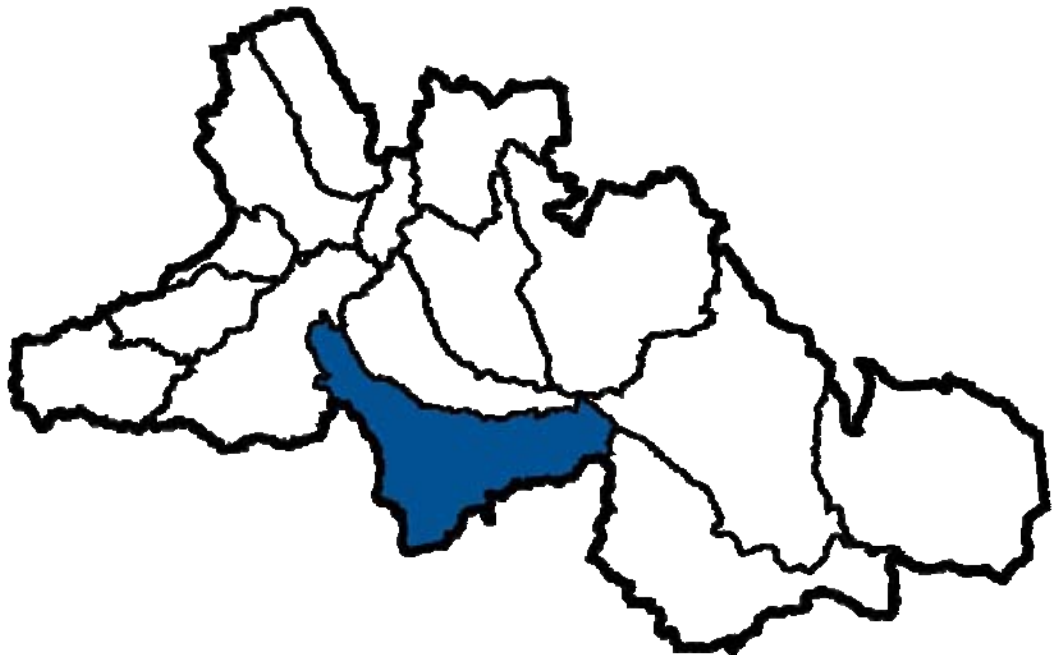


Rosebud Subwatershed



4.12 Rosebud River Subwatershed

4.12.1 Watershed Characteristics

The Rosebud River subwatershed encompasses about 478,590 ha and is located in the Counties of Kneehill, Mountain View and Wheatland and the Municipal District of Rocky View No. 44. A small portion of the subwatershed lies within the boundaries of the City of Calgary (Figure 315).

The Rosebud River subwatershed is located in the south-central region of the Red Deer River watershed and lies in the Central Parkland, Foothill Fescue, Northern Fescue and Mixedgrass Subregions (Figure 316). The Central Parkland Subregion is dominated by grassland with groves of aspen (*Populus* spp.), with the grassland vegetation being dominated by rough fescue (*F. campestris*). The Foothills Fescue Subregion is dominated by rough fescue (*F. campestris*), Idaho fescue (*F. idahoensis*) and oat grass (*Trisetum* spp.), where as the Northern Fescue Subregion is dominated by rough fescue (*F. campestris*). The vegetation of the Mixedgrass Subregion is dominated by spear grass (*Piptochaetium* spp.), western porcupine grass (*H. spartea*), western wheat grass (*P. smithii*) and northern wheat grass (*E. lanceolatus*). Much of the natural vegetation of the Mixedgrass Subregion has been replaced by agricultural crops. The moister, cooler conditions of this Subregion are reflected in the greater productivity of rangelands, which typically produce 25% more biomass (Heritage Community Foundation, 2008).

The geology of the Rosebud River subwatershed is dominated by the Paskapoo Formation in addition to localized deposits belonging to the Scollard and Horseshoe Canyon Formations. These formations formed in the Paleocene epoch (56-65 million years ago) and in the Upper Cretaceous period (65-100 million years ago). The youngest of the formations from the Paleocene, Upper Paskapoo, consists of diverse sandstones and siltstone/mudstones and minor shale deposits. The Scollard Formation (Paleocene and Upper Cretaceous) consists of sandstone, mudstone and thick coal deposits. The Horseshoe Canyon Formation (Upper Cretaceous) consists of sandstones, mudstones, shales, ironstone, bentonite and minor limestone deposits (Alberta Geological Survey, 2006).

The climate of the Rosebud River subwatershed is continental, with mean annual temperatures ranging from 2-5 °C and mean May-September temperatures ranging from 11-15 °C. The mean annual precipitation ranges from 350-500 mm, with the May-September precipitation averaging 280-300 mm (Environment Canada, 2006). There are about 90 frost-free days per annum.

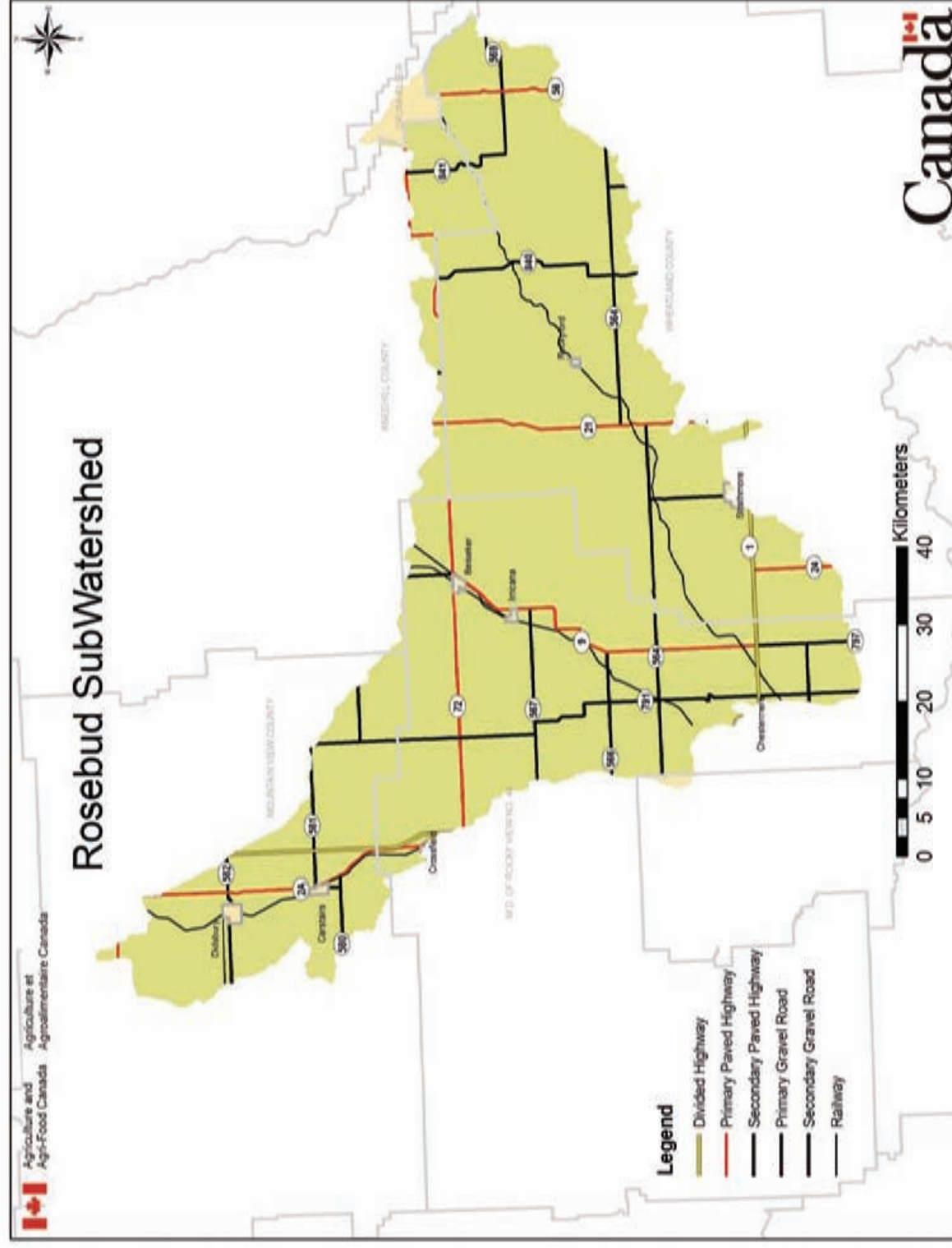


Figure 315. Location of the Rosebud River subwatershed (AAFC-PFRA, 2008).

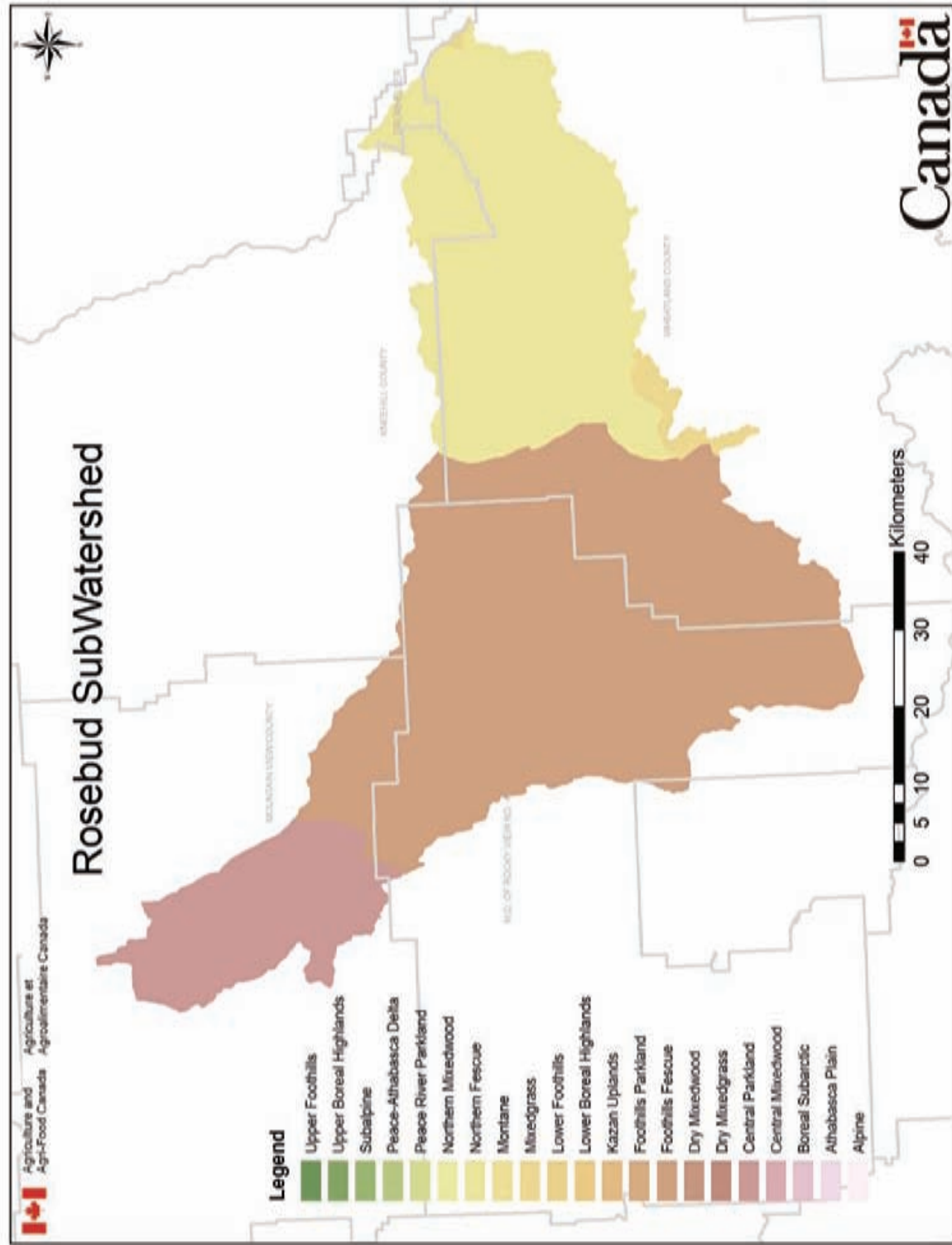


Figure 316. Natural subregions of the Rosebud River subwatershed (AAFC-PFRA, 2008).

4.12.2 Land Use Indicators

Changes in land use patterns reflect major development trends, such as forested lands converted to agriculture and agricultural lands developed and lost to urban sprawl. Land use changes and the subsequent changes in management practices impact both the quantity and quality of water within the Red Deer River watershed. Six metrics were used to indicate changes in land use and land use practices in the Red Deer River watershed and its 15 subwatersheds:

- Wetland Loss – Condition Indicator
- Riparian Health – Condition Indicator
- Livestock Manure Production – Risk Indicator
- Urban, Rural and Recreational Developments – Risk Indicator
- Linear Developments – Condition Indicator
- Oil and Gas Activities – Risk Indicator

These six land use change indicators also reflect socioeconomic growth in a region. Hence, while human activities in a region can have negative environmental impacts, it is important to strive for a balance between socioeconomic growth and the sustainable management of natural ecosystems to ensure their long-term health and enjoyment by future generations.

4.12.2.1 Wetland Loss

Wetlands serve many functions in the natural landscape including water storage, flood attenuation, wildlife habitat, groundwater recharge and general water quality improvements (e.g., nutrient uptake, degradation of pesticides, sediment retention). Additionally, wetlands provide a cost effective and sustainable alternative to engineered treatment options. The loss of wetlands to development and/or agriculture can be deleterious to surface and groundwater quantity and quality.

Land cover data indicate the presence of 8,606 ha of wetlands (1.80% of the total subwatershed area) in the Rosebud River subwatershed (AAFC-PFRA, 2008); however, there are no data on the classes, forms and types of wetlands (*sensu* National Wetlands Working Group, 1997) within the subwatershed. Given the presence of lentic (lakes) and lotic (streams and rivers) systems, marshes and shallow open water wetlands are likely present in the subwatershed. In addition, ephemeral, temporary, seasonal and semi-permanent wetlands (*sensu* Stewart and Kantrud, 1971) are likely present in the subwatershed as well.

The Prairie Habitat Joint Venture program (a partnership between federal and provincial governments, organizations and conservation groups in Manitoba, Saskatchewan and Alberta) has assessed the loss of wetlands in the Parkland Natural Region (in the Central Parkland Subregion) and the Grassland Natural Region (in the Northern Fescue and Foothills Fescue Subregions) from 1985-2001 (Watmough and Schmoll, 2007). In Alberta, the Parkland Natural Region has lost 7% of its total wetland area and 8% of its total number of wetlands due to anthropogenic disturbances in that 16-year period. Comparatively, losses in wetland area have been lower in the Grassland Natural Region (1-4%; range based on two Subregions that fall within the Rosebud River subwatershed), but losses in the number of wetlands have been similar (5-9%; range based on two Subregions that fall within the Rosebud River subwatershed). There appears to be no change in the rate of wetland loss in the Prairie Parkland Region over the past 50-70 years. Caution must be taken when extrapolating these data to the entire subwatershed, since

the Prairie Habitat Joint Venture program has assessed wetland losses along only one transects in the Grassland Natural Region none in the other Natural Region in this subwatershed (Watmough and Schmoll, 2007).

4.12.2.2 Riparian Health

Riparian areas are an important transition zone between uplands and water. They act as buffer zones, protecting water quality and attenuating floods. Contaminants are adsorbed onto sediments, assimilated by vegetation and transformed by soil microbes into less harmful forms. They have long been proven effective in reducing nutrients, sediments and other anthropogenic pollutants that enter surface waters via overland and subsurface flow.

The riparian health has been assessed along several sections along the major streams in the Rosebud River subwatershed (Table 130). Overall, the health assessments showed that 63% of all sites received a rating of healthy but with problems and 37% received a rating of unhealthy. None of the sites examined rated healthy. The primary concerns centre on generally unrestricted access of livestock to streams and creeks, heavy grazing pressure on riparian vegetation, the absence of desired woody plants species and the presence of invasive and noxious weeds in the riparian areas.

Table 130. Riparian health assessment of waterbodies in the Rosebud River subwatershed.

Waterbody	Location	Primary health issues	Ranking
Serviceberry Creek ¹	20.1 km	Noxious and disturbance-caused weeds, grazing of desirable woody plants, channel incisions	17 locations: 0 healthy, 14 healthy with problems, 3 unhealthy
Rosebud River ²	14.7 km	Noxious and disturbance-caused weeds, grazing of desirable woody plants, altered streambanks, pugging and hummocking, channel incisions	13 locations: 0 healthy, 5 healthy with problems, 8 unhealthy

Note: 1 = Cows and Fish (2003b), 2 = O'Shaughnessy (2002).

Recommendations included limiting the presence of livestock that was grazing on herbaceous and woody vegetation, restricting livestock access to creek and river banks, planting of desirable woody plants and reducing the presence of noxious and disturbance-caused plants.

4.12.2.3 Livestock Manure Production

Areas of higher livestock density within a subwatershed, and their associated higher manure production, are expected to have greater impacts on downstream water quality. Streams that drain land with high intensity livestock operations have higher nutrient concentrations, dissolved nutrients, mass loads, fecal bacteria and exports of total dissolved phosphorus than streams with medium or low intensity livestock operations and manure production.

There are 25 feedlots/intensive livestock operations in the Rosebud River subwatershed. Nearly half of these feedlots finish poultry, with the remainder finishing or feeding cattle/cows and swine (Figure 317) (AAFC-PFRA, 2008).

Cattle density is lowest below the confluence of Serviceberry Creek and Rosebud River (0-0.20 cattle/ha). Cattle density increases towards the central (0.81-1.00 cattle/ha) and west-central (0.41-0.60 cattle/ha) areas of the subwatershed (Figure 318) (AAFC-PFRA, 2008). Manure production ranges from 2.6-5.0 tonnes manure/ha throughout most of the subwatershed but decreases to 0.2-2.5 tonnes manure/ha in the lower reaches of Rosebud River (Figure 319) (AAFC-PFRA, 2008). Overall, manure production is considered low in the Rosebud River subwatershed relative to the remainder of the Red Deer River watershed.

Agricultural intensity, expressed as the percent land cover used as croplands, generally ranges from 60-80% throughout the subwatershed. Near Beiseker, agricultural intensity is highest, ranging from 80-100% (Figure 320) (AAFC-PFRA, 2008).

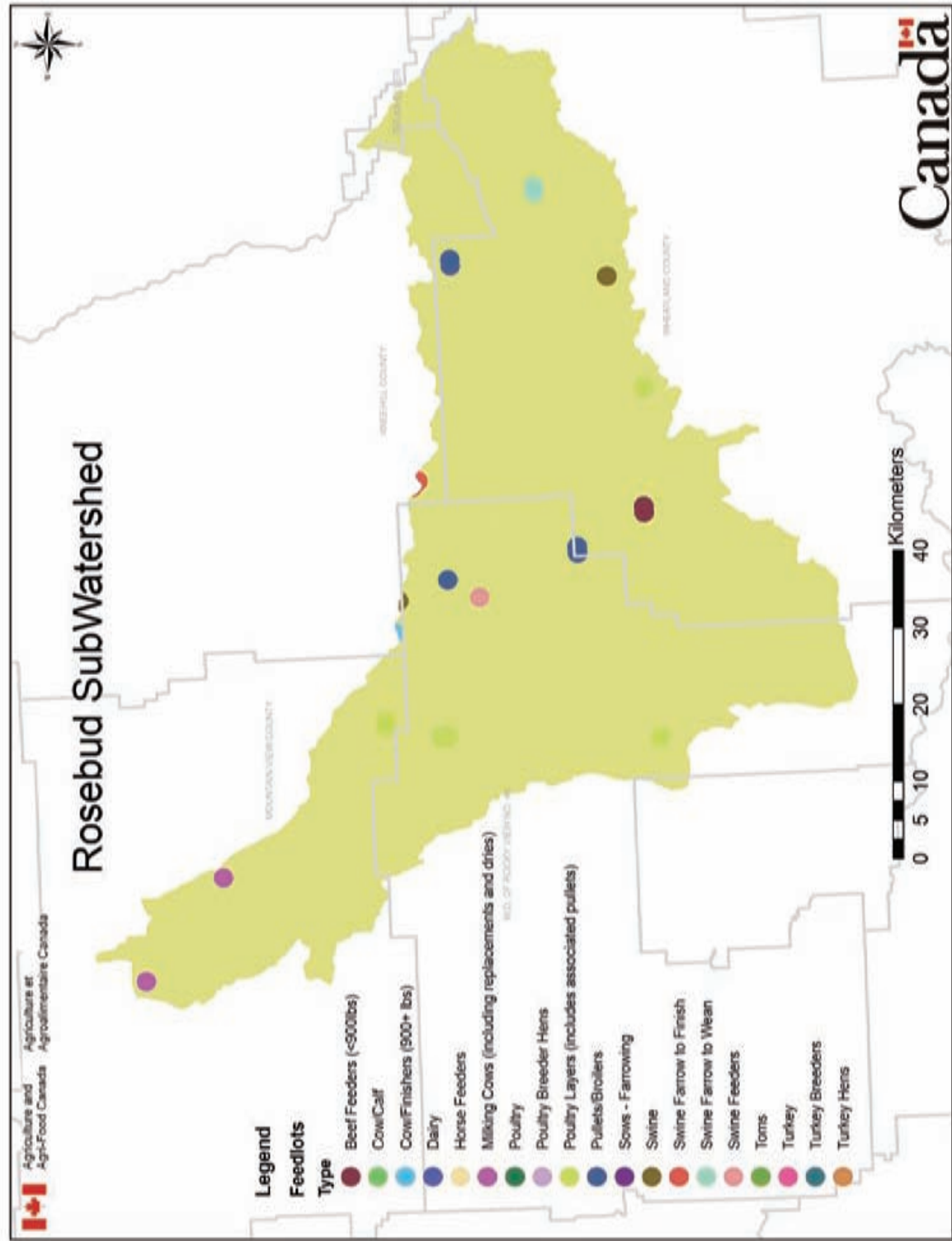


Figure 317. Feedlots and intensive livestock operations in the Rosebud River subwatershed (AAFC-PFRA, 2008).

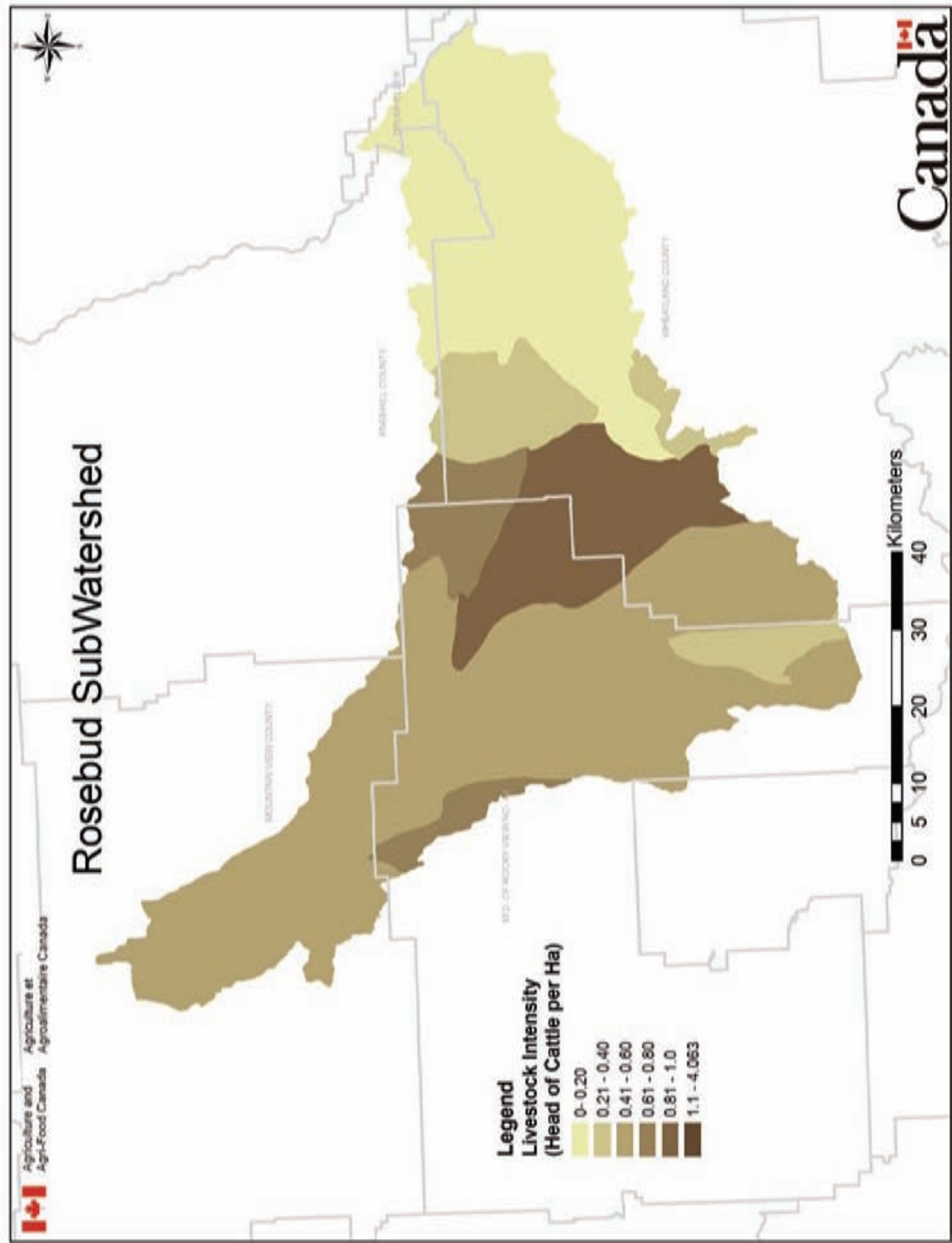


Figure 318. Cattle density (cattle/ha) in the Rosebud River subwatershed (AAFC-PFRA, 2008).

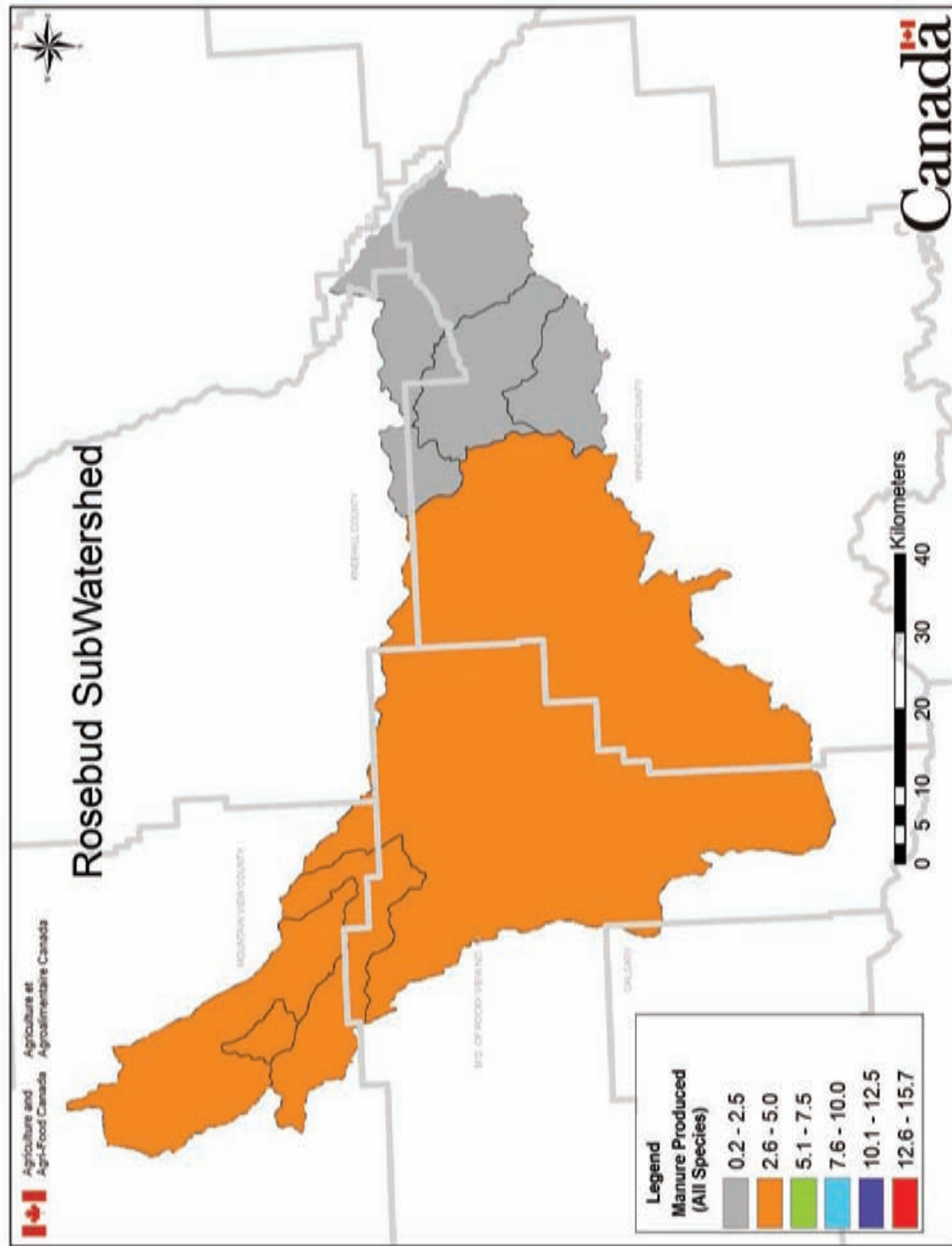


Figure 319. Manure production (tonnes/ha) in the Rosebud River subwatershed (AAFC-PFRA, 2008).

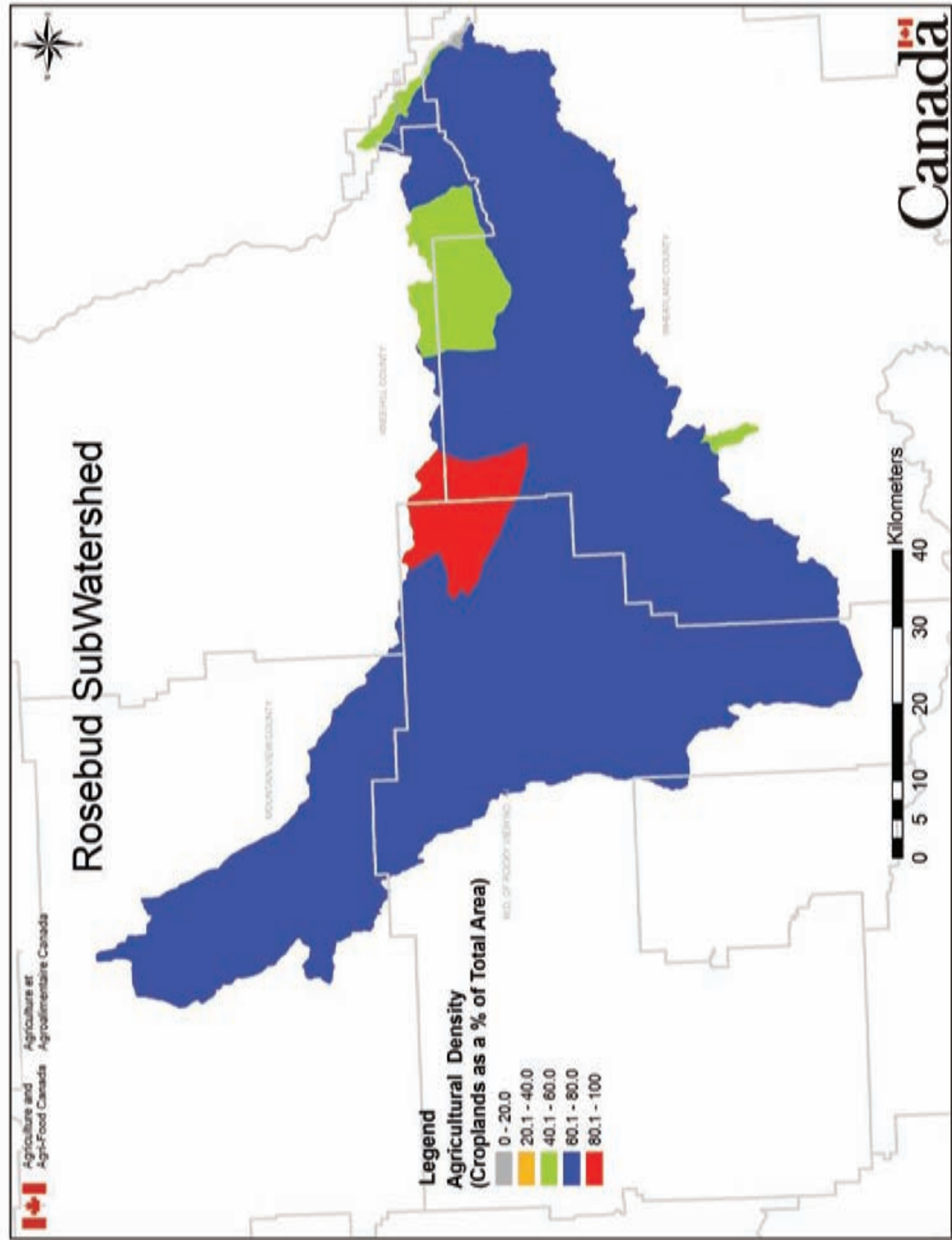


Figure 320. Agricultural intensity (% cropland) in the Rosebud River subwatershed (AAFC-PFRA, 2008).

4.12.2.4 Urban, Rural, Agricultural and Recreational Developments

Urban sprawl, rural and recreational development is the expansion of urban areas, rural subdivisions and recreational areas into surrounding landscape. This expansion can have many negative effects on the environment, including the loss of wetlands, riparian areas, intermittent streams and wildlife habitat, as well as increased surface runoff into neighboring creeks, rivers and lakes.

Communities in the Rosebud River subwatershed include the Towns of Crossfield, Didsbury, Drumheller, Irricana and Strathmore, the Villages of Beiseker and Rockyford and numerous hamlets, including Ardenode, Baintree, Beynon, Caruso, Cheadle, Craigdhu, Crump, Dalroy, Dalum, Delacour, Dunshalt, Gayford, Hamlet, Inverlake, Kathyryn, Keoma, Langdon, Lyalta, Nightingale, Norfolk, Redland, Rosebud, Rosedale, Taylor, Tudor and Wessex (Government of Canada, 2006). Aside from campgrounds, there are no provincial parks, recreational areas or natural areas in the subwatershed (Alberta Tourism, Parks and Recreation, 2008b).

4.12.2.5 Linear Developments

Linear developments include seismic lines, pipelines, roads, railways and utility right of ways. Quantifying linear development will help us understand potential changes in water quality and fish and wildlife populations, e.g., wildlife corridors can be interrupted by roads, and watersheds can have their drainage patterns permanently altered by increases in impervious or compacted surfaces.

The most prominent linear developments in the Rosebud River subwatershed are urban and rural roads, which have a total length of 4,760 km and cover 76.2 km² of the subwatershed's landbase. Other major linear developments include pipelines (Table 131). In total, all linear developments cover an area of 127.5 km², or 2.7% of the total area of the subwatershed (Figure 321) (AAFC-PFRA, 2008).

Table 131. Linear developments in the Rosebud River subwatershed (AAFC-PFRA, 2008). The dominant linear development is highlighted.

Linear Development	Length (km)	Width (m)	Area (km ²)	Proportion of total linear disturbances (%)
All roads	4,760	16	76.16	59.8
Cutlines/trails	1,100	6	6.60	5.2
Pipelines	2,200	15	33.00	25.9
Powerlines	210	30	6.30	4.9
Railways	360	15	5.40	4.2
Total	8,630		127.46	

In addition to linear developments, the Rosebud River subwatershed has 531 bridges that cross waterbodies, mostly streams and creeks, or culverts that connect waterbodies. These are primarily associated with Rosebud River, Serviceberry Creek and Crossfield Creek (Figure 322) (AAFC-PFRA, 2008). Pipeline crossings are distributed throughout the Rosebud River subwatershed, although their density is lower in the southern area of the subwatershed, i.e., south of Irricana. Pipeline crossing density is highest in the headwaters of the Rosebud River and near the confluence of Serviceberry Creek and Rosebud River in the eastern area of the subwatershed (Figure 323) (AAFC-PFRA, 2008).

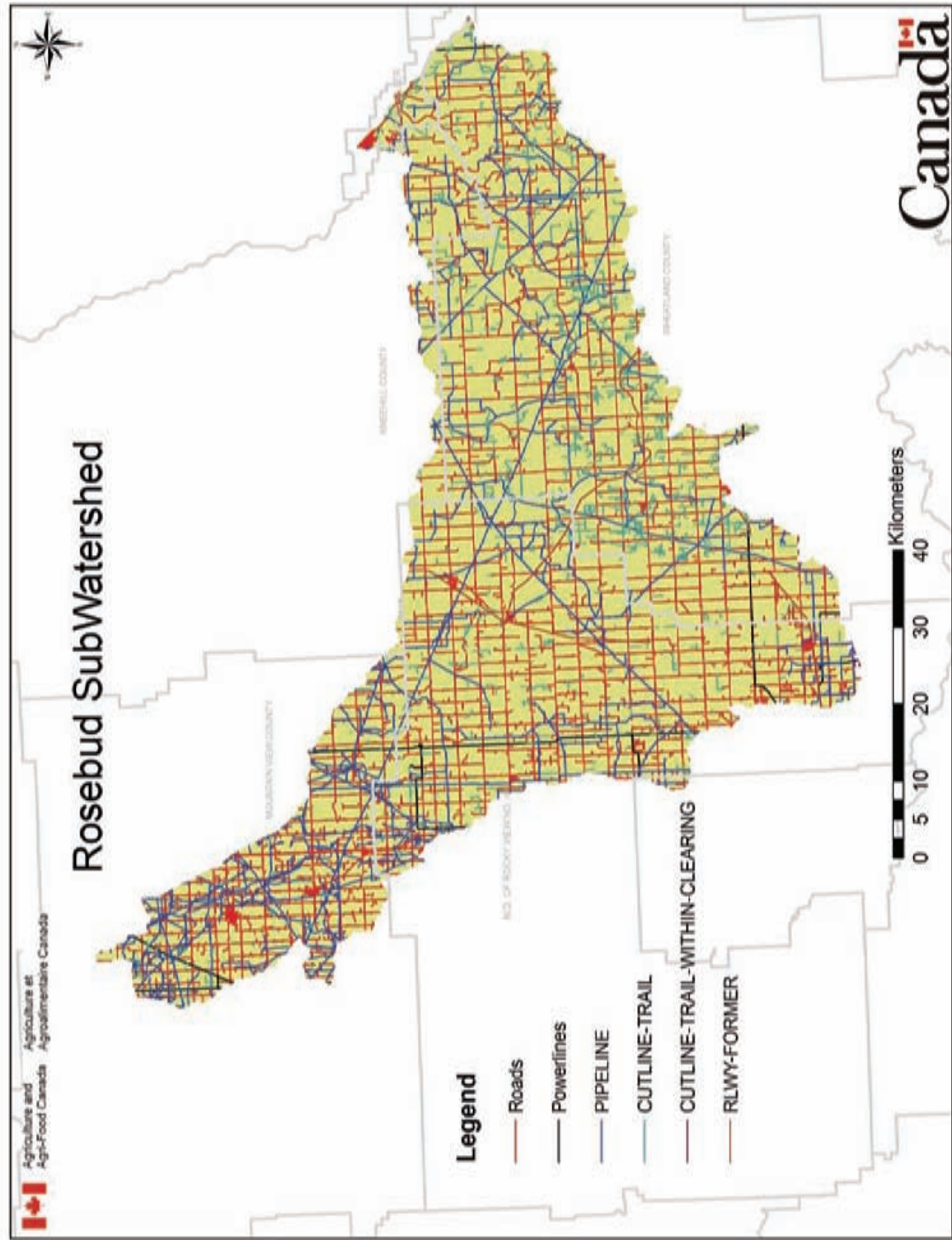


Figure 321. Linear developments in the Rosebud River subwatershed (AAFC-PFRA, 2008).

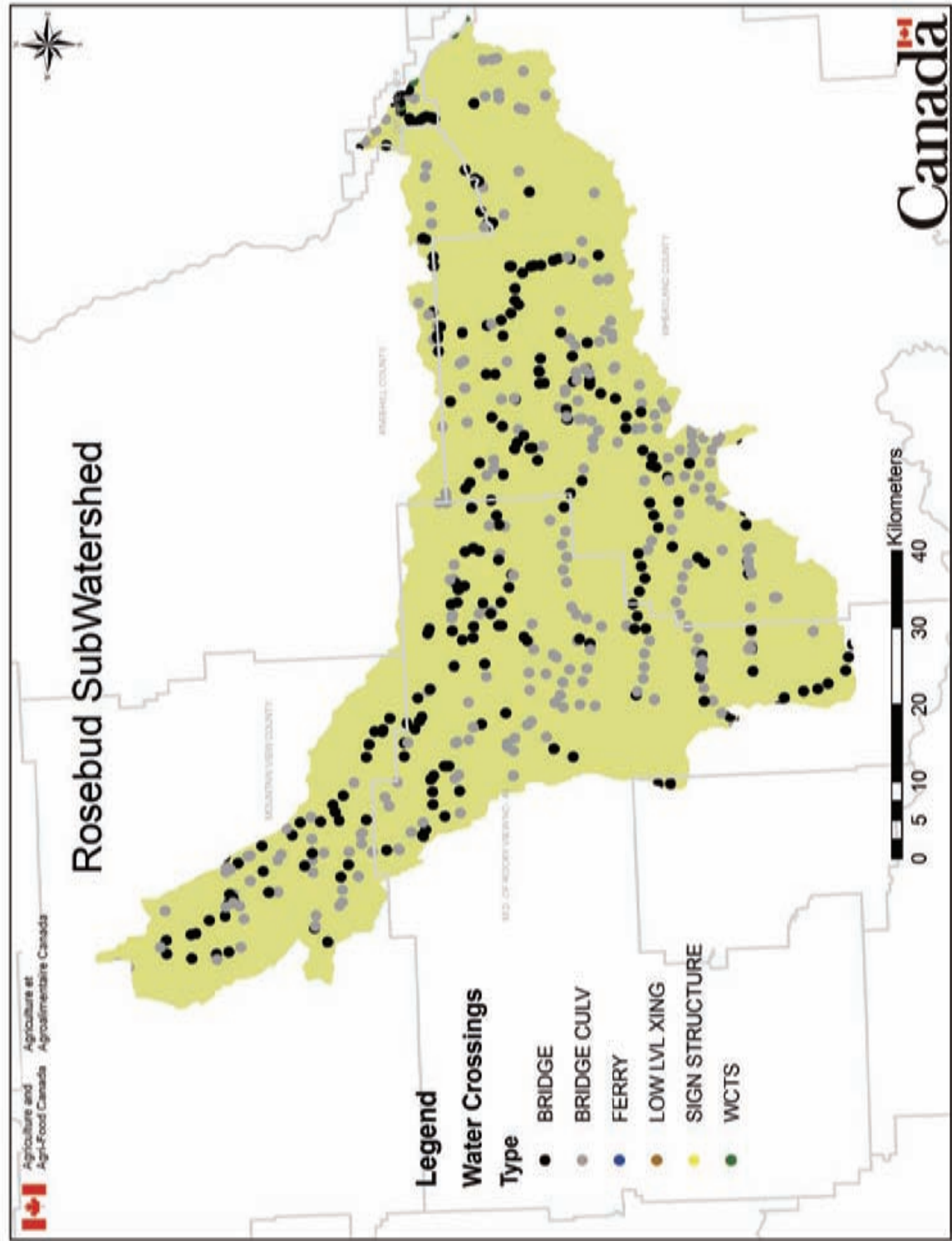


Figure 322. Waterbody crossings in the Rosebud River subwatershed (AAFC-PFRA, 2008).

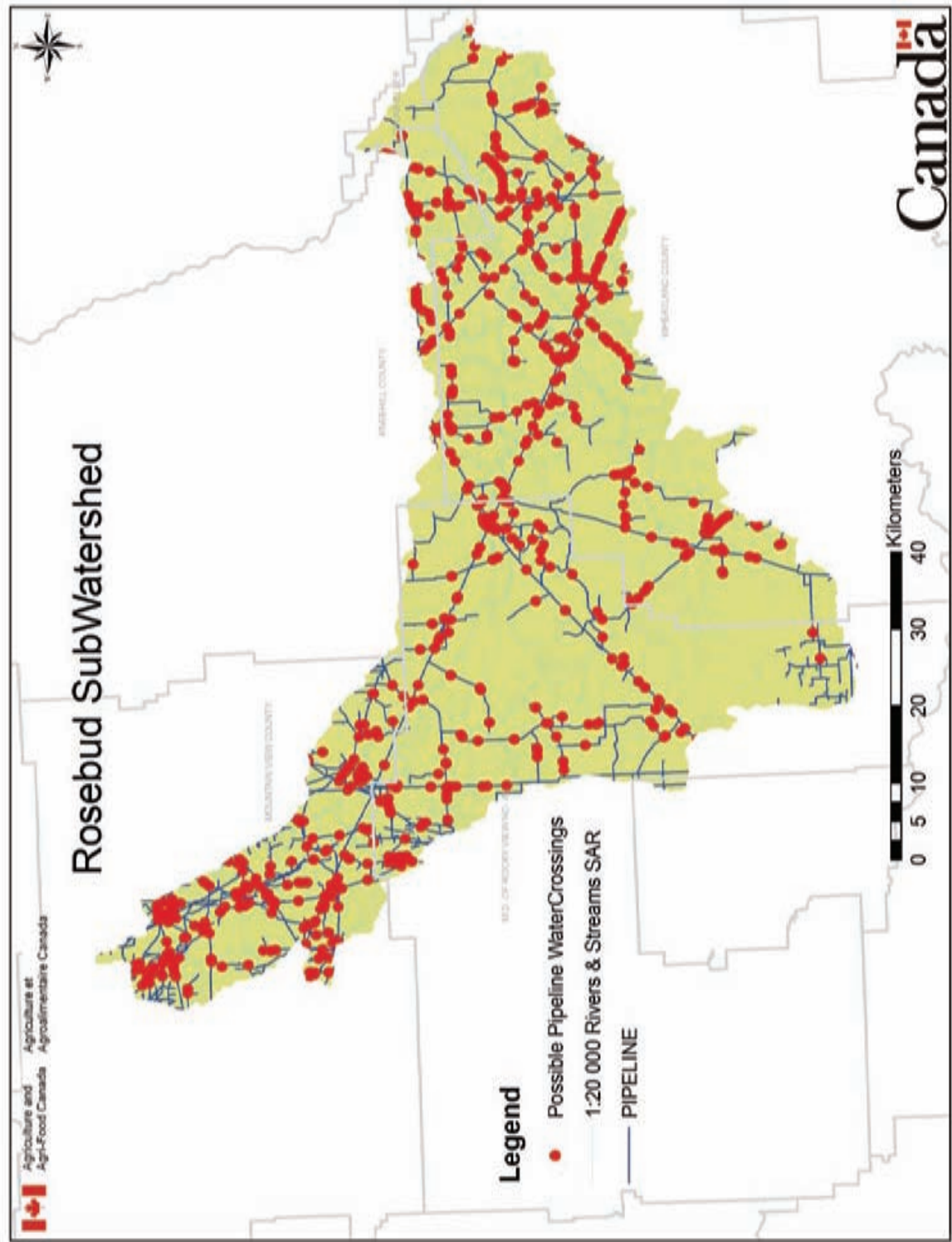


Figure 323. Pipeline crossings over waterbodies in the Rosebud Rover subwatershed (AAFC-PFRA, 2008).

4.12.2.6 Oil and Gas Activities

Oil and gas activity is very common throughout the province of Alberta. With oil and gas development there can be a number of associated impacts, including loss of wetlands, habitat fragmentation, increased water use and surface water and groundwater contamination (Alberta Centre for Boreal Studies, 2001).

The Rosebud River subwatershed has an average well density of 2.42 wells/km²; however, well density increases up to 10 wells/km² in the Beynon-Taylor-Wayne area near the confluence of the Rosebud River and the Red Deer River, near Dalroy-Rockyford and near Beiseker (Figure 324). About 85% of all wells are active, with the majority being unspecified wells, followed by gas and oil wells (Table 132) (AAFC-PFRA, 2008).

Table 132. Number of known active and abandoned oil, gas, water and other wells in the Rosebud River subwatershed (AAFC-PFRA, 2008).

Well type	Quantity
Wells – active *	6,345
Wells – abandoned *	1,368
Total	7,713
Gas wells – active	3,145
Gas wells – abandoned	241
Total	3,386
Oil wells – active	308
Oil wells – abandoned	131
Total	439
Water wells – active	40
Water wells – abandoned	6
Total	46
Total active wells in subwatershed	9,838
Total abandoned wells in subwatershed	1,746
Total wells in subwatershed	11,584

* The purpose of these wells is undefined and may include standing, newly licensed, flowing coalbed methane, testing coalbed methane, carbon dioxide injector or general exploration wells.

Coal bed methane (CBM) is natural gas that is found within coal formations. It has received attention recently as an additional source of energy; however, it brings with it potential environmental impacts, some of which are similar to conventional oil and gas exploration and production endeavors. Conversely, some potential impacts it brings with it are new, including an increased intensity in wells, compressors, pipeline infrastructure and completion and production of natural gas from formations above the base of groundwater protection. Some CBM wells are estimated to produce over 65,000 L of waste water per day (Lennon, 2008). In addition, common to oil, gas and unconventional gas (CBM and Shale gas) production is the risk of groundwater contamination through fracturing. Fracturing results from pumping fluids or gases into bedrock formations at high rates and pressures to ‘fracture’ the bedrock and increase gas or oil production. Fracturing fluids may contain toxic or carcinogenic compounds, which may leach into groundwater sources and pose a threat to human health through contaminated drinking water (Natural Resources Defense Council, 2002).

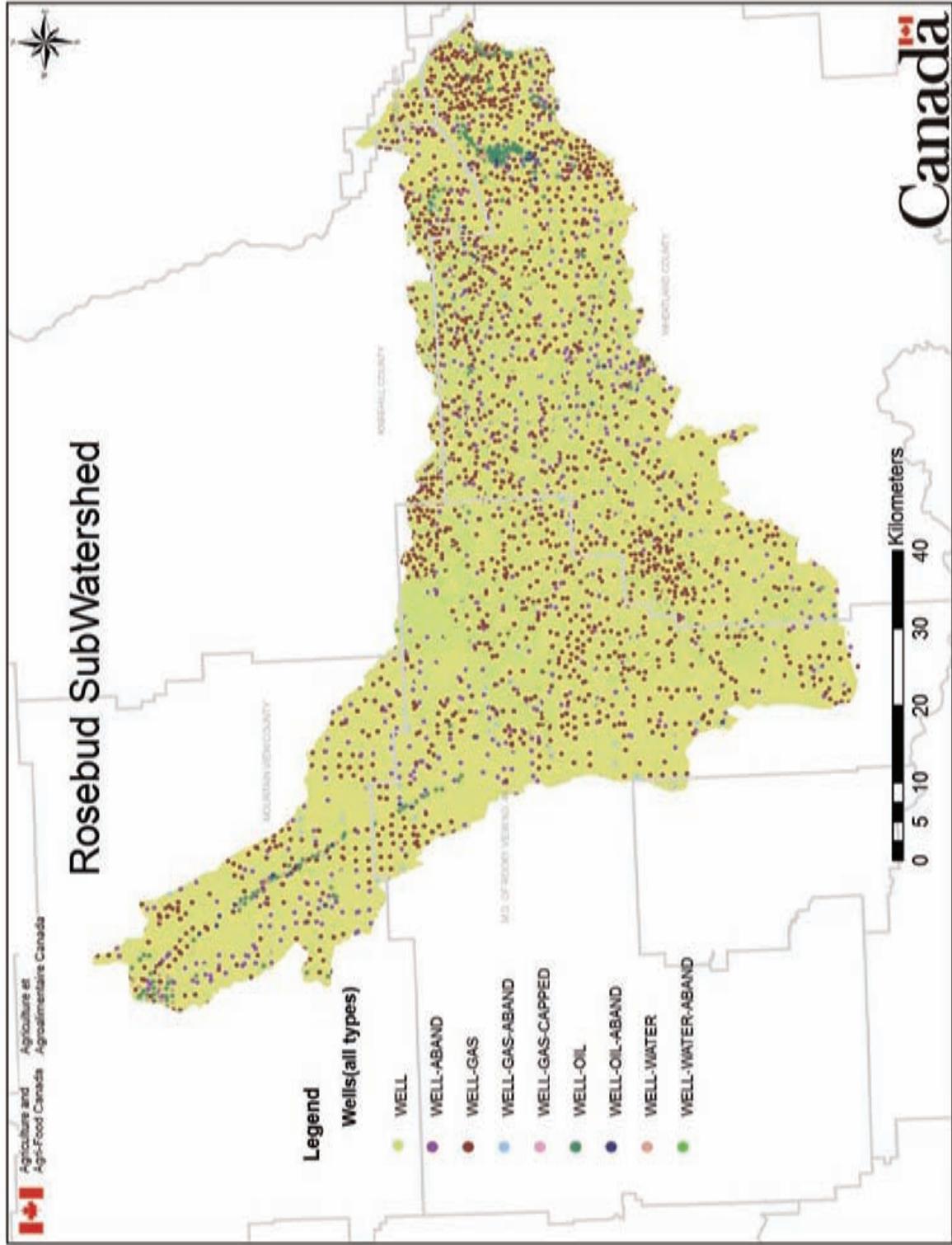


Figure 324. Known active and abandoned oil, gas, water and other wells in the Rosebud River subwatershed (AAFC-PFRA, 2008).

4.12.3 Water Quality Indicators

Changes in water quality indicate either a deterioration or improvement in the condition of the watershed and demonstrate specific areas that require further attention or protection. Changes in water quality result from changes in land use or land management practices, landscape disturbance and natural events. The major anthropogenic impacts on water quality result from natural resource extraction and processing, wetland drainage, dredging, dam construction, agricultural runoff, industrial wastes, municipal wastes, land erosion, road construction and land development. Five metrics were used to indicate changes in water quality in the Red Deer River watershed and its 15 subwatersheds:

- Nutrients – Condition Indicator
- Bacteria – Condition Indicator
- Parasites – Condition Indicator
- Pesticides – Condition Indicator
- Point Source Inputs

These five water quality indicators reflect socioeconomic growth in a region. Hence, while human activities in a region can have negative impacts on aquatic ecosystems, it is important to strive for a balance between socioeconomic growth and the sustainable management of these aquatic ecosystems to ensure their long-term health and enjoyment by future generations.

4.12.3.1 Nutrients

Nitrogen and phosphorus are essential nutrients for most aquatic plants, whereby excess nutrients can lead to eutrophication, i.e., an excessive amount of aquatic plant and phytoplankton growth. Concomitant with increased plant and phytoplankton growth, oxygen levels may significantly decrease in the water column, which may negatively impact aquatic organisms, including fish. In addition, excessive phytoplankton growth, particularly of cyanobacteria, can lead to the release of toxins into the water column, which may be harmful to aquatic organisms, waterfowl, livestock and humans.

The water quality was assessed in the Rosebud River subwatershed in the mid-1980s. TP and TN concentrations in Serviceberry Creek have been above CCME PAL guidelines, averaging 0.260 mg/L and 1.007 mg/L, respectively (Table 133). Sources of phosphorus and nitrogen may include surface application of manure and/or fertilizer by agricultural producers (Carpenter et al., 1998; Chambers et al., 2001), municipal wastewater effluents (Servos et al., 2001) and urban run-off (Marsalek et al., 2001), all of which have been demonstrated to be a source of excess nutrients to surface waterbodies. Both agricultural and livestock operations occur near Serviceberry Creek and may contribute to the nutrient loading of the creek.

4.12.3.2 Bacteria

Coliforms are a broad class of bacteria found in human and animal wastes. Total coliforms include *Escherichia coli*, fecal bacteria and other coliforms that occur naturally in warm blooded animals. *E. coli* is one of three bacteria commonly used to measure the direct contamination of water by human or other mammal wastes. Ingestion of or exposure to fecal bacteria can have negative health impacts.

Sources of this type of bacteria include agricultural and municipal runoff, wildlife, faulty septic systems and septic fields.

Total coliform and fecal coliform bacterial concentrations have been assessed in Serviceberry Creek, a major tributary of Rosebud River. Concentrations of both groups of bacteria have been below CCME-Agriculture/Irrigation guidelines in the 1980 (Table 133). More recent data are absent.

Table 133. Water quality in Serviceberry Creek. Data are average values of samples collected February 1985-September 1987 (data from Alberta Environment, 2008). n = sample size. All concentrations in mg/L unless otherwise noted. Concentrations exceeding water quality guidelines are highlighted *.

Parameter	Mean	n
TP	0.260	20
TDP	0.164	9
TN	1.007	11
NO ₃ ⁻ -NO ₂ ⁻	0.127	20
NH ₃	0.072	11
DO	9.33	11
Chl. <i>a</i> (µg/L)	--	--
pH	8.13	19
Specific Conductivity (µS/cm)	839	20
TDS	--	--
Total coliforms (CFU/100 mL)	197	9
Fecal coliforms (CFU/100 mL)	58	10

* TN from ASWQG PAL chronic exposure guideline; fecal and total coliforms from CCME-Agriculture/Irrigation guideline; all others from CCME PAL. Variable abbreviations as in Table 10.

4.12.3.3 Parasites

Waters that are polluted may contain several different disease-causing organisms, commonly called parasites. Enteric parasites, those that live in the intestine of warm blooded animals, can carry or cause a number of infectious diseases. *Cryptosporidium* and *Giardia* spp. are two such parasites. Both occur in almost all environments, including lakes, rivers, reservoirs and groundwater. They come from the feces of rodents, birds, cows, pigs and humans, and the ingestion of these parasites causes gastrointestinal conditions known as cryptosporidiosis and giardiasis.

Parasite data were not located for any waterbody in the Rosebud River subwatershed.

4.12.3.4 Pesticides

Pesticides are a group of chemicals, including herbicides, insecticides, rodenticides and fungicides, used for many purposes, including pest control and aesthetics in urban areas, golf courses and in forestry and agricultural production. Pesticides are a common contaminant of streams and dugouts in the high intensity agricultural areas of Alberta.

Pesticide concentrations have been monitored in the Rosebud River, and 12 different pesticides have been detected (Table 134). None of the pesticides exceeded CCME PAL guidelines; however, half of them currently do not have maximum concentration guidelines.

Table 134. Pesticide concentrations in the Rosebud River. n = sample size. All concentrations in µg/L.

Pesticide	Mean range *	Maximum	CCME PAL	n
2,4-D	0.056-0.057	0.146	4.0	14
2,4-DP	0.0004-0.0050	0.006	---	14
Atrazine	0.006-0.008	0.016	1.8	14
Bromoxynil	0.014-0.016	0.111	5.0	14
Clopyralid	0.007-0.021	0.040	---	14
Dicamba	0.038-0.047	0.177	10.0	14
Gamma-benzenehexachloride	0.001-0.005	0.007	---	14
Guthion	0.001-0.186	0.012	---	14
MCPA	0.025-0.026	0.137	2.6	14
MCP	0.016-0.017	0.085	---	14
Picloram	0.004-0.008	0.029	29.0	14
Triallate	0.001-0.005	0.007	0.24	14

* A precise mean could not be determined because the analytical methods used do not distinguish between values of zero and values that are below the detection limit (BDL). The range of the mean was calculated by first assuming that all BDL samples were equal to zero (providing the lower end of the range), and then by assuming that all BDL samples were equal to the detection limit (providing the upper end of the range). Where no values below the detection limit were present, a single average value was calculated. Water samples were collected March 1999-March 2000 (data from Alberta Environment).

4.12.3.5 Point Source Inputs

Point source inputs include effluents from waste water treatment plants (WWTP), stormwater outfalls and industry. Effluent from WWTP's, although regulated, generally has higher concentrations of certain compounds (e.g., nutrients, solids, pharmaceuticals, metals, etc.) than the receiving environment. Similarly, stormwater outfalls contain elevated levels of nutrients, salts and solids compared to the receiving environment, and industrial effluents can contribute elevated levels of a suite of different contaminants, such as metals, solids, hydrocarbons and/or salts, as well as other chemicals used in processing or manufacturing, to aquatic ecosystems.

At least 45 upstream oil/gas facilities as well as 4 commercial facilities, 2 power generation facilities, 1 waste treatment/disposal facility, 1 oil/gas storage/refining facility and 1 oil sands/heavy oil facility have released pollutants continuously or sporadically into the air in the Rosebud River subwatershed since 1998. Pollutants from the upstream oil/gas facilities include volatile organic compounds (VOCs), carbon monoxide (CO), nitrous oxide (N₂O) and particulate matter < 10 µm in size. The pollutants from the commercial facilities include VOCs, a hydrocarbon (styrene), particulate matter < 10 µm in size and copper-containing compounds, while those from the power generation facilities include ammonia (NH₃), CO, hydrocarbons (e.g., dioxins, furans), hydrochloric acid (HCl), sulphuric acid (H₂SO₄) and particulate matter < 10 µm in size. The waste treatment/disposal facility has released hydrocarbons (e.g., toluene, xylene), alcohols and ethylene glycol into the atmosphere. This facility also treats pollutants off-site prior to disposal or injects pollutants into the ground. Pollutants from the oil/gas refining/storage and oil sands/heavy oil facilities are similar and include CO, N₂O and particulate matter < 10 µm in size (NPRI,

2008). No pollutants were released directly into aquatic ecosystems according to the National Pollution Release Inventory.

4.12.4 *Water Quantity Indicators*

Water quantity is important for the maintenance of aquatic habitat, it has functions related to water quality and it is essential for the treatment and production of sufficient volumes of drinking water to meet current demands. Irrigation, industry and livestock production are highly dependent on a minimum amount of water. Sufficient water quantity is necessary for many recreational activities, and in recent years many cottagers and recreational lake users across Alberta have voiced concerns about the decreasing volumes of water seen across the province. Five metrics were used as water quantity indicators in the Red Deer River watershed and its 15 subwatersheds:

- Volume
- Minimum Flows to Maintain Ecological Integrity – Condition Indicator
- Contributing Areas to the Watershed
- Allocations
- Groundwater Recharge/Discharge

Water discharge rates, allocations and minimum flow rates to maintain ecological integrity can reflect socioeconomic growth in a region. Human activities in a region frequently reduce available water quantities required to maintain healthy aquatic ecosystems. It is important to balance socioeconomic growth and the sustainable management of these aquatic ecosystems to ensure their long-term health and enjoyment by future generations.

4.12.4.1 Volume

Water volume is the amount of water flowing past one point over a given time, or in the case of lakes or other standing waterbodies, the total amount of water present in the waterbody at a given time. This amount varies seasonally and annually with shifts in weather patterns. Water withdrawals for consumptive uses have increased dramatically in recent years and have resulted in some watersheds within the province being closed to new water licenses.

The total length of all watercourses in the Rosebud River subwatershed is about 3,289 km (Figure 325) (AAFC-PFRA, 2008). The major streams in the subwatershed are Atusis Creek, Carstairs Creek, Crossfield Creek, Deadrick Creek, Rosebud River, Serviceberry Creek and Severn Creek. The largest lakes are Bruce Lake, Chestermere Lake, Two Bar Lake, Weed Lake and Whey Lake. In addition, there are numerous small creeks, lakes and sloughs in the subwatershed (Government of Canada, 2006).

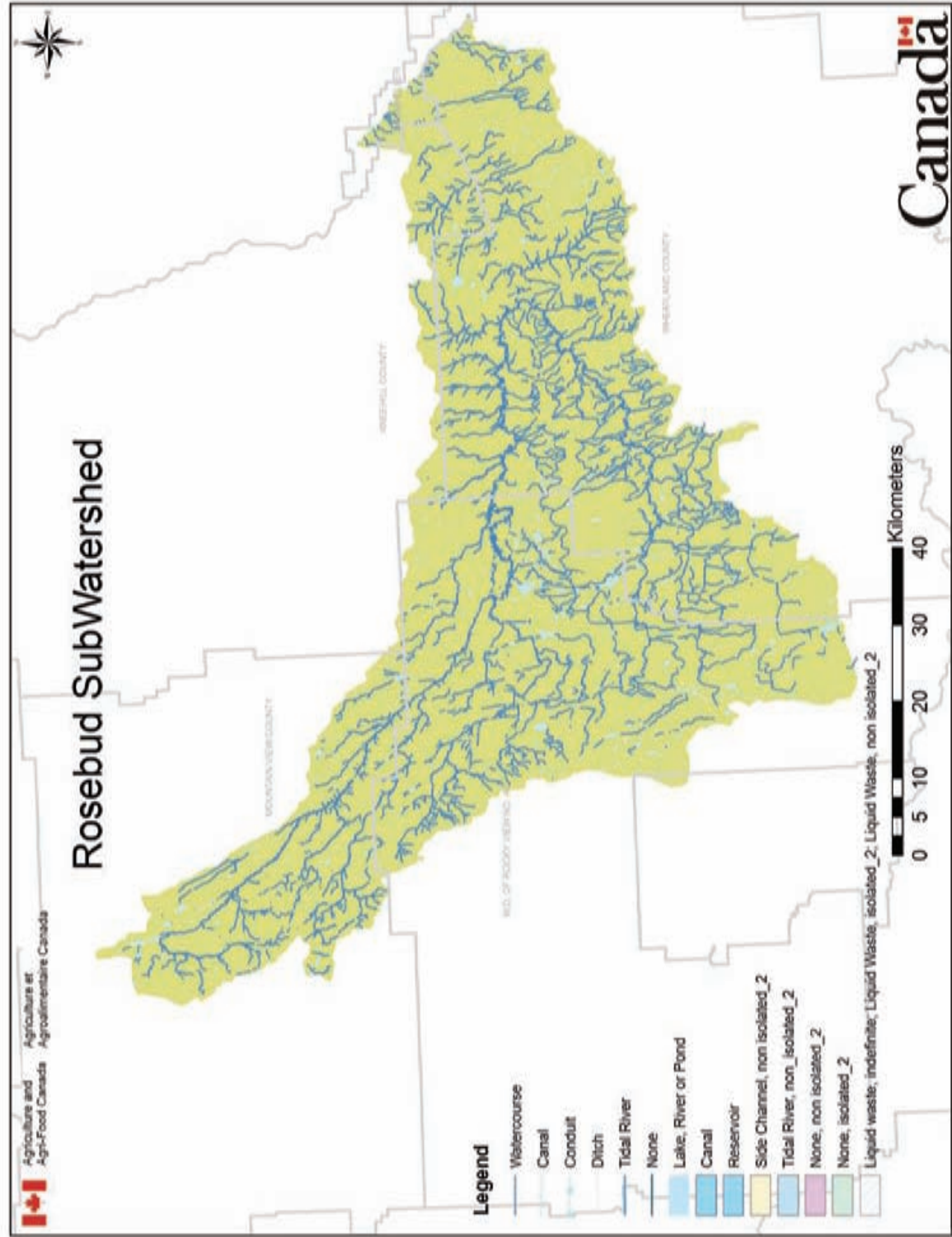


Figure 325. Waterbodies in the Rosebud River subwatershed (AAFC-PFRA, 2008).

Alberta Environment has been monitoring water discharge rates in the Rosebud River subwatershed at seven locations: In Rosebud Creek near Taylor (discontinued, 05CE003), in Rosebud Creek near Redland (real-time active, 05CE005), in Severn Creek (discontinued, 05CE009), in Atusis Creek (discontinued, 05CE008), in Rosebud Creek below the confluence with Carstairs Creek (active, 05CE006), in Rosebud Creek above the confluence with Carstairs Creek (discontinued, 05CE004) and in a tributary of Rosebud Creek east of Carstairs (discontinued, 05CE019) (Government of Alberta, 2008c)

Water discharge rates in Rosebud Creek at Redland are relatively constant throughout the year, ranging from 1-3 m³/sec from April-October. In October, they rapidly decrease to about 0.4 m³/sec. Historically, water discharge rates have reached maxima of 7 m³/sec and minima 0.6 m³/sec in the spring (April) and minima of 0.3 m³/sec in the fall (October). In late May-early June 2008, water discharge rates exceeded average levels considerably, reaching and/or exceeding 20 m³/sec on at least two occasions. For the remainder of the year, water discharge rates were similar to average levels (Figure 326) (Government of Alberta, 2008c).

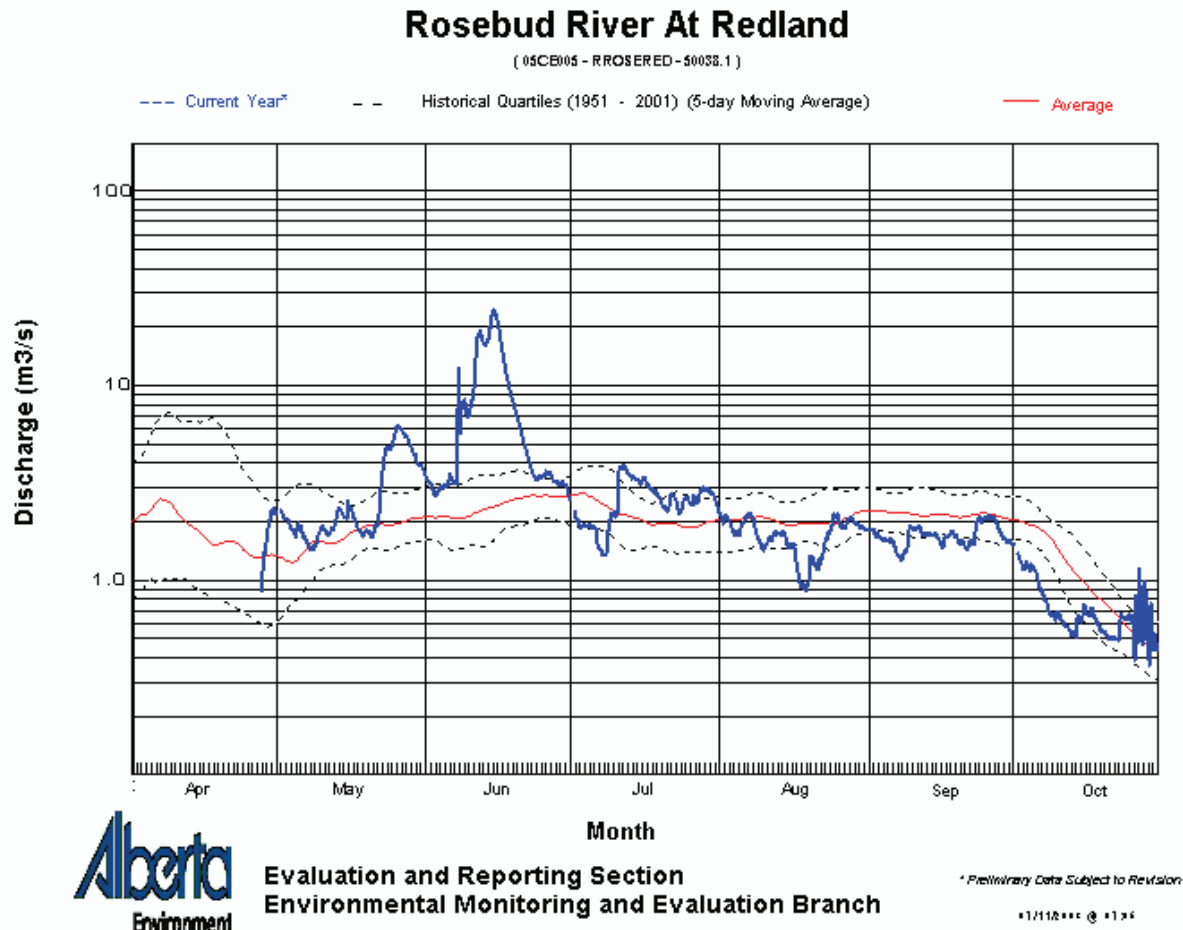


Figure 326. Discharge rates in Rosebud River at Redland (Government of Alberta, 2008c). “Current year” indicates water discharge rates in 2008.

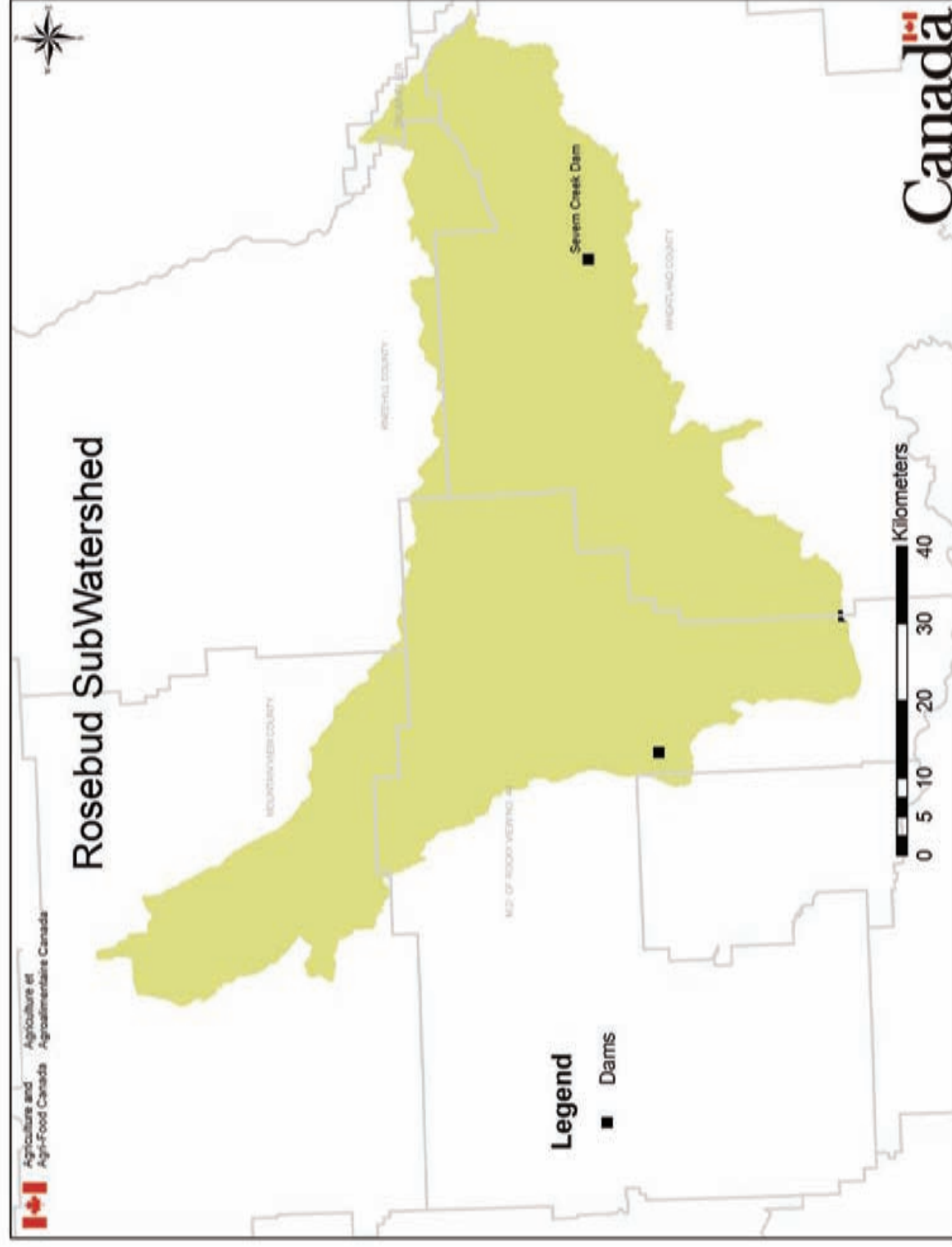


Figure 327. Major dams in the Rosebud River subwatershed (AAFC-PFRA, 2008).

There are three major dams located in the Rosebud River subwatershed (Figure 327). Severn Creek Dam forms Severn Creek Reservoir in the east of the subwatershed, while a dam is also located on Twin Lake near Delacour in the western area of the subwatershed. In addition, there are numerous smaller water infrastructures in the subwatershed, e.g., small dams, sluices, weirs and dykes, which control water flow.

4.12.4.2 Minimum Flows to Maintain Ecological Integrity

Minimum flows to maintain ecological integrity are the lowest flows or volumes (lakes) required to sustain native aquatic species and natural ecosystem functions. Minimum flows must be determined before allocation of water can safely take place to preserve the ecological functionality of aquatic ecosystems.

Minimum flow requirements for the maintenance of ecological integrity have not been determined in the Rosebud River subwatershed.

4.12.4.3 Contributing Areas to the Watershed

Contributing areas to the watershed are areas from which runoff flows into the lakes, creeks and rivers of the watershed. These data are used to determine an estimated volume of water contributed to the river on an annual basis.

In the Rosebud River subwatershed, 166,292 ha (or 37.9% of the total area of the subwatershed) of land do not contribute to the drainage of the subwatershed (Figure 328). These areas are located primarily throughout the central, south-central and eastern areas of the subwatershed, e.g., west of the Irricana-Keoma-Delroy-Cheadle corridor, near Beiseker and east of the confluence of Serviceberry Creek and Rosebud River, where the topography is relatively flat (Figure 329), and precipitation does not run off into nearby waterbodies (AAFC-PFRA, 2008).

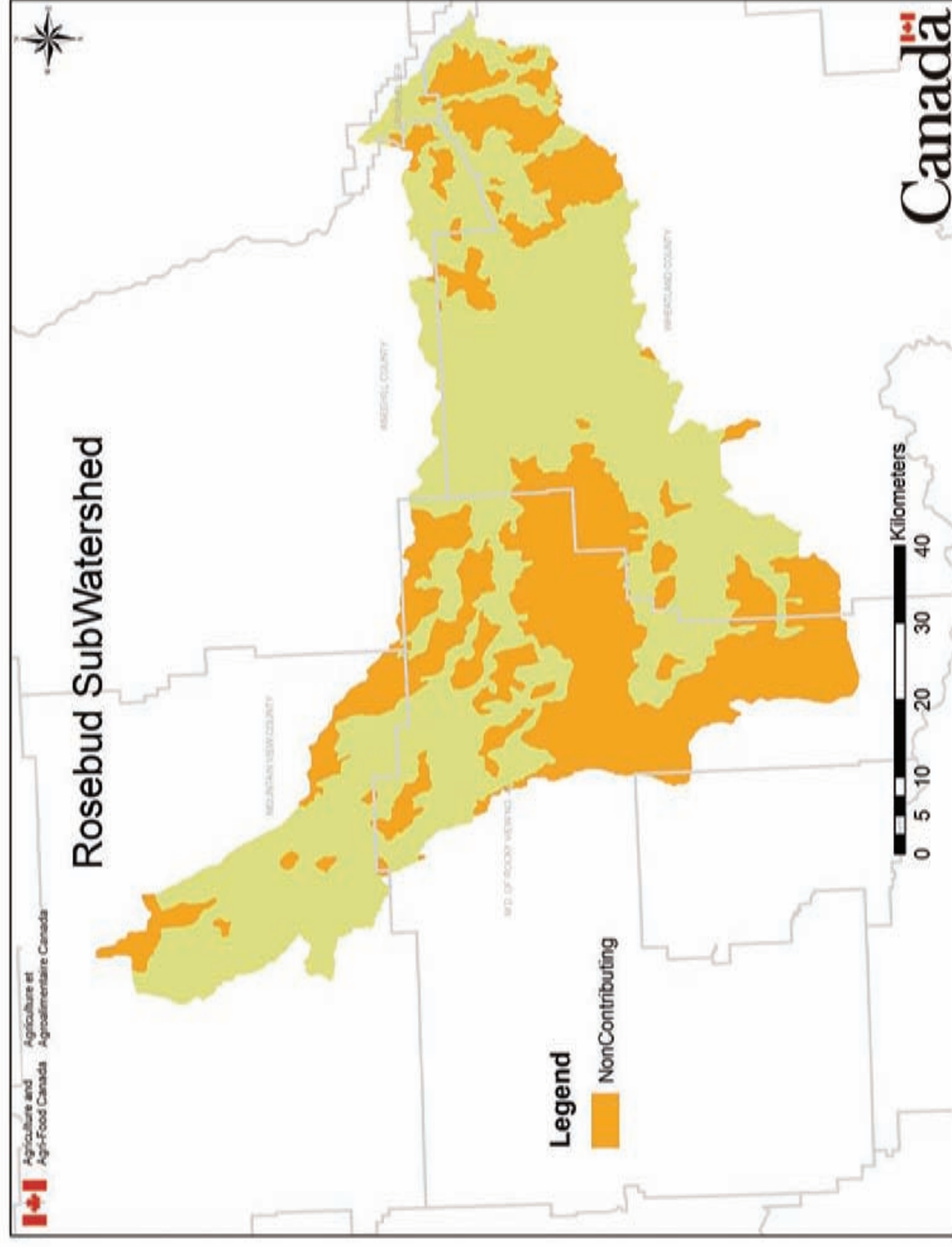


Figure 328. Non-contributing drainage area in the Rosebud River subwatershed (AAFC-PFRA, 2008).

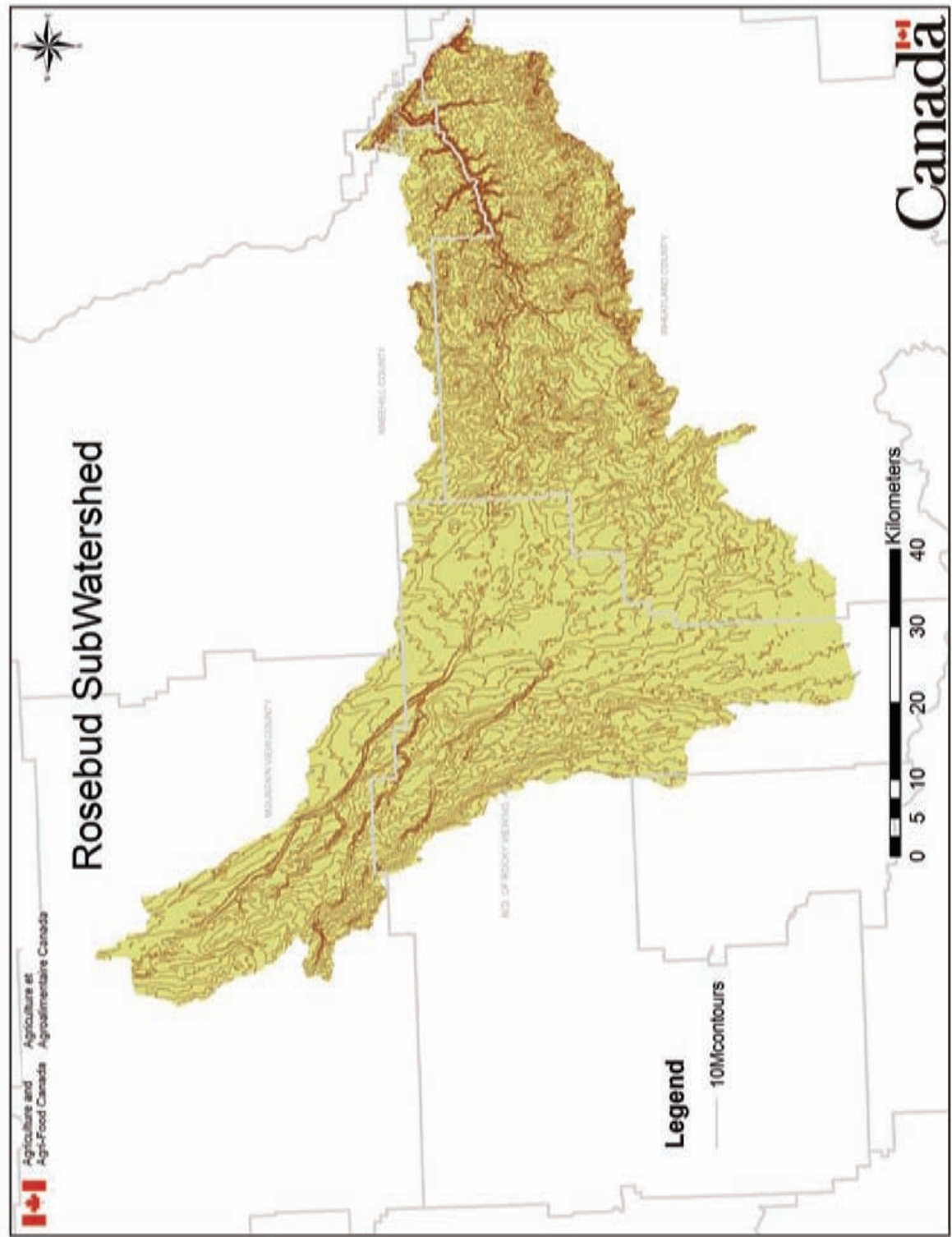


Figure 329. Topography (10-m contour intervals) of the Rosebud River subwatershed (AAFC-PFRA, 2008).

4.12.4.4 Allocations

Surface and groundwater water withdrawal permits for the watershed are quantified by user sector along with information on licenses, consumption and return flows. This information will be used along with water flow data to identify areas of potential future constraints on surface water availability, which may have implications for future development.

In the Rosebud River subwatershed, 2,198 surface water licenses and 1,395 groundwater licenses have been issued for water diversion projects (Figures 330, 331, respectively) (AAFC-PFRA, 2008). They are distributed throughout the entire subwatershed, although licenses for groundwater diversions are more common in the northwestern area of the subwatershed.

About 5.72 million m³ of surface and groundwater are diverted annually in the Rosebud River subwatershed (Government of Alberta, 2008d). The most prominent uses of surface water are for irrigation (40% of total surface water diversions) and agricultural practices (20% of total surface water diversions), while the most prominent users of groundwater are municipalities (47% of total groundwater diversions) and agricultural operations (41% of total groundwater diversions) (Table 135). The majority of water diverted in the entire subwatershed comes from surface water sources, e.g., lakes, streams and rivers (64%) (Government of Alberta, 2008d). Additional groundwater diversion information is provided in HCL (2000a, 2002, 2003b, 2005).

Table 135. Surface and groundwater diversions in the Rosebud River subwatershed (Government of Alberta, 2008d). The highest uses for water have been highlighted. Data reported exclude any water diverted from the Red Deer River mainstem.

Purpose	Surface water (m ³ /yr)	Groundwater (m ³ /yr)
Agriculture	722,277	833,302
Commercial	419,537	181,681
Dewatering	209,680	---
Groundwater exploration	---	6,044
Habitat enhancement	418,145	---
Industrial	118,410	57,970
Irrigation	1,453,115	7
Municipal	---	967,162
Other purposes specified by the Director	---	4,546
Recreation	---	1,230
Water management	334,270	---
Total	3,675,433	2,051,942
Grand total		5,717,458

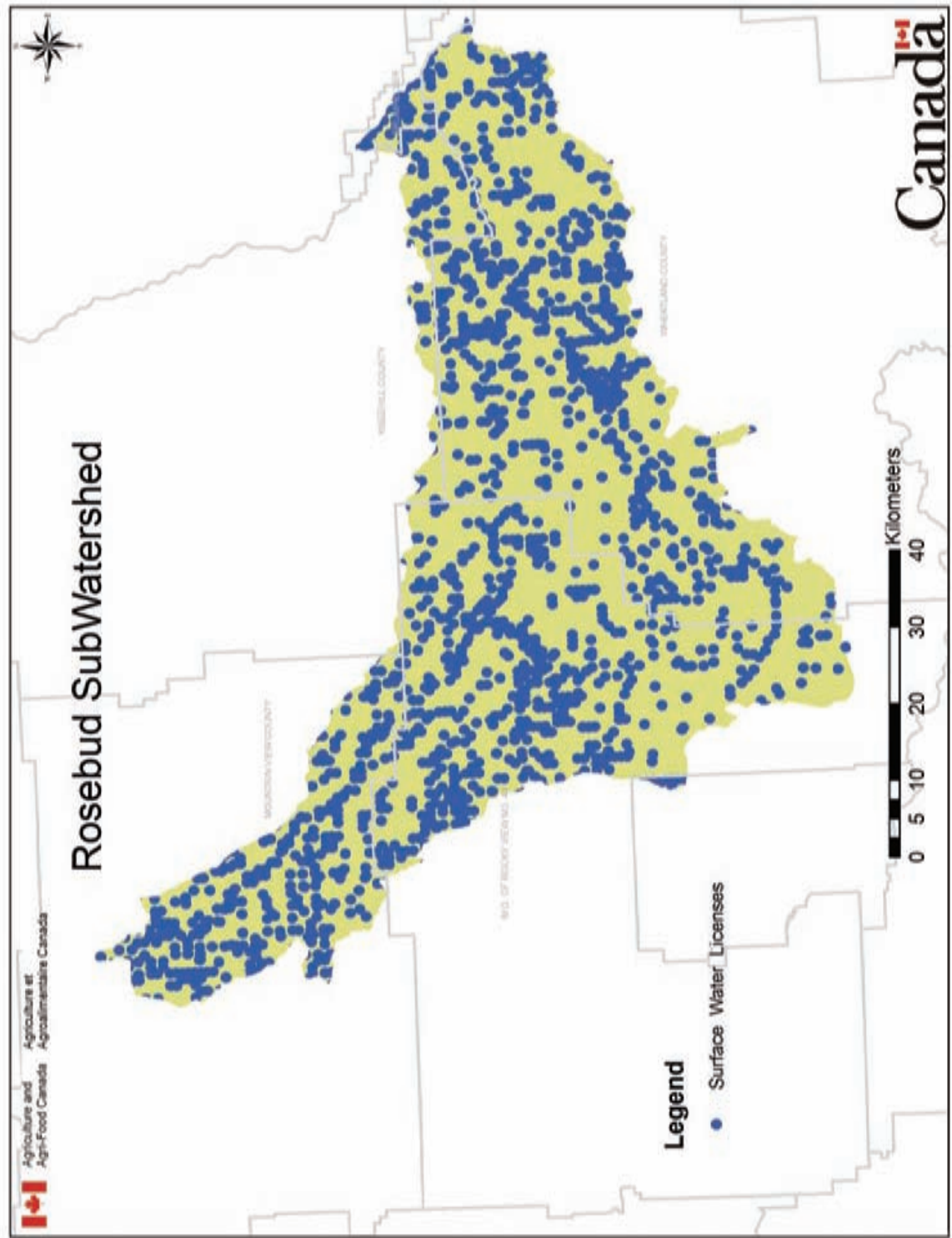


Figure 330. Surface water licenses in the Rosebud River subwatershed (AAFC-PFRA, 2008).

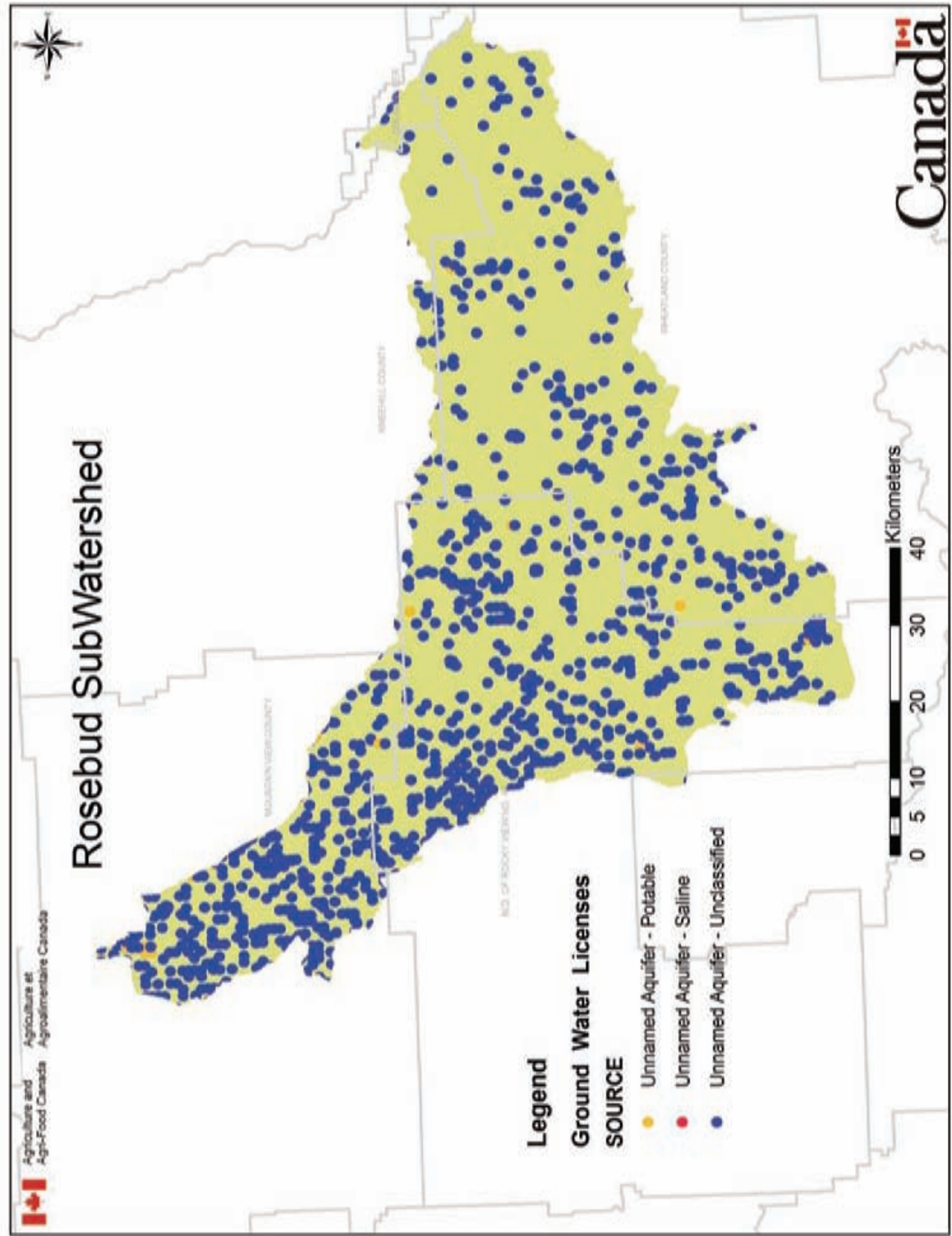


Figure 331. Groundwater licenses in the Rosebud River subwatershed (AAFC-PFRA, 2008).

4.12.4.5 Groundwater Recharge/Discharge

Areas where groundwater gets recharged or discharges to the surface indicate areas where the groundwater table is close to the surface and the soils are generally more permeable. These areas are at greater risk of becoming negatively impacted from development or agricultural and/or industrial activities. Knowing where groundwater recharges and discharges occur will help to identify areas requiring special protection and limitations to land use.

Freshwater springs are points in the landscape where the aquifer surface meets the ground surface, i.e., freshwater springs are areas of groundwater discharge. The Rosebud River subwatershed has about 40 freshwater springs located primarily along Rosebud River and Serviceberry Creek in the Beiseker-Rosebud-Rockyford triangle. Several springs are also located along Carstairs Creek southeast of the Town of Carstairs.

The Rosebud River subwatershed lies in the Counties of Kneehill, Mountain View and Wheatland and the Municipal District of Rocky View No. 44. Groundwater assessments have been conducted for these counties by HCL (2000a, 2002, 2003b, 2005). The assessments indicated that most of the area of this subwatershed is a groundwater recharge area (i.e., water moves from the surface into groundwater reservoirs). Groundwater discharge areas (i.e., water moves from groundwater reservoirs to the surface) are more prevalent in the middle reaches of the Rosebud River and along Crossfield Creek and Serviceberry Creek. Specific areas of groundwater recharge include small depressions in the landscape and temporary and ephemeral wetlands, which collect rainwater and snow melt and release a proportion of this accumulated water into shallow groundwater and regional aquifers (van der Kamp and Hayashi, 1998; Hayashi et al., 2003). Additional information on aquifers, water quantity and quality of the groundwater associated with each aquifer, hydraulic relationship among aquifers and possible groundwater depletion areas associated with each upper bedrock aquifer is provided in HCL (2000a, 2002, 2003b, 2005).

4.12.5 *Biological Indicators*

Bioindicators are biological (plant and animal) data from which various aspects of ecosystem health can be determined or inferred. The presence, absence and abundance of such data can be linked to water quality, quantity and ultimately to overall watershed health. Four metrics were used as biological indicators in the Red Deer River watershed and its 15 subwatersheds:

- Wildlife Biodiversity
- Fish
- Land Cover – Condition Indicator
- Species at Risk

Changes in biological populations often reflect socioeconomic growth in a region. Human settlement and the subsequent exploration and extraction of natural resources alters the landscape and with it the habitat of the indigenous flora and fauna. It is important to balance socioeconomic growth with the preservation of natural habitat integrity to ensure the long-term health of natural biological populations.

4.12.5.1 Wildlife Biodiversity

Wildlife inventories to determine the biodiversity within the watershed will indicate changes in environmental conditions (e.g., habitat fragmentation, loss of nesting and breeding sites, nutrient enrichment, etc.). A loss of biodiversity can cause an ecosystem to become less stable and more vulnerable to environmental change. A change in diversity may also affect nutrient cycling and/or energy flow through the ecosystem.

Wildlife biodiversity assessment data have not been located for the Rosebud River subwatershed.

4.12.5.2 Fish

Inventories of selected fish populations may show increases or declines through introductions or changes in environmental conditions. Indicator species sensitive to environmental pollution may show areas of concern through their absence, while others may show similar with their presence. Invasive species, if present, will indicate areas of concern requiring future monitoring.

Fish population data were not located for any waterbody in the Rosebud River subwatershed.

4.12.5.3 Land Cover

Land cover is the type of vegetation, or lack thereof, covering the landscape. Inventory of vegetation populations may show increases or declines through introductions or changes in environmental conditions. Indicator species that are sensitive to environmental pollution may show areas of concern with their absence, while others may show areas of concern with their presence. Changes in land cover can indicate a change in land use and identify areas that need restoration, are at risk of erosion and/or areas with rare plant species that need protection. Land cover is a separate measurement from land use even though these two terms are sometimes used interchangeably.

The majority of the land base of the Rosebud River subwatershed is covered by annual and perennial croplands/pastures (63% and 23%, respectively). The remaining land cover types cover < 5% individually (Figure 332, Table 136) (AAFC-PFRA, 2008).

One Ecologically Significant Area has been identified in the Rosebud River subwatershed: the Irricana Reservoir (Twp. 27, Rge. 26, W 4) (Alberta Environmental Protection, 1997). It is located in the Municipal District of Rocky View No. 44 and covers an area of 237 ha. The following factors make the Irricana Reservoir a nationally designated significant area:

- nationally significant California gull breeding habitat
- provincially significant ring-billed gull and goose breeding habitat

There are no provincially or internationally designated Ecologically Significant Areas in the subwatershed (Alberta Environmental Protection, 1997).

Table 136. Land cover in the Rosebud River subwatershed (AAFC-PFRA, 2008). The most prominent land cover types are highlighted.

Land cover type	Area (ha)	Proportion of subwatershed area (%)
Waterbodies	4,798	1.00
Exposed land	3,754	0.78
Developed land	5,124	1.07
Shrubland	6,345	1.33
Wetland	8,606	1.80
Grassland	15,840	3.31
Annual cropland	300,084	62.70
Perennial cropland/pastures	109,509	22.88
Coniferous forests	1,030	0.22
Deciduous forests	1,262	0.26
Mixed forests	148	0.03
No data	22,091	4.62
Total	478,590	

4.12.5.4 Species at Risk

Identifying species at risk and their habitats will help to determine sensitive areas and level of protection required. The *Species at Risk Act* (SARA) was introduced in June 2003 to provide legal protection of wildlife species and conservation of biological diversity. The Act aims to prevent Canadian indigenous species, subspecies and distinct populations from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species and encourage the management of other species to prevent them from becoming at risk. Currently, there are 363 species listed as either endangered (169 species), threatened (110 species) or of special concern (84 species) (Species at Risk, 2008).

“Endangered species” are those species that face imminent extirpation or extinction, while “threatened species” are those that are likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction. “Species of special concern” are those species that warrant special attention to ensure their conservation.

The Rosebud River subwatershed is home to two endangered species (burrowing owl, *A. cunicularia*; piping plover, *C. melodus circumcinctus*), three threatened species (loggerhead shrike, *L. ludovicianus excubitorides*; peregrine falcon, *F. peregrinus anatum*; Sprague’s pipit, *A. spragueii*) and three species of special concern (long-billed curlew, *N. americanus*; monarch butterfly, *D. plexippus*; yellow rail, *C. noveboracensis*). Detailed treaties of these species can be found in section 3.1.3.7.

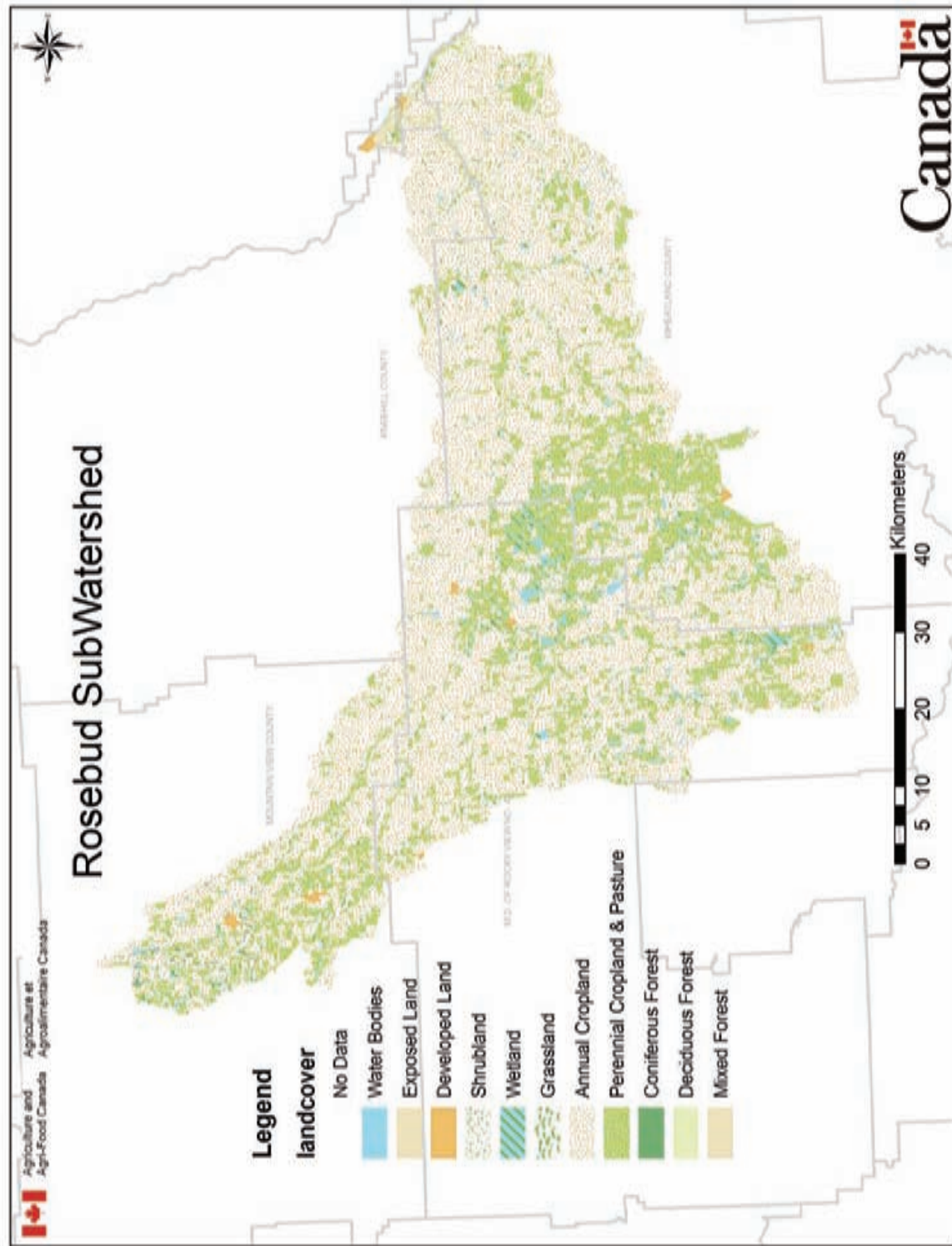


Figure 332. Land cover of the Rosebud River subwatershed (AAFC-PFRA, 2008).

4.12.6 Subwatershed Assessment

The Rosebud River subwatershed lies in the Central Parkland, Foothill Fescue, Northern Fescue and Mixedgrass Subregions and is characterized by medium livestock intensity and high to very high agricultural intensity relative to the Alberta average. Its 25 feedlots are located in the vicinity of urban centres, which include several towns, villages and hamlets. There are no cities in the subwatershed. Resource exploration and extraction activities have contributed to a complex network of linear developments (mostly roads) and the establishment of 9,838 wells (mostly for unspecified purposes). These land use practices have contributed to the deterioration of riparian zones, which have been ranked healthy with problems or unhealthy along the Rosebud River. Concomitantly, nutrient concentrations have increased in aquatic ecosystems. For example, both TN and TP concentrations exceeded CCME PAL guidelines in Serviceberry Creek, and 12 pesticides have been detected in the Rosebud River, although none exceeded water quality guidelines. No parasite and only limited bacteria data were located for any waterbody in the Rosebud River subwatershed. Water discharge rates in the Rosebud River can reach 20 m³/sec following the spring freshet, but are generally about 2-3 m³/sec. An abundance of streams and creeks in the subwatershed may have contributed to the issuance of 3,593 water diversion licenses, which permit the diversion of 5.72 million m³ of water annually for primarily irrigation and agricultural operations and municipalities. No biodiversity assessment or fish community data were located for this primarily annual cropland-dominated subwatershed; however, it is home to two endangered species, three threatened species and three species of special concern.

The Red-Bow Regional Watershed Alliance previously assessed the health of the Rosebud River subwatershed in 2002 and gave it a rating of “marginal” for water quality and “healthy with problems to unhealthy” for riparian areas and wetlands (Red-Bow Regional Watershed Alliance, 2002). Water quality was impaired due to excessive phosphorus concentrations, elevated bacterial concentrations during the summer months (“some” risk for recreational uses and irrigation) and elevated salinity, which could pose some risk to sensitive crops. The same overall rating of “marginal” was given in 2001 as well.

An Indicator Workshop held in March 2008 identified a total of 20 indicators to be used to assess the overall health of the Red Deer River watershed and its 15 subwatersheds. These indicators included land use, water quality, water quantity and biological indicators. In November 2008, a subset of these indicators was selected to indicate the overall condition of, or risk to, the individual subwatersheds. There were nine “condition indicators” and three “risk indicators”. The condition indicators were ranked “good”, “fair” or “poor” based on existing guidelines, while risk indicators were ranked “low”, “medium” or “high” relative to the other subwatersheds. The overall subwatershed ranking is based on an “A”-“B”-“C” ranking system with “+” and “-” subrankings. The overall ranking system is based on a subjective evaluation of the combined rankings of the condition and risk indicators.

Based on the available data, the Rosebud River subwatershed receives a rating of “fair” for the condition indicators and a rating of “medium” for the risk indicators (Tables 137, 138). Overall, this subwatershed receives a ranking of “B-”. There are substantial data gaps, and several of the condition rankings are based on limited data. Consequently, it is recommended to implement a detailed water quality sampling program, conduct a wetland inventory and regularly monitor riparian health conditions along

the major waterbodies in the subwatershed. Of particular concern are (1) nutrient concentrations that occasionally exceed water quality guidelines, likely due to widespread impaired riparian area health conditions and excessive agricultural runoff, municipal effluent and urban runoff that reach waterbodies throughout the subwatershed, (2) the loss of wetlands, which likely occurred as a result of agricultural land conversions, drainage, infilling and the disruption of their hydrology following linear developments and (3) the conversion of the landbase from its natural state into annual and perennial croplands and pastures.

Table 137. Condition and risk indicator summary for the Rosebud River subwatershed. Gray logos indicate data gaps.

Condition Indicators



Risk Indicators



Table 138. Condition and risk assessments of the Rosebud River subwatershed. Indicators with a “poor” or “high” ranking are highlighted.

Indicators		Rating
Condition	Wetland loss	POOR
	Riparian health	FAIR
	Linear developments	FAIR
	Nutrients	
	Total phosphorus	POOR
	Total nitrogen	FAIR
	Bacteria	GOOD
	Parasites	---
	Pesticides	GOOD
	Minimum flows to maintain ecological integrity	---
	Land cover	POOR
Overall		FAIR
Risk	Livestock manure production	LOW
	Urban, rural, agricultural and recreational developments	MEDIUM
	Oil/gas wells	MEDIUM
Overall		MEDIUM