CHAPTER 5: THE PRAIRIE SUB-BASINS

Farming along the Oldman River – ARD

Chapter 5: The Prairie Sub-basins

The Prairie Sub-basins comprise the eastern part of the Oldman watershed, including the Little Bow River and the mainstem of the Oldman from Lethbridge eastward. Three sub-basins have been delineated – the Upper Little Bow (upstream of Travers Reservoir), the Lower Little Bow (Travers Reservoir to the mouth), and a large ungauged area where flow is either internal or directly into the mainstem of the Oldman River (Figure 5.1). Numerous lakes and irrigation reservoirs within the ungauged area provide important habitat for migrating waterfowl and recreational opportunities for local residents, and water supply sources for irrigation and other uses. Information on this ungauged area and the mainstem of the Oldman River is provided in Chapter 6 of this report.

The Prairie Sub-basins are the true plains, home originally to herds of bison and the First Nations people who followed them. The land has subsequently been cultivated, and agriculture is the predominant land use in the Sub-basins (Figure 5.1). Bedrock is Cretaceous sandstones and shales, but these are deeply buried beneath glacial till and glacial meltwater material, varying from 10 to 100 m in thickness. The surface is level to undulating. The southern parts show evidence of the extensive glacial lakes that formed when meltwater from upstream areas of the Oldman watershed was dammed against the mass of the continental ice sheet in the Lethbridge area near the end of the last (Wisconsin) glaciation. From 12 000 to 8 000 years ago, the ice retreated slowly, and these

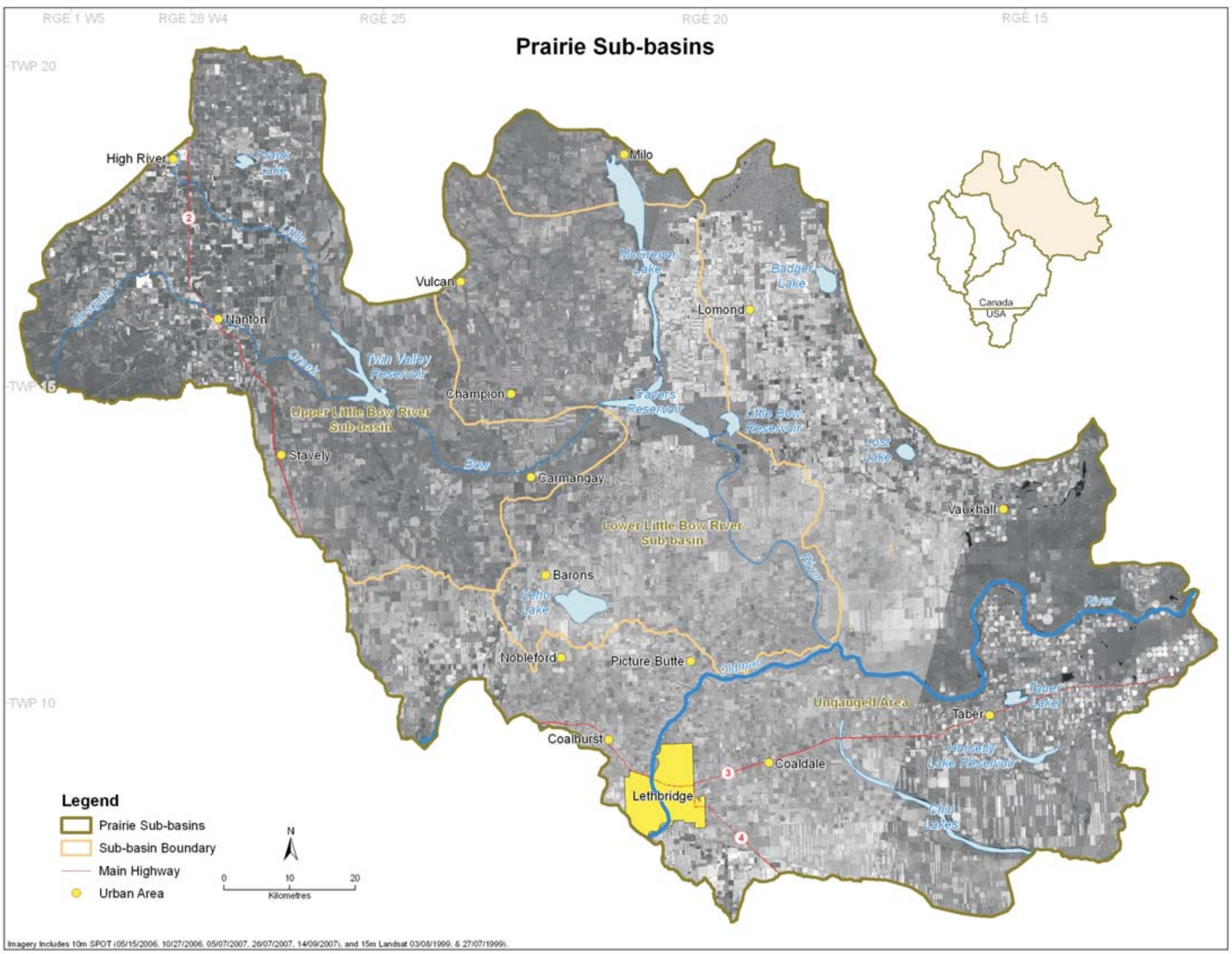


Figure 5.1 Prairie Sub-basins

lakes drained through channels and coulees in the area, such as Chin Coulee. The great volume of meltwater created channels that appear vastly over-sized compared to current flow conditions.

The Little Bow valley is another example of an over-sized channel. The Little Bow and the Highwood River are naturally connected by surface water under high flow conditions. The Little Bow probably once carried meltwater flows south from the Highwood River (Rood et al. 2005) during deglaciation. Near the hamlet of Kipp (ESA #291), an eroded cutbank on the east side of the Oldman River exposes one of the most complete and significant sequences of glacial deposits in Canada. This area is recognized as 'environmentally significant' at the international level (Sweetgrass 1997).

The climate in the Prairie Sub-basins is significantly drier than in the upstream portion of the Oldman watershed, with precipitation falling from 500 to 600 mm per year in the mountains, to 450 mm per year at Lethbridge, to less than 300 mm per year at the confluence with the Bow River. Summers are hot, dry, and sunny, and the growing season can be 3 to 4 months long. Frequent windy conditions reduce soil moisture and without irrigation, productivity is limited. Wind speed often exceeds 50 kph at Lethbridge, and gusts of 170 kph have been recorded. Winters are cold and dry. The annual temperature range in the Prairie Sub-basins is large. Average daily temperatures at Taber range from 18.8°C in July to -8.6°C in January. However, temperatures at Taber have ranged from an extreme minimum of -43°C in January 1969 to an extreme maximum of 40.6°C in July 1936 (Environment Canada 2002).

Mosquito Creek, the most westerly stream in the Prairie Sub-basins, rises among the deciduous forests of the Montane region and flows for a short way through the upland shrublands of the Foothills Parkland and Foothills Fescue natural sub-regions west of Nanton. Most of the Prairie Sub-basins lies within the Dry Mixedgrass and Mixedgrass natural sub-regions (Figure 5.2). The transition between the two sub-regions is subtle, reflecting slightly higher precipitation towards the west and a slightly cooler summer climate. Grasslands, now largely cultivated, were the predominant natural vegetation, and the name 'mixed' grass refers to co-dominance of short and medium height grasses. Shrubs and trees, usually cottonwoods and poplar, grow only in valley bottoms or in wet protected areas. Small variations in slope and aspect over short distances can create favourable conditions for a variety of species and vegetation communities.

Soils are deep fertile chernozemics that have formed under grassland vegetation on glacial till and glacio-lacustrine materials. Soil development in this region reflects the influence of precipitation. With increasing precipitation, the soils grade from Brown to Dark Brown Chernozemics as organic matter content increases.

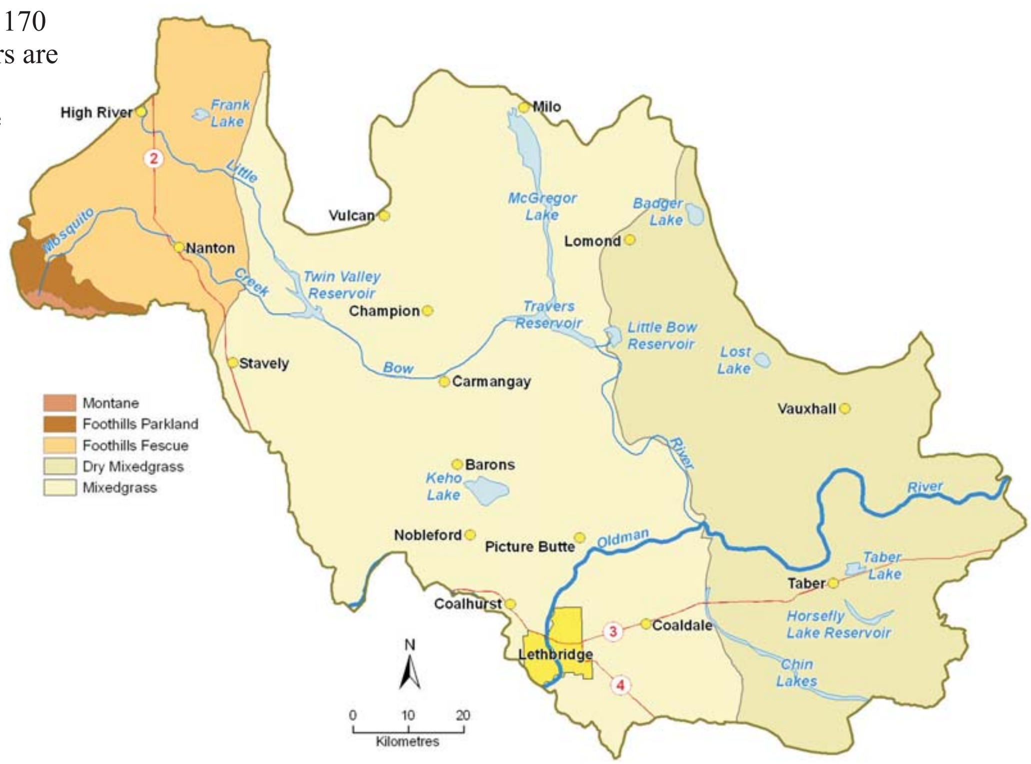


Figure 5.2: Natural Sub-regions in the Prairie Sub-basins

The cottonwoods of the Prairie Sub-basins have been the subject of much study and controversy during and since the construction of the Oldman River Dam. In this landscape, cottonwoods provide important habitat for birds, nutrients for the adjacent aquatic ecosystem, and microhabitats for fish (Willms 1998). Expansion of riparian and specifically cottonwood habitat in the Upper Little Bow sub-basin may be one outcome of the construction and operation of the Little Bow Project. See Section 5.1.2 for a description of the project. Increased flow along the Upper Little Bow River due to the Little Bow Project is expected to have a positive impact on riparian vegetation along the river.

The coulees of the area provide protective habitat for many species of mammals and birds, and indeed bird watching is a prime attraction in the Lethbridge and Taber areas, especially during spring and fall migrations. The deeply incised valley of the Oldman River from Lethbridge to the Little Bow junction (ESA #291) is recognized as an environmentally significant area (ESA) for its productive nesting habitat for prairie falcons, golden eagles, and ferruginous hawks. The valley is also characterized by extensive riparian woodland and interesting geological and geomorphological features (Sweetgrass 1997).

To the east of Taber, at Purple Springs (ESA #289), stabilized sand dunes covered by native needle and thread grass and sandgrass are recognized as an ESA (Sweetgrass 1997). The area also provides habitat for the great plains toad, sand verbena, and tiny cryptanthe, rare amphibian and plant species in Alberta, and is also known as a feeding area for birds of prey and migrating waterfowl in nearby wetlands.

Human land use in the Prairie Sub-basins is primarily agricultural with some municipal, recreational and industrial uses as well. The water uses are predominately for irrigation. Alberta Environment (AENV) and several irrigation districts direct surface water both into and out of the watershort Prairie Sub-basins. Intensive livestock operations are spread throughout, however, the majority lie east of Lethbridge, both north and south of the Oldman River mainstem. The majority of oil and gas wells and associated facilities in the Oldman watershed are located within the Prairie Sub-basins. Recently, ENMAX has constructed a wind farm near Taber which provides electricity to the city of Calgary and to local energy consumers.

5.1 Overview of Indicators

5.1.1 Terrestrial and Riparian Ecology

Land Cover

The land cover map of the Prairie Sub-basins (Figure 5.3) includes primarily cultivated land and grassland, with a small amount of shrubland, deciduous forest, and urban areas. The area of each land cover type is shown in Table 5.1.

Figure 5.3: Land Cover in the Prairie Sub-basins

Table 5.1: Land Cover in the Prairie Sub-basins

Land Cover	Area of Prairie Sub-basins (%)
Cultivated Land	76
Grassland	21
Shrubland	1
Water (including Reservoirs)	2
Forest (Deciduous)	<1
Urban	<1
Total	**100**

Cultivated Land

Cultivated land (76%) predominated throughout the Prairie Sub-basins. These lands occur within the Grassland natural sub-region and within the seven counties and municipal districts (MDs) of the Prairie Sub-basins (Figure 5.4). The four easternmost counties and Mds contain the majority of the cultivated land (Table 5.2). Irrigated crops predominate in the county of Lethbridge and MD of Taber. Agricultural data from the MD of Ranchland No. 66 has been omitted because only a small portion of the MD is located within the Prairie Sub-basins. cereals are the dominant crops grown within each MD (Table5.3).

Common livestock raised include cattle, hogs, horses, sheep, bison, goats, llamas and alpacas, and poultry.

Grassland

Native grasslands are found near the Oldman and Little Bow rivers within the Mixedgrass and Dry Mixedgrass natural sub-regions. The Mixedgrass natural sub-region is the most intensively cultivated sub-region in Alberta (Natural Regions Committee 2006). Grazing is the main agricultural activity that occurs within the Dry Mixedgrass natural sub-region. Native grassland communities are found within the Foothills Fescue natural sub-region. These communities consist of mountain rough fescue and Parry oat grass.

Shrubland

Shrubs (1%) are primarily found within the Foothills Parkland natural sub-region of the Prairies Sub-basins. Snowberry, silverberry, rose and Saskatoon occur on moist northerly slopes, while willow communities occur on poorly drained depressions and along streams and rivers. Most of this portion of the Prairie Sub-basins is utilized for grazing.

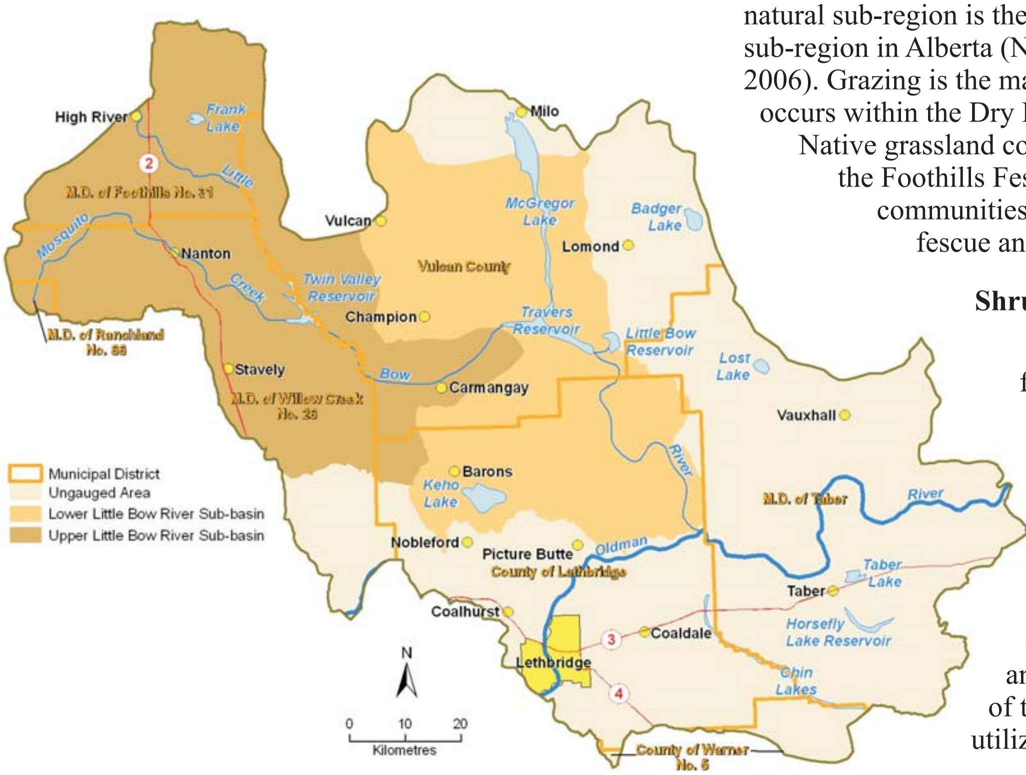


Figure 5.4: Municipal Districts in the Prairie Sub-basins

Table 5.2: Land Cover by Municipal District or County (%)

Land Cover	MD Foothills No. 31 (% Area)	MD Willow Creek No. 26 (% Area)	County of Lethbridge (% Area)	MD Taber (% Area)	Vulcan County (% Area)	County of Warner No. 5 (% Area)
Grassland (for grazing)	37	44	13	33	19	31
Cultivated:						
– Cropped	42	40	69	52	58	50
– Summerfallow	2	1	7	6	14	10
– Seeded pasture	10	12	6	7	7	7
Subtotal	*54*	*53*	*82*	*65*	*79*	*67*
Other (water/treed)	9	3	5	2	2	2
Irrigation (included in cultivated)	1	4	37	29	5	4
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Stats Canada. 2006. Agriculture Profiles.

Table 5.3: Types of Crops by Municipal District or County

Agricultural Land Use	MD Foothills No. 31 (% Area)	MD Willow Creek No. 26 (% Area)	County of Lethbridge (% Area)	MD Taber (% Area)	Vulcan County (% Area)	County of Warner No. 5 (% Area)
Cereal (wheat, oats, barley, rye)	33	36	70	53	64	61
Forage (alfalfa, hay)	13	9	11	5	5	7
Canola	5	3	5	4	8	4
Legumes	1	1	3	6	4	2
Specialty (mustard, triticale)	0	1	2	3	1	1
Other	48	50	9	29	18	25
Total	**100**	**100**	**100**	**100**	**100**	**100**

Forest

Deciduous forest (<1% of the Prairie Sub-basins) is found within the Montane natural sub-region and the Foothills Parkland natural sub-region. Grazing is an important agricultural land use within this portion of the Prairie Sub-basins.

A small portion (<1%) of the Prairie Sub-basins is managed for commercial forest harvesting by Spray Lakes Sawmills including the easternmost portion of the Porcupine Hills, west of Nanton.

Water

Approximately 2% of the land area consists of natural water bodies (1%) and man-made reservoirs (1%). The main reservoirs include Twin Valley Reservoir, McGregor Lake, Travers Reservoir, Little Bow Reservoir, Badger Lake Reservoir, Keho Lake Reservoir, Chin Lake Reservoir, Stafford Reservoir, Taber Lake Reservoir and Horsefly Lake Reservoir. These reservoirs were constructed primarily to provide a continuous supply of irrigation water to local area farmers and ranchers. Frank Lake is a large, formerly dry prairie slough that was established as a wetland by Ducks Unlimited in the 1950s, and, in the late 1980s, was expanded and stabilized by municipal and industrial treated effluents and diversions from the Highwood River.

Urban Centers

The towns and villages of High River, Nanton, Stavely, Vulcan, Champion, Carmangay, Lomond, Barons, Nobleford, Picture Butte, Coaldale, Coalhurst, Vauxhall and Taber together with the city of Lethbridge and occupy less than 1% of the Prairie Sub-basins.

Soil Erosion

Soil erosion risk is generally rated as low to moderate. High risk of soil erosion in the Prairie Sub-basins is primarily related to high winds and agricultural operations (Figure 5.3). High and severe erosion risk areas occur near Vulcan, Lethbridge, Lomond, Coaldale and Champion. Moderate erosion risk areas occur near Stavely, Carmangay, Barons, Nobleford and Picture Butte (Figure 5.5). The area of each risk category is shown on Table 5.4.

A number of soil conservation practices have been adopted in the Prairie Sub-basins to minimize soil erosion, including crop rotation, rotational grazing, planting shelterbelts and modifying tillage practices to include zero-till and mini-till. The use of chemicals over tillage in summerfallow operations has also helped in reducing soil erosion losses (Table 5.5).

Riparian Health

In the Prairie Sub-basins, 69 sites were reviewed as part of the Riparian Health Assessment Program. The results indicate that: 4% are healthy, 31% are healthy but with problems, and 65% are unhealthy (Cows and Fish Program 2009). The results suggest that the riparian health of the Prairie Sub-basins is worse than the average condition of riparian sites throughout the Oldman watershed where 15% are healthy, 55% are healthy with problems and 30% are unhealthy.

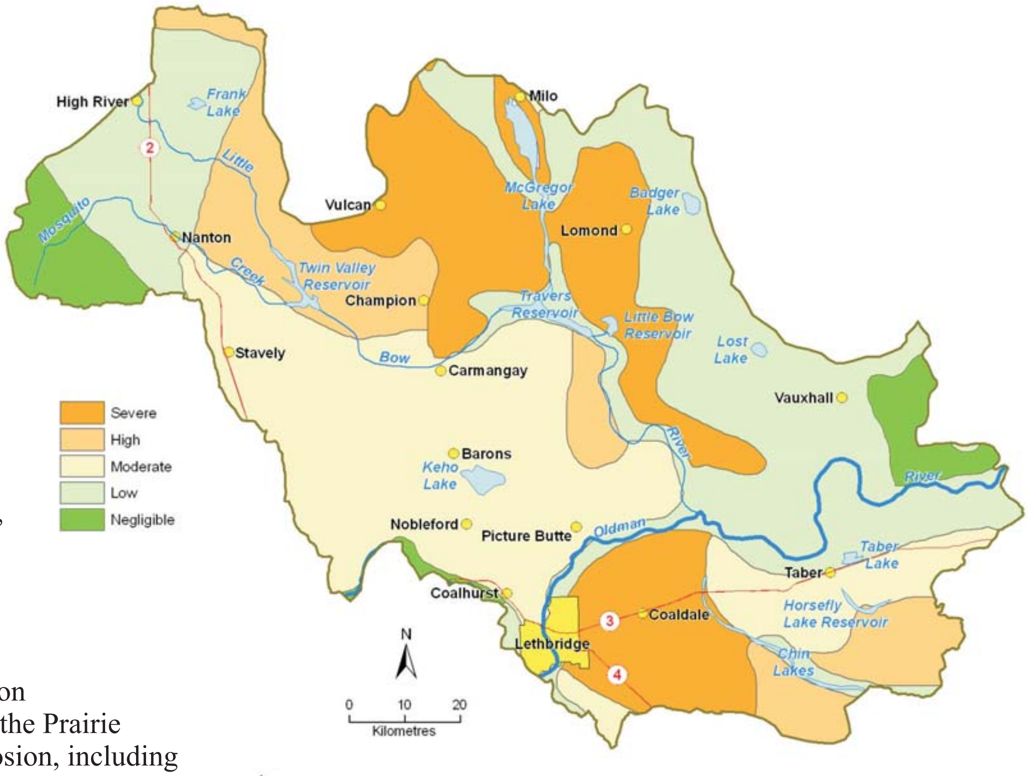


Figure 5.5: Soil Erosion Rating in the Prairie Sub-basins

Table 5.4: Soil Erosion Risk Area (ha)

Soil Erosion Risk Rating Class	Area (ha)	% of Total Area
Negligible	62 360	5
Low	390 127	32
Moderate	349 586	29
High	154 421	13
Severe	256 026	21
No Data	2 870	<1
Total	**1 215 390**	**100**

Table 5.5: Erosion Control Practices by Municipality

Erosion Control Practice	MD of Willow Creek (% of Farms[1])	MD of Ranchland (% of Farms[1])	MD of Taber (% of Farms[1])	MD of Lethbridge (% of Farms[1])	MD of Warner (% of Farms[1])	MD of Vulcan County (% of Farms[1])	MD of Foothills (% of Farms[1])
Crop rotation	46	15	75	65	65	77	34
Rotational grazing	54	46	26	25	38	32	49
Windbreaks or shelterbelts	45	33	26	32	31	31	42
Buffer zones around water bodies	19	17	11	11	11	13	15
Winter cover crops	6	2	10	5	6	7	4
Plowing down green fields	2	0	3	3	2	2	3
Weed Control:							
– chemfallow	4	0	11	7	21	24	3
– combined chemicals & tillage	5	2	9	5	10	18	4
– summerfallow only	3	2	11	5	15	10	4

[1] Based on the number of farms for the MD.

Land Use

Human activities on the land create disturbances throughout the Prairie Sub-basins. Land uses are grouped into five general categories and the extent of disturbance within the Sub-basins is shown on Figure 5.6 and in Table 5.6.

Agriculture

Approximately 67% of the Prairie Sub-basins has been altered by agricultural activities. Most (59%) is formed on an annual basis (cropped or summerfallowed), while 8% is seeded pasture land and 12% is irrigated.

The Prairie Sub-basins has a carrying capacity of 65 256 animal unit months (AUMs) on public lands. These cover about 84 146 ha distributed among 165 grazing dispositions. A further 1743 ha is managed under 20 cultivation permits and 16 farm development leases (C. Piccin, pers comm.).

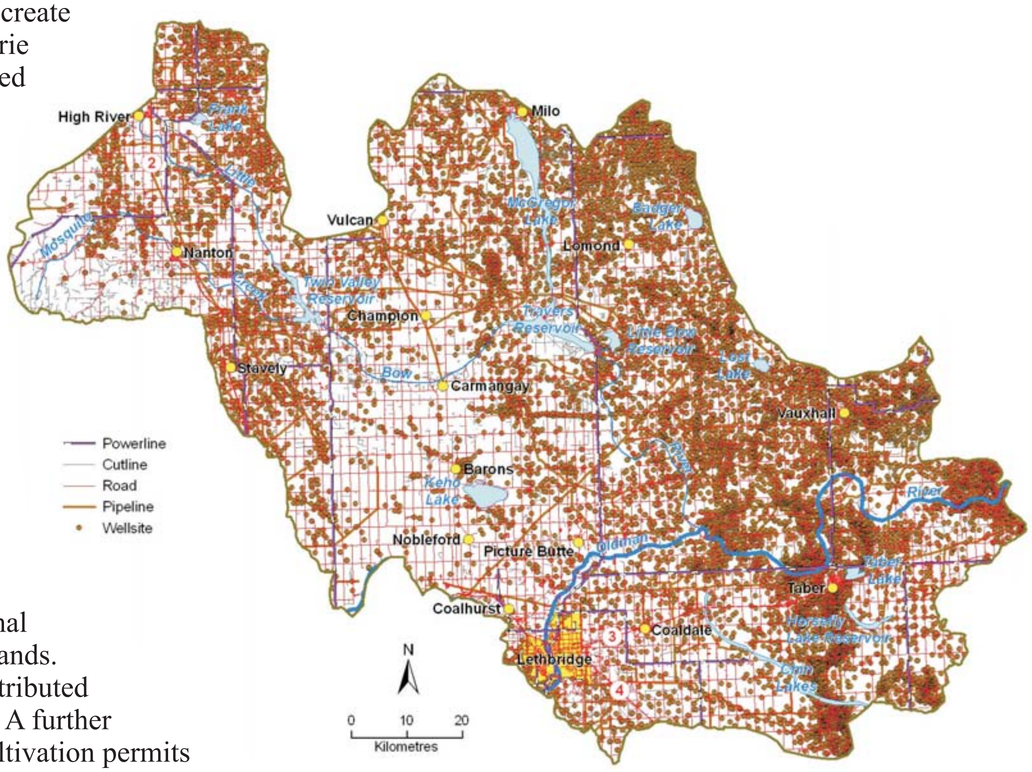


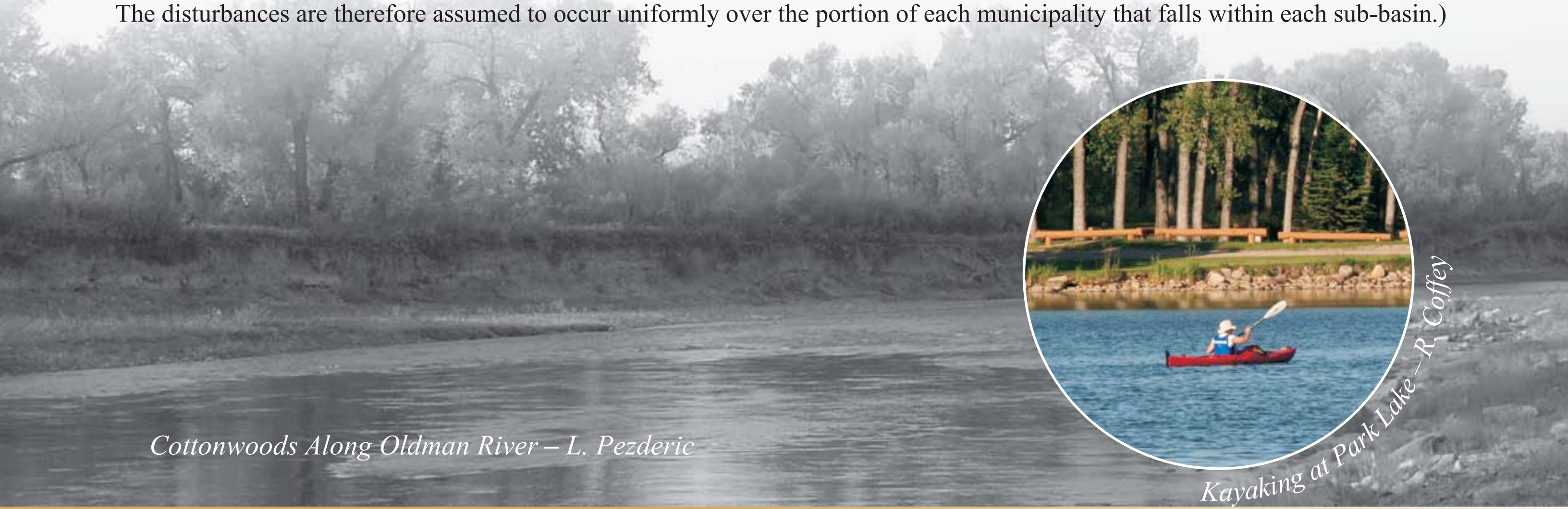
Figure 5.6: Land Use in the Prairie Sub-basins

Table 5.6: Land Use in the Prairie Sub-basins

Disturbance	Length (km)	km/km^2	Total Area Disturbed (ha)	% of Total Area
Agriculture				
Crops			626 070	52
Summerfallow			83 066	7
Grazing-seeded			99 385	8
Irrigation[1]			141 610	12[1]
Subtotal			*808 521*	*67*
Infrastructure				
Roads	13 000	1.07	15 560	1.3
Railways	540	0.04	540	<0.1
Powerlines	651	0.05	1 301	0.1
Pipelines	4 623	0.38	13 868	1.1
Cutlines	3 803	0.31	2 663	0.2
Wells – oil and gas			15 210	1.2
Airfields and runways			100	<0.1
Sewage lagoons			300	<0.1
Gravel pits			168	<0.1
Subtotal			*49 710*	*4.1*
Urban				
Residential, commercial and light industrial developments			18 550	1.5
Recreation				
Parks, recreation areas and campgrounds			50	<0.1
Surface Water Supply Sources				
Reservoirs			11 300	1
Total Disturbance			**888 131**	**73**

[1] Irrigated land is a combination of grazing and cropped land, and does not include irrigation of native grassland since it is not disturbed. Area is included in "crops" category.

Note: these data are derived from StatsCan agriculture census data for an entire municipality, and for a specific year, i.e., 2006. The disturbances are therefore assumed to occur uniformly over the portion of each municipality that falls within each sub-basin.)



Cottonwoods Along Oldman River – L. Pezderic

Kayaking at Park Lake – R. Coffey

The location of the 663 approved confined feeding operations (CFOs) on 368 sites is shown by quarter section on Figure 5.7. This amounts to approximately 66% of the applications approved within the Oldman watershed. Most of the CFOs are located within the County of Lethbridge. CFOs within the other municipalities are widely disturbed with some concentrations along Highway 3, or along river valleys (i.e., Little Bow River and Oldman River). The area of these operations is included in the agricultural land use category.

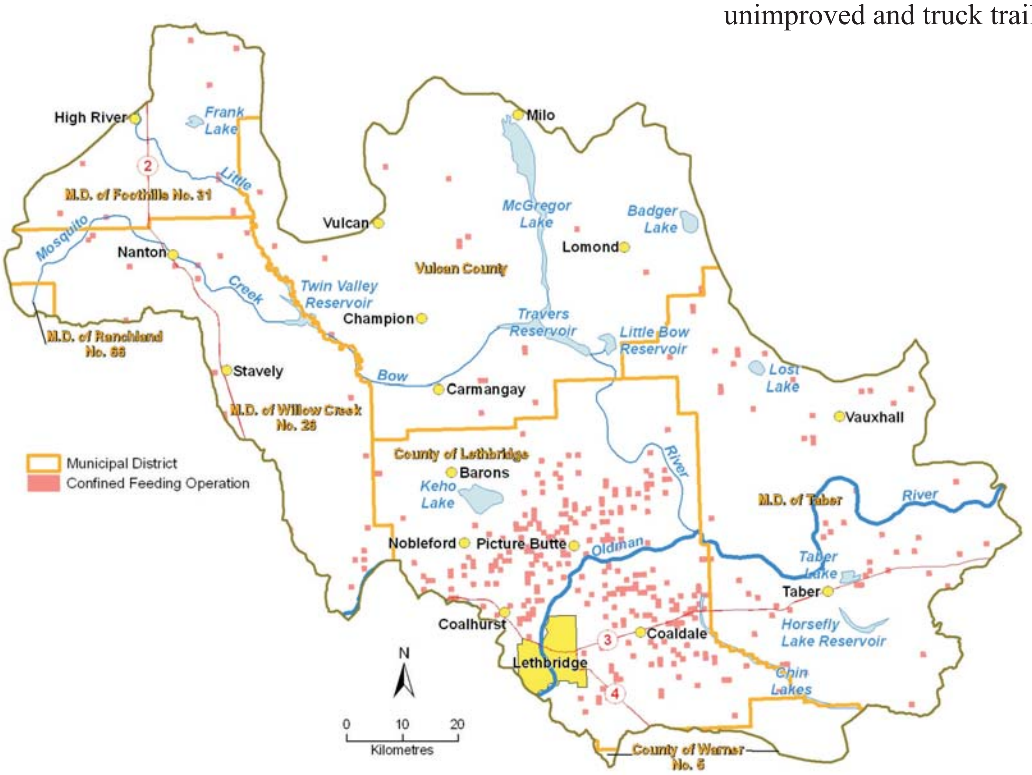


Figure 5.7: Confined Feeding Operations in the Prairie Sub-basins

Infrastructure

Infrastructure, primarily linear developments, takes up just over 4% of the Prairie Sub-basins. Roads (1.3%) produce the greatest amount of linear disturbance, followed by pipelines (1.1%). Oil and gas wells also produce some disturbance (1.2%) and are concentrated in the eastern half of the area. Most of the roads are part of the rural grid road network and have been developed to provide access to rural communities, as well as to wellsites and pipeline facilities. Road types include paved, gravel, unimproved and truck trails.

Piglets – ARD

Feedlot Operation – ARD

Recreation

Provincial Recreation Areas are located on McGregor Lake, Travers Reservoir, Little Bow Reservoir and Clear Lake, and include campgrounds, picnic areas, and boat launches (Figure 5.8 and Table 5.7). Little Bow Provincial Park, on Travers Reservoir, provides camping and water sport facilities, plus a general store and concession. Travers Dam Recreation Area has a campground, day use area, beach and a boat launch. Park Lake Provincial Park located north of Lethbridge has camping and water sport facilities, a general store and concession. Twin Valley Reservoir has a public day camp and boat launch. Clear Lake has public boat launch, dock and day picnic area. Altogether, less than 0.1% is covered by these recreational areas.

Recreational and resort development is an increasing issue with the Prairie Sub-basins. Recreational subdivisions are currently located on McGregor Lake near Milo and Lamond; and two on Travers Reservoirs. Intensive resort development on the Twin Valley Reservoir currently consists of a 379 home resort that has been approved, and there is an application for a further 500 houses.

Surface Water Supply Sources

The reservoirs of the Prairie Sub-basins cover about 1% of the Sub-basins and have been developed primarily as irrigation water supply sources.

Urban

Urban development represents one of the smaller land uses, affecting approximately 1.5% of the land. Urban development includes residential, commercial and light industrial land uses within the villages and towns of the MDs and counties, plus the City of Lethbridge.

The population has increased by 10% during the period 1996 to 2006 (Table 5.8). While the MD of Foothills No. 31 experienced the greatest increase since 1996, showing a 38% population increase, the majority of the MD is outside of the Oldman watershed and the largest population increases occurred south of Calgary. In contrast, Vulcan County saw its population decline by 2% during the same period. The urban municipalities of High River and Carmangay also saw their populations increase between 1996 and 2006 by 46% and 30%, respectively. The village of Milo and town of Picture Butte experienced declines in population of 15% and 5%, respectively.

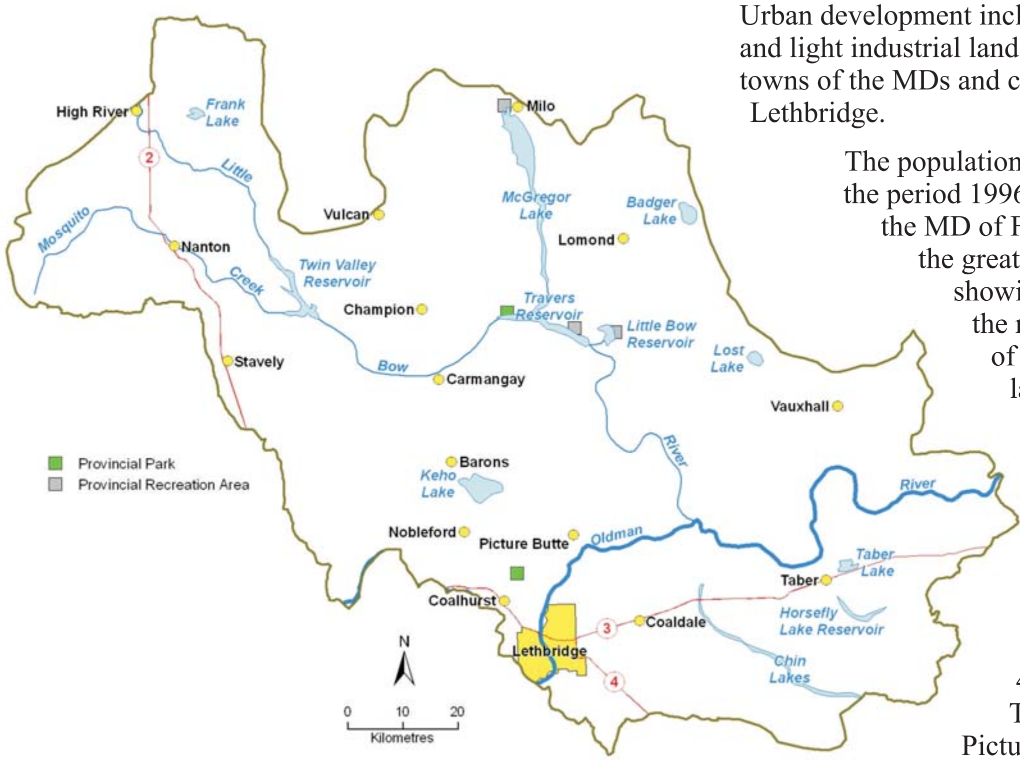


Figure 5.8: Parks and Protected Areas in the Prairie Sub-basins

Table 5.7: Recreational Areas, Ecological Reserves and Parks

Protected Area Type	Name	Area (ha)
Provincial Recreation Area	5 different areas	211
Provincial Park	Little Bow, Park Lake	226
Total		**437**

Total Land Use

Approximately 73% of the Prairie Sub-basins is affected by human disturbance. Agricultural activities comprise the largest human disturbance component (67%), followed by linear developments such as roads and pipelines, and oil and gas wells.

5.1.2 Water Quantity

The Prairie Sub-basins are dominated by poorly defined natural drainage, diversions into and out of the Sub-basins, and extensive irrigation infrastructure (canals, pipelines, reservoirs, and drains). The Little Bow River and its primary tributary, Mosquito Creek, are the key natural drainages in the Prairie Sub-basins. Within the Upper and Lower Little Bow River sub-basins, there are three diversions that influence the hydrology and water use.

There are two diversions from the Highwood River (in the Bow River watershed) into the Little Bow River sub-basin. The Women's Coulee Diversion diverts water through a small reservoir to Women's Coulee and Mosquito Creek, a major tributary of the Little Bow River. The diverted flow is used for irrigation, stockwater, municipal and waterfowl conservation purposes along Women's Coulee, Mosquito Creek and the Little Bow River. A portion of the diverted flow and natural flow of Mosquito Creek is diverted to Clear Lake where it supports waterfowl, recreation and irrigation uses. The Women's Coulee Diversion has a capacity of 1.7 m^3/s.

The second diversion, the Little Bow Diversion, is located within the Town of High River. It diverts water from the Highwood River, through the town, and into the Little Bow River. Its capacity was recently

Table 5.8: Population of Municipalities within Prairie Sub-basins

Municipality	1996	2006	% Population Change (1996 to 2006)
Barons	285	276	-3
Carmangay	258	336	30
Champion	362	364	1
Coaldale	5 770	6 177	7
Coalhurst	1 439	1 523	6
County of Lethbridge	9 251	10 302	11
County of Warner	3 561	3 674	3
High River	7 359	10 716	46
Lethbridge	63 053	74 637	18
Lomond	170	175	3
MD of Foothills No. 31	14 331	19 736	38
MD of Taber	5 970	6 280	5
MD of Willow Creek No. 26	5 106	5 337	5
Milo	117	100	-15
Nanton	1 672	2 055	23
Nobleford	558	689	23
Picture Butte	1 669	1 592	-5
Stavely	453	435	-4
Taber	7 214	7 591	5
Vauxhall	1 011	1 069	6
Vulcan	1 558	1 940	25
Vulcan County	3 808	3 718	-2
Total	**134 975**	**158 722**	**10**

expanded from 2.86 m^3/s to 8.50 m^3/s through construction of the Little Bow Project /Highwood Plan (AENV 2008). The diverted water is used for irrigation, stockwater and municipal purposes along the Little Bow River between High River and Travers Reservoir. The operation of the two diversion projects is governed by a diversion plan that was largely developed and recommended by the Highwood Management Plan Phase 1 Public Advisory Committee. The plan has been approved by the Natural Resources Conservation Board (NRCB 2008) and Alberta Environment (AENV 2008) with some qualifications.

The Twin Valley Reservoir at the confluence of Mosquito Creek and the Little Bow River is a major component of the Little Bow Project/Highwood Diversion Plan. The reservoir stores diverted flow from the Highwood River as well as natural flow of the Little Bow River and Mosquito Creek and regulates the outflow to match water supplies with water demands.

A third diversion to the Little Bow River sub-basin diverts water from the Bow River near Carseland through the Carseland-Bow River Headworks System to McGregor, Travers Reservoir, and Little Bow Lake (east of Travers Reservoir). The water from this diversion is primarily used for irrigation purposes within the Bow River Irrigation District (BRID). (The district is licensed to withdraw water from the Bow River through AENV's Carseland-Bow River Headworks System.) A small portion of the diverted water supports irrigation on the Siksika First Nation Reserve, as well as municipal, industrial, domestic, stockwater, recreation and waterfowl conservation purposes. The diversive capacity is 51.0 m^3/s.

The Sub-basins have a large ungauged area that flows directly into the Oldman River mainstem and other large areas where the drainage is heavily influenced by irrigation district canals, storage projects and return flow drains. Return flows are directed to the Oldman River, Bow River, Little Bow River or South Saskatchewan River. All or portions of irrigation districts that occupy lands within the Prairie Sub-basins and their water sources are shown in Table 5.9.

Table 5.9: Irrigation Districts and Water Supply Sources

District	Water Supply Source
Bow River Irrigation District (BRID)	Bow River
Lethbridge Northern Irrigation District (LNID)	Oldman River
St. Mary River Irrigation District (SMRID)	Waterton, Belly and St. Mary Rivers
Taber Irrigation District (TID)	Waterton, Belly and St. Mary Rivers

Irrigating Potato Crop – ARD

All irrigation districts occupying the Prairie Sub-basins are supported by water from outside the watershed. None of these districts are licensed to withdraw naturally flowing water from the Prairie Sub-basins. Canals, reservoirs and return flow drains within the districts have obscured the natural drainage.

Locations of diversion works and reservoirs in the Prairie Sub-basins are shown in Figure 5.9, and the storage capacity of the reservoirs is summarized in Table 5.10. Additional reservoirs supporting irrigation in the four districts are located in the Southern Tributaries Sub-basins, and areas outside the Oldman watershed.

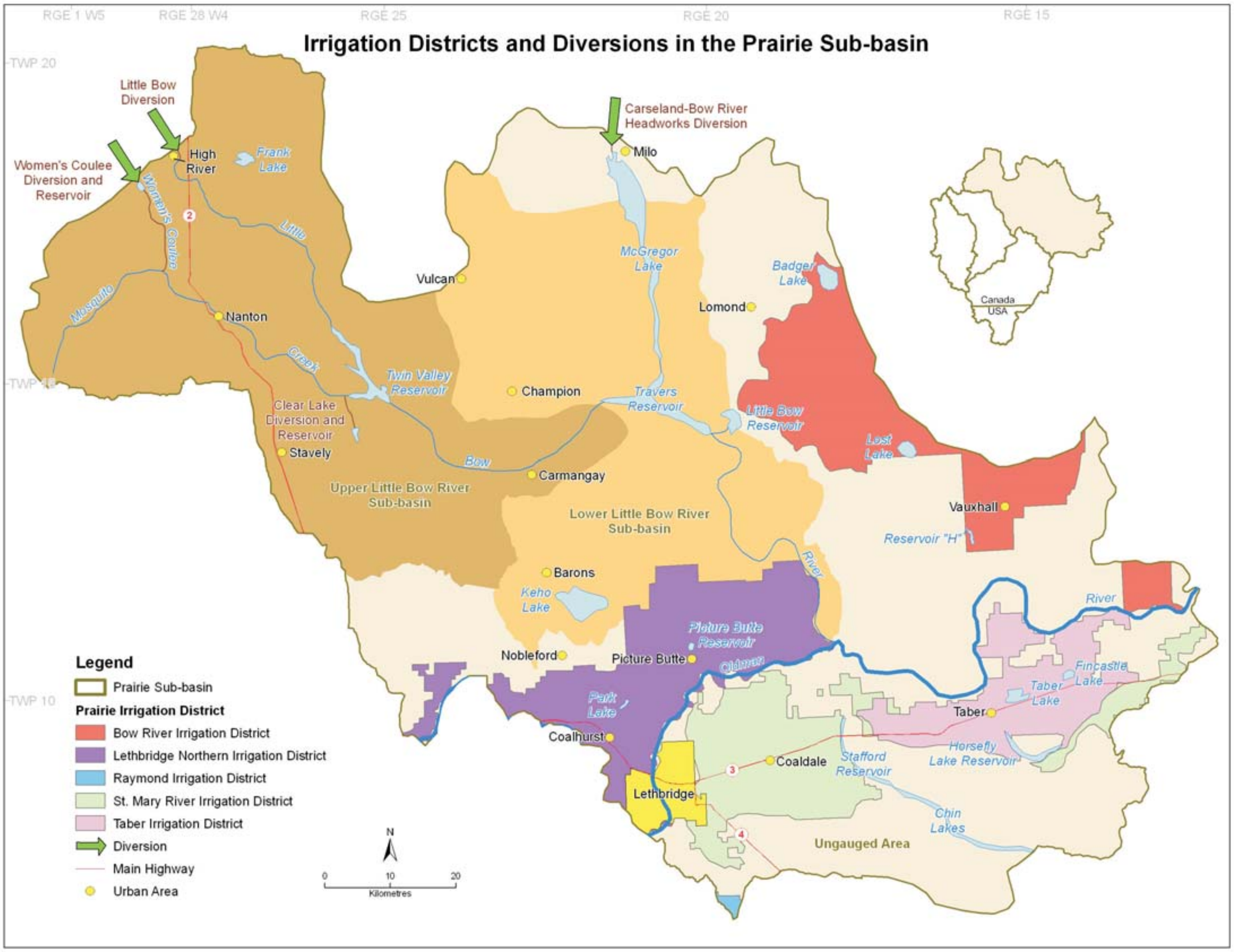


Figure 5.9: Irrigation Districts and Diversions in the Prairie Sub-basins

Table 5.10: Reservoirs Associated With Irrigation and Other Uses in Prairie Sub-basins

Location	Reservoir	Live Storage (dam^3)
Carseland-Bow River (BRID)	Little Bow McGregor Lake Travers Badger H Reservoir Lost Lake	21 078 351 059 104 638 53 650 2 220 5 050
	Total Storage	**537 695**
Little Bow Project/Highwood Diversion Plan	Women’s Coulee Twin Valley Reservoir Clear Lake	362 62 700 5 750
	Total Storage	**68 812**
Lethbridge Northern Irrigation District (LNID)	Keho Lake Park Lake Picture Butte	95 635 740 1 600
	Total Storage	**97 975**
Waterton-St. Mary (SMRID)	Chin Lake Reservoir Stafford Reservoir	190 330 23 315
	Total Storage	**213 645**
Taber Irrigation District	Fincastle Horsefly Lake Taber Lake	3 085 9 250 6 415
	Total Storage	**18 750**

Stafford Reservoir – ARD

Chin Lakes Reservoir – ARD

The Women's Coulee Diversion has diverted water from the Highwood River into the Upper Little Bow River sub-basin since 1933. Average annual diversion during the past 10 years is 12 520 dam^3 (Figure 5.10).

The Little Bow Diversion at High River has diverted water from the Highwood River into the Little Bow River since 1905. Average annual diversion during the past 10 years is 60 745 dam^3 (Figure 5.11).

The Carseland-Bow River Diversion has diverted water into the Lower Little Bow River sub-basin since 1920. Discharge into the Lower Little Bow River sub-basin from the diversion has averaged 386 165 dam^3 annually over the 10-year period 1995 to 2005 (Figure 5.12). The capacity of the diversion canal has been recently increased from about 45 m^3/s to about 51 m^3/s.

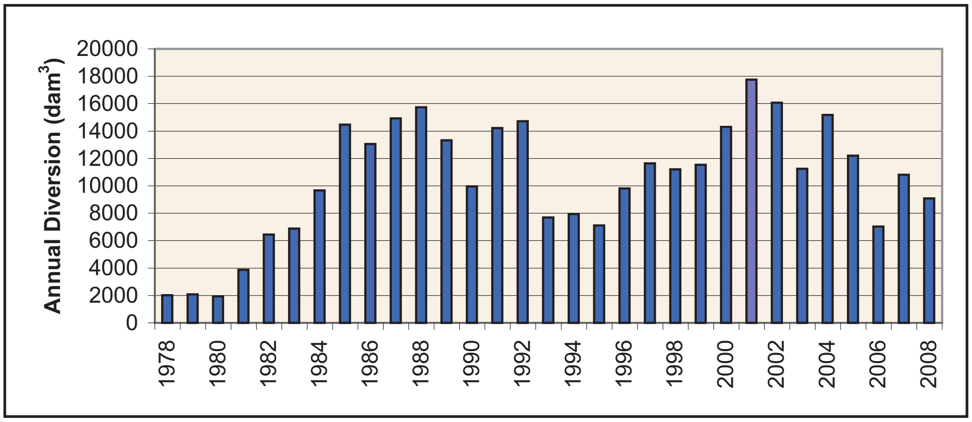


Figure 5.10: Discharge from the Highwood River Through Women's Coulee from 1978 to 2008

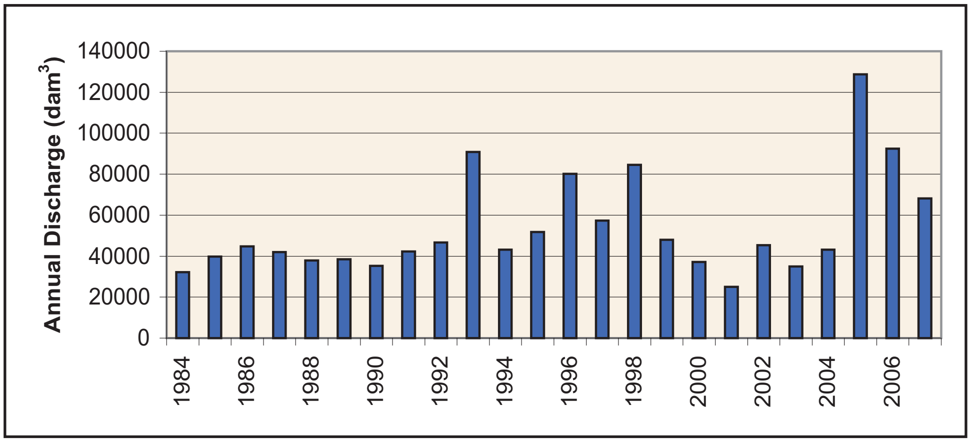


Figure 5.11: Discharge Through the Little BowCanal at High River from 1984 to 2007

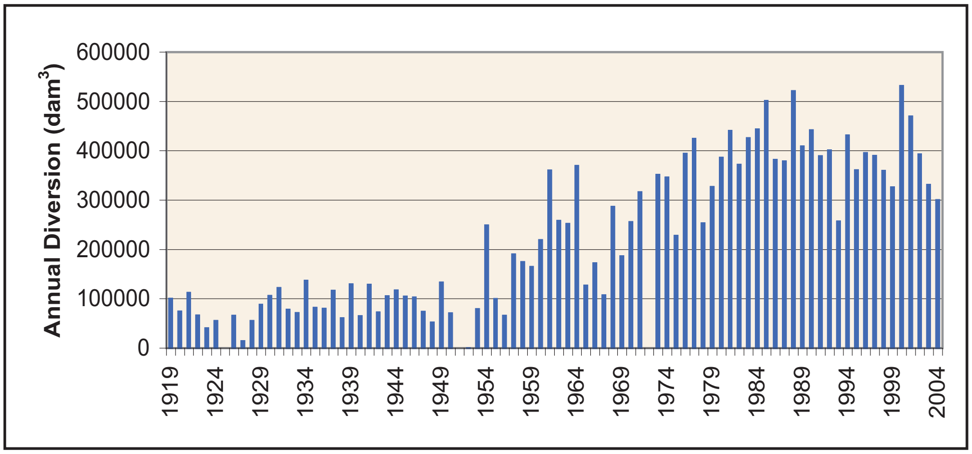


Figure 5.12: Discharge through Carseland-Bow River Diversion from 1919 to 2004

Two long-term recorded and natural flow hydrometric stations are located in the Prairie Sub-basins on the Little Bow River (Figure 5.13). These are:

- Little Bow River at Carmangay; and
- Little Bow River near the Mouth.

The analysis of stream flow characteristics and water quantity indicators was conducted for the two natural flow stations. The standard period (i.e., 1912 to 2001) is used for trend analysis.

Terms used in this Section are defined in Section 1.3.2.

Figure 5.13: WSC Stations in the Prairie Sub-basins

Pump Inlet on Keho Reservoir – ARD

Historic Notes – Diversions from the Bow River Watershed to the Little Bow River Sub-basin

Little Bow Diversion at High River

In 1898, the Government of the Northwest Territories applied for a licence to divert 1.4 m^3/s from the Highwood River to the Little Bow River for stockwatering and domestic purposes. These works were licensed in 1905. In 1922, the Little Bow Irrigation District (LBID) applied for a licence to divert, from the Highwood River, sufficient water for irrigation of 1335 ha in the Little Bow River sub-basin. An Authorization was issued in the same year. The LBID experienced financial problems, and in 1950, an Order-in-Council dissolved the district and transferred ownership and operation of the works authorized in 1922 to the Crown. The Order-in-Council recognized that the works were intended to serve domestic and irrigation needs. The Crown made necessary repairs and improvements to the works and assumed responsibility for operations. Up until 2003, the maximum capacity of the diversion works was 2.83 m^3/s. In 2003, the capacity was increased to 8.5 m^3/s as a component of the Little Bow Project/Highwood Diversion Plan.

Women's Coulee Diversion

Originally known as the Squaw Coulee Diversion, this diversion works directed water from the Highwood River into the canal to Mosquito Creek. It was constructed by the provincial government in 1933. In 1936, it was transferred to the MD of Riley and transferred again to the MD of Highwood in 1948. The Prairie Farm Rehabilitation Administration (PFRA) undertook rehabilitation work on the diversion several times throughout the years. The provincial government assumed responsibility for the diversion in 1978, and rehabilitation efforts over the next three years included relocation of the inlet channel from the Highwood River and enlargement of the headgate and canal. The capacity of the diversion is 1.7 m^3/s.

Carseland–Bow River Headworks

Construction of the Carseland-Bow River diversion and canal began in 1909 by a land development company from England with the intent to irrigate a large tract of land between the Little Bow River and Medicine Hat. By 1912, the main canal stretched over 300 km – at a cost of $5 million. Work on the canal system was halted in 1914 with the outbreak of World War I. Construction resumed in 1917 under the direction of the Canada Land and Irrigation Company. The first irrigation water was delivered in 1920 and by 1927, the irrigated area had grown from about 3700 ha to 12 000 ha.

The depression of the 1930s again stopped expansion and forced many farmers to abandon their land. The federal government provided $80,000 to enable the company to continue operations. In 1949, an agreement was approved between the company and the provincial and federal governments that paved the way for increased settlement by drought-plagued dryland farmers and returning war veterans, and the irrigation area expanded. From 1951 to 1954, nearly 250 km of canals and structures were rebuilt by the PFRA and the province. Several new works were also incorporated including Travers Dam, Scope Reservoir and Expanse Coulee. The distribution system and control works were administered as a crown corporation until the BRID was formed in 1968. In 1973, ownership of the Carseland-Bow River Headworks was transferred to the Province of Alberta through a provincial-federal agreement.

The current capacity of the diversion works is 51.0 m^3/s.

Hydrologic Characteristics of the Little Bow River

Flows were recorded at Carmangay from 1918 to 1936 and from 1955 to 2007. Alberta Environment has reconstructed natural flows and extended the period to the standard 1912 to 2001 period using statistical methods. Water use is high in the Little Bow River sub-basin upstream of the Carmangay monitoring station, and there is a substantial amount of regulation along that stretch of the river. The data table in Figure 5.14 quantifies the diversions entering the Little Bow River sub-basin from the Highwood River, through the Women's Coulee and Little Bow diversions. The difference between the natural and recorded flows is considerable, with recorded flow general being higher than natural flow. In 2004, the Twin Valley Reservoir was brought to operation, however its impacts on flows are too recent to have been included in this natural flow assessment.

Flow has been recorded on the Little Bow River near the Mouth since 1973 during the open water period only. Recorded flow is significantly different from the natural flows during the 1992 to 2001 period, especially during the fall months (Figure 5.15). This

Little Bow River at Carmangay

Gross DA	km^2	2780
Effective DA	km^2	1270
Natural Discharge 1912-2001		
Mean Annual	dam^3	30,259
Upper Quartile	dam^3	39,359
Median	dam^3	19,750
Lower Quartile	dam^3	11,609
Average Diversion from Highwood River (1999-2008)		
Via Women's Coulee (dam^3)		12,520
Via Little Bow River (dam^3)		60,745
Median Yield		
Gross DA	dam^3/km^2	0.0
Effective DA	dam^3/km^2	0.0

DA = Drainage Area

Mean Discharge of of the Little Bow River at Carmangay, 1992-2001

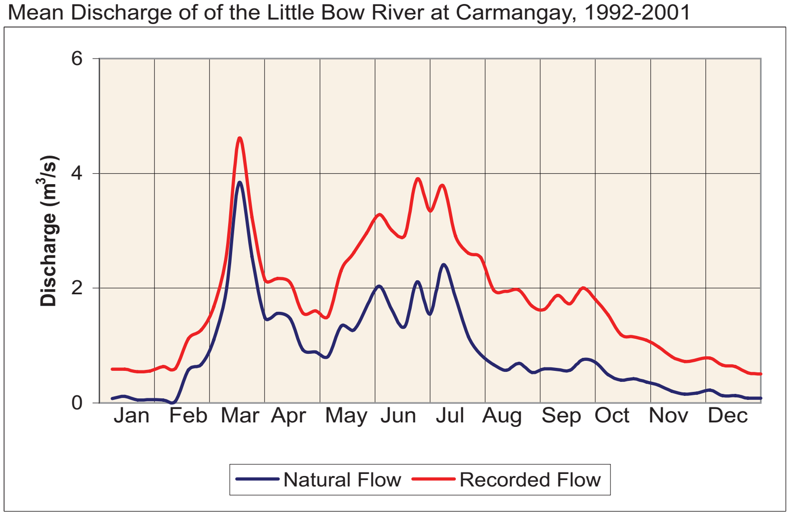


Figure 5.14: Hydrologic Characteristics – Little Bow River at Carmangay

Little Bow River near the Mouth

Gross DA	km^2	5900
Effective DA	km^2	3280
Natural Discharge 1912-2001		
Mean Annual	dam^3	33,285
Upper Quartile	dam^3	43,297
Median	dam^3	21,724
Lower Quartile	dam^3	12,770
Median Yield		
Gross DA	dam^3/km^2	0.0
Effective DA	dam^3/km^2	0.0
Average Diversion from Highwood River (1999-2008)		
Via Women's Coulee		12,520
Via Little Bow River		60,745

DA = Drainage Area

Mean Discharge of of the Little Bow River near the Mouth, 1992-2001

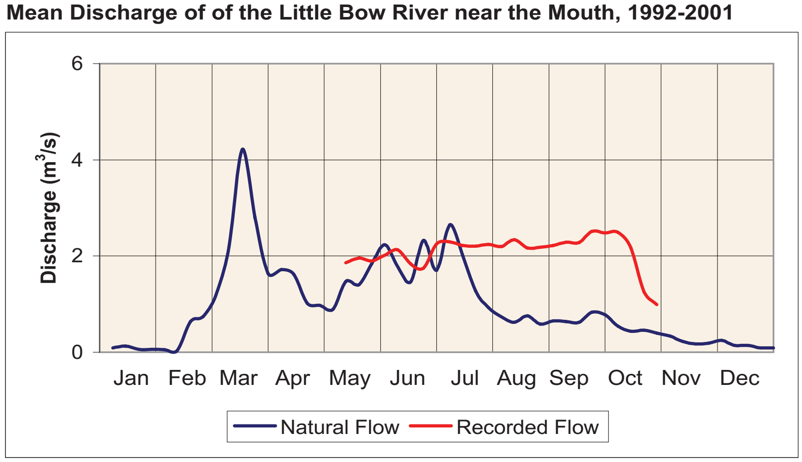


Figure 5.15: Hydrologic Characteristics – Little Bow River Near the Mouth

difference is primarily due to the diversions from the Highwood River, as well as the regulation by the Travers and Twin Valley reservoirs.

The monthly distributions of natural flows at both Little Bow River monitoring stations show a peak flow in early spring, followed by minor peaks during the summer months. The early spring peak is likely a function of snow melt. The later peaks are reflective of precipitation events, particularly in the higher-yielding Mosquito Creek (Upper Little Bow River) sub-basin.

Based on the slope of trend lines, annual flows on the Little Bow River are decreasing by about 7% per year at both Carmangay and near the Mouth (Figures 5.16 and 5.17), for the period from 1912 to 2001. According to both the linear trend analysis and the Mann-Kendall test, these decreases represent statistically significant trends. On a monthly basis, significant decreasing trends in flow are observed in April and from August to December, and significant increasing trends are observed in January at both stations on the Little Bow River.

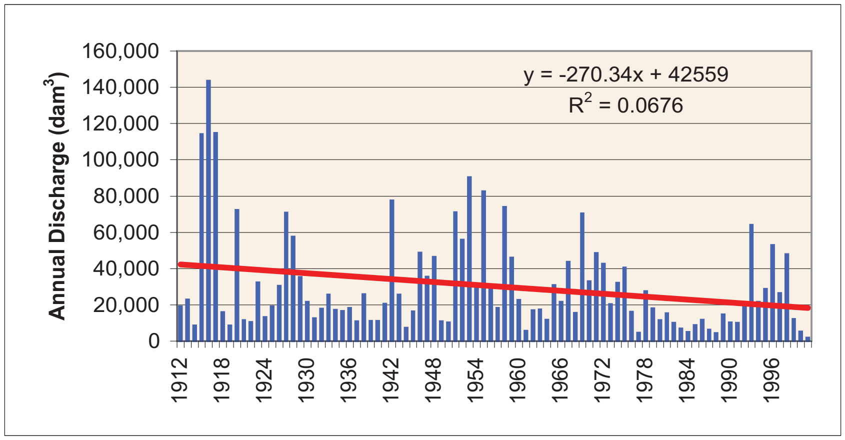
Little Bow River at Carmangay

	MK-Stat	p-value
Annual	-2.17	0.03
Jan	3.75	0.00
Feb	-0.34	0.74
Mar	-0.16	0.87
Apr	-2.03	0.04
May	-0.91	0.36
Jun	-1.20	0.23
Jul	-1.60	0.11
Aug	-3.49	0.00
Sep	-2.74	0.01
Oct	-2.72	0.01
Nov	-4.14	0.00
Dec	-2.74	0.01

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line



Average annual decrease in flow = 270 dam^3, based on trend line slope.

Figure 5.16: Trends in Natural Flow – Little Bow River at Carmangay

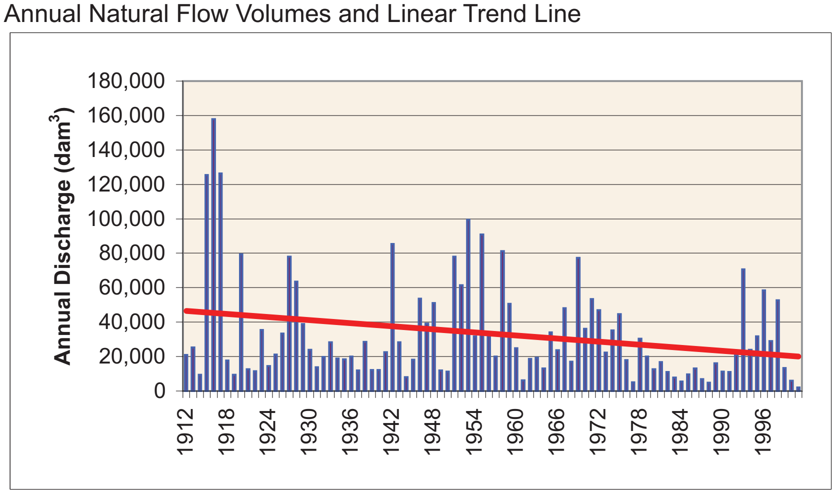
Little Bow River near the Mouth

	MK-Stat	p-value
Annual	-2.16	0.03
Jan	3.83	0.00
Feb	-0.32	0.75
Mar	-0.17	0.86
Apr	-2.03	0.04
May	-0.91	0.36
Jun	-1.20	0.23
Jul	-1.60	0.11
Aug	-3.49	0.00
Sep	-2.75	0.01
Oct	-2.70	0.01
Nov	-4.14	0.00
Dec	-2.75	0.01

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line



Average annual decrease in flow = 297 dam^3, based on trend line slope.

Figure 5.17: Trends in Natural Flow – Little Bow River Near the Mouth

Licensed Allocation and Actual Use

Little Bow River Sub-basin

Water is used for irrigation, agricultural, municipal, commercial, and other uses within the Little Bow River sub-basin. At Carmangay, allocations are about 314% of median natural flows. Most of consumptive use is supplied by diversions from the Highwood River. The allocations are about 60% of the median natural flow plus the average contributions from the Highwood River in recent years, and actual use is about 67% of these flows.

Irrigation is the largest water use in the sub-basin, representing 85% of the total allocation and actual use at Carmangay (Figure 5.18). Municipal, commercial and other agricultural uses together comprise less than 3% of the total actual water uses at Carmangay while other uses, primarily evaporation from reservoirs, have allocations and actual uses of 10% and 12%, respectively.

Surface water allocations on the Little Bow River near the Mouth are almost 300% of the median natural flows, however, including the water diverted from the Highwood River the allocations are about 69% of the flows. Actual use is about 60% of annual flows which include the diversions from the Highwood River through Women's Coulee and Little Bow diversions.

Irrigators hold and use about 83% of the total allocations and uses (Figure 5.19). Municipal, commercial, agricultural and other uses accounts for the remaining 17% of the allocated water near the Mouth.

Within the Little Bow River sub-basin, flows needed to meet the existing water uses to provide sufficient water to meet the recommended Water Conservation Objectives (WCO) were assessed at Carmangay and near the Mouth. (There were no Instream Objectives (IOs) established at the time of writing.) Both at Carmangay and near the Mouth, there were no shortfalls in providing the WCO requirements. However, it is noted that in the absence of IOs, the WCOs are solely indexed to natural flow (45% of natural flow) which sometimes falls to zero, particularly in the winter months.

Little Bow River at Carmangay

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	52,939	46,175
Other Agric	795	596
Municipal	1545	537
Commercial	299	299
Industrial		
Other	6517	6517
Totals	62,095	54,124
% of median flow		
Natural flow	314%	274%
Natural + diversions	66.8%	58.2%

Distribution of Water Allocation and Actual Use by Purpose.

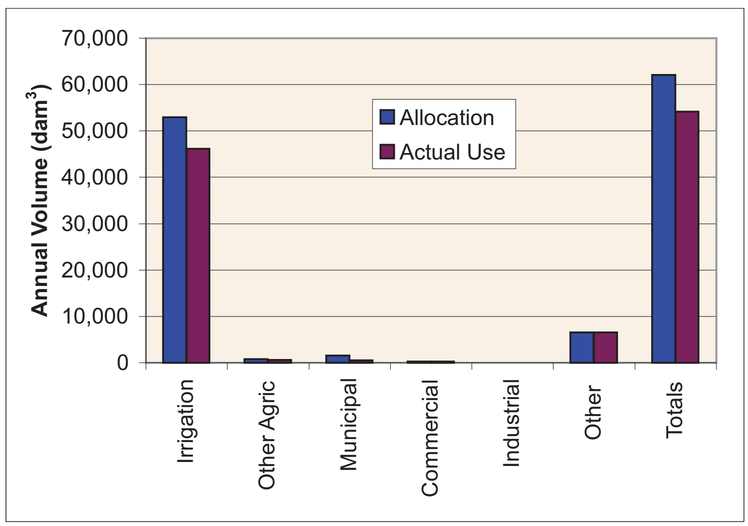


Figure 5.18: Allocations and Actual Water Use – Little Bow River at Carmangay

Little Bow River near the Mouth

Purpose Sector	Allocation dam³	Est. Actual Use dam³
Irrigation	54,336	47,394
Other Agric	2223	1667
Municipal	1545	985
Commercial	620	466
Industrial		0
Other	6538	6538
Totals	65,262	57,050
% of median flow		
Natural flow	300%	263%
Natural + diversions	68.7%	60.1%

Distribution of Water Allocation and Actual Use by Purpose.

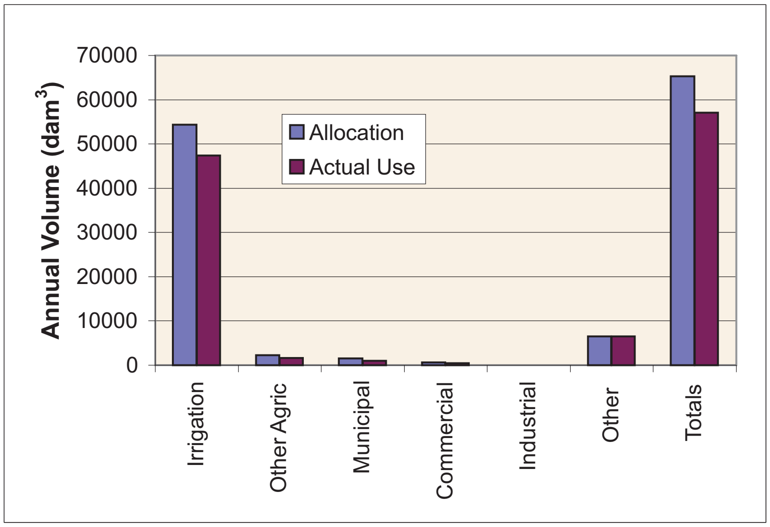


Figure 5.19: Allocations and Actual Water Use – Little Bow River Near the Mouth

Irrigation and Municipal Water Use

There are four irrigation districts located at least partially within the Prairie Sub-basins. There are no irrigation districts licensed to draw water from streams in the Prairie Sub-basins, however, water from other sources is diverted to the Sub-basins.

The Little Bow Diversion at High River and through Women's Coulee diverts water from the Highwood River into the Little Bow River sub-basin. The Carseland-Bow River Headworks diverts water through the Little Bow River sub-basin into the BRID on the eastern side of the Prairie Sub-basins. The Lethbridge Northern Headworks Diversion Weir is located on the Oldman River and water is directed into the Prairie Sub-basins. Diversions from this weir to the LNID will be addressed as part of the Oldman River mainstem (Chapter 6). The St. Mary River Irrigation District (SMRID) diverts water north from the St. Mary River to areas south of the Oldman River. Diversions from the SMRID have been included in the Southern Tributaries Sub-basins (Chapter 4).

Communities in the Prairie Sub-basins using surface water are listed below, with the water source:

- Nanton (Mosquito Creek and Highwood River through the works of AENV);
- Carmangay (Little Bow River and Highwood River through the works of AENV):
- Champion (Bow River through the works of AENV (Travers Reservoir)); and
- Vulcan (Highwood River through the works of AENV (Twin Valley Reservoir)) under the Master Agreement on Apportionment.

LNID Diversion – ARD

5.1.3 Prairie Sub-Basins – Water Quality

Water quality monitoring has occurred along both the Little Bow River and Mosquito Creek sub-basins. Water quality monitoring stations, identified by station numbers, are shown on Figure 5.20.

Total Nitrogen

Water quality observations in the Prairie Sub-basins started in the early 1980s and continued sporadically until mid or late 1990s. After 1998, water quality monitoring became more frequent in the Little Bow River sub-basin (Appendix D). Stations on both the Little Bow River and Mosquito Creek were assessed for trends in nitrogen concentrations over the collection period from 1998 to 2006. Total nitrogen loadings were determined at the water quality sites at Mosquito Creek east of Parkland and the Little Bow River at Carmangay and near the Mouth where both water quality and flow data were available. These data represent middle and lower reaches of the Little Bow River.

Total nitrogen concentrations in the Prairie Sub-basins were typically less than the guideline (Table 5.11) for the period from 1974 to 2006. There were several random instances where the median total nitrogen concentrations exceeded the guidelines in 1991, 1996, 2003 and 2006.

> Alberta Environment Surface Water Quality Guidelines for Protection of Aquatic Life threshold:
>
> Total Nitrogen = 1.0 mg/L
> Total Phosphorus = 0.05 mg/L

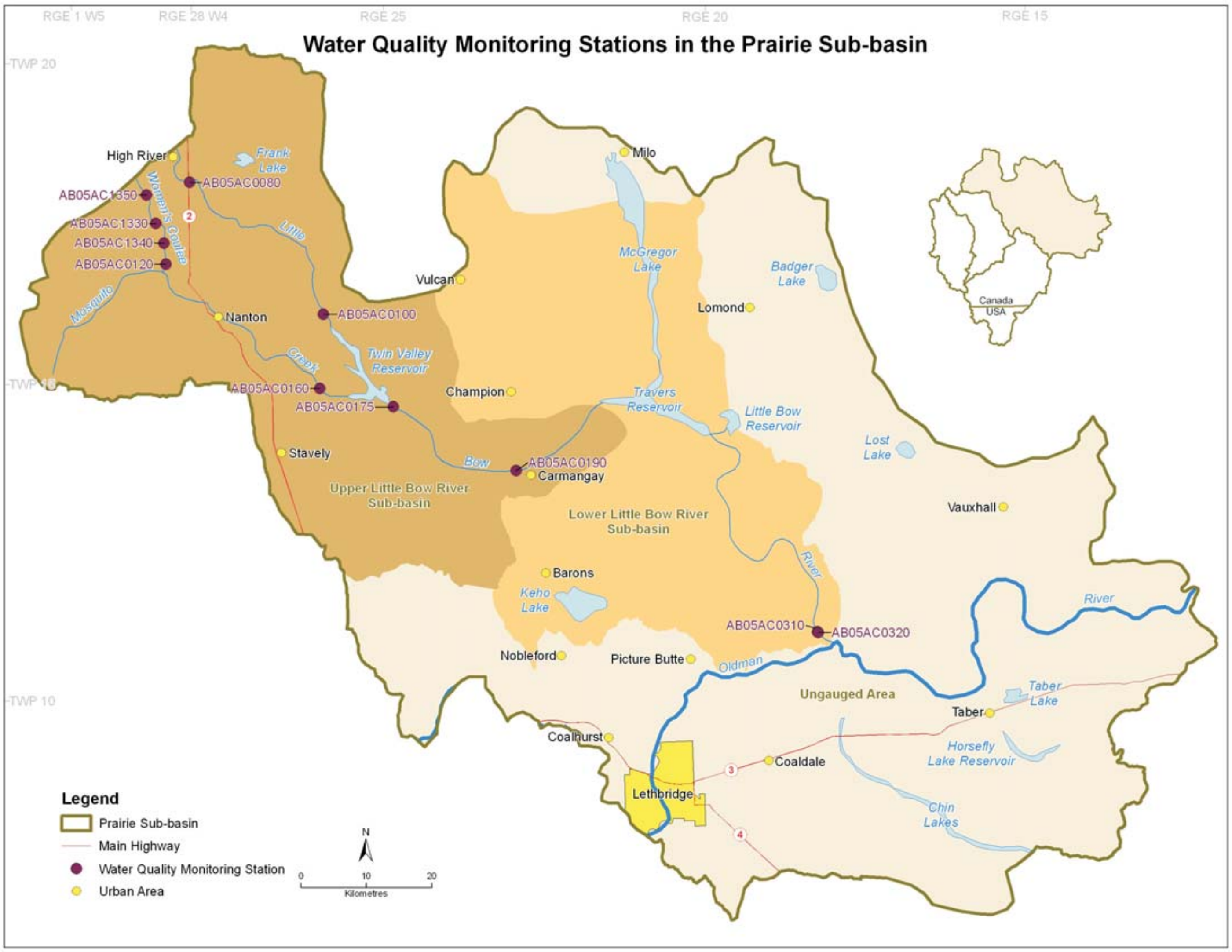


Figure 5.20: Water Quality Monitoring Stations in the Prairie Sub-basins

Table 5.11: Annual Median Total Nitrogen (mg/L) Guideline Adherence by Site

Monitoring Sites / Years	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LITTLE BOW RIVER AT HWY 2 SOUTHEAST OF HIGH RIVER									< 1.0								< 1.0	< 1.0					< 1.0 *	< 1.0	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0	< 1.0			
LITTLE BOW RIVER AT HWY 533 EAST OF NANTON									< 1.0								< 1.0	< 1.0			< 1.0 *		< 1.0 *	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			
WOMEN'S COULEE OPPOSITE NELSON HOUSE																																				
WOMEN'S COULEE AT 658 AVE																																				
WOMEN'S COULEE D/S RESERVOIR																												< 1.0								
WOMEN'S COULEE AT 690 AVE									< 1.0								< 1.0	1.0 - 5.0								< 1.0	< 1.0		< 1.0							
MOSQUITO CREEK AT HWY 529 EAST OF PARKLAND									< 1.0								< 1.0	1.0 - 5.0 *			< 1.0 *				< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.0 - 5.0			
LITTLE BOW RIVER D/S OF NEW RESERVOIR																										< 1.0	< 1.0	< 1.0	< 1.0	1.0 - 5.0	< 1.0	< 1.0	< 1.0			
LITTLE BOW RIVER AT CARMANGAY									< 1.0								< 1.0	< 1.0			< 1.0 *				< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			
LITTLE BOW RIVER NEAR CONFLUENCE WITH OLDMAN RIVER			< 1.0 *																																	
LITTLE BOW RIVER NEAR THE MOUTH											< 1.0											< 1.0 *	1.0 - 5.0 *	< 1.0 *	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0 *				

* median not calculated, results shown are based on less than 3 samples
No Data
< 1.0 mg/L (below guideline)
1.0 - 5.0 mg/L
> 5.0 mg/L

The occurrence of guideline exceedances at four monitoring sites is shown in Table 5.11.

Total nitrogen loadings for 1991, 1994/1995, 1998 and 2001 are indicated on Figure 5.21 for sites on the Little Bow River and Mosquito Creek. Loadings of total nitrogen are similar at all three sites that represent the Prairies Sub-basins and were higher in 1998 than in 1991 and 1994/95. The lowest loadings over these four snapshots were in 2001. The high loadings observed in 1998 are likely a result of high flows in that year compared to the average annual flow observed over the period 1974 to 2001.

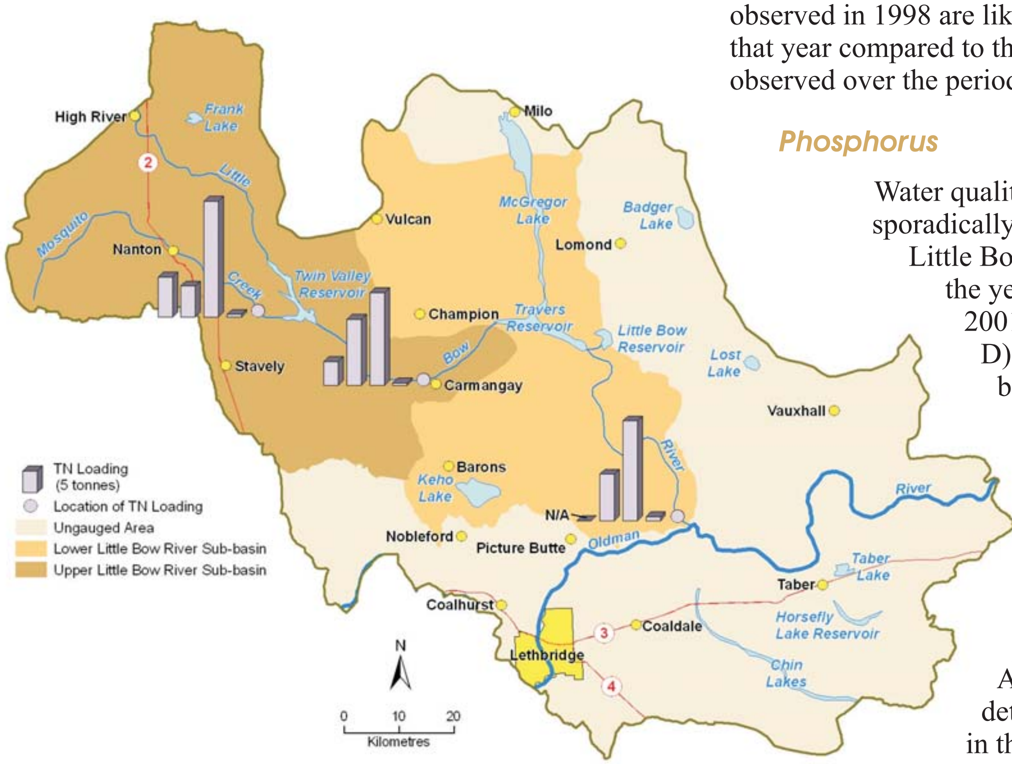


Figure 5.21: Total Nitrogen Loadings in the Prairie Sub-basins (1991, 1994/1995, 1998, 2001)

Phosphorus

Water quality data were collected sporadically at various locations in the Little Bow River sub-basin throughout the years 1982, 1990, 1997 to 1999, 2001 and 2003 to 2006 (Appendix D). At some sites, the monitoring became more consistent and continuous after 1998. Stations on both the Little Bow River and Mosquito Creek were assessed for trends in phosphorus concentrations over the most complete collection period from 1998 to 2007. Annual loadings were determined for total phosphorus in the Little Bow River and Mosquito Creek at reaches where flow data were available.

Total phosphorus in the Prairie Sub-basins often exceeded the guideline (Table 5.12) during the period from 1976 to 2009. Exceedances were observed at all sites during at least one year between 1976 and 2009.

Total phosphorus loadings for 1991, 1995, 1998 and 2001 are indicated on Figure 5.22 for Mosquito Creek and the Little Bow River at Carmangay and near the Mouth. Loadings of total phosphorus were much higher in 1998 in both Mosquito Creek and the Little Bow River than in 1991, 1994/95 or 2001. This appeared to be because of much higher flows that year compared to the average annual flow over the period of observations. Phosphorus transport as represented by loadings values in 2001 was several times lower compared to other years represented. This was true for all sites from upstream to downstream.

Table 5.12: Annual Median Total Phosphorus (mg/L) Guideline Adherence by Site

Monitoring Sites / Years	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
LITTLE BOW RIVER AT HWY 2 SOUTHEAST OF HIGH RIVER									< 0.05							
LITTLE BOW RIVER AT HWY 533 EAST OF NANTON									< 0.05							
WOMEN'S COULEE OPPOSITE NELSON HOUSE																
WOMEN'S COULEE AT 658 AVE																
WOMEN'S COULEE D/S RESERVOIR																
WOMEN'S COULEE AT 690 AVE									0.05 - 0.5							
MOSQUITO CREEK AT HWY 529 EAST OF PARKLAND									0.05 - 0.5							
LITTLE BOW RIVER D/S OF NEW RESERVOIR																
LITTLE BOW RIVER AT CARMANGAY									0.05 - 0.5							
LITTLE BOW RIVER NEAR CONFLUENCE WITH OLDMAN RIVER			0.05 - 0.5													
LITTLE BOW RIVER NEAR THE MOUTH				0.05 - 0.5					0.05 - 0.5 *		0.05 - 0.5					

Monitoring Sites / Years	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LITTLE BOW RIVER AT HWY 2 SOUTHEAST OF HIGH RIVER	< 0.05	0.05 - 0.5					< 0.05 *	< 0.05	< 0.05	< 0.05	< 0.05			< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05 *
LITTLE BOW RIVER AT HWY 533 EAST OF NANTON	< 0.05	0.05 - 0.5			< 0.05 *		0.05 - 0.5 *	> 0.5	0.05 - 0.5	< 0.05	0.05 - 0.5	< 0.05	< 0.05	< 0.05	< 0.05	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	
WOMEN'S COULEE OPPOSITE NELSON HOUSE												< 0.05		< 0.05	< 0.05	< 0.05	< 0.05			
WOMEN'S COULEE AT 658 AVE												< 0.05		< 0.05	< 0.05	< 0.05	< 0.05			
WOMEN'S COULEE D/S RESERVOIR												< 0.05		< 0.05	< 0.05	< 0.05	< 0.05			
WOMEN'S COULEE AT 690 AVE	0.05 - 0.5	0.05 - 0.5								0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	< 0.05	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5			
MOSQUITO CREEK AT HWY 529 EAST OF PARKLAND	0.05 - 0.5	0.05 - 0.5 *			< 0.05 *				0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	< 0.05	< 0.05	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	< 0.05	
LITTLE BOW RIVER D/S OF NEW RESERVOIR										< 0.05	< 0.05	< 0.05	< 0.05	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5 *
LITTLE BOW RIVER AT CARMANGAY	< 0.05	0.05 - 0.5			0.05 - 0.5 *				0.05 - 0.5	< 0.05	< 0.05	< 0.05	< 0.05	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5	0.05 - 0.5 *
LITTLE BOW RIVER NEAR CONFLUENCE WITH OLDMAN RIVER																				
LITTLE BOW RIVER NEAR THE MOUTH						< 0.05 *	0.05 - 0.5 *	0.05 - 0.5 *	0.05 - 0.5	< 0.05	< 0.05	< 0.05	0.05 - 0.5	< 0.05	0.05 - 0.5	0.05 - 0.5	< 0.05	0.05 - 0.5		

* median not calculated, results shown are based on less than 3 samples

No Data
< 0.05 mg/L (below guideline)
0.05 - 0.5 mg/L
> 0.5 mg/L

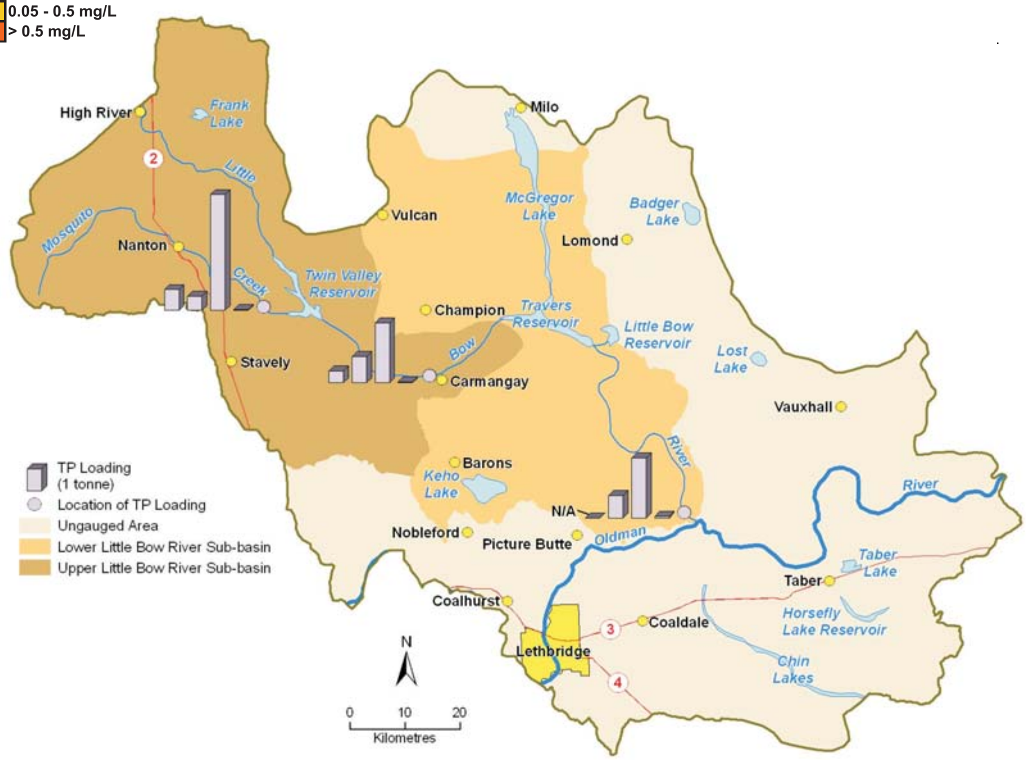


Figure 5.22: Total Phosphorous Loadings in the Prairie Sub-basins (1991, 1994/1995, 1998, 2001)

Total Suspended Solids

Total suspended solids (TSS) were monitored infrequently in the Little Bow River sub-basin from 1974 to late 1990s, however more intensive sampling has been done in the last decade (Appendix D). Stations on both the Little Bow River and Mosquito Creek were assessed for loadings and trends in TSS concentrations over the period from 1998 to 2008.

The median annual TSS concentrations for stations in the Prairie Sub-basins are compared to the TSS medians over the whole period of observations for the same locations in Table 5.13. The medians over the period of observation show a relative background as the most commonly measured values. There are no extremely high median TSS concentrations at the water quality sampling sites. Clearly, the control structures within the Prairie Sub-basins are preventing large flood events from impacting the sediment levels in the surface water sources. However, a relative increase in TSS concentrations over the last years is noticeable in most of the streams.

Total suspended solids loadings were determined in the Prairie Sub-basins at Mosquito Creek east of Parkland and in the Little Bow River at Carmangay and near the Mouth for 1991, 1994/95, 1998 and 2001 (Figure 5.23). The levels of TSS loadings varied considerably between the sites and generally followed flow patterns. No clear patterns emerged indicating that one water quality station had consistently higher loadings than another. The highest loadings of TSS occurred in 1998 in both Mosquito Creek and the Little Bow River and correspond with higher than average annual flows.

Table 5.13 : Annual Median TSS (mg/L) Compared to Data Set Median

Monitoring Sites / Years	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LITTLE BOW RIVER AT HWY 2 SOUTHEAST OF HIGH RIVER									*																											*
LITTLE BOW RIVER AT HWY 533 EAST OF NANTON									*												*															
WOMEN'S COULEE OPPOSITE NELSON HOUSE																											*									
WOMEN'S COULEE AT 658 AVE																											*									
WOMEN'S COULEE D/S RESERVOIR																											*									
WOMEN'S COULEE AT 690 AVE									*																											
MOSQUITO CREEK AT HWY 529 EAST OF PARKLAND									*									*			*															
LITTLE BOW RIVER D/S OF NEW RESERVOIR																												*								*
LITTLE BOW RIVER AT CARMANGAY									*												*															*
LITTLE BOW RIVER NEAR CONFLUENCE WITH OLDMAN RIVER	*																																			
LITTLE BOW RIVER NEAR THE MOUTH									*													*	*	*												

* median not calculated, results shown are based on less than 3 samples

- no data
- < median
- 0%-100% above median
- >100% above median

Oldman River at Lethbridge – R. Coffey

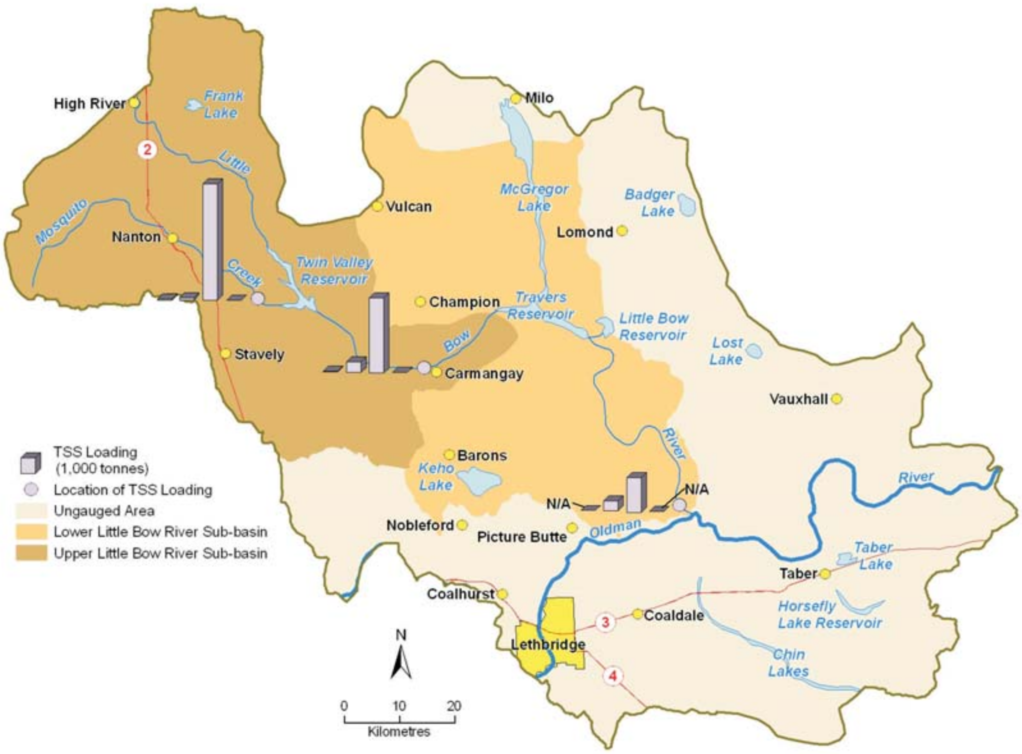


Figure 5.23: Total Suspended Solids Loadings in the Prairie Sub-basins (1991, 1994/1995, 1998, 2001)

Fecal Coliforms

Fecal coliform sampling was conducted regularly from 1997 onward at four sites at the Little Bow River east of Nanton, at Carmangay and near the Mouth, and at Mosquito Creek east of Parkland (Appendix D). Sporadic data collection occurred at other sites and during other time periods, however the most comprehensive acquisitions occurred between 1997 and present.

Trends in fecal coliform numbers and total loadings were assessed for the period from 1998 to 2007 at the Little Bow River at Carmangay and near the Mouth and at Mosquito Creek east of Parkland.

Almost each site sampled for fecal coliforms had at least one year with median counts higher than the guideline (Table 5.14). Since 1998, exceedances of the guideline were observed at only at two locations on the Little Bow River with an extreme exceedance occurring near the Mouth in 2005. This extreme exceedance is likely due to the large rain event that occurred that year. Women's Coulee had median counts in exceedance of the guideline in four of six years and continued until 2002 when monitoring of this parameter was discontinued at this site. The number of exceedances of the irrigation guidelines in Women's Coulee indicates that there is a significant source of fecal coliforms within reach of the water body.

Annual loadings of fecal coliforms in the Little Bow River were higher than those observed on Mosquito Creek east of Parkland for 1991, 1994/95, 1998 and 2001 (Figure 5.24). Loadings were highest in 1998 at all three sites assessed for water quality. This increase in loadings corresponds with high annual flows at all three sites which were more than double the annual average flow from 1974 to 2001.

> Alberta Environment Surface Water Quality Guidelines for Irrigation threshold:
>
> Fecal Coliforms = 100 coliforms/100 mL

Table 5.14: Annual Median Fecal Coliform Count Guideline Adherence by Site

Monitoring Sites / Years	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
LITTLE BOW RIVER AT HWY 2 SOUTHEAST OF HIGH RIVER									<100								<100	100-1000
LITTLE BOW RIVER AT HWY 533 EAST OF NANTON									<100								<100	<100
WOMEN'S COULEE OPPOSITE NELSON HOUSE																		
WOMEN'S COULEE AT 658 AVE																		
WOMEN'S COULEE D/S RESERVOIR																		
WOMEN'S COULEE AT 690 AVE									<100 *								100-1000	<100
MOSQUITO CREEK AT HWY 529 EAST OF PARKLAND									<100 *								<100	<100 *
LITTLE BOW RIVER D/S OF NEW RESERVOIR																		
LITTLE BOW RIVER AT CARMANGAY									<100 *								<100	<100
LITTLE BOW RIVER NEAR CONFLUENCE WITH OLDMAN RIVER	<100 *	<100	<100 *															
LITTLE BOW RIVER NEAR THE MOUTH											<100							

Monitoring Sites / Years	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LITTLE BOW RIVER AT HWY 2 SOUTHEAST OF HIGH RIVER						<100	<100	<100	<100									
LITTLE BOW RIVER AT HWY 533 EAST OF NANTON			100-1000 *			100-1000	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	
WOMEN'S COULEE OPPOSITE NELSON HOUSE																		
WOMEN'S COULEE AT 658 AVE																		
WOMEN'S COULEE D/S RESERVOIR																		
WOMEN'S COULEE AT 690 AVE								100-1000	100-1000		100-1000							
MOSQUITO CREEK AT HWY 529 EAST OF PARKLAND			100-1000 *				100-1000	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	
LITTLE BOW RIVER D/S OF NEW RESERVOIR								<100 *	100-1000 *									
LITTLE BOW RIVER AT CARMANGAY			<100 *				<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	
LITTLE BOW RIVER NEAR CONFLUENCE WITH OLDMAN RIVER																		
LITTLE BOW RIVER NEAR THE MOUTH				100-1000 *	100-1000 *	<100 *	100-1000	<100	<100	<100	<100	<100	<100 *	>1000 *				

* median not calculated, results shown are based on less than 3 samples

No Data
< 100 per 100 mL (below guideline)
100 - 1000 per 100 mL
> 1000 per 100 mL

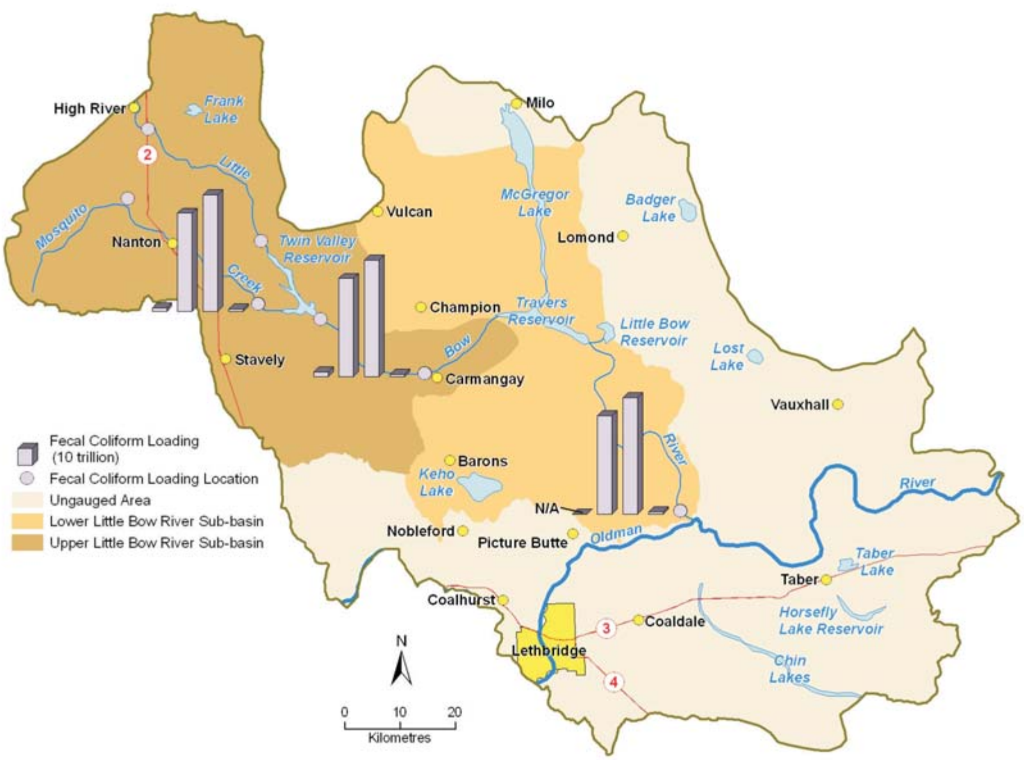


Figure 5.24: Fecal Coliform Loadings in the Prairie Sub-basins (1991, 1994/1995, 1998, 2001)

Prairie Sub-basins Water Quality Overview for Non-indicator Parameters

Temperature[2]

The median water temperature in the Little Bow River, from 1998 to 2003, was 9.4°C. The Oldman River, upstream of the confluence with the Little Bow River had a median water temperature of 8.8°C. The median and maximum temperatures of the Little Bow River and the Oldman River are very similar and the Little Bow River is not likely to have adverse thermal effects on the mainstem.

pH[2]

In the Little Bow River, the median pH was 8.15. This value is very similar to the median pH of 8.27 observed for the Oldman River upstream of the confluence with the Little Bow River during the same time period.

Dissolved Oxygen[2]

Median dissolved oxygen concentrations were somewhat lower in the Little Bow River than in the Oldman River upstream of the confluence with the Little Bow River. The median values were 10.39 mg/L and 11.24 mg/L, respectively.

Hardness[2]

The Little Bow River, during the period from 1998 to 2003, had a median hardness level of 195 mg $CaCO_3$/L which is classified as "very hard" by Health Canada[3]. This value was somewhat higher than that observed in the Oldman River upstream of the confluence with the Little Bow River where a median hardness level of 150 mg $CaCO_3$/L was observed, putting it in the "hard" category[3]. The hardness levels in the Little Bow River may be due to areas dominated by topsoil and limestone or by groundwater inputs from aquifers in mineral rich deposits.

Metals and Ions[2]

Metals were very low the Little Bow River with median values of dissolved iron and manganese below detection levels. Ions measured between 1998 and 2003 included fluoride, chloride, and sulphate. Median dissolved fluoride concentrations in the Little Bow River was above the Guideline for the Protection of Aquatic Life with a value of 0.2 mg/L. Median chloride and sulphate concentrations in the Little Bow River were well below guideline levels.

Pesticides[2]

Pesticide concentrations in the Little Bow River were generally below guideline during the sampling period between 1998 and 2003. Exceedances of the Guideline for the Protection of Aquatic Life were observed for MCPA in 1998, 2002 and 2003 while Dicamba exceedances occurred during each sampling period between 1998 and 2003.

Water Quality Indices[1]

The Water Quality Index takes several different indicators and, using thresholds for best to worst quality, combines the indicators into one index to give a general overview of the water quality in a tributary or at a specific site. According to the Water Quality Index, the water in the lower Little Bow River went from good to fair between 1998 and 2002.

Sources:

1. Oldman Watershed Council (OWC). 2005. Oldman River Basin Water Quality Initiative - Five Year Summary Report.

2. Saffran, K. 2005. Oldman River Basin Water Quality Initiative Surface Water Quality Summary Report April 1998 - March 2003, Oldman River Basin Water Quality Initiative.

3. Health Canada 2009.

Guidelines: AENV 1999; CCME 2005.

5.2 Current Issues and Trends

5.2.1 Terrestrial and Riparian Ecology

Within this prairie landscape, the dominant land use is agriculture, primarily cultivated land. Twelve percent of the cultivated land is irrigated, with irrigation holding 83% of the total allocated use of the Little Bow River near its mouth with the Oldman River. Riparian health within the Sub-basins is lower than the average conditions found throughout Alberta, with 4% rate as healthy and 65% rated as unhealthy. The Prairie Sub-basins are experiencing substantial population growth, especially within and close to major urban centres such as Calgary (e.g., west of Nanton) and Lethbridge.

5.2.2 Water Quantity

The Little Bow River is the primary sub-basin that lies within the Grassland natural sub-region and flows through two storage facilities before discharging to the Oldman River, the Twin Valley Reservoir and Travers Reservoir. Due to the climatic characteristics including low annual precipitation, the flows in the Little Bow River are supplemented by diversions from the Highwood River to meet the water demands in the sub-basin. The Little Bow River sub-basin is impacted by diversions, regulated flows and extensive surface water use.

The Little Bow River has recorded flows which are much higher than the natural flows because of the large diversion volume from the Highwood River. Water uses in the Prairie Sub-basins are primarily irrigation with some municipal, commercial and agricultural uses.

Significant decreasing streamflow trends exist both in annual and late summer and fall natural flows, as well as early spring flows (April). Both flow monitoring stations on the Little Bow River indicate that a significant increasing flow trend exists for January.

Instream Objectives have not been set by AENV for the Little Bow River, and so the frequency of deficits was not determined. No deficits to the WCO have been recorded in the 1992 to 2001 period.

5.2.3 Water Quality

The water quality within Prairie Sub-basins is largely dependent on land management patterns and hydrological conditions. Irrigation, agricultural and industrial uses are likely responsible for guideline exceedances observed in nutrient concentrations and fecal coliform counts. This is also reflected in loadings for phosphorus, nitrogen, TSS, and fecal coliforms.

Annual loadings for nitrogen, fecal coliforms, and TSS in the Little Bow River sub-basin are highly related to annual flows – this shows effects associated with watershed patterns rather than point source discharges of contaminants. Reservoirs interrupt the downstream migration of water quality indicators by changing the catchment area, hydrology and hydraulics of the water course.

The water quality trend in the Prairie Sub-basins shows relatively consistent changes in water quality during the 1998 to 2007 period. The upper reach of Little Bow River has generally increasing trends for all parameters. Mosquito Creek has different patterns, and generally no trends for indicators are visible. The middle reach of Little Bow River at Carmangay shows increasing trends in all indicators except TSS. Further downstream, at the Little Bow River near the Mouth, nitrogen showed an increasing trend with decreasing trends in Total fecal coliforms and no trends in the other two indicators (phosphorus and TSS).

Total nitrogen concentrations in the Little Bow River and Mosquito Creek show an increasing trend during the period from 1998 to 2007 (Figure 5.25). These trends were considered significant at a 90% confidence level in the Little Bow River and at an 80% confidence level in Mosquito Creek. Trends in total nitrogen could not be determined for other sites in the Prairie Sub-basins, including Women's Coulee, due to a lack of consecutive water quality data for several years. Nitrogen shows a clearly increasing trend at all sites in the Prairie sub-basins.

Trends in total phosphorus concentrations between 1998 and 2007 were site dependent. A decreasing trend occurred at Mosquito Creek east of Parkland. In the Little Bow River, increasing trends were observed southeast of High River and at Carmangay. A decreasing trend in total phosphorus was seen downstream of Nanton, and no trends were observed at the water quality stations downstream of the new reservoir or near the mouth.

Increasing trends in the concentration of TSS were observed in the upper reaches of the Little Bow River, at the sites southeast of High River and east of Nanton. No other monitoring sites in the Little Bow River, Mosquito Creek or Women's Coulee showed trends in TSS.

An increasing trend in fecal coliforms (at an 80% confidence level) was observed at the Little Bow River east of Nanton and at Carmangay, while a decreasing trend occurred at the Little Bow River near the Mouth (at a 90% confidence level) over the period from 1998 to 2007 (Figure 5.25). Fecal coliform counts in Mosquito Creek did not show any trends during this period.

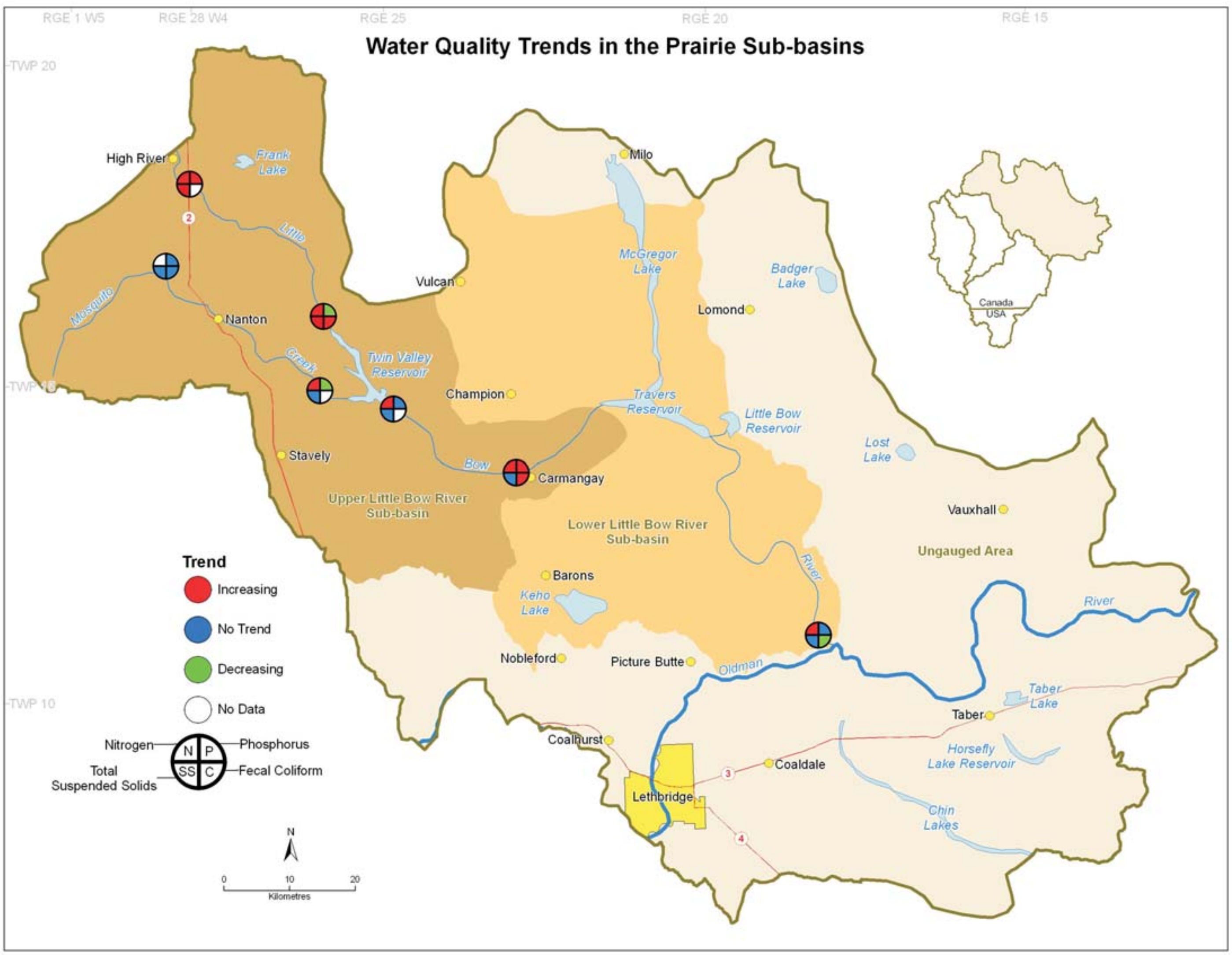


Figure 5.25: Water Quality Trends in the Prairie Sub-basins

5.3 Summary

Overall, the Prairie Sub-basins is rated as **Fair** to **Poor**. A summary of the observations and analyses of indicators and trends in the Prairie Sub-basins is provided.

Terrestrial (Poor)

- Land cover of natural grassland is 21%, rated poor.
- Soil erosion risk is moderate to severe, rated poor
- Riparian health is unhealthy, rated poor.
- Linear developments cover 4.1% of area, rated poor.
- Total land use at 73%, rated fair.

Water Quantity (Fair to Poor)

- Very low unit runoff in the Prairie Sub-basins.
- Significant decreasing trend in annual volumes and in about half of the monthly volumes in the Little Bow River at both Carmangay and near the Mouth. The certainty of these trends is impaired by the difficulty in reconstructing natural flow in the Little Bow River sub-basin, with extensive ungauged irrigation use and diversions from the Highwood and Bow rivers, and resulting potential errors in the natural flow.
- Water allocations are about 300% of the median natural flow. Water use is about 270% of the median natural flow. When diversions from the Highwood River are included on the supply side, these percentages drop to about 70% and 60%, respectively. Because there is so little difference between allocation and use, the potential for increased use within existing allocations is minimal.
- No IOs have been established for the Little Bow River. Deficits to the WCO are minor, probably because natural flow is supplemented by diversions from the Bow River watershed.

Water Quality (Fair to Poor)

- The water quality within Prairie Sub-basins is largely dependent on land management patterns and hydrological conditions.
- Irrigation, agricultural and industrial uses are likely responsible for guideline exceedances observed in nutrient concentrations and fecal coliform counts.
- Annual loadings for nitrogen, fecal coliforms, and TSS are highly related to annual flows that show effects associated with watershed patterns rather than point source discharges of contaminants.
- Trends and loadings demonstrate the impact of reservoirs on water quality.

As with Beaver Creek sub-basin in the Foothills Sub-basins, the Little Bow River demonstrated significant declining trend in flows. This may reflect the possible effects of climate change or changing land use. Or, the computation of natural flow may not be as accurate as it is in other areas in the Oldman watershed because of diversion into the Prairie Sub-basins and the high level of unmonitored water use. Therefore, like Beaver Creek in the Foothills Sub-basins, management plans should:

- continue to monitor flows in Little Bow River and conduct trend analyses periodically;
- monitor irrigation water use;
- assess land use change; and
- develop adaptation measures in the event of continued declines.

Monitoring of flow volumes and land use change should occur at five year intervals, using this State of the Watershed report as a baseline to assess change.

Water diversions from the Highwood River (outside the Oldman watershed) are necessary to meet existing allocations plus WCOs within the Little Bow River sub-basin (Ios have not been established). Currently water use is 87% of the licensed allocation. Expansion potential within existing allocations is low. If the diversions into the watershed did not occur, there would be water shortages. With diversions from the Highwood River, the current level of water use is sustainable. Instream objectives along various reaches of the Little Bow River should be established.

Land use activities, mainly agriculture, affect 73% of the land base and irrigation occurs on 12% of the cultivated lands. Populations are increasing and industry (e.g., CFOs) is also increasing. Riparian areas are not healthy. These trends in land use activity are reflected in the observed increasing trends for all water quality indicators in several of the upper reaches of the tributary streams. Water quality trends change moving downstream: showing no trend except for fecal coliforms which demonstrated a decreasing trend. As a result, management plans need to incorporate good stewardship actions, and highlight the need to improve the health of riparian areas.

Additional management recommendations are presented in Chapter 10.