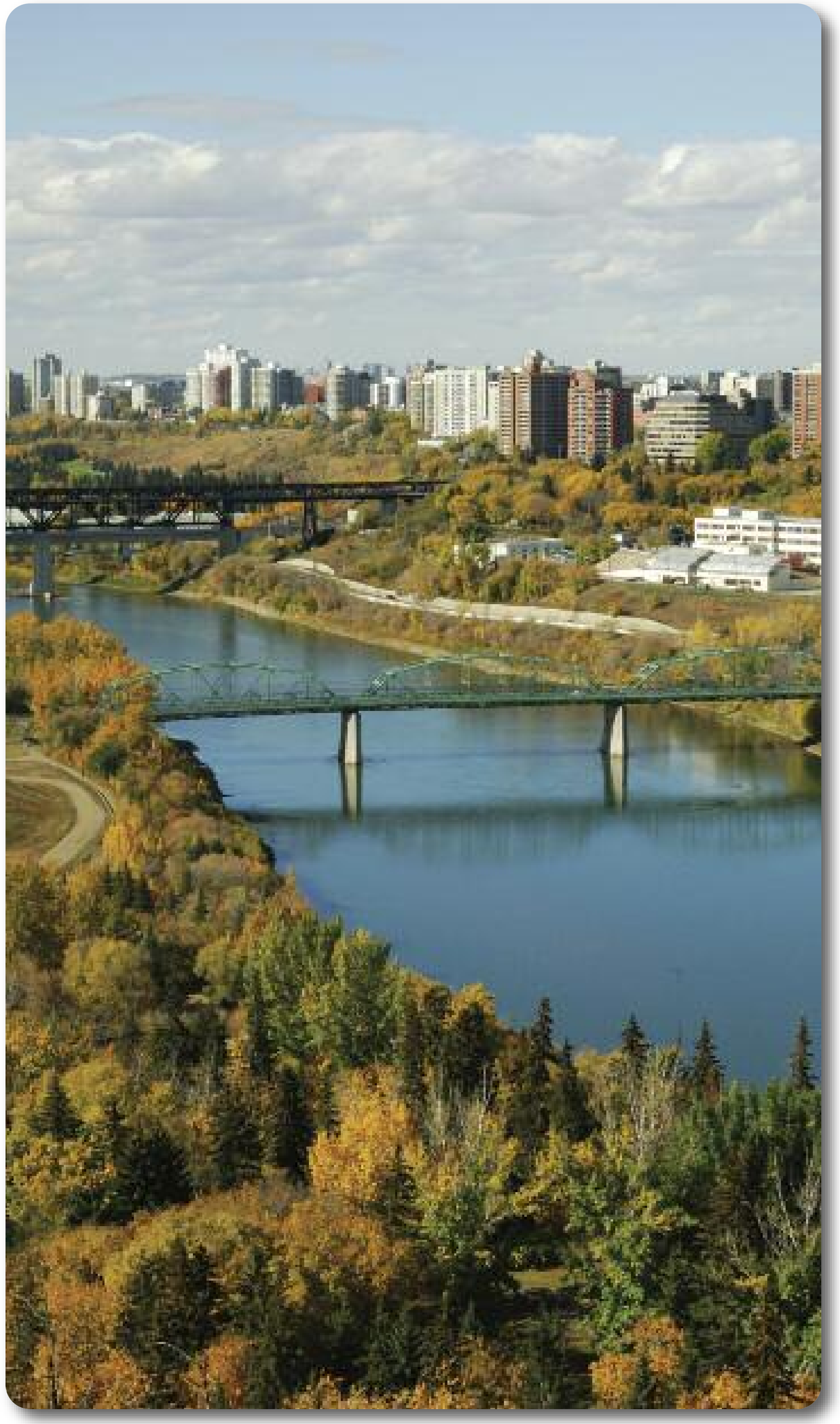
An important water use in the NSRW is the production of drinking water for the watershed's 1.2 million inhabitants. EPCOR water runs two large drinking water plants in Edmonton and supplies treated water to many communities in the Alberta Capital region and beyond. Map 14 illustrates how far the drinking water distribution system network from the City of Edmonton extends into surrounding rural areas. The network of pipelines extends north into County of Thorhild No.7, east into County Minburn, west into Parkland County and south into Beaver County. Future water lines will extend into Vermilion County, Smoky Lake County and Two Hills County No. 21.

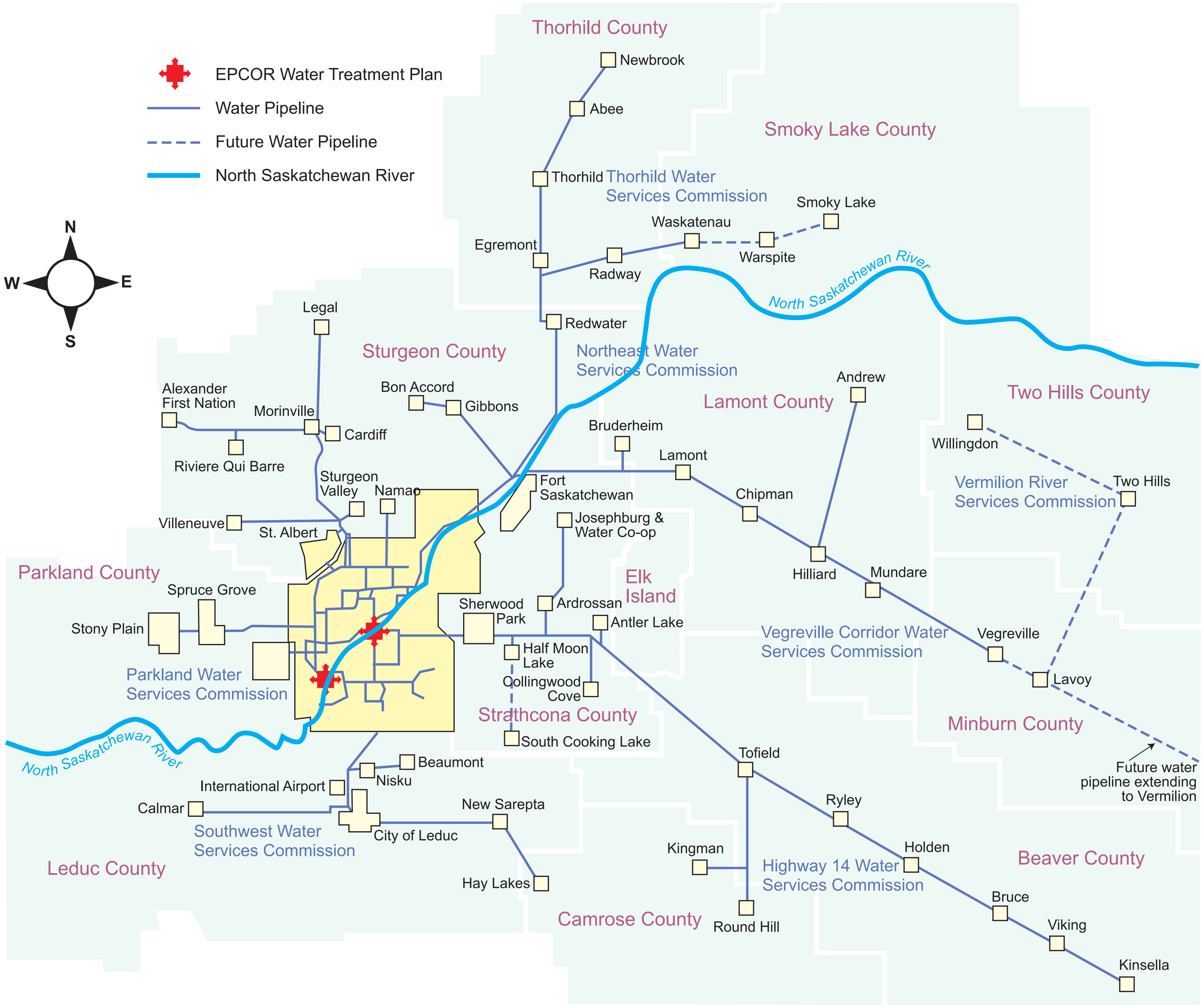
Map 15 shows licensed water use across the watershed, based on data for active licences from Alberta Environment and Sustainable Resource Development Environmental Management System. Map 16 illustrates licensed use of surface water for major water use sectors in the Greater Edmonton Area.

Licensed Water Use by Sector

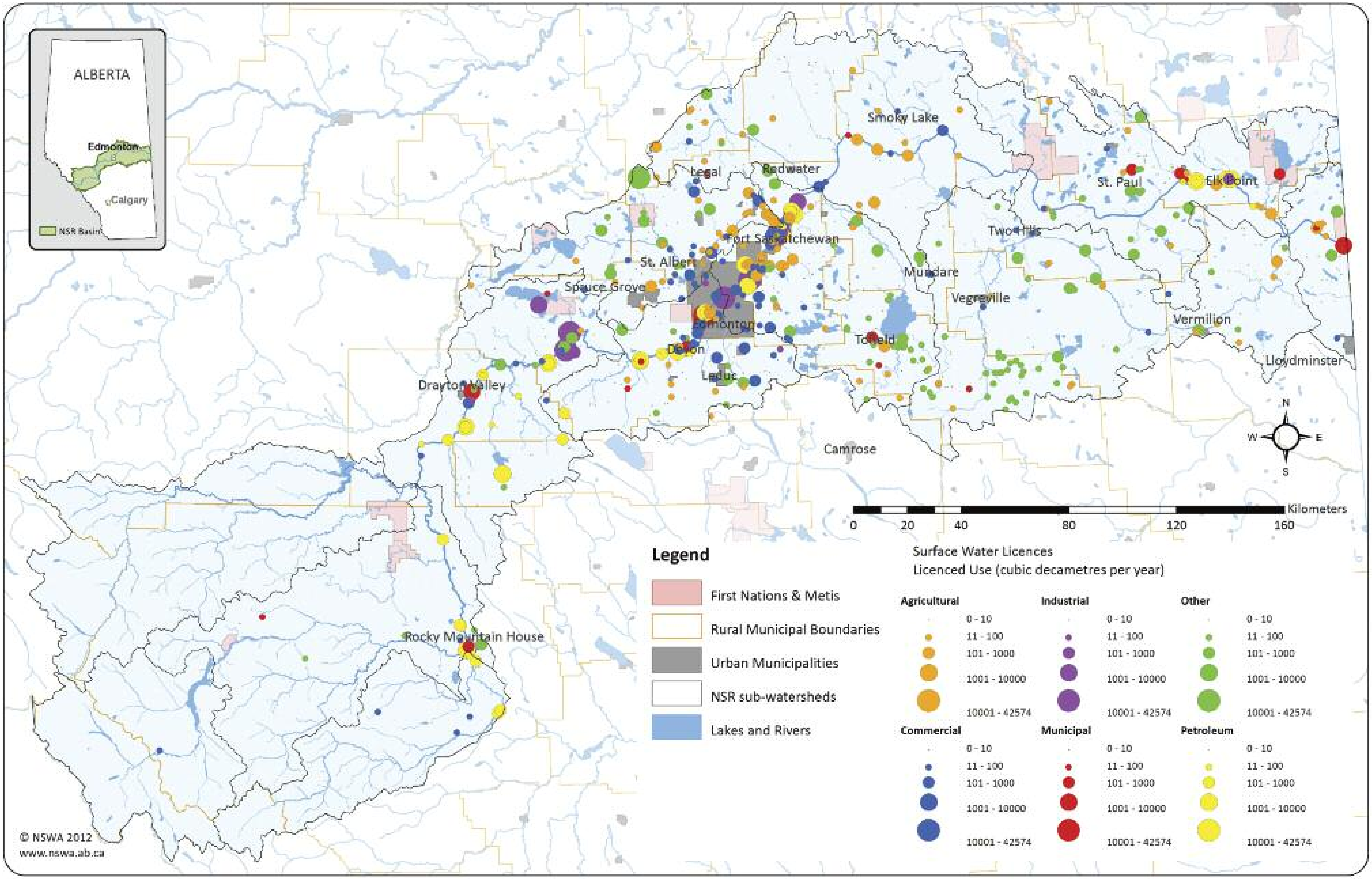


Licensed water use by sector in the North Saskatchewan River watershed. Data provided by Alberta Environment and Sustainable Resource Development.

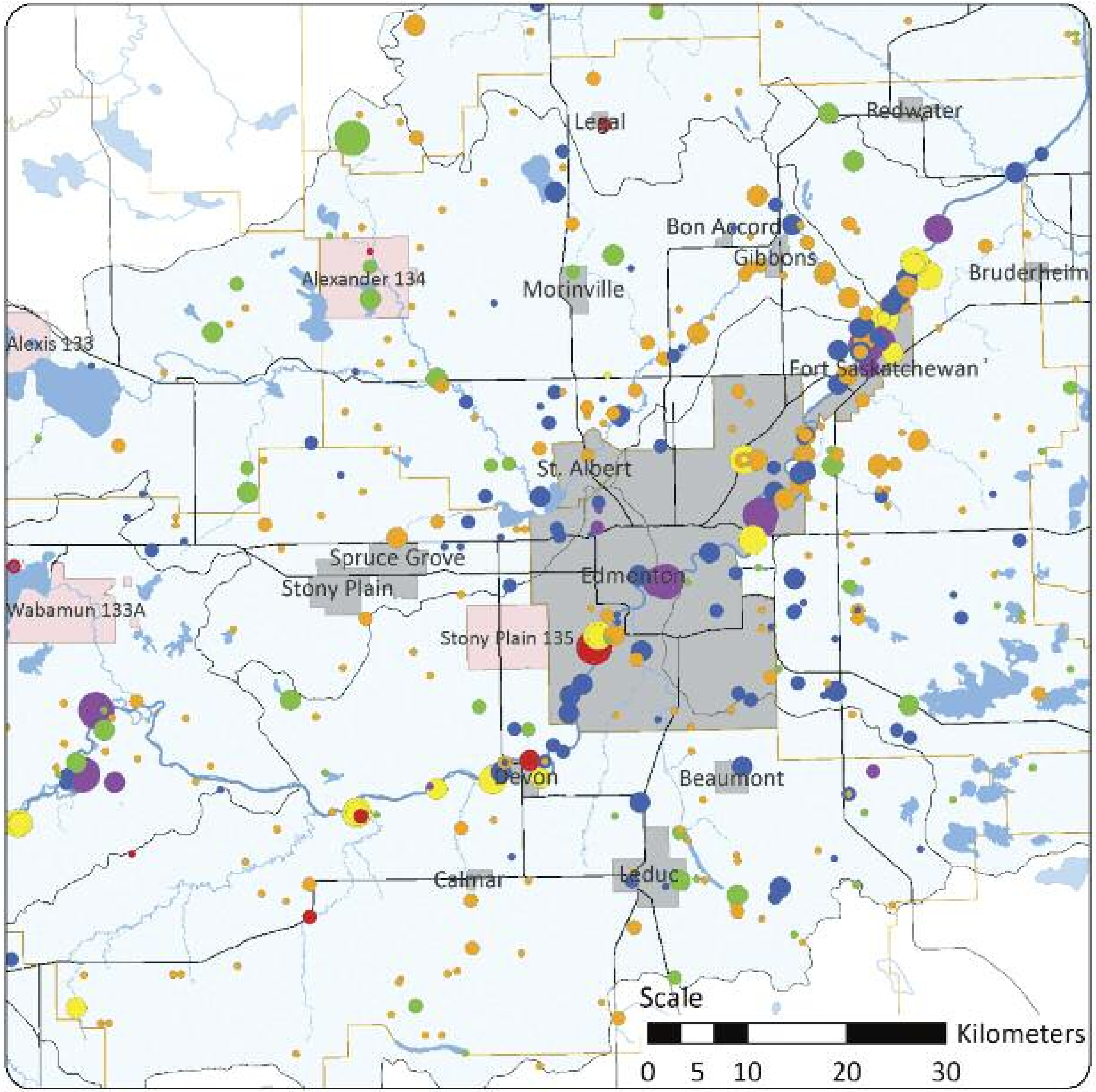



EPCOR Water Treatment Plan
Water Pipeline
Future Water Pipeline
North Saskatchewan River
N
W
E
S
Thorhild County
Newbrook
Abee
Smoky Lake County
Thorhild
Thorhild Water Services Commission
Smoky Lake
Waskatenau
Egremont
Radway
Warspite
North Saskatchewan River
Legal
Redwater
Sturgeon County
Northeast Water Services Commission
Andrew
Lamont County
Two Hills County
Bon Accord
Gibbons
Alexander First Nation
Morinville
Cardiff
Bruderheim
Willingdon
Riviere Qui Barre
Lamont
Vermilion River Services Commission
Two Hills
Sturgeon Valley
Namao
Fort Saskatchewan
Chipman
Villeneuve
Josephburg & Water Co-op
St. Albert
Parkland County
Elk Island
Hilliard
Mundare
Spruce Grove
Sherwood Park
Ardrossan
Stony Plain
Antler Lake
Vegreville Corridor Water Services Commission
Vegreville
Half Moon Lake
Parkland Water Services Commission
Collingwood Cove
Lavoy
Strathcona County
Minburn County
South Cooking Lake
North Saskatchewan River
Tofield
Future water pipeline extending to Vermilion
Beaumont
Nisku
International Airport
Ryley
New Sarepta
Calmar
Southwest Water Services Commission
City of Leduc
Holden
Kingman
Beaver County
Leduc County
Highway 14 Water Services Commission
Hay Lakes
Bruce
Camrose County
Round Hill
Viking
Kinsella

Map 15. Surface Water Licences in the North Saskatchewan River Watershed



Surface water licenses in the Greater Edmonton Area (see legend on map 15 for colour codes).



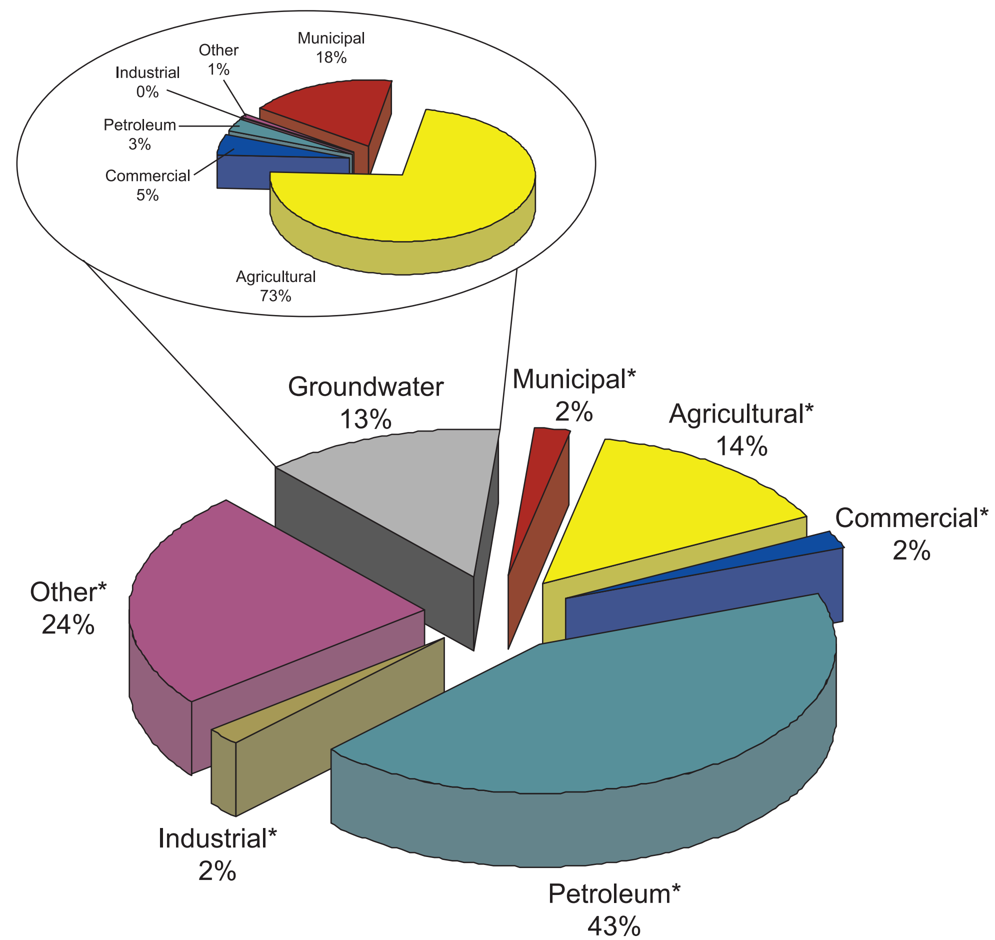
Water Well Density

Groundwater resources play a critical role in rural communities in the North Saskatchewan River watershed, but little detail is available about the amount of usable groundwater, groundwater movement, or water quality. As of 2005, about 13% of water use in the North Saskatchewan River watershed was groundwater, but this estimate may be low as estimates of domestic water use were not included. Under Alberta Environment and Sustainable Resource Development guidelines, domestic water use does not require a licence, so the amounts that are used are not reported. Agriculture accounts for approximately 50% of total groundwater use in the province.

Map 17 illustrates the density of all licenced water wells (active and inactive) across the North Saskatchewan River watershed. The highest densities are associated with rural residential subdivisions in Parkland and Strathcona Counties (up to 100 wells per square mile). Lower densities are found across rural areas (1-12 wells per square mile). Water use related to oil and gas activities are responsible for the distribution of Licences in western portions of the river watershed.

More information on groundwater conditions in the North Saskatchewan River watershed may be found in the NSWA publication “Overview of Groundwater Conditions, Issues and Challenges”, prepared by Worley Parsons (2009).

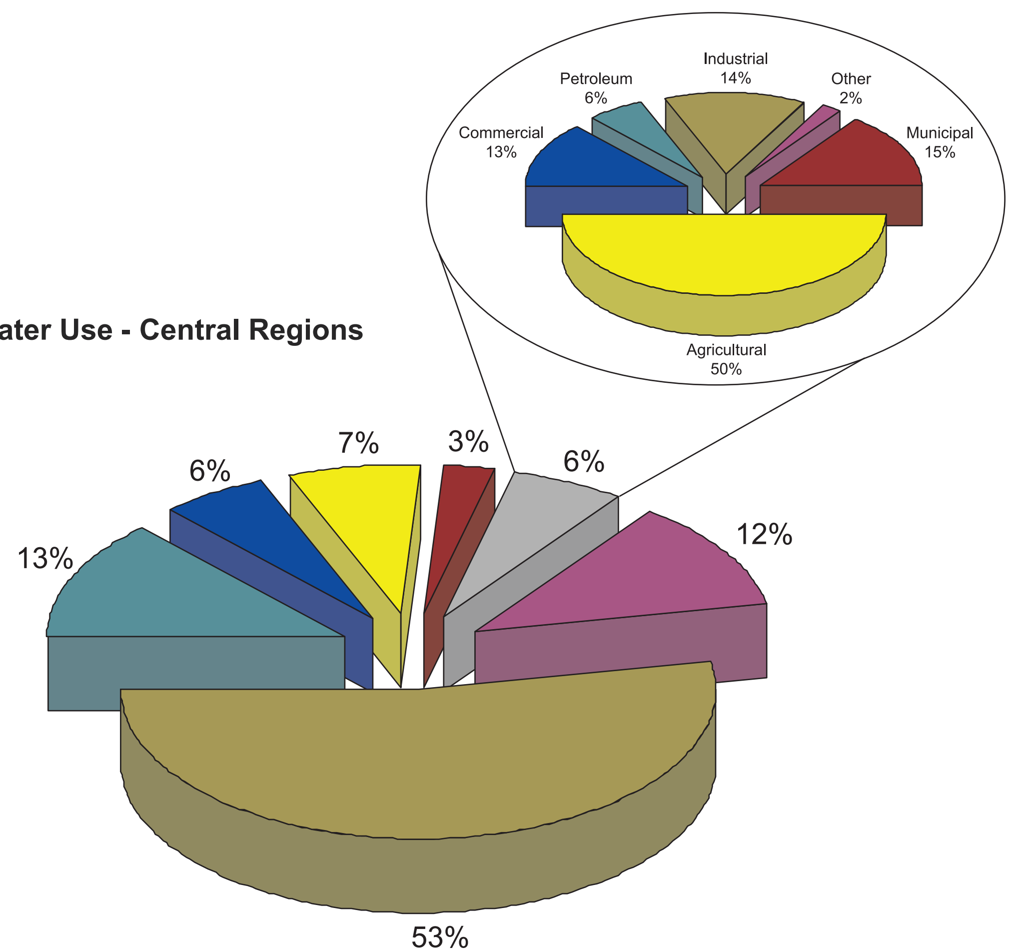
Estimated Water Use - Eastern Regions



Petroleum* | Other* | Municipal* | Industrial* | Groundwater | Agricultural* | Commercial*

Estimated total surface water use (2005): 20,274 dam^3 (87%)
Estimated total groundwater use (2005): 3,011 dam^3 (13%)
Estimated total water use (2005): 23,285 dam^3
Notes: * denotes surface water use
Source: AMEC (2007)

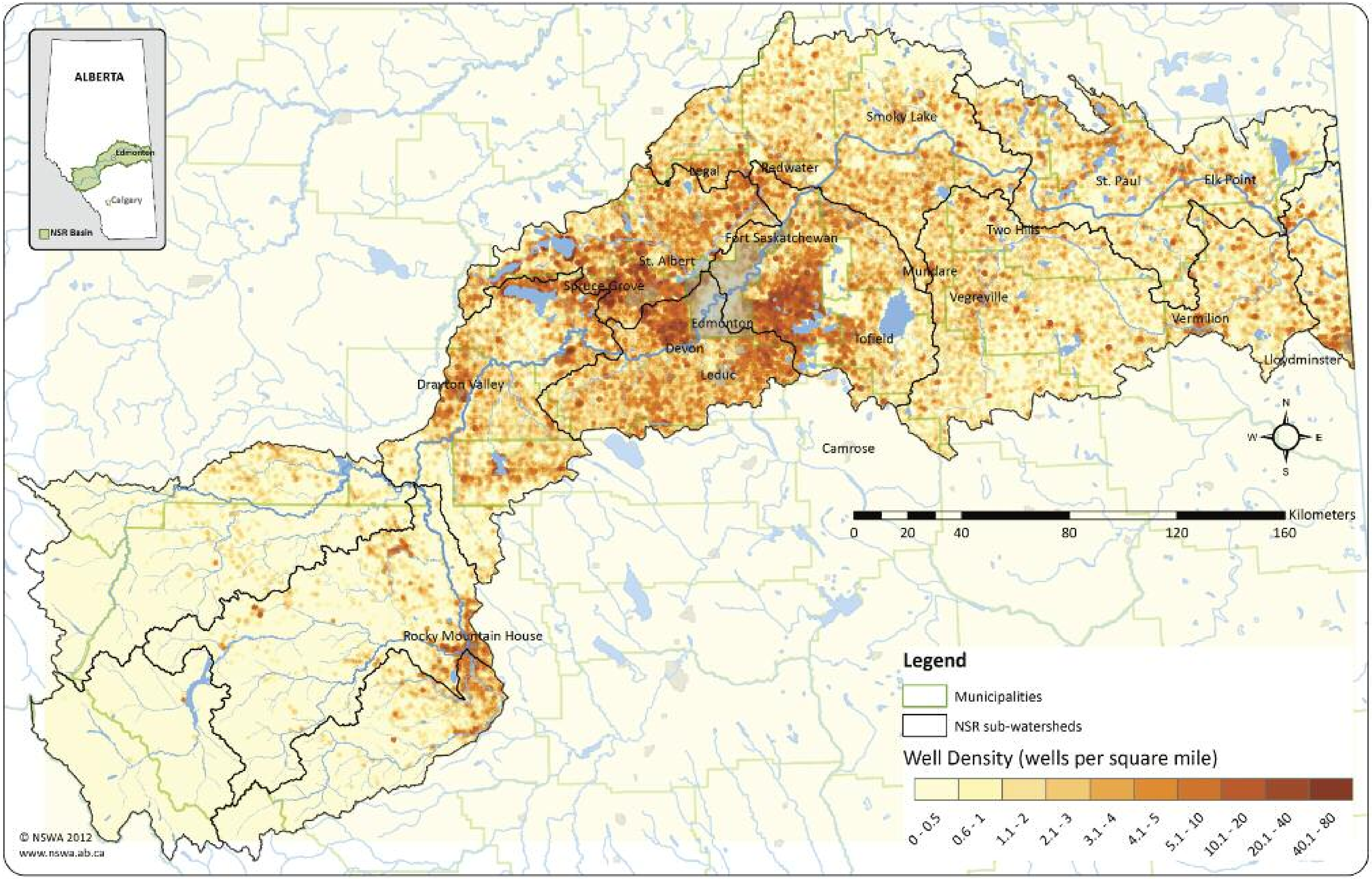
Estimated Water Use - Central Regions



Industrial* | Groundwater | Agricultural* | Other* | Municipal* | Commercial* | Petroleum*

Estimated total surface water use (2005): 163,927 dam^3 (94%)
Estimated total groundwater use (2005): 9,701 dam^3 (6%)
Estimated total water use (2005): 173,628 dam^3
Notes: * denotes surface water use
Source: AMEC (2007)

Map 17. Water Well Density in the North Saskatchewan River Watershed



Wastewater Treatment

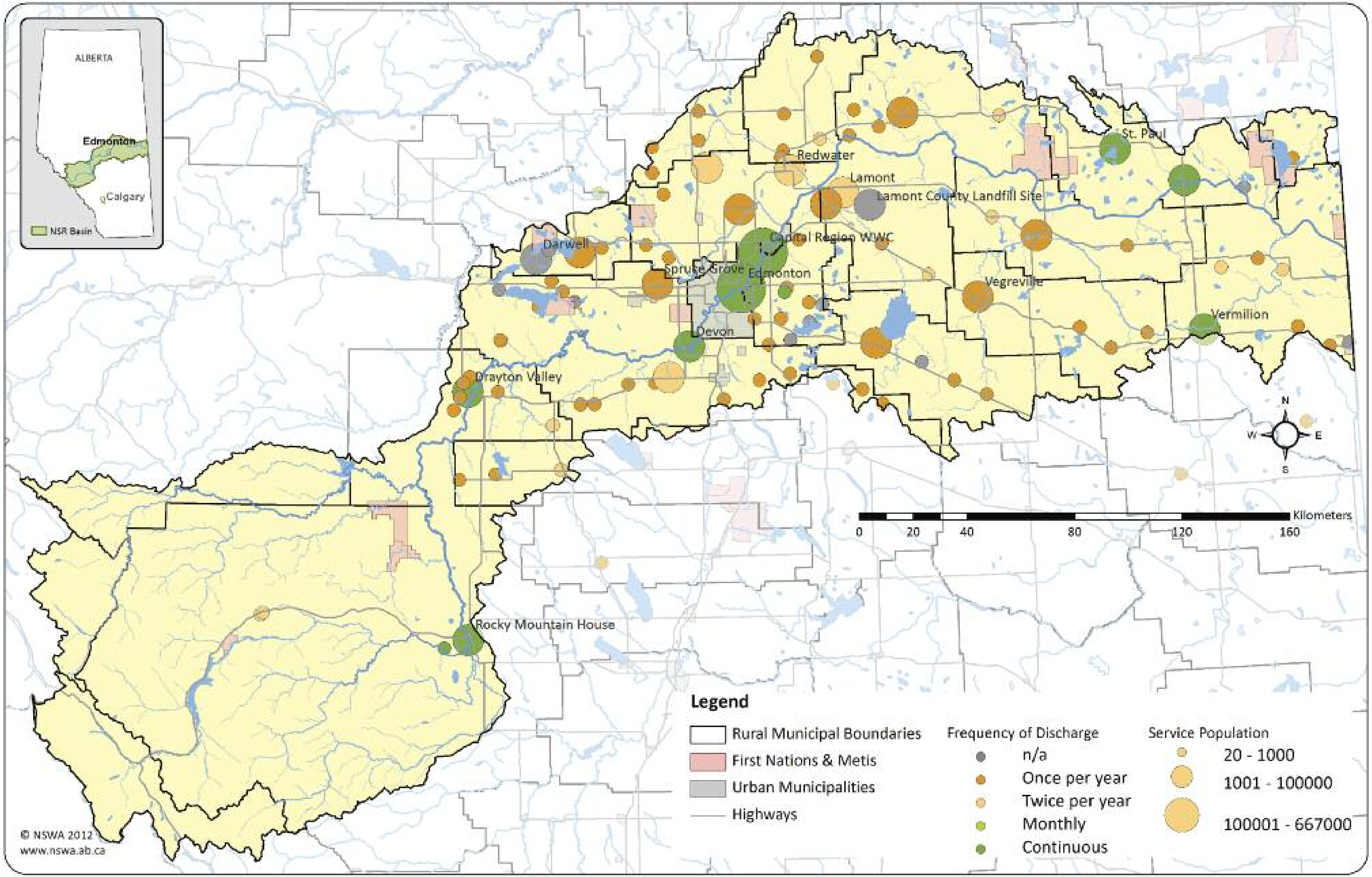
Human waste and wastewater from municipal, industrial and commercial activities must be treated before being released into water bodies. The type of wastewater treatment depends on the population of the area serviced, the type of wastes carried in the wastewater, and environmental and regulatory considerations. For instance, small towns and villages in the NSRW treat wastewater using natural decomposition processes in a series of lagoons assisted by aeration or other techniques. Large urban centres like Edmonton use advanced wastewater treatment at the Gold Bar and Capital Region wastewater treatment plants. They use techniques such as settling, aeration, biological nutrient removal and ultraviolet light disinfection to improve the quality of wastewater discharged.

Improvements to the Gold Bar and Capital Region Wastewater plants over the past few decades have improved the quality of the effluent released to the NSR. These wastewater treatment plants also supply reclaimed water to industry and use biogases generated in the plant to help fuel operations.

Map 18 depicts the location and service population of Wastewater Treatment Plants (WWTPs) across the North Saskatchewan River watershed, categorized by type of treatment. It also shows the frequency of discharges to surface water from each plant. Note that a number of lagoon systems in the Edmonton region are currently inactive or used only for temporary storage. Many homes and developments in rural Alberta use on-site wastewater treatment, typically septic tanks and fields. Some rural municipalities in the NSRW now require rural residential subdivisions of a certain size to install communal wastewater treatment facilities.

Aerial view of the Gold Bar Wastewater Treatment Plant in Edmonton.

Map 18. Wastewater Treatment in the North Saskatchewan River Watershed



Linear Disturbance Features

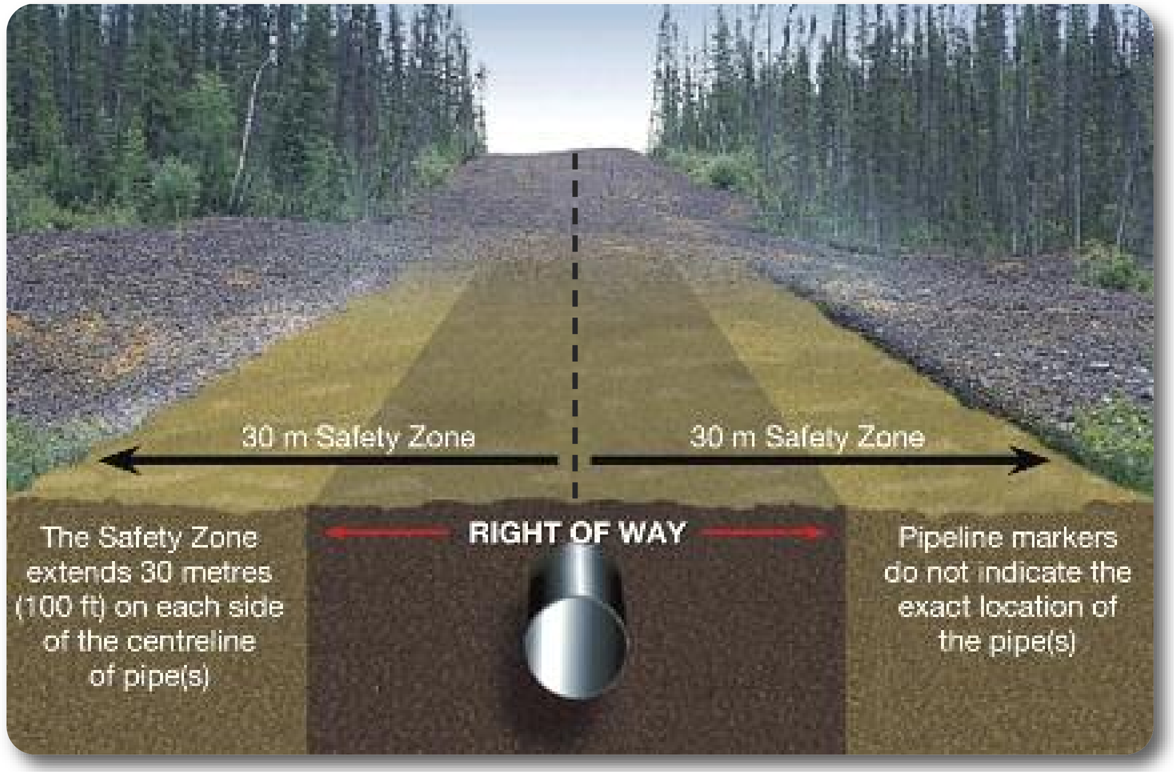
The movement of goods, energy and people across the landscape requires roads, highways, electricity transmission lines, pipelines and railways. These are known as linear features. Cumulatively, these features can impact the watershed by fragmenting and degrading habitat for terrestrial and aquatic organisms, increasing erosion and degrading water quality. In order to protect the watershed, changes in linear features over time need to be monitored and impacts managed carefully.

Linear features are measured using linear density, which is the total length of all linear features in a given area. The highest linear densities (greater than 18 km/km^2) in the watershed are in the Alberta Capital Region, in the Drayton Valley area, and along the Redwater River, northeast of Edmonton (Map 19). In the Alberta Capital Region, streets account for most of the linear density. In the other areas, high densities of seismic lines, pipelines, and access roads dominate the landscape. The lowest linear densities are found in National and Provincial Parks and in sparsely populated rural areas in the eastern part of the watershed.

Stream crossings associated with roads may disturb aquatic habitat and riparian areas. These crossings can increase stormwater runoff and erosion, which can impact fish spawning areas. Culverts at road crossings may create small "waterfalls" which erode the soil below the culvert openings. Over time, these depressions may become deep enough that during low water flows, fish are unable to move upstream past the culvert; this is referred to as a "hanging" culvert.

Other potential impacts from linear disturbances include public access and recreational use in isolated areas, which contributes to wildlife disturbance, erosion, road sand and salt pollution, damage to native vegetation and the spread of invasive organisms.

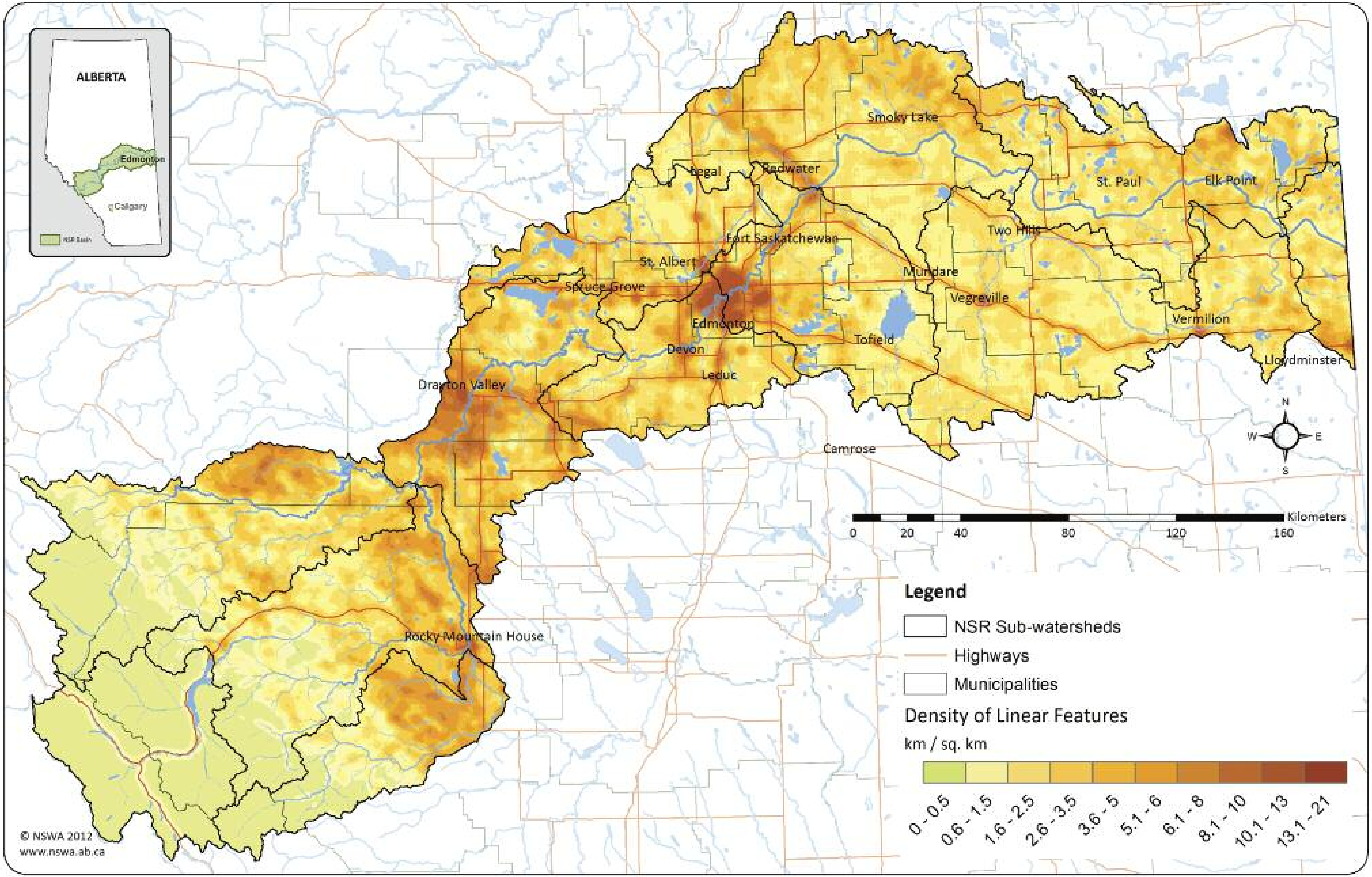
An example of a hanging culvert.



Pipeline right of ways are typically 60 meters wide and are kept free of tree and shrub growth. Transmission lines also have a similar right of way configuration. The right of ways are meant for access for repairs and maintenance, and offer a safety buffer in the event of accidents. National Energy Board, 2011.

An example of how linear disturbance fragments the Alberta landscape.

Map 19. Density of linear features in the North Saskatchewan River Watershed



Oil & Gas Well Density

Alberta is a province rich in energy resources, and over the past century these resources have been heavily used. As a result, there are a large number of oil and gas wells across the province. Map 20 displays the density of oil and gas wells calculated as the number of wells per square mile* in the NSRW. This map shows all well sites (active, inactive and abandoned) recorded as of 2008 in the Energy Resources Conservation Board (ERCB) database. It does not represent current activity, but does show the cumulative activity of oil and gas extraction in the North Saskatchewan River watershed. Reclaimed wells are not represented.

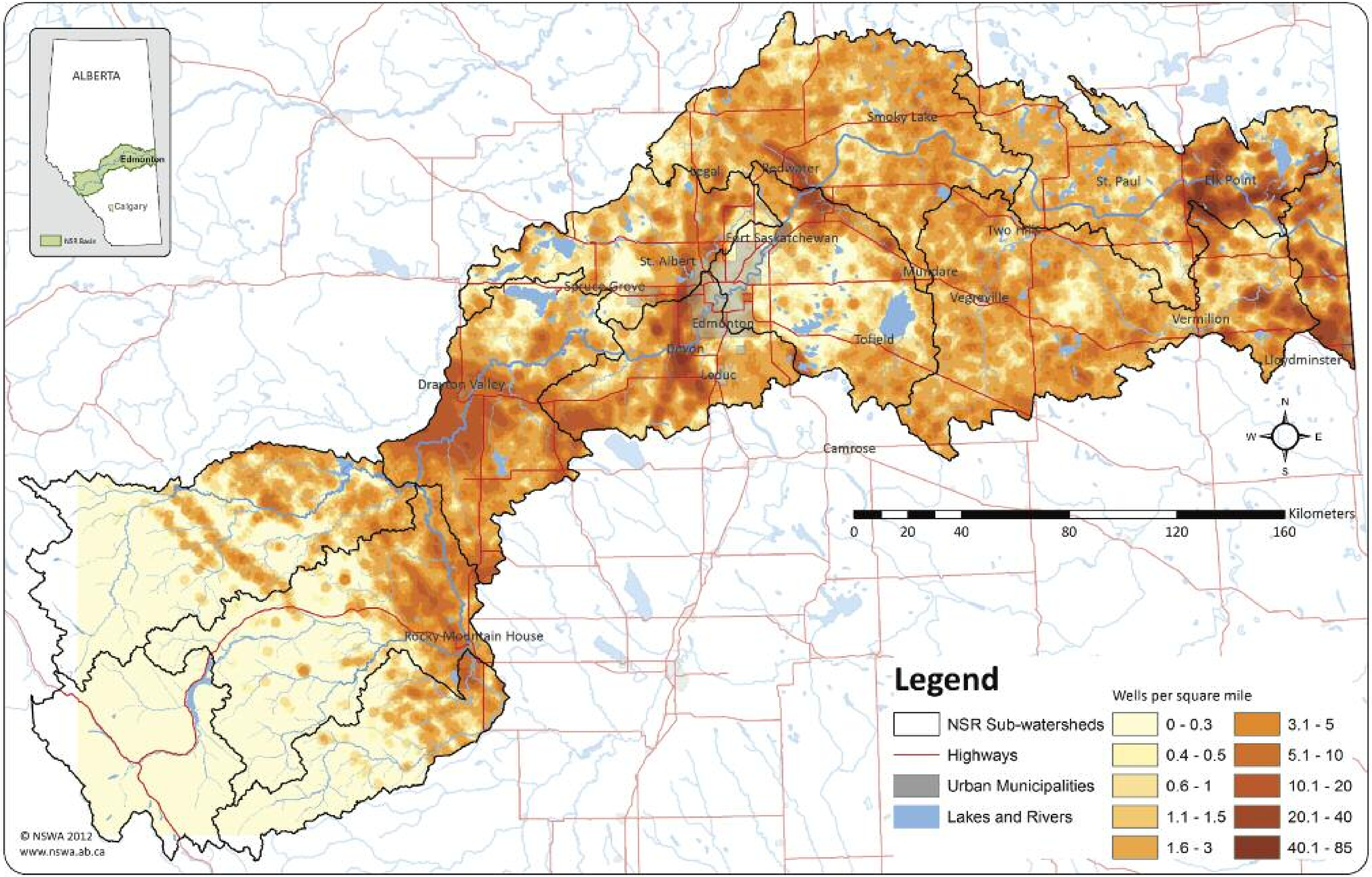
The highest densities of oil and gas wells are around Drayton Valley (12-20 wells per square mile), Redwater (22-30 wells per square mile), Devon (38-50 wells per square mile), and in the Counties of St. Paul and Vermilion River (more than 64 wells per square mile).

Environmental risks associated with drilling for oil and gas include hydrocarbon and salt spills, the release of toxic gases (such as hydrogen sulfide), the generation of wastes (drilling mud) and well blowouts and fires. Others include the clearing of vegetation for well pads and their associated access roads.

More information on oil and gas production can be found at www.ercb.ca.

* *Square mile is a common unit of reference for land regulation in rural Alberta.*

Well pads for oil and gas drilling are common across the landscape


ALBERTA
Edmonton
Calgary
NSR Basin
Smoky Lake
St. Paul
Elk Point
Legal
Redwater
Two Hills
Fort Saskatchewan
St. Albert
Mundare
Spruce Grove
Vegreville
Vermilion
Edmonton
Tofield
Devon
Lloydminster
Leduc
Drayton Valley
Camrose
N
W
E
S
0
20
40
80
120
160
Kilometers
Rocky Mountain House
Legend
Wells per square mile
NSR Sub-watersheds
Highways
Urban Municipalities
Lakes and Rivers
0 - 0.3
0.4 - 0.5
0.6 - 1
1.1 - 1.5
1.6 - 3
3.1 - 5
5.1 - 10
10.1 - 20
20.1 - 40
40.1 - 85
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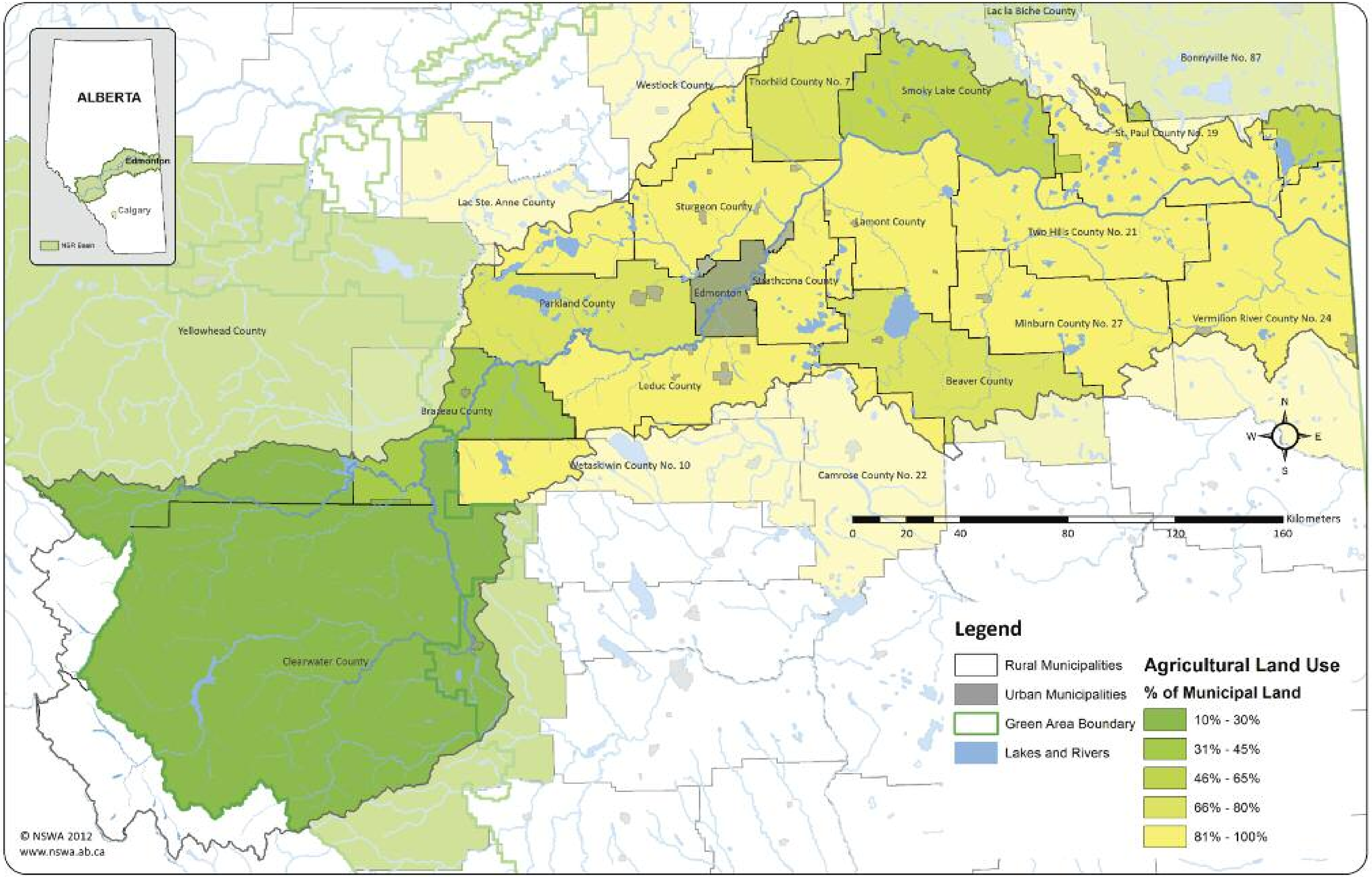
Agricultural Land Use in Rural Municipalities

The Census of Agriculture conducted by Statistics Canada every five years provides a comprehensive database of information on farm types, ownership, land management, land use, livestock and crop production, agricultural economics, farm implements and farm operators. Since 1971 the Census of Population and the Census of Agriculture have been linked. This provides a wide range of socio-economic information for rural areas of Canada.

Agricultural land use in rural municipalities in the NSRW is generally crop-based or livestock-based. The data in Map 21 show the percentage of rural municipal lands that are in agricultural use. The data are only available for the White (settled) Area and excludes grazing uses on public land in the Green (Crown land) Area. Data shown are for the entire extent of the municipality, not just the areas within the North Saskatchewan River watershed.

Photo: The Sturgeon River watershed. It is apparent that crop-based agricultural land use is prevalent here. The yellow squares are canola fields.


ALBERTA
Edmonton
Calgary
NSR Basin
Lac la Biche County
Bonnyville No. 87
Westlock County
Thorhild County No. 7
Smoky Lake County
St. Paul County No. 19
Lac Ste. Anne County
Sturgeon County
Lamont County
Two Hills County No. 21
Strathcona County
Edmonton
Parkland County
Minburn County No. 27
Vermilion River County No. 24
Yellowhead County
Leduc County
Beaver County
Brazeau County
Wetaskiwin County No. 10
Camrose County No. 22
Clearwater County
N
W
E
S
Kilometers
0
20
40
80
120
160
Legend
Rural Municipalities
Urban Municipalities
Green Area Boundary
Lakes and Rivers
Agricultural Land Use
% of Municipal Land
10% - 30%
31% - 45%
46% - 65%
66% - 80%
81% - 100%
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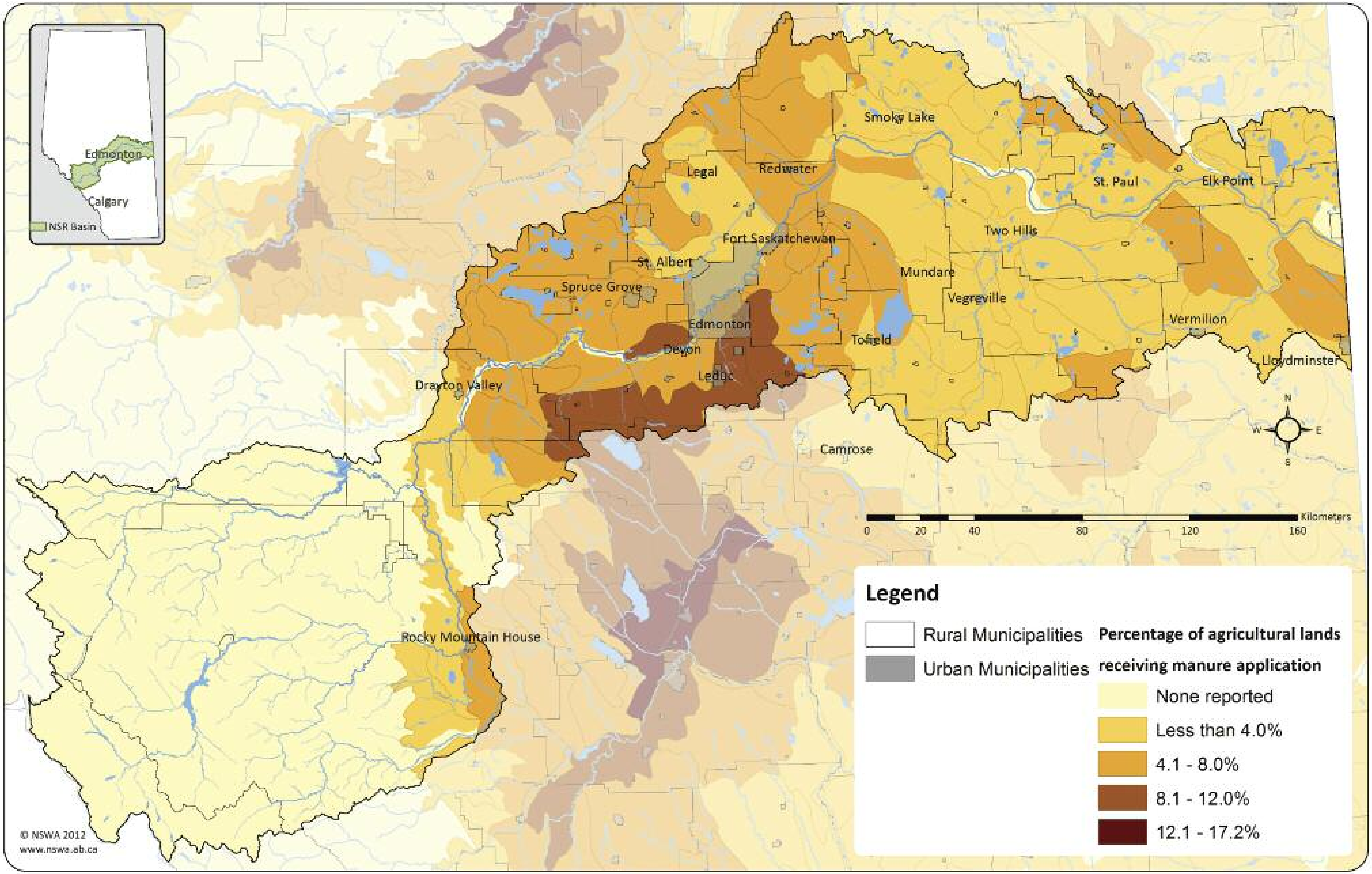
Manure Application

Except for the headwaters and the metropolitan area of the Capital Region, the majority of the North Saskatchewan River watershed is under agricultural land use. Over half of the 20,000 farms in the watershed have livestock ranging from traditional beef and dairy cattle, hogs, sheep and goats, horses and ponies, and poultry, to alternative types of livestock including wild boars, llamas/alpacas, bison, deer and elk. Larger operations often provide manure to crop growers to use as fertilizer on their land. It is applied using many different methods, from soil incorporation to injection and surface application.

Map 22 illustrates the extent of application of manure from livestock in each municipality as reported in the 2006 Census of Agriculture. Different methods of application have different benefits and drawbacks. The majority of manure used in the watershed is applied using either the injection or incorporation method. Surface application is the least popular method across the watershed. The incorporation of manure into the soil reduces the chance of manure running off the land during a rainfall event, whereas surface application increases the risk of runoff and possible contamination of surface waters.

Manure is viewed as a resource, not a waste. When managed appropriately it contributes significantly to crop production and yield, reduces need for inorganic fertilizers, increase soil organic matter and improves water-holding capacity. When manure is not managed effectively there is increased risk of contamination to surface, groundwater and stored water supplies. Environmentally beneficial management practices include improved handling techniques and application methods as well as runoff control measures. For instance, the composting of manure is practiced on over a third of livestock farms within the North Saskatchewan River watershed.

A less commonly used method of manure application is surface spreading (above). This method is not used as much as incorporation or injection (below) due to increased chance of contamination from surface runoff during rainfall events.


Edmonton
Calgary
NSR Basin
Smoky Lake
Legal
Redwater
St. Paul
Elk Point
Two Hills
Fort Saskatchewan
St. Albert
Mundare
Spruce Grove
Vegreville
Vermilion
Edmonton
Tofield
Devon
Lloydminster
Leduc
Drayton Valley
Camrose
Kilometers
0
20
40
80
120
160
Legend
Rural Municipalities
Urban Municipalities
Percentage of agricultural lands receiving manure application
None reported
Less than 4.0%
4.1 - 8.0%
8.1 - 12.0%
12.1 - 17.2%
Rocky Mountain House
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www.nswa.ab.ca

Potential Risk of Groundwater Contamination

Human activities on the surface of the land come with a risk of introducing contaminants into groundwater, particularly if the activity takes place on geologically permeable surfaces. Waste management facilities, industrial and petrochemical storage and refinery sites, and concentrated livestock feedlots need to be situated away from highly permeable areas and managed carefully to prevent contaminants from entering the groundwater.

Map 23 illustrates the relative suitability of lands in the NSRW for placement of waste management facilities, based on bedrock and surface permeability, proximity to buried aquifers and thickness of surface materials above bedrock. These criteria could also be applied to the placement of feedlots and industrial facilities. Areas were assigned to one of four categories: suitable; unsuitable; uncertain, and insufficient information. As demonstrated in the map, a large portion of the watershed is unsuitable for waste management facilities, based on highly permeable underlying geology.

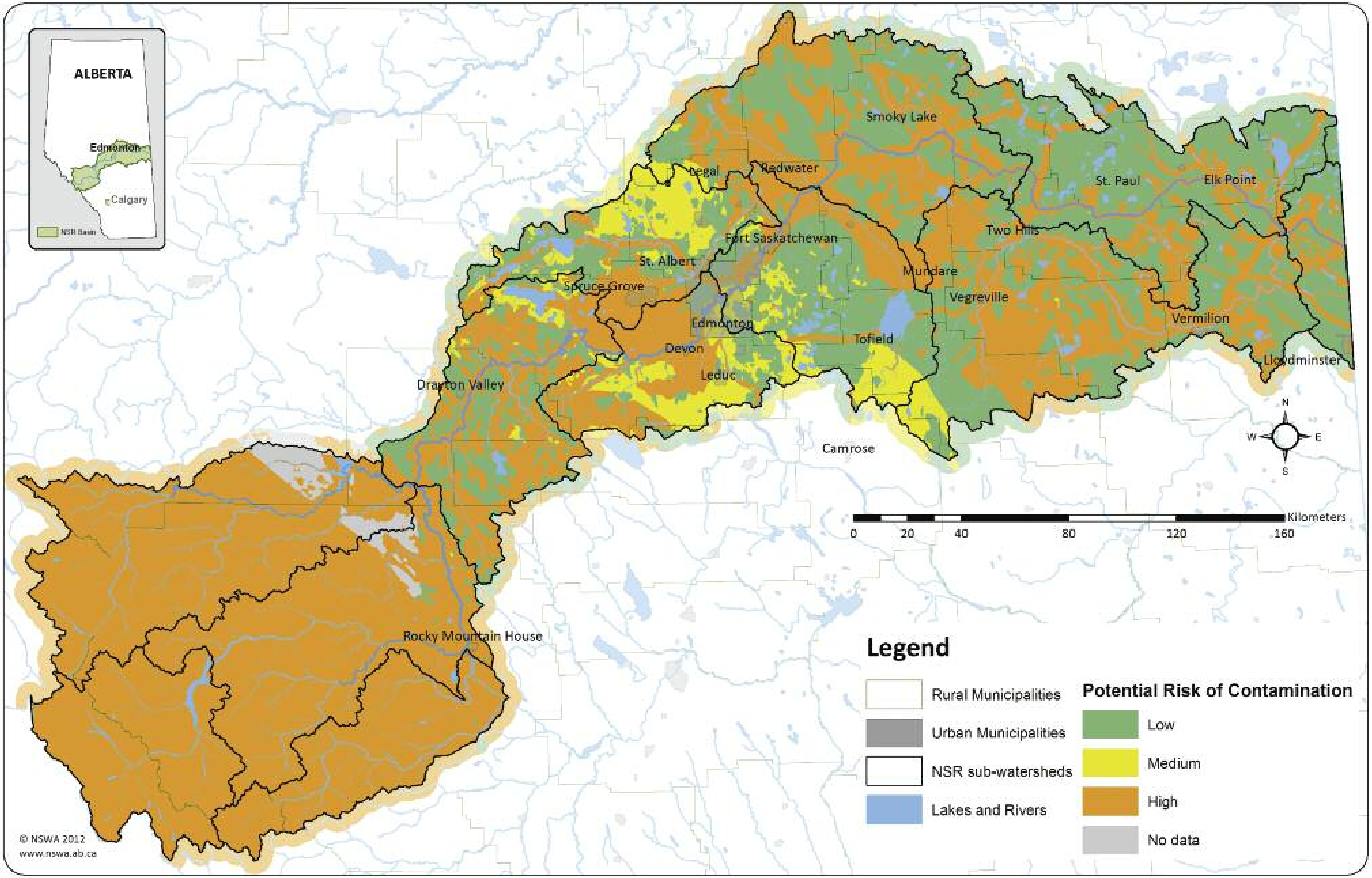
The data used to produce this map are sparse, and should only be used as a rough indicator of suitability for facility placement. All proposed projects should undergo thorough site-specific studies before final facility placement decisions are made. Further information, as well as a province-wide map is available from the Alberta Geological Survey.

Permeability

Permeability, when referenced in geological terms, refers to the ease in which fluid transmits through pore spaces in rocks or sediments. Some rocks and sediments have more connected pore spaces than others. High permeability in a rock or sediment increases the chance of contaminants making their way through and potentially affecting underground aquifers.

Facilities such as landfills and large confined feeding operations must be placed carefully on the landscape to avoid contamination of groundwater supplies through the infiltration of leachate.

Map 23. Potential Risk of Groundwater Contamination based on Geological Setting



Environmentally Significant Areas

Environmentally Significant Areas (ESAs) across the province were first inventoried and mapped by Alberta Environment in 1998 and the inventory was updated in 2009. Map 24 demonstrates all of the ESAs in the North Saskatchewan River watershed, as well as the natural regions and subregions. A total of 754 ESAs were identified across the province in the original 1998 inventory. ESAs represent areas that are important for long-term care and management of biodiversity, soils, water and other natural attributes. These areas have rare or unique features that may require special conservation practices. ESAs do not have legislated protection, but are intended to inform municipal land use planning processes and consideration of special conservation measures.

ESAs are assigned a significance rating based upon seven defined criteria and whether there is an international, national or provincially significant or rare feature. The seven criteria are as follows:

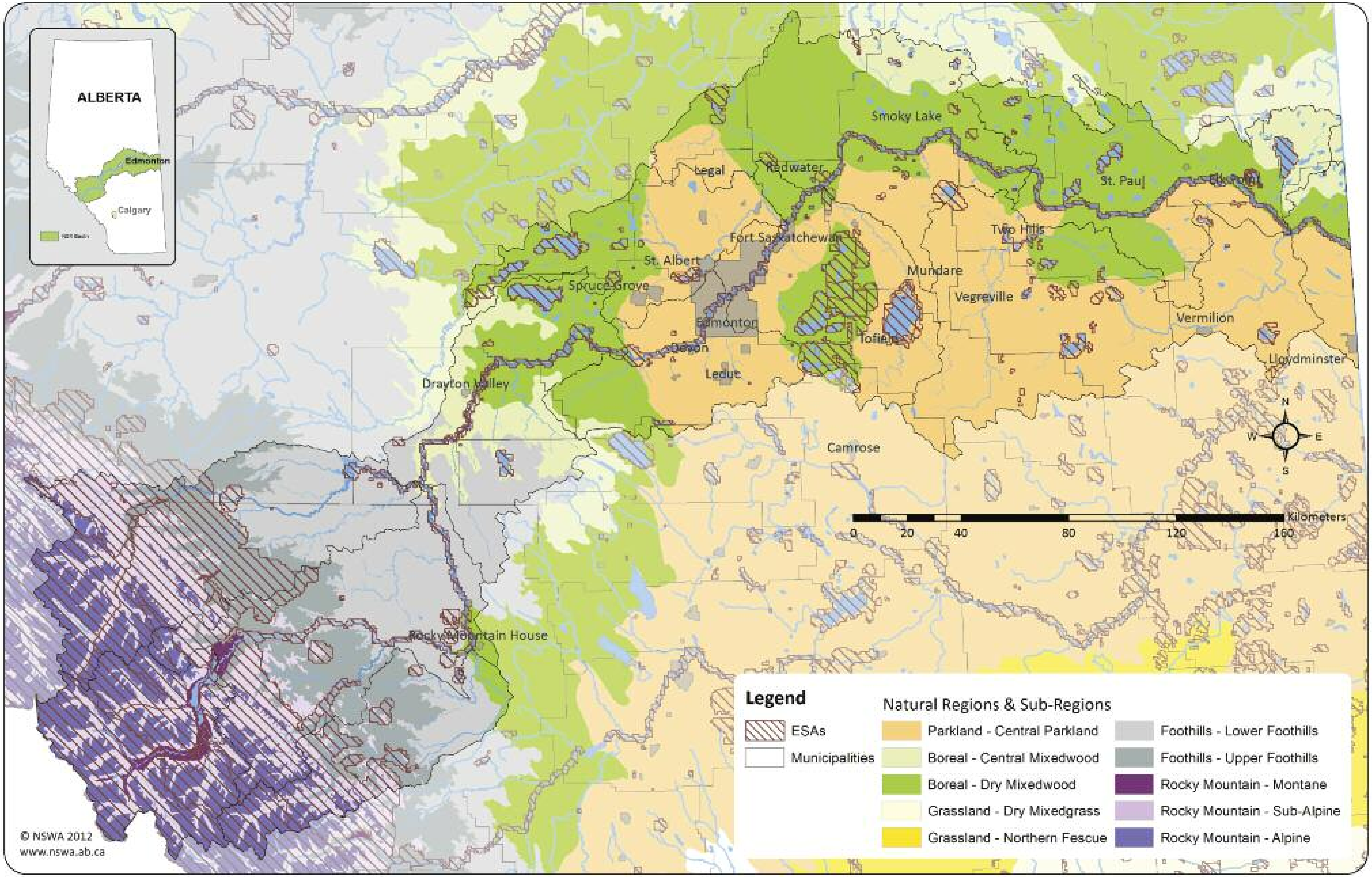
1) Areas that contain features of conservation concern
2) Areas that contain rare or unique landforms
3) Areas that contain habitat for significant, rare or endangered plant or animal species
4) Areas that contain important wildlife habitat
5) Riparian areas
6) Large natural areas
7) Sites of recognized significance

There are a total of 91 ESAs within the NSR watershed, and many are of international or national significance.

The percentage of total subwatershed area that has been assigned an ESA designation is as follows:

- 28% in the Beaverhill subwatershed
- 64% in the Brazeau subwatershed
- 45% in the Clearwater subwatershed
- 96% in the Cline subwatershed
- 8% in the Frog subwatershed
- 10% in the Modeste subwatershed
- 4% in the Monnery subwatershed
- 38% in the Ram subwatershed
- 5% in the Strawberry subwatershed
- 9% in the Sturgeon subwatershed
- 4% in the Vermilion subwatershed
- 7% in the White Earth subwatershed

Map 24. Environmentally Significant Areas (ESAs) in the North Saskatchewan River Watershed



Forest Management Areas, Parks and Protected Areas

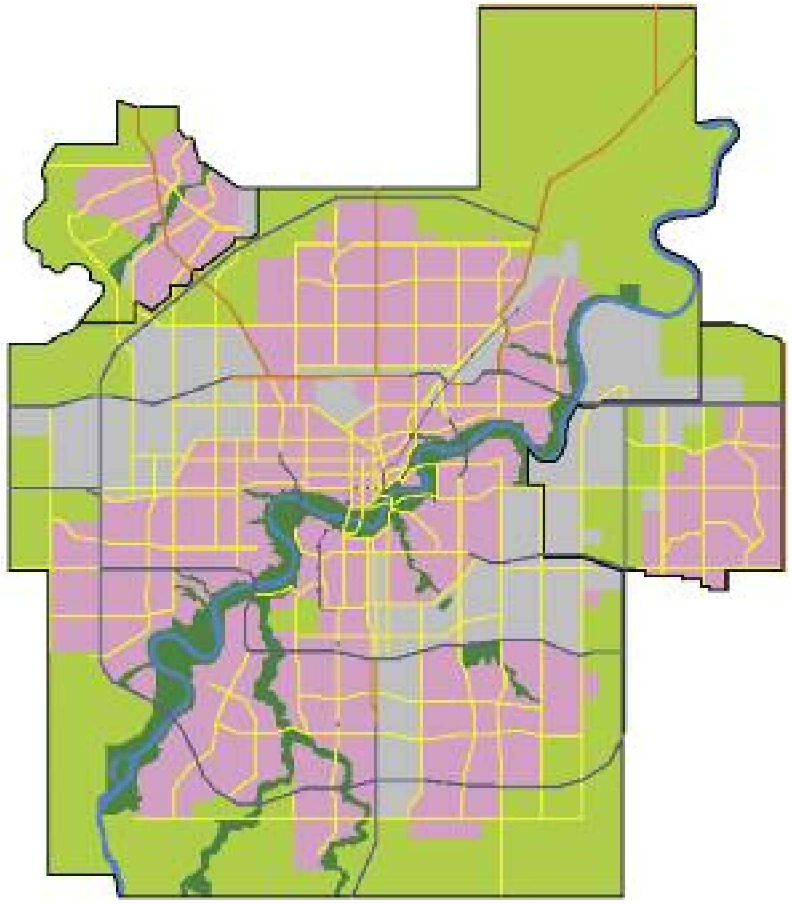
As previously noted, Alberta is divided into two main areas for land management: the Green Area (61% of Alberta) and the White Area (39%) (page 26). Most of the White Area is privately owned land and is primarily used for agriculture, human settlement, oil and gas development, tourism and recreation. Municipalities have provincially delegated authority to manage land use in the White Area.

The Green Area is primarily publicly owned land (provincial Crown land). It is characterized by a wide variety of resource management arrangements for the purposes of timber production, watershed protection, fish and wildlife habitat, tourism and recreation, oil and gas development, conservation of natural spaces and other uses. Agricultural land use does occur but is limited to grazing leases. Alberta Environment and Sustainable Resource Development is the provincial ministry responsible for managing forestry and other Green Area activities.

Public lands in the Green Area and some parts of the White Area are divided into Forest Management Units (FMUs) to manage timber and other resources. Forest Management Areas (FMAs) are managed using Forest Management Agreements and Forest Management Plans. Forest Management Units are administered by the Province. The Forest Management Plan is a technical document prepared by forestry companies describing forest management objectives, strategies and commitments. It identifies intended methods of cutting, reforesting, and managing timber resources within the FMA.

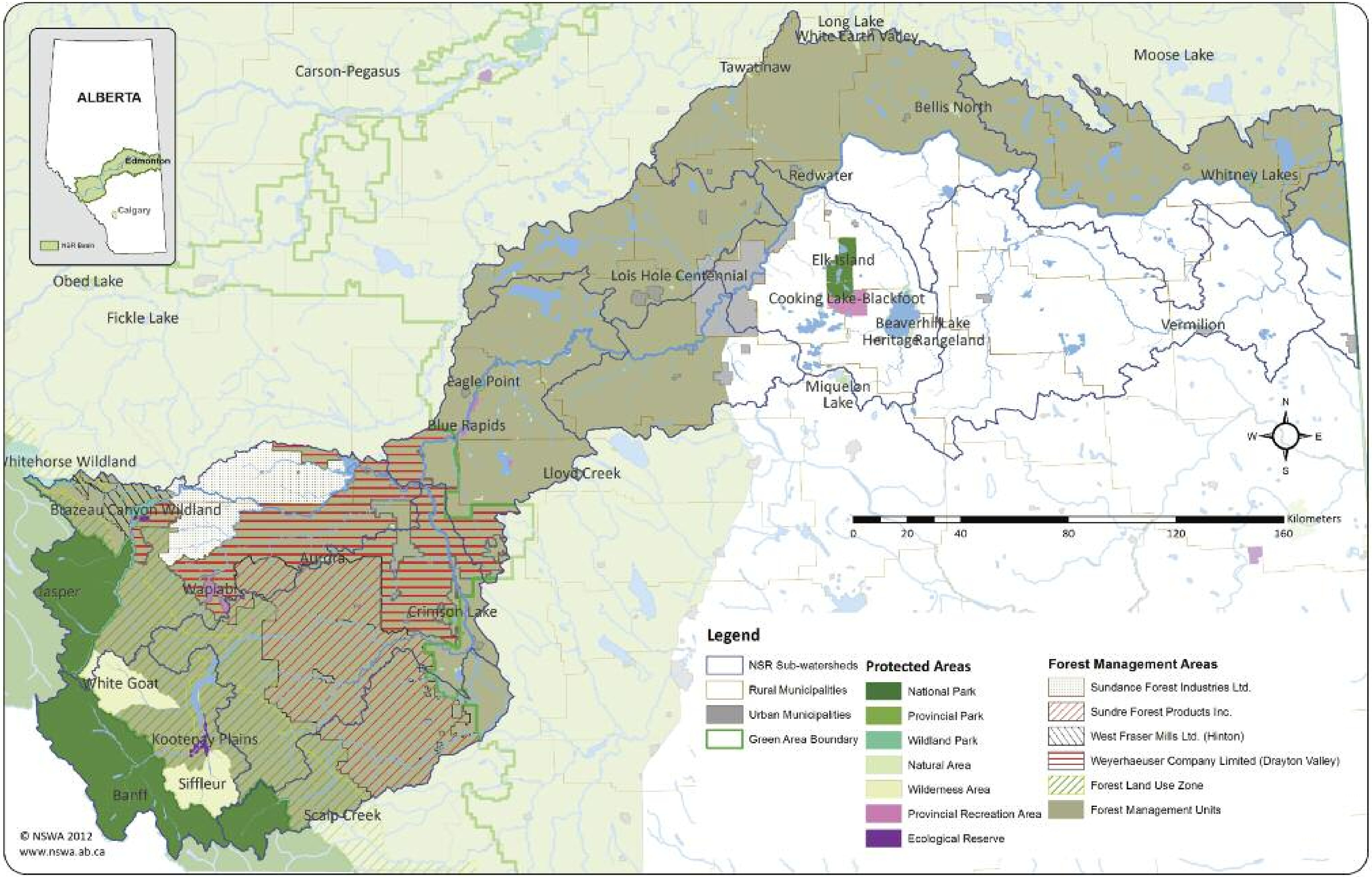
Several types of parks and other areas with varying levels of legal protection exist on federal and provincial land in Alberta, including: National Parks, Provincial Parks, Wilderness Areas, Wilderness Parks, Wildland Parks, Provincial Recreation Areas, Ecological Reserves and Natural Areas. Protected areas greater than 1,000 acres are labeled on Map 25. The Alberta Parks system covers 27,678 km of the province, and includes almost 14,000 campsites and 250 provincial campgrounds. Parks and Protected Areas are managed by Alberta Tourism, Parks and Recreation, who released a 10 year Plan for Parks 2009. This plan has increased the land area of parks and protected areas in the province by 990 hectares since its release.

The North Saskatchewan River Valley Park System (or "Ribbon of Green") is 48 km long and when fully completed will provide recreational opportunities extending from Devon downstream to Fort Saskatchewan. It is the largest urban park system in all of Canada and includes a series of parks whose total area amount to 7,400 ha (see map at right).



The North Saskatchewan River Valley Park System is shown in the map above.

Elk Island National Park



ALBERTA
Edmonton
Calgary
NSR Basin
Carson-Pegasus
Long Lake
White Earth Valley
Tawatinaw
Moose Lake
Bellis North
Redwater
Whitney Lakes
Elk Island
Lois Hole Centennial
Cooking Lake-Blackfoot
Beaverhill Lake
Heritage Rangeland
Vermilion
Obed Lake
Fickle Lake
Miquelon Lake
Eagle Point
Blue Rapids
Lloyd Creek
Whitehorse Wildland
Brazeau Canyon Wildland
Aurora
Jasper
Wapiabi
Crimson Lake
White Goat
Kootenay Plains
Siffleur
Banff
Scalp Creek
N
W
E
S
0
20
40
80
120
160
Kilometers
Legend
NSR Sub-watersheds
Rural Municipalities
Urban Municipalities
Green Area Boundary
Protected Areas
National Park
Provincial Park
Wildland Park
Natural Area
Wilderness Area
Provincial Recreation Area
Ecological Reserve
Forest Management Areas
Sundance Forest Industries Ltd.
Sundre Forest Products Inc.
West Fraser Mills Ltd. (Hinton)
Weyerhaeuser Company Limited (Drayton Valley)
Forest Land Use Zone
Forest Management Units
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Best Management Practice Adoption

Best management practices (BMPs) are a wide range of land management practices employed by land owners to contribute to environmentally sustainable agriculture. BMPs are key to preventing or minimizing adverse effects to the environment due to agricultural production. Development and adoption of BMPs have been ongoing since the 1980's to mitigate impacts of farming and ranching on the environment. Agricultural production relies extensively on a healthy environment, including air, water, land and biodiversity resources.

All agricultural best management practices are derived from three key concepts: a) prevent bare ground, b) control runoff, and c) optimize inputs and resources. Best management practices are specific to each type of land use. A change in land use necessitates a change in land management or the type of BMPs adopted on the landscape. One of the most significant BMPs adopted since the 1980's has been conservation tillage by direct seeding. Conservation tillage has reduced the amount of summerfallow from 25-30% to 10% or less in some regions. This has resulted in significant reductions in soil erosion and reduced sedimentation of streams and water bodies. For example, the two recent droughts of 2002-04 and 2008-09 were of historic proportions, more severe than the one experienced in the Dirty Thirties. As a result of conservation tillage practices, effective crop residue management prevented a return the 'dust bowl' scenario of that era.

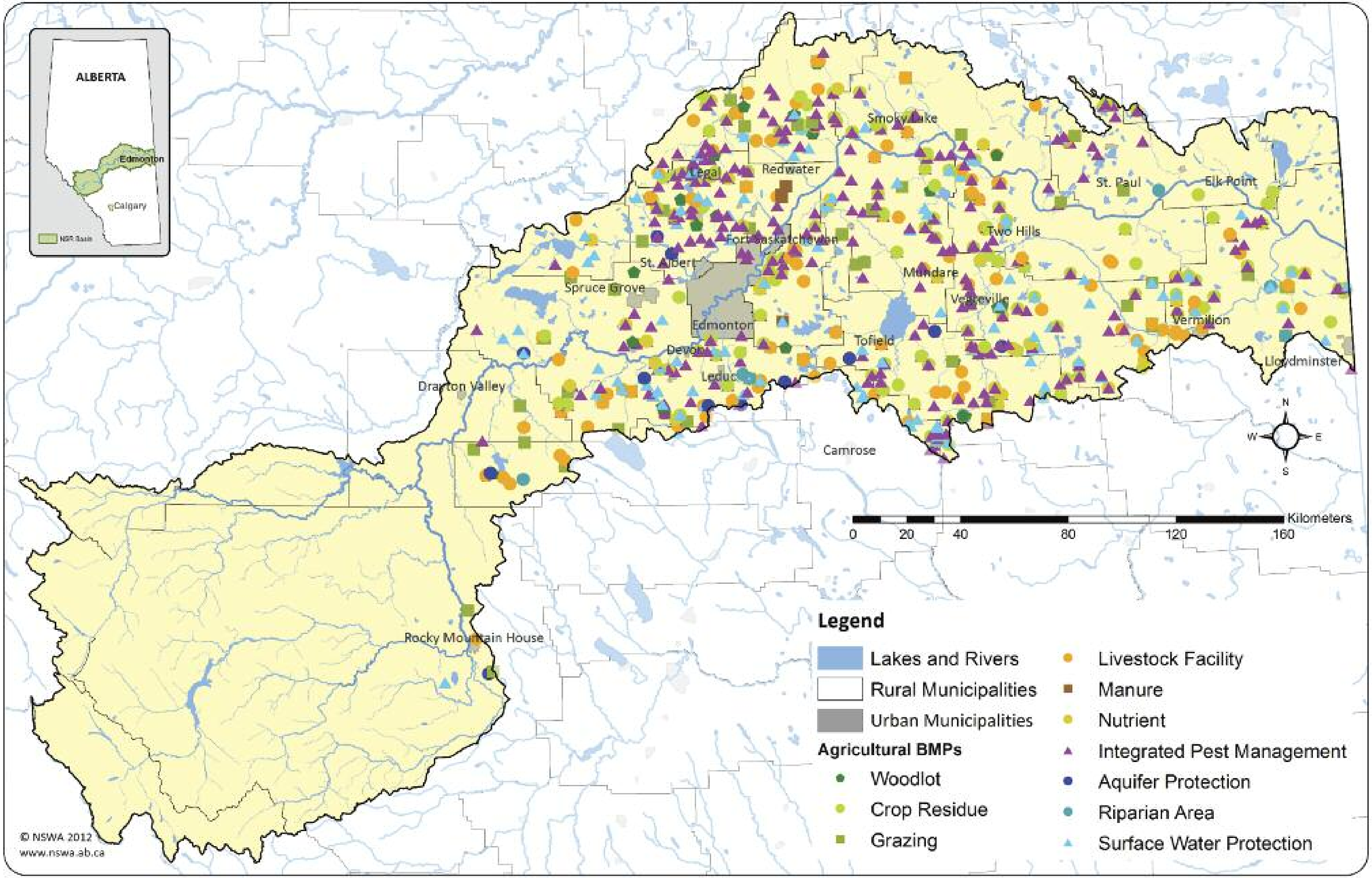
Map 26 displays 1,236 successfully adopted agricultural BMP projects between 2003 and 2008 administered by the Canada-Alberta Farm Stewardship Program. A pre-requisite of participating in this program required each farm or ranch operation to successfully complete an Environmental Farm Plan (EFP), which is an assessment and plan that helps producers identify environmental risks and opportunities in their operations. This map does not display the multitude of other agricultural operations already employing various BMPs across the province.

The following are brief examples of the types of BMPs depicted in the map:

- **Woodlot**: Timber management and harvesting; buffer strips; road placement.
- **Crop residue**: Leaving residue from crop harvesting on the field in order to prevent erosion and assist with soil fertility; leaving taller stubble.
- **Grazing, Livestock, Manure and Nutrient Management**: Controlled grazing; fencing; proper storage and distribution of silage and hay; offsite watering systems, proper use, handling and storage of manure; drainage and erosion control; paddock management; manure composting; maintenance of buffer strips.
- **Integrated Pest Management**: Pest monitoring; crop rotation; pest removal; pesticide timing and application; biological control; mowing
- **Aquifer management**: Prevention of leaks and spills; proper waste disposal; keeping storage tanks away from water wells.
- **Riparian Area and Surface Water Protection**: Livestock fencing; buffer strips; erosion and runoff prevention.

Best management practices such as conservation tillage and offsite livestock watering are becoming more common on farms across Alberta. Conservation tillage leaves a large portion of the ground covered with the previous year's crop residue, which helps prevent erosion and returns nutrients to the soil. Offsite watering keeps livestock from seeking water out of creeks, wetlands and lakes, which can become contaminated with fecal matter from the animals.

Map 26. Best Management Practice Adoption (2003-08) in the North Saskatchewan River Watershed



Provincial Policy and Planning Initiatives

A number of different regional planning initiatives have developed at different times and scales in the NSRW. A brief summary of these landscape-based planning initiatives is presented below, and Map 27 shows the boundaries of the major planning areas.

In 2000, a voluntary, regional planning collaborative known as the Beaver Hills Initiative (www.beaverhills.ab.ca/) was formed to address land-use and biodiversity issues in the rural municipalities surrounding Elk Island National Park.

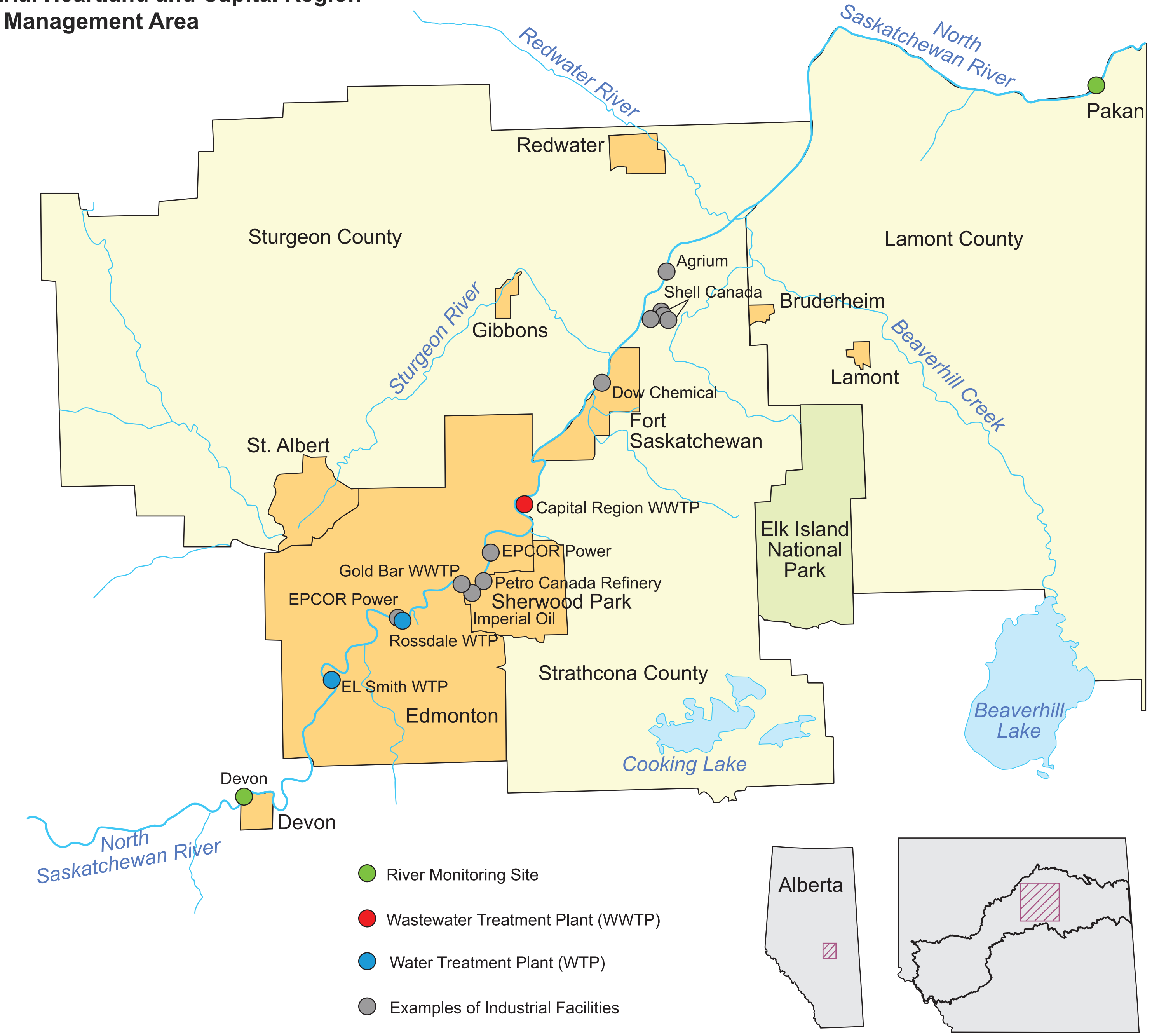
In 2003, under *Water for Life: Alberta's Strategy for Sustainability* the provincial government proposed the creation of Watershed Planning and Advisory Councils (WPACs), which were intended to lead watershed planning, report on the state of watersheds and promote environmental education and stewardship activities. The NSWA was designated the WPAC for the North Saskatchewan River watershed in Alberta in 2005, and there are currently a total of 11 WPACs within the province, based on the major river basins. The NSWA completed its State of the Watershed Report in 2005 and the Integrated Watershed Management Plan in 2012.

In 2006, Alberta Environment and Sustainable Resource Development shifted its policy focus to Cumulative Effects Management Systems (CEMS), which focuses on the integration of air, land and water considerations in land use planning. Four Cumulative Effects pilot projects were initiated to address significant, regional development pressures. Only the Industrial Heartland and Capital Region project remains today, as a water management planning project lead by Alberta Environment and Sustainable Resource Development.

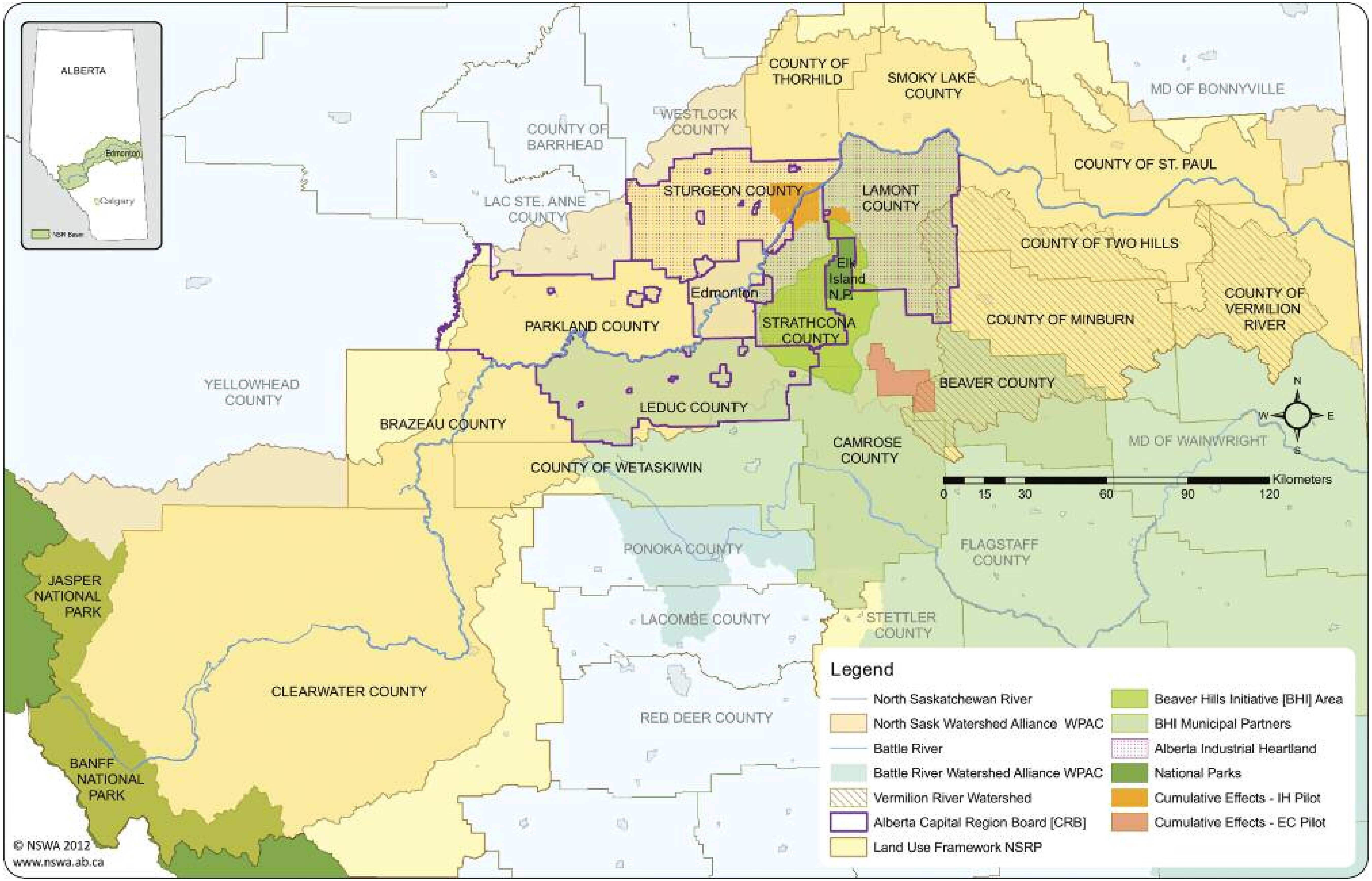
In 2007, the Premier of Alberta directed the Alberta Capital Region Board to complete a growth management plan in response to unprecedented demand for land, resources and exponential population growth in the large urban centres. The Alberta Capital Region Board continues on regional planning to address other issues including the protection of environmentally sensitive areas and agricultural lands.

In 2008, the Alberta Land Use Framework was introduced and new legislation called the *Alberta Land Stewardship Act* (ALSA) followed in 2009. ALSA amended or aligned 27 other pieces of legislation to enable better regional planning and provide legislation for new conservation tools. The work to date has focused on the South Saskatchewan Regional Plan and the Lower Athabasca Regional Plan. It is anticipated the North Saskatchewan Regional Plan will be started in 2012.

Industrial Heartland and Capital Region Water Management Area



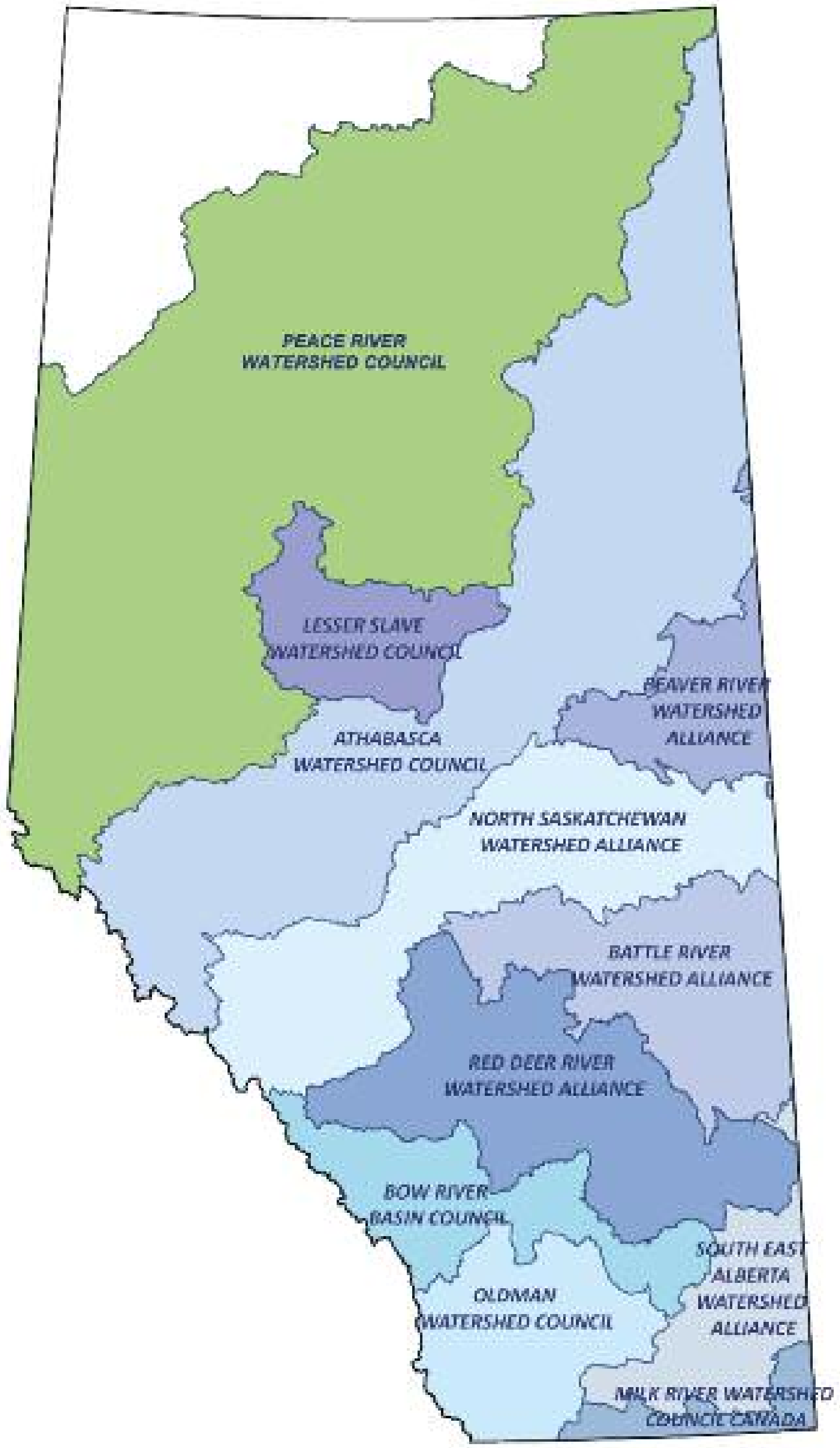
Map 27. Planning Initiatives within the North Saskatchewan River Watershed



Postscript

WPACs are important stewards of Alberta's major watersheds. They are independent, non-profit organizations that are designated by Alberta Environment to assess the condition of their watershed and prepare advice and recommendations to Government of Alberta and stakeholders. They also conduct education and stewardship activities throughout their watersheds. This includes supporting and collaborating with Watershed Stewardship Groups in each watershed. They engage watershed residents in their work and seek consensus on solutions to watershed issues. The NSWA is one of 11 WPACs within the province (see map at right).

This atlas represents only a small portion of the mapping work and reporting the NSWA has completed over the last 10 years. The NSWA will continue to be a source of research and educational information for all stakeholders and residents in the watershed, and further information is available upon request, or from our website, www.nswa.ab.ca.



References

Agriculture & Agri-food Canada. Canada Land Inventory, CanSIS.
http://sis.agr.gc.ca/cansis/nsdb/cli/intro.html

Agriculture & Agri-food Canada. Climatic Moisture Index, Land Suitability Rating System.
www.sis2.agr.gc.ca/cansis/publications/manuals/1995-6/lsrs.pdf

Agriculture & Agri-food Canada. Drought Watch.
www4.agr.gc.ca/DW-GS/current-actuelles.jspx?lang=eng

Agriculture & Agri-food Canada. Landcover, circa 2000.
www4.agr.gc.ca/AAFC-AAC/display afficher.do?id=
1227635802316&lang=eng

Agriculture and Agri-Food Canada Soil Information System. “Local Surface Form”.
http://sis.agr.gc.ca/cansis/nsdb/slc/v3.1.1/component/locsf.html

Agriculture & Agri-Food Canada. National Farm Stewardship Program.
www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=
1181580519716&lang=eng

Agriculture & Agri-food Canada. Soil Landscapes of Canada, CanSIS.
http://sis.agr.gc.ca/cansis/nsdb/slc/intro.html

Agriculture and Agri-food Canada. Soil Texture and Water Quality.
www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=
1197483793077&lang=eng#a1

Alberta Agriculture and Rural Development. AGRASID.
www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag3254

Alberta Agriculture and Rural Development. “Quantitative Morphometric Descriptions and Classification of Typical Alberta Landforms”.
www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag10470.

Alberta Agroclimate Network
www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag6300

Alberta Municipal Affairs. Types of Municipalities in Alberta.
www.municipalaffairs.alberta.ca/am_types_of_municipalities_in_
alberta.cfm

Alberta Sustainable Resource Development.
www.srd.alberta.ca/

Alberta Sustainable Resource Development
www.srd.alberta.ca/ManagingPrograms/ForestManagement/Default.aspx

Alberta Tourism, Parks and Recreation.
www.tpr.alberta.ca/parks/heritageinfocentre/environsigareas/default.aspx

Alberta Tourism, Parks and Recreation. 2005. Natural Regions and Subregions of Alberta.
www.tpr.alberta.ca/parks/heritageinfocentre/naturalregions/default.aspx

Atlas of Canada. 2009.
http://atlas.nrcan.gc.ca/site/english/maps/freshwater/1

Barker, A.A., Riddell, J.T.F., Slattery, S.R., Andriashek, L.D., Moktan, H., Wallace, S., Lyster, S., Jean, G., Huff, G.F., Stewart, S.A. and T.G. Lemay. 2011. Edmonton–Calgary Corridor groundwater atlas; Energy Resources Conservation Board, ERCB/AGS Information Series 140, 90 p.

COSEWIC. 2009. Stay Informed Press Release.
www.cosewic.gc.ca/eng/sct7/sct7_3_13_e.cfm

Cows and Fish. 2011. What is Riparian?
www.cowsandfish.org/riparian/riparian.html

Ducks Unlimited Canada. 2010. Wetlands in the Battle River Watershed. Provided by T. Scott.

Environment Canada. Wetlands.
www.ec.gc.ca/default.asp?lang=en&n=540B1882-1

EPCOR. Capital Region Service Map.
www.epcor.ca/en-ca/Customers/water-customers/pressure-and-supply/Pages/RegionalWaterSupplySystem.aspx

EPCOR. Gold Bar Wastewater Treatment Plant.
www.epcor.ca/en-ca/about-epcor/operations/operations-alberta/Edmonton/gold-bar/Pages/default.aspx

National Energy Board. Proposed Damage Prevention Regulations.
www.neb-one.gc.ca/clf-nsi/rpblctn/ctsndrgltn/rrggnmgpnb/dmgprvntnrgltn/prpsddmgprvntnrgltndgn2009-eng.html

North Saskatchewan Watershed Alliance. AMEC Earth and Environmental. (2007). “Current and Future Water Use in the North Saskatchewan River Basin”.
www.nswa.ab.ca/resources/nswa_publications

North Saskatchewan Watershed Alliance. (2008). Sullivan, M., et. al. “Cumulative Assessment of the North Saskatchewan River Watershed Using ALCES.”

North Saskatchewan Watershed Alliance: Golden Associates. (2008). “Water Supply Assessment in the North Saskatchewan River Basin”.

NSWA. 2009. Cumulative Effects Assessment for the North Saskatchewan River Watershed. Edmonton, Alberta: The North Saskatchewan Watershed Alliance Society.
www.nswa.ab.ca/cumulative_effects

North Saskatchewan Watershed Alliance. (2009). Worley Parsons. North Saskatchewan River Basin: Overview of Groundwater Conditions, Issues and Challenges.
www.nswa.ab.ca/reports/groundwater.

Partners FOR the Saskatchewan River Basin.
www.saskriverbasin.ca/file/SRB%20A1%20Basin%20Map.pdf?PHPSESSID=slnitm4qqigd86ho11psc88175

PFRA Watershed Project, Agriculture and Agri-Food Canada.
www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1228406865942&lang=eng

Prepas, E. and Mitchell P. 1993. Atlas of Alberta Lakes.
http://sunsite.ualberta.ca/Projects/Alberta-Lakes/characteristics.php

Statistics Canada. 2006 Census of Agriculture.
www.statcan.gc.ca/ca-ra2006/index-eng.htm

Statistics Canada. 2006 Census of Canada.
www12.statcan.ca/census-recensement/2006/dp-pd/index-eng.cfm

Statistics Canada. Census of Population.
www12.statcan.gc.ca/census-recensement/index-eng.cfm

Statistics Canada. “Loss of Dependable Agricultural Land in Canada”, Rural and Small Town Canada Analysis Bulletin, Vol. 6, No. 1 (January 2005). Catalogue 21-006 XIE, 16 pgs.

Wetlands Alberta.
http://wetlandsalberta.ca/

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Clearwater County (OHV images - 3 images to the right) - page 28

M. Lavoie (OHV image - 1st quad image) - page 28

EPCOR - page 31 and 36

Photo by D. Park (top image on the right) - page 38

Highland Feeders - page 46

Parks Canada (Elk Island National Park) - page 50

Alberta Agriculture and Rural Development - page 52

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Map Reference Information

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- Agriculture and Agri-Food Canada - Agri-Environmental Services Branch (AAFC-AESB) for information on municipal boundaries, census data, soils, land cover, topography, land form, surficial geology, Canada Land Inventory, climate data, sub-watersheds and base hydrology.
- Alberta Environment (AENV) for information on wastewater treatment plants and density of oil and gas wells.
- Alberta Sustainable Resource Development (ASRD) for information on water bodies, stream order, linear features, and land and forest management boundaries.
- The Alberta Geological Survey (AGS) for data displayed on “Potential Risk of Groundwater Contamination based on Geological Setting”.
- The Energy Resources Conservation Board (ERCB) for information on oil and gas wells.