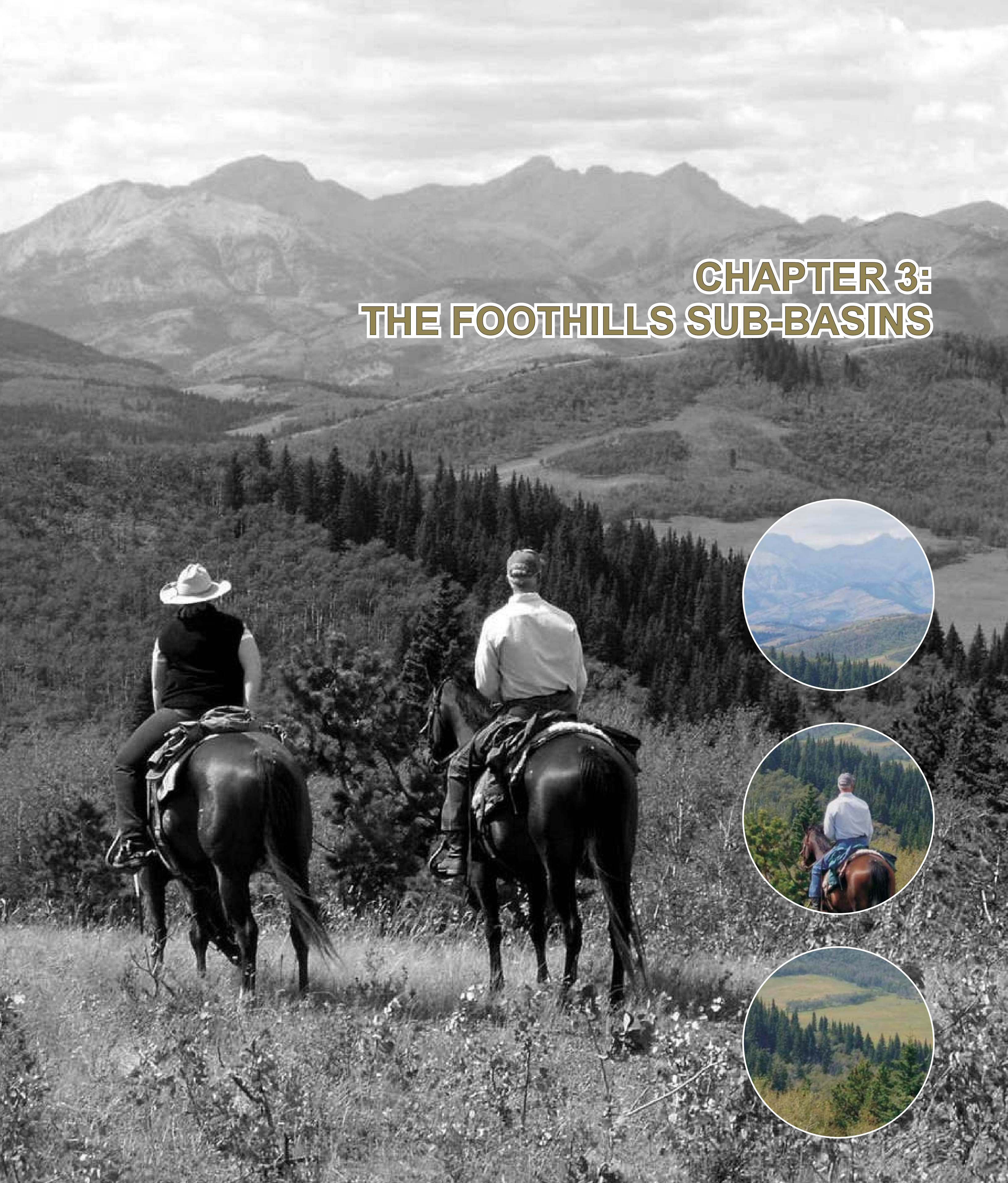


CHAPTER 3: THE FOOTHILLS SUB-BASINS

On Top of the World - OWC

Chapter 3: The Foothills Sub-basins

The Foothills Sub-basins lie in the transition zone between the mountains and forests to the west and the Prairie grasslands and agricultural land to the east (Figure 3.1). The mainstem of the Oldman River runs from west to east across the lower third of the Sub-basins. The Foothills Sub-basins contain three primary tributaries to the Oldman River – Willow, Beaver and Pincher creeks. Surface water flow in a fourth ungauged and unnamed sub-basin drains directly into the mainstem of the Oldman River. All four sub-basins are described in this section, but no streamflow or water quality information is available for the ungauged area.

The topography of the Foothills Sub-basins is rolling and reflects the steeply dipping shale and sandstone bedrock that underlies the area. Outcrops are common. Surface materials are glacial and glacio-fluvial sands and gravels, and soil development varies markedly with local conditions across the area. The Sub-basins span five natural sub-regions, including small high-elevation areas of Sub-Alpine in the northwest and southwest corners, a north-south band of Montane, Foothills Parkland in the north, Foothills Fescue grasslands through the centre, and Mixedgrass Prairie in the east (Figure 3.2).

Vegetation patterns express the combinations of varying conditions in these natural sub-regions. The Sub-Alpine supports coniferous forests. Coniferous and deciduous forests dominate in the Montane where, depending on elevation, moisture conditions, and slope and aspect, species occur in pure or mixed stands. Shrubland characterizes the Foothills Parkland. Grasslands predominate in the Foothills Fescue; the Mixedgrass Prairie sub-region is common

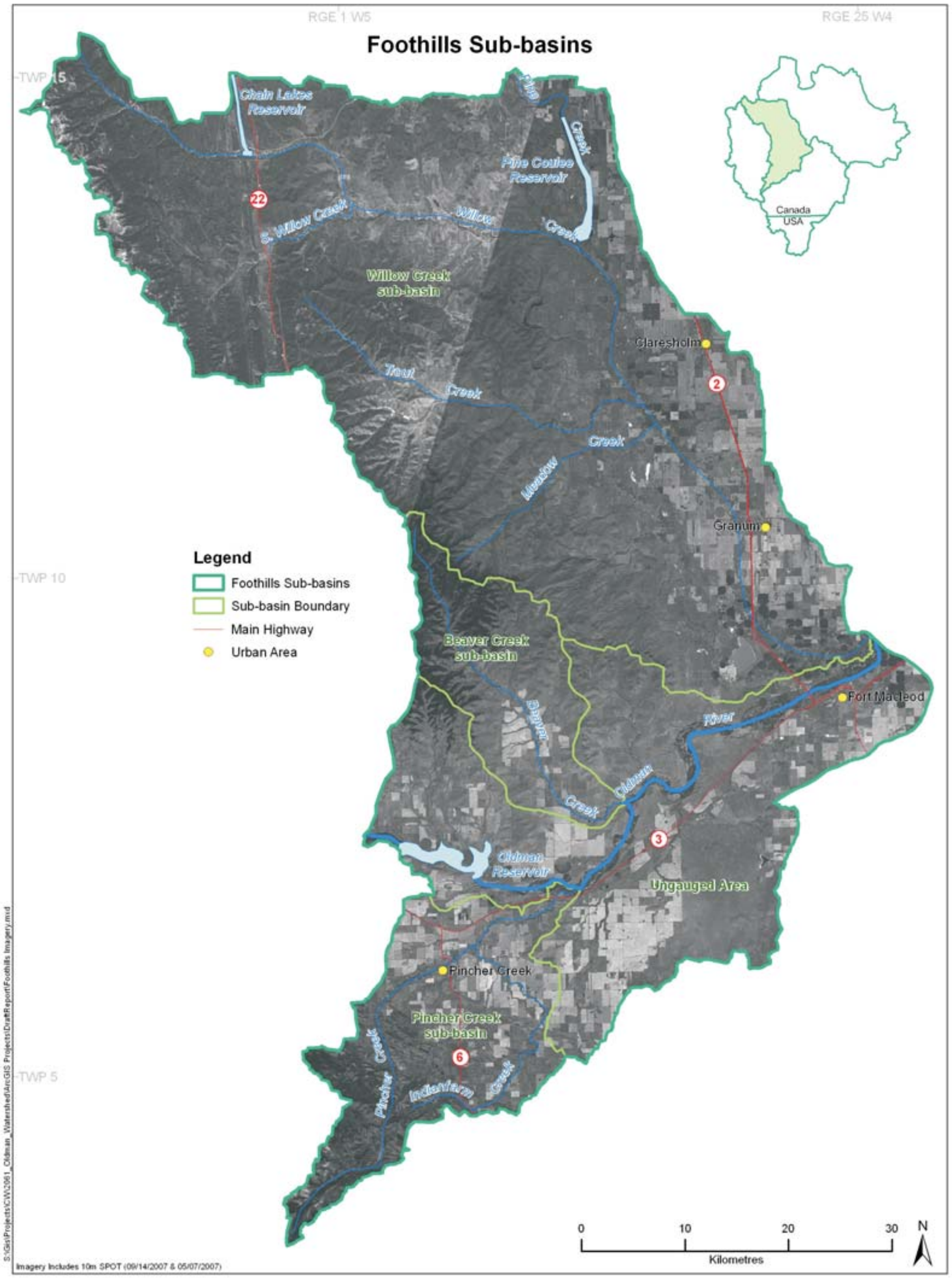


Figure 3.1: The Foothills Sub-basins

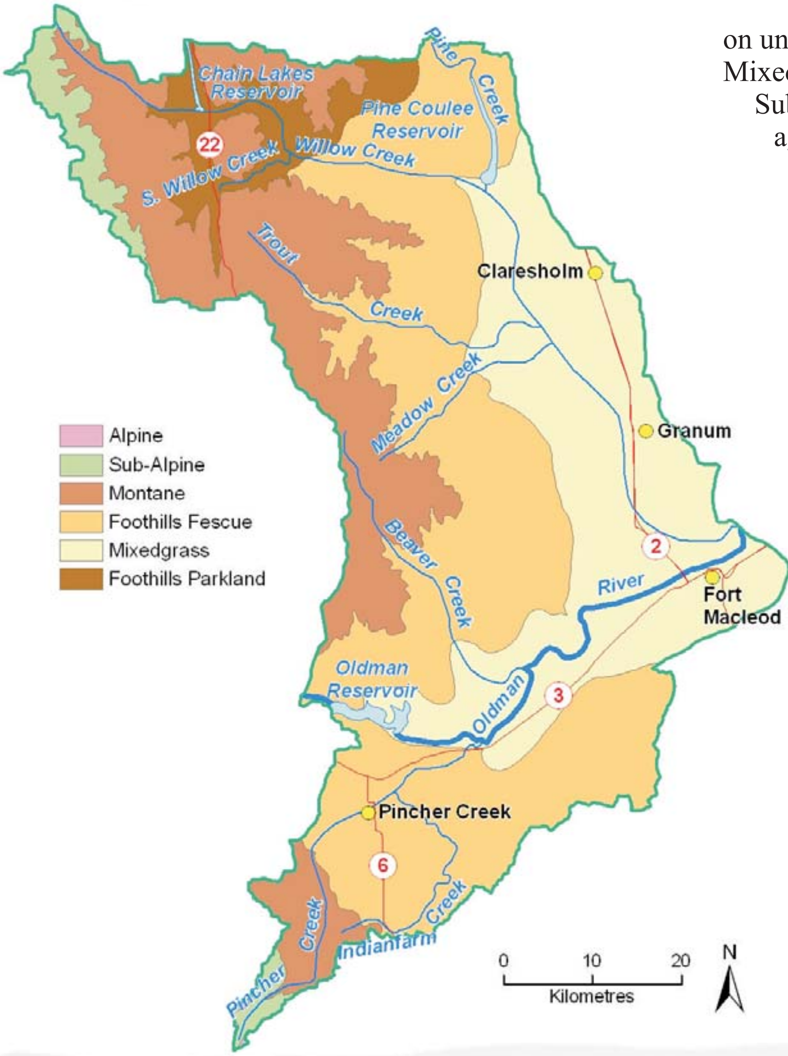
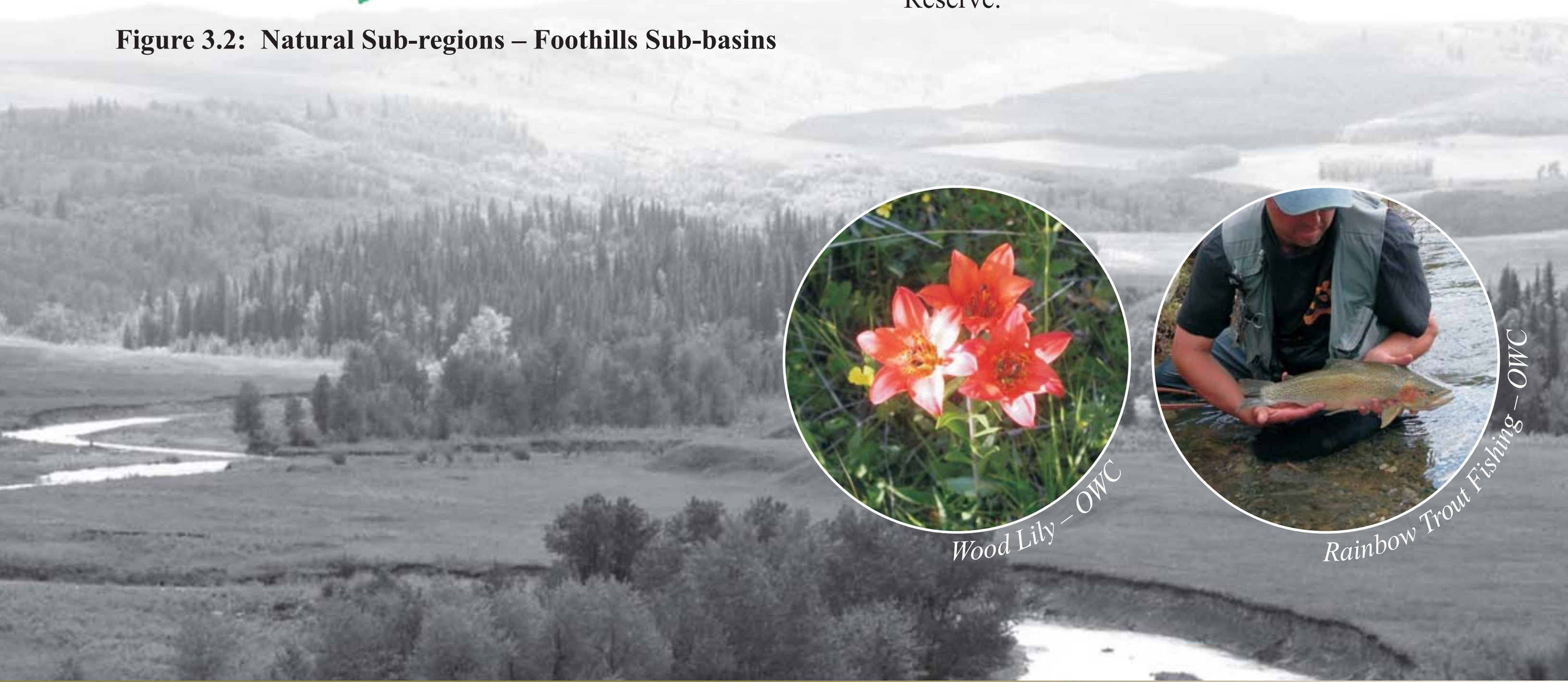


Figure 3.2: Natural Sub-regions – Foothills Sub-basins

on ungrazed and moderately grazed sites. The Mixedgrass Prairie region in the eastern side of the Sub-basins has largely been cultivated, and agricultural land predominates. Soils are predominantly deep Orthic Brown, Dark Brown and some Black Chernozemics, which formed under conditions of ample precipitation and high organic matter content, and which today comprise some of the richest, and most intensively cultivated, agricultural soils in Alberta (Natural Regions Committee 2006). Non-peat wetlands occur throughout the Foothills Sub-basins, but are generally small, seasonal and shrink through the summer season.

The Willow Creek sub-basin extends northwest of Fort McLeod and includes the mountains, deep valleys and rolling hills. Soils at higher elevations are shallow with frequent outcrops and small low-lying boggy areas. As Willow Creek enters the Mixedgrass Prairie natural sub-region, agricultural activity dominates and the stream flows through level cultivated land.

Beaver Creek is a small spring-fed stream that rises in the Montane natural sub-region of the Porcupine Hills and flows southeast through the Foothills Fescue grassland for about 35 km. It enters the Oldman River within the Piikani First Nation Reserve.



Wood Lily – OWC

Rainbow Trout Fishing – OWC

Willow Creek – ARD

Pincher Creek rises from springs and snowmelt on Victoria Peak in the far southwestern corner of the Oldman watershed and flows through the Montane and Foothills Fescue natural sub-regions to join the mainstem of the Oldman near Brocket.

Although these sub-basins begin in the mountains, all three creeks are shallow and warm up quickly in the summer. Based on data from 1998 to 2003, the median water temperatures in Beaver Creek, Pincher Creek, and Willow Creek were 10.1°C, 11.0°C and 10.6°C, respectively. These temperatures are considerably warmer than the mainstem of the Oldman River near Brocket (6.9°C). This warmer water contributes to increased median temperatures downstream of Fort McLeod, where the median temperature of the mainstem is 9.5°C (Saffran 2005).

Extreme precipitation and streamflow events have significant impacts: river channels can be altered, bed and bank erosion and sedimentation in surface waters are increased, and water quality is affected. The highest and second highest streamflows in the sub-basins were recorded in 1995 and 1975 respectively. In 2005, high flows were recorded on Pincher Creek and Beaver Creek (66.4 m^3/s and 26.3 m^3/s, respectively) as a result of spring precipitation events, and the effects can be seen in water quality indicators for that period.

Two environmentally significant areas (ESA) are notable in the Foothills Sub-basins – Canon Coulee (ESA #193) and Bluestem (ESA #306), both in the Willow Creek sub-basin (Sweetgrass 1997). Canon Coulee is a deep, steep-sided coulee in a former glacial meltwater channel. The area provides high density nesting habitat for birds of prey, such as Ferruginous hawks, Golden eagle, Prairie falcon and merlin. Bluestem is a former glacial lake bottom that now supports a diversity of mixed grasses on its coarse deposits. These include the most extensive stands of the rare little bluestem, *Schizachyrium scoparium,* in Alberta.

Pincher Creek – ARD

3.1 Overview of Indicators

3.1.1 Terrestrial and Riparian Ecology

Land Cover

The land cover map of the Foothills Sub-basins (Figure 3.3) provides an overview of the types of land cover found within this area. These include grassland, cultivated land, forests and urban areas. The area that each land cover type occupies within the Foothills Sub-basins is shown in Table 3.1.

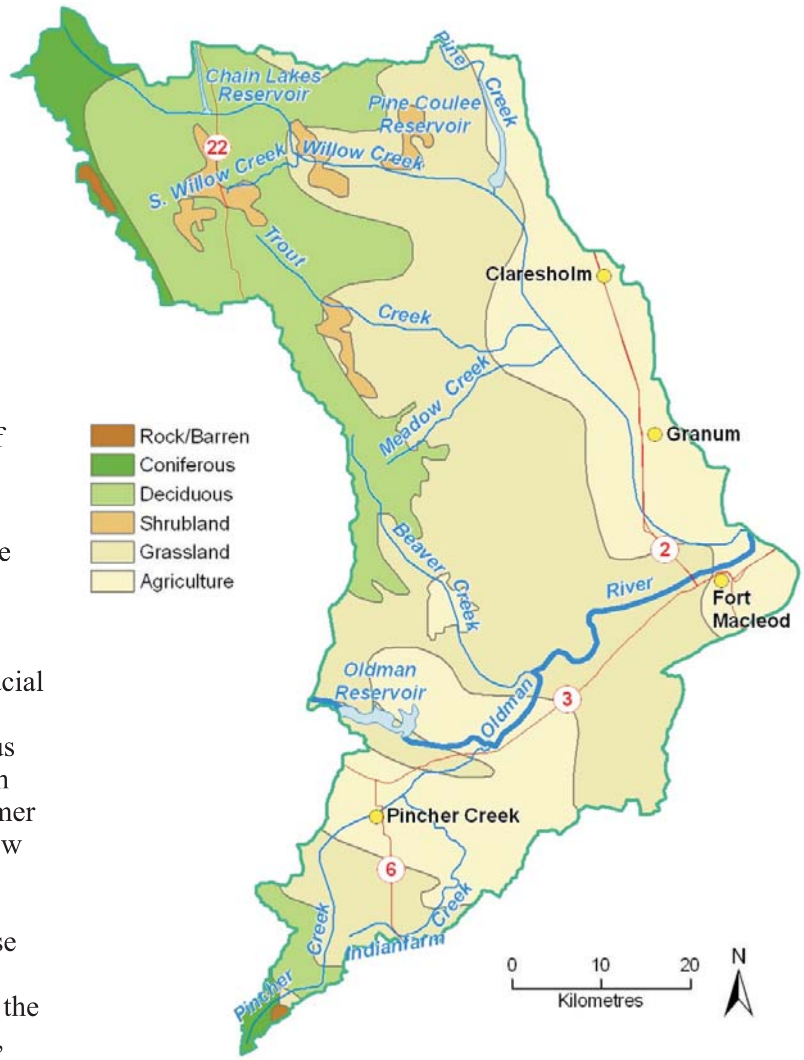


Figure 3.3: Land Cover – Foothills Sub-basins

Table 3.1: Land Cover in the Foothills Sub-basins

Land Cover	Area of Foothills Sub-basins (%)
Grassland	40
Cultivated Land	30
Forest (Coniferous & Deciduous)	20
Shrubland	8
Rock/Barren	1
Urban	<1
Total	**100**

Grasslands

Grasslands, consisting of native species, cover the largest area, at 40%, in the Sub-basins, primarily within the Foothills Fescue natural sub-region (Figure 3.4). The Grassland cover class includes the nearly level areas in the northern end of the Foothills Sub-basins and the cool, high-elevation native grassland below the mountain slopes. Both are important areas for grazing.

The Black Creek Heritage Rangelands, located within the Foothills Sub-basins, is an area of carefully managed cattle grazing that contributes to the ecological integrity of large tracts of native grassland. This Heritage Rangeland area ensures the ongoing protection of native grasslands while continuing the traditional grazing approach.

Cultivated Land

Cultivated land (30%) is found within a fertile band that extends north of Claresholm to south of Granum and includes the area around Pincher Creek and east of the Oldman Reservoir. The cultivated lands lie within the Mixedgrass natural sub-region. The cultivated lands are primarily found within the municipal district (MD) of Willow Creek No. 26, MD of Pincher Creek No. 9, and Peigan (North Piikani) Indian Reserve 147 (Table 3.2). Agricultural crops grown within each MD as of the 2006 census (Statistics Canada 2006) are shown in Table 3.3. The percentage of cropped land versus summerfallow land will change every year depending on the various environmental or economic factors affecting the Foothills Sub-basins.

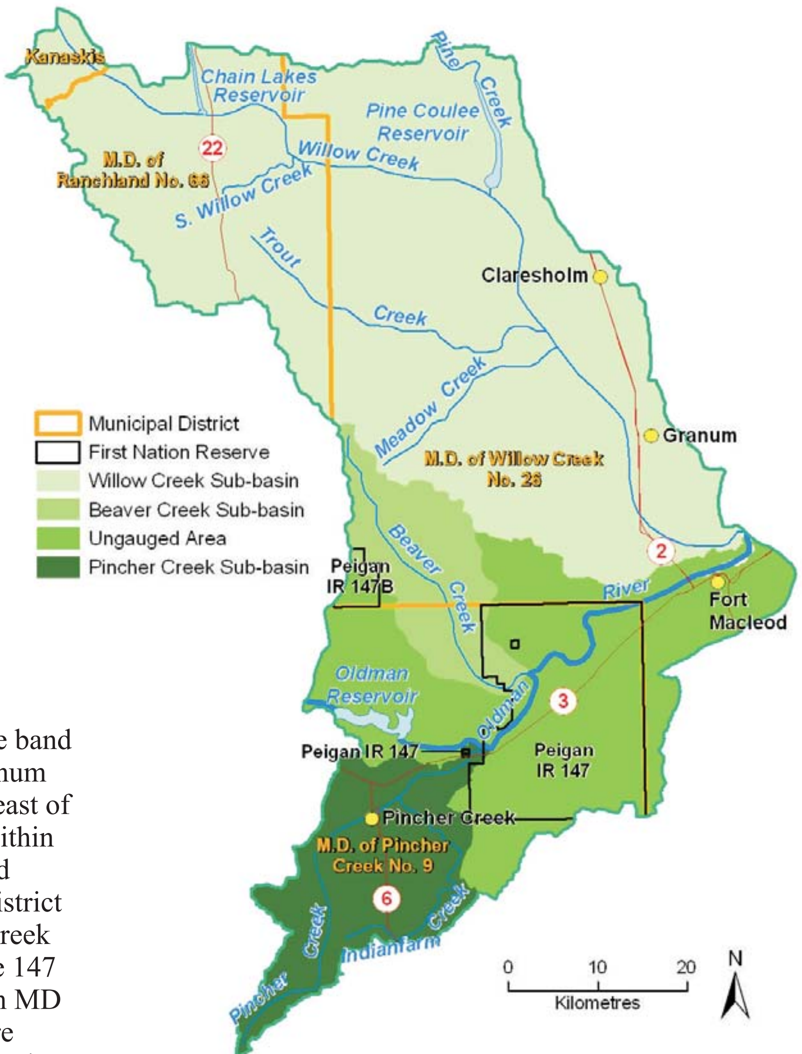


Figure 3.4: Municipal Districts and First Nation Reserves – Foothills Sub-basins

Table 3.2: Land Cover by Municipal Districts (%)

Land Cover	MD of Ranchland No. 66 (%)	MD Willow Creek No. 26 (%)	MD Pincher Creek No. 9 (%)
Grassland (for Grazing)	94	44	57
Cultivated:			
– Cropped	1	40	26
– Summerfallow	0	1	1
– Seeded pasture	2	12	8
Subtotal	*3*	*53*	*35*
Other (water/treed)	3	3	8
Irrigation (included in Cultivated Lands)	0	4	1
Total	**100**	**100**	**100**

Source: StatsCan 2006. Agriculture Profiles.

Table 3.3: Types of Crops by Municipal District

Agricultural Land Use	MD of Ranchland No. 66 (% Area)	MD Willow Creek No. 26 (% Area)	MD Pincher Creek No. 9 (% Area)
Cereal (wheat, oats, barley, rye)	<1	65	60
Forage (alfalfa, hay)	<1	24	38
Canola	n/a	7	1
Field Peas	n/a	3	n/a[1]
Specialty (mustard, triticale)	n/a	<1	<1
Total	**<1**	**100**	**100**

[1] n/a = not applicable.

Livestock commonly raised within the Foothills Sub-basins include cattle, hogs, horses, sheep, bison, goats, llamas and alpacas, poultry, and bees. All of these species are raised within both MDs, with the exception of bees which are only kept within the MD of Willow Creek No. 26. Substantially fewer animals are raised within the MD of Ranchlands No. 66 where only cattle, horses and poultry are present in low numbers compared to the other municipalities.

Forest

Coniferous and deciduous forests cover approximately 20% of the Foothills Sub-basins. As in the Mountain Sub-basins, most of the coniferous trees are found in the higher elevations of the Sub-Alpine natural sub-region.

Approximately 94% of the Foothills Sub-basins is included within the C01, C02 and C5 Forest Management Units (FMUs). Almost 100% of the land designated within FMUs is encompassed in the C5 FMU with small areas in C01 and C02. The characteristics of forest harvesting, reforestation, fire, and management of mountain pine beetle (MPB) discussed in the Mountains Sub-basins apply to the Foothills Sub-basins.

The Foothills Sub-basins within the Green Zone has a carrying capacity of 29 708 animal unit months (AUMs) (C. Piccin, pers. comm.) on approximately 57 483 ha of public land, which are managed through 22 grazing dispositions.

The Willow Creek Forest Land Use Zones (FLUZ) is located in the northern portion of the Foothills Sub-basins. In Willow Creek, FLUZ access is restricted to only off-highway vehicles (OHVs) on designated trails. A large portion of the Porcupine Hills within the Foothills Sub-basins is also located within the

Livingstone Range (ESA #48) and Porcupine Hills (ESA #183) environmentally significant areas. Other protected areas include recreation areas, natural areas, ecological reserves and provincial parks (Figure 3.5). Combined, these protected areas cover approximately 1% of the Foothills Sub-basins (Table 3.4).

Shrubland

Shrubland covers approximately 8% of the Foothills Sub-basins. This land cover appears as discrete pockets interspersed within the grassland and deciduous forest and roughly corresponds to the Foothills Parkland Sub-region (Figure 3.2). Shrublands characterize the Porcupine Hills and the valleys of creeks and rivers.

Rock and Barren Land

Approximately 1% of the Foothills Sub-basins consists of the rock and barren land found on the high mountain elevations, as well as the Oldman Reservoir and other water bodies.

Urban Centers

The urban centres of Claresholm, Granum, Fort Macleod and Pincher Creek cover less than 1% of the Foothills Sub-basins.

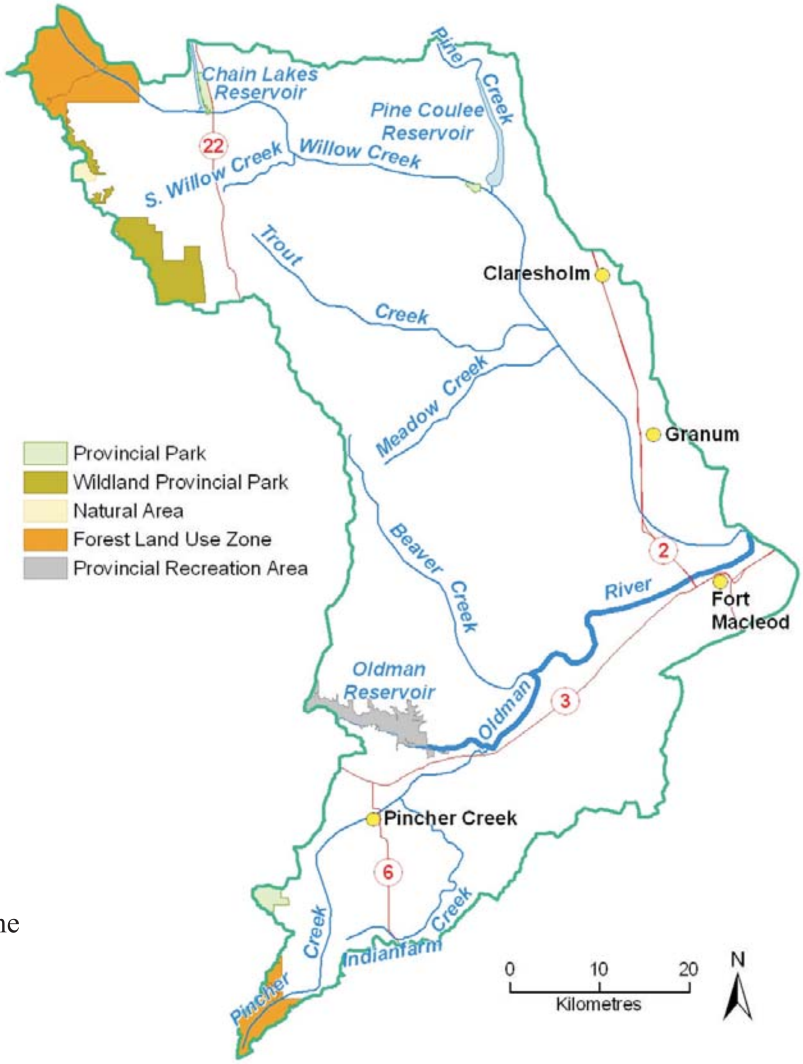


Figure 3.5: Parks, Protected Areas and Forest Land Use Zones in the Foothills Sub-basins

Table 3.4: Recreational Areas, Ecological Reserves and Parks

Protected Area Type	Name	Area (ha)
Provincial Recreation Area	13 different areas	3 013
Natural Area	Mt. Livingston	454
Provincial Park	Chain Lakes, Willow Creek, Beauvais Lake	1 283
Ecological Reserve	Plateau Mountain	33
Total		**4 783**

Soil Erosion

Soil erosion risk from wind and water is largely negligible over about 63% of the area of the Foothills Sub-basins (Figure 3.6). The risk rises to moderate in the agricultural areas around Claresholm and south of Fort Macleod, with low risk around Pincher Creek. The area within each risk category is shown in Table 3.5.

A number of erosion control techniques have been adopted within the Foothills Sub-basins. These include crop rotation, rotational grazing, windbreaks, buffer zones, winter cover crops, green manuring (plowing down green fields), and a combination of chemical weed control with either fallow or tillage practices, such as zero-till and mini-till. The various erosion control practices for two municipalities within the Foothills Sub-basins are described in Table 3.6.

Riparian Health

In the Foothills Sub-basins, 197 sites were reviewed as part of the Riparian Health Assessment Program. The results indicate that 14% are healthy, 63% are healthy but with problems, and 23% are unhealthy (Cows and Fish Program 2009). This is slightly better than the average in the Oldman watershed where 15% are healthy, 55% are healthy but with problems, and 30% are unhealthy; and also slightly better than the average measurements of riparian health throughout Alberta where 21% of Alberta's riparian areas are healthy, 51% are healthy with problems, and 28% are unhealthy (Fitch and Ambrose 2003).

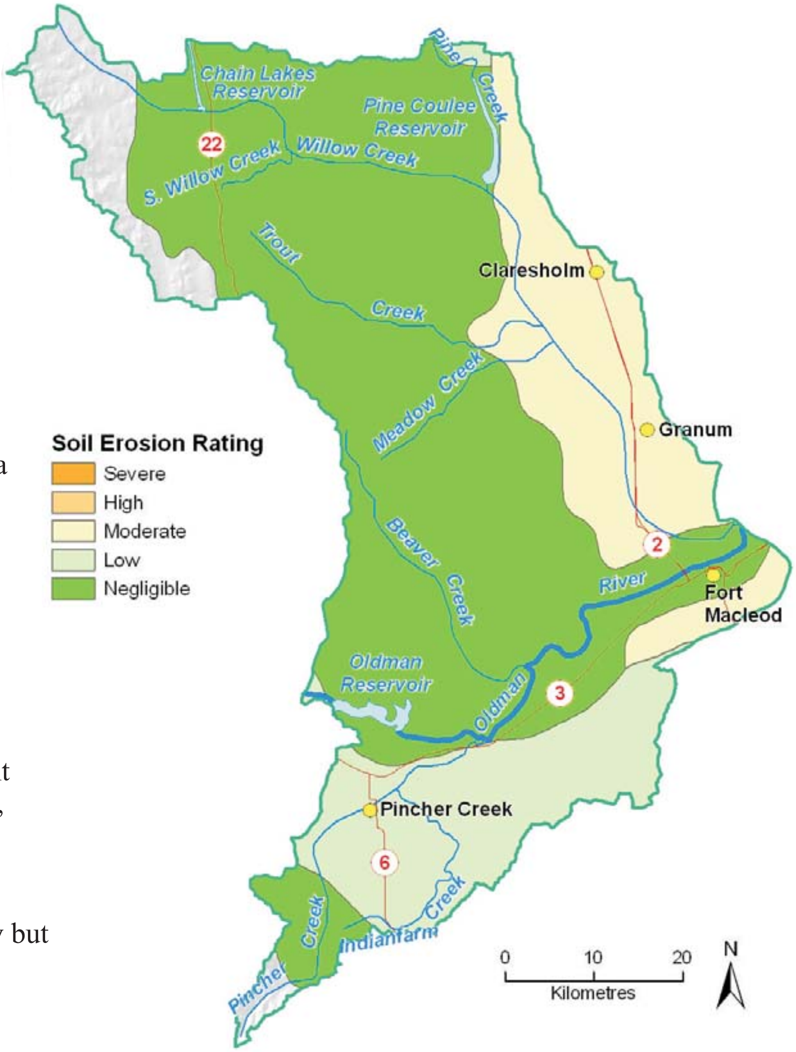


Figure 3.6: Soil Erosion Rating in the Foothills Sub-basins

Table 3.5: Soil Erosion Risk Area (ha)

Soil Erosion Risk Rating Class	Area (ha)	% of Total Area
Negligible	265 932	63
Low	61 847	14
Moderate	71 024	17
Not applicable (Alpine Rocky Mountain Natural Region)	25 682	6
Total	**424 485**	**100**

Table 3.6: Erosion Control Techniques by Municipality

Erosion Control Technique	MD of Willow Creek No. 26 (% of Farms[1])	MD of Pincher Creek No. 9 (% of Farms[1])
Crop rotation	27	43
Rotational grazing	32	57
Windbreaks or shelterbelts	26	52
Buffer zones around water bodies	11	25
Winter cover crops	4	6
Plowing down green fields	1	2
Weed Control:		
– chemfallow	49	0
– combined chemicals and tillage	38	0
– summerfallow only	13	20

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

Land Use

Human activities on the land create different disturbances throughout the Foothills Sub-basins; these are grouped into five general categories. The extent of disturbance with the Foothills Sub-basins is shown on Figure 3.7 and in Table 3.7.

Agriculture

Agricultural activities for producing cereal and forage crops affect about 37% of the area of the Foothills Sub-basins.

The Foothills Sub-basins, outside the Forest Reserve, has a carrying capacity of about 54 733 AUMs on 53 708 ha for publicly-managed lands. These are divided into 171 grazing dispositions (C. Piccin, pers. comm.). In Table 3.7, the category "grazing – seeded" includes public lands that have been disturbed. As well, five dispositions have been issued for farm development leases, and account for 272 ha.

The majority of the 60 confined feeding operations (CFOs) are located in the vicinity of Fort Macleod and Granum (Figure 3.8). Minimal information is available on the number of animals contained by these operations. Since 2002, approvals for CFOs have been issued by the Natural Resources Conservation Board (NRCB).

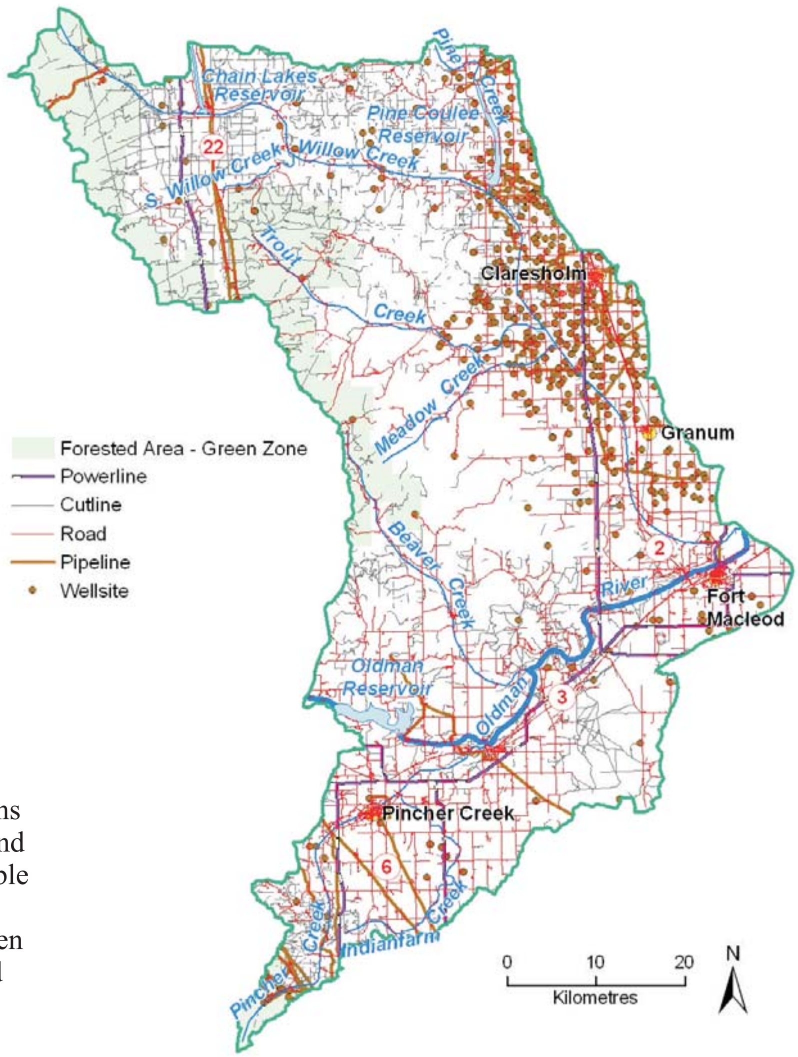


Figure 3.7: Land Use – Foothills Sub-basins

Table 3.7: Land Use in the Foothills Sub-basins

Disturbance	Length (km)	km/km^2	Total Area Disturbed (ha)	% of Total Area
Agriculture				
Crops			115 352	27
Summerfallow			4 043	1
Grazing - seeded			36 508	9
Irrigation[1]			10 221	2[1]
Subtotal			*155 903*	*37*
Infrastructure				
Roads	3 102	0.75	3 763	0.9
Railways	139	0.03	97	<0.1
Powerlines	170	0.04	341	0.1
Pipelines	413	0.10	1 240	0.3
Cutlines	3 182	0.77	2 228	0.5
Wells – oil and gas			605	0.1
Wells – water			2 203	0.5
Airfields and runways			81	0.1
Sewage lagoons			345	0.1
Gravel pits			0	0
Subtotal			*10 903*	*2.6*
Urban				
Residential, commercial and light industrial developments			4 215	1
Recreation				
Parks and campgrounds			90	<0.1
Surface Water Supply Sources				
Reservoirs			2 008	0.5
Total Disturbance			**173 119**	**40**

[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.)

Farming Along Indianfarm Creek – ARD

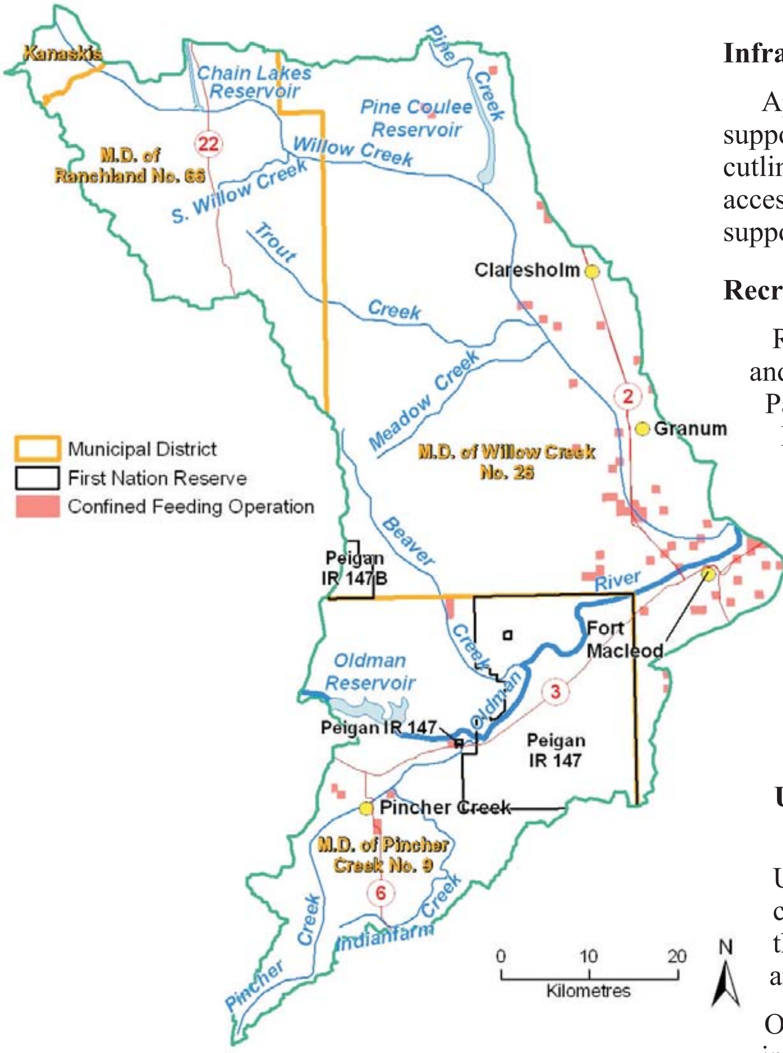


Figure 3.8: Confined Feeding Operations in the Foothills Sub-basins

Infrastructure

Approximately 2.6% of the Foothills Sub-basins supports human infrastructure made up of roads, cutlines and pipelines. Most of the roads are used to access wellsites and pipeline facilities, while cutlines support exploration activities.

Recreation

Recreational activities such as camping, fishing and hiking occur within Chain Lakes Provincial Park, located at the south end of Chain Lakes Reservoir and within Willow Creek Provincial Park northwest of Claresholm. Less than 1% of the Foothills Sub-basins is designated for recreational activities. However, extensive random recreational activities also occur throughout the Porcupine Hills.

Surface Water Supply Sources

The Oldman, Chain Lakes and Pine Coulee reservoirs occupy <1% of the area.

Urban

Urban development affects 1% of the land. Urban development includes residential, commercial and light industrial activities within the towns of Claresholm, Granum, Fort Macleod and Pincher Creek.

Overall population has increased 2% due to growth in Claresholm (Table 3.8). The community of Granum experienced the greatest increase since

Table 3.8: Population of Municipalities Within Foothills Sub-basins

Municipality	1996	2006	% Population Change (1996 to 2006)
Claresholm	3 427	3 700	8
Granum	337	415	23
Fort Macleod	3 034	3 072	1
Pincher Creek	3 659	3 625	<1
Ranchland No. 66	108	86	-20
Willow Creek No. 26	5 106	5 337	4
Pincher Creek No. 9	3 172	3 309	4
Peigan (North Piikani) Indian Reserve No. 147	1 662	1 300	-22
Total	**20 505**	**20 844**	**2**

1996 showing a 23% population change. In contrast, Pincher Creek's population declined slightly (<1%), during the same period. At the municipal level, Ranchland No. 66 decreased during this 10-year period while Willow Creek No. 26 and Pincher Creek No. 9 both increased by 4%. The population on the Peigan (North Piikani) Indian Reserve 147 declined 22% between 1996 and 2006.

Total Land Use

Approximately 40% of the Foothills Sub-basins is altered by human development. Agricultural activities comprise the largest component (37%), followed by linear developments such as roads, pipelines and cutlines (2.6%). Recreational developments, industrial activities, surface water supply sources and urban development combine to produce the remaining 1% of disturbance.

3.1.2 Water Quantity

The Foothills Sub-basins have been divided into four sub-basins to identify flows and assess trends in natural and recorded flows (Figure 3.1). These are Willow Creek, Beaver Creek, Pincher Creek sub-basins and an ungauged area that flows directly into the Oldman mainstem. Information on this ungauged area is provided in Chapter 6 Oldman River mainstem. Five long-term natural flow hydrometric stations (Figure 3.9) are located in the Foothills Sub-basins: three on Willow Creek, one on Beaver Creek and one on Pincher Creek. These are:

- Willow Creek above Chain Lakes Reservoir
- Willow Creek near Claresholm;
- Willow Creek near Nolan[3];
- Beaver Creek near Brocket; and
- Pincher Creek at Pincher Creek.

The analysis of streamflow characteristics and water quantity indicators was conducted for the latter four stations. Supplemental information on trends is provided for Willow Creek above Chain Lakes Reservoir. 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.

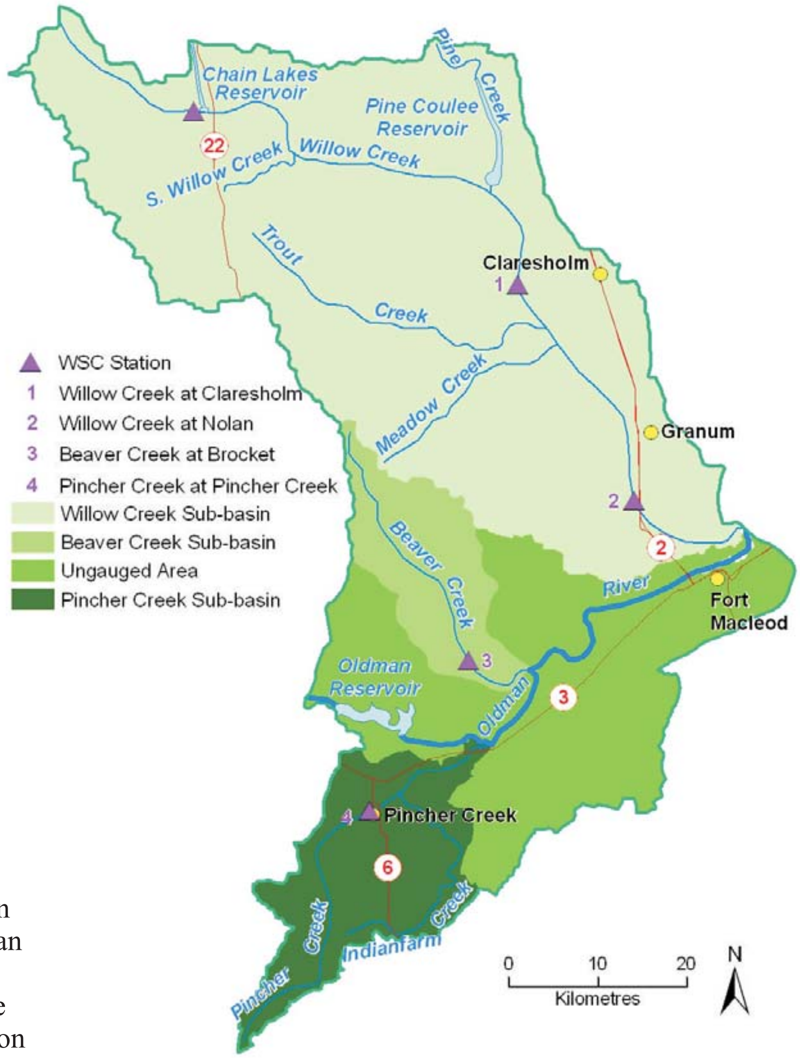


Figure 3.9: WSC Stations in the Foothills Sub-basins

Cattle Drive – ARD

[3] Nolan was a hamlet at one time, but is no longer identified as such. The WSC hydrometric station still goes by that name.

Hydrologic Characteristics

Willow Creek

Water use from Willow Creek upstream of the Chain Lakes Reservoir is low, and the hydrometric station in that stretch of the creek essentially records natural flow. The period of recorded flows for this station is 1965 to 1995. Alberta Environment (AENV) has extended the record to the standard period, 1912 to 2001, using statistical methods.

Since 1966, when the Chain Lakes Reservoir was built, flows on Willow Creek near Claresholm and Nolan have been regulated. Pine Coulee Reservoir, offstream, was built in 1999 and further regulates flows on the creek. Mean natural and recorded flows at each of the two lower stations (near Claresholm and near Nolan) show very little difference for the most recent 10-year period for which natural flows are available (1992 to 2001) (Figures 3.10 and 3.11).

The monthly distribution of flows at all three Willow Creek stations are typical of foothills region streams with peak flows occurring in late May or early June and very low winter flows. Willow Creek at Claresholm has considerably higher yields than the Nolan station. Nolan has a higher percentage of its drainage area in the low yielding grassland area.

Willow Creek near Claresholm

Gross DA	km^2	1180
Effective DA	km^2	1120
Natural Discharge 1912-2001		
Mean Annual	dam^3	101,562
Upper Quartile	dam^3	129,328
Median	dam^3	80,484
Lower Quartile	dam^3	46,170
Median Yield		
Gross DA	dam^3/km^2	68.2
Effective DA	dam^3/km^2	71.9

DA = Drainage Area

Mean Discharge of Willow Creek near Claresholm, 1992-2001.

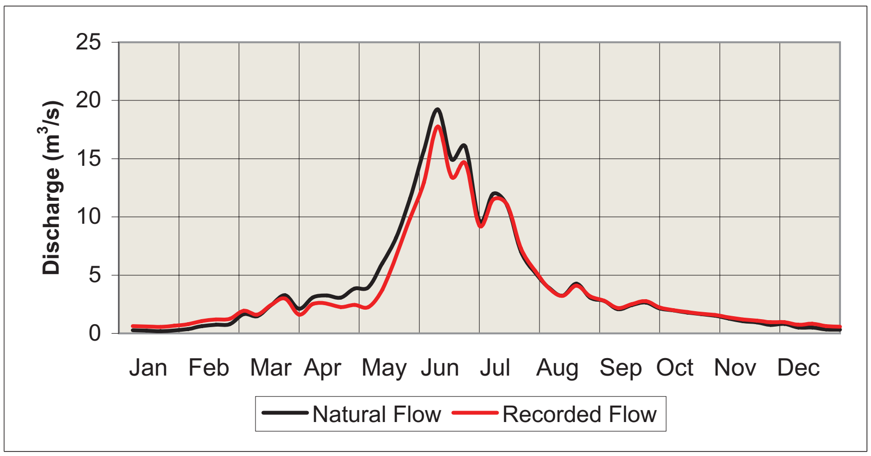


Figure 3.10: Hydrologic Characteristics – Willow Creek Near Claresholm

Willow Creek near Nolan

Gross DA	km^2	2290
Effective DA	km^2	2080
Natural Discharge 1912-2001		
Mean Annual	dam^3	137,979
Upper Quartile	dam^3	169,065
Median	dam^3	101,908
Lower Quartile	dam^3	61,088
Median Yield		dam^3/km^2
Over Gross DA		44.5
Over Effective DA		49.0

DA = Drainage Area

Mean Discharge of Willow Creek near Nolan, 1992-2001.

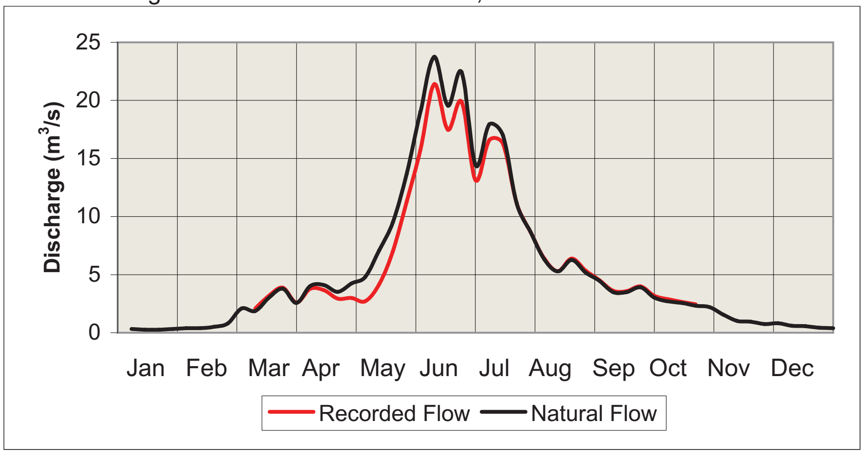


Figure 3.11: Hydrologic Characteristics – Willow Creek Near Nolan

Based on the slope of trend lines, annual flows on Willow Creek are decreasing by an average 0.3% per year near Claresholm and by 0.4% per year near Nolan (Figure 3.12), based on records from 1912 to 2001. However, these decreases do not represent statistically significant trends. On a monthly basis, a significant decrease in flows is observed in April at all three Willow Creek stations; in November near Nolan; as well as in January and July above Chain Lakes. The station above Chain Lakes shows stronger tendencies towards decreasing flows than the two stations further downstream.

Willow Creek near Nolan

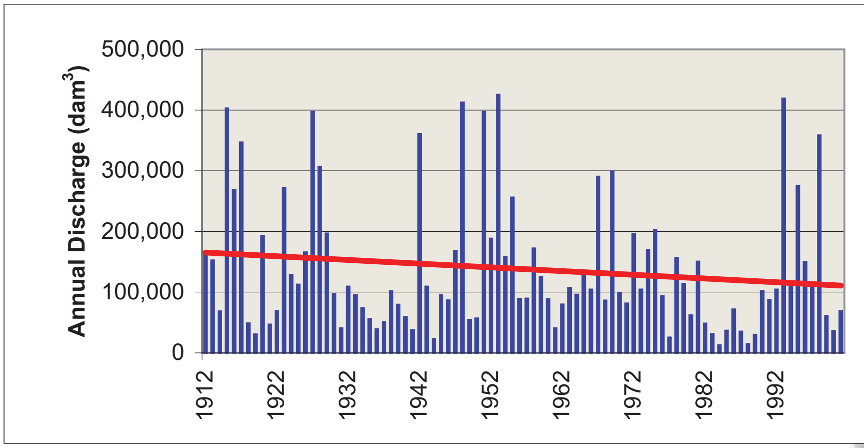
Mann-Kendall Trend Analysis

	MK Stat	p-value
Annual	-1.37	0.17
Jan	-0.38	0.70
Feb	1.18	0.24
Mar	-0.42	0.67
Apr	-3.04	0.00
May	-0.95	0.34
Jun	-1.17	0.24
Jul	-1.14	0.25
Aug	-0.52	0.60
Sep	-0.61	0.54
Oct	-1.41	0.16
Nov	-3.00	0.00
Dec	-1.73	0.08

Significant Trend (yellow: Apr 0.00, Nov 0.00)

Probable Trend (green: Dec 0.08)

Annual Natural Flow Volumes and Linear Trend Line.



Average annual decrease in flow = 610 dam^3 based on trend line slope.

Figure 3.12: Trends in Natural Flow – Willow Creek Near Nolan

Beaver Creek – S. Palechek

Beaver Creek

Water uses in Beaver Creek sub-basin are low. Natural and recorded flows are essentially the same (Figure 3.13). This sub-basin also shows a flow profile that is typical of a foothills stream with peak flows occurring in June. Unlike Willow Creek, Beaver Creek is not regulated and flows are highly variable year-to-year.

Beaver Creek flows show prolonged droughts in the 1930s and 1980s. Annual flow volumes show a significant decrease averaging 0.5% per year over the period from 1912 to 2001. Significant decreasing trends are indicated in every month except March, June and August (Figure 3.14).

Beaver Creek near Brocket

Gross DA	km^2	256
Effective DA	km^2	256
Natural Discharge 1912-2001		
Mean Annual	dam^3	7667
Upper Quartile	dam^3	9686
Median	dam^3	5356
Lower Quartile	dam^3	3371
Median Yield		
Gross DA	dam^3/km^2	20.9
Effective DA	dam^3/km^2	20.9

Mean Discharge of Beaver Creek near Brocket, 1992-2001

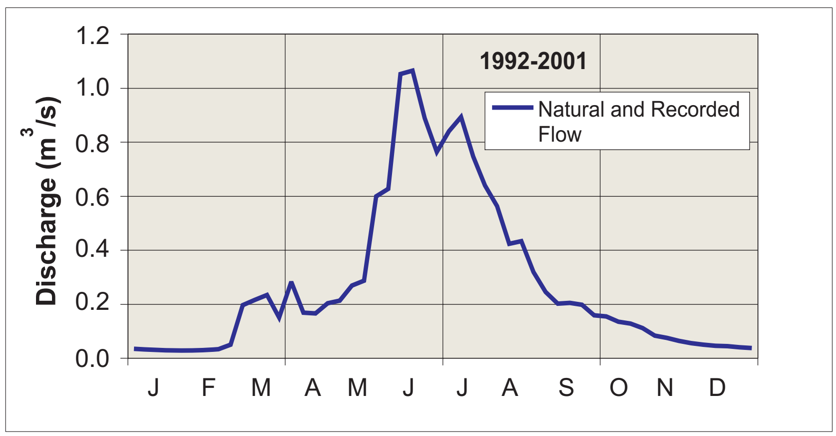


Figure 3.13: Hydrologic Characteristics – Beaver Creek Near Brocket

Beaver Creek near Brocket

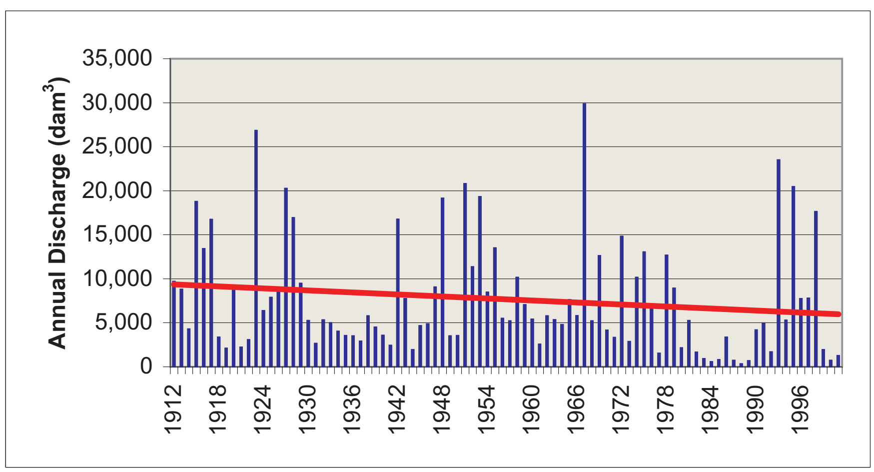
Mann-Kendall Trend Analysis

	MK Stat	p-value
Annual	-2.28	0.02
Jan	-3.35	0.00
Feb	-3.23	0.00
Mar	-1.46	0.15
Apr	-3.37	0.00
May	-1.92	0.05
Jun	-1.43	0.15
Jul	-2.13	0.03
Aug	-1.92	0.06
Sep	-2.76	0.01
Oct	-3.23	0.00
Nov	-3.34	0.00
Dec	-3.34	0.00

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line.



Average annual decrease in flow = 38 dam^3 based on trend line slope.

Figure 3.14: Trends in Natural Flow – Beaver Creek Near Brocket

Pincher Creek

As with the other gauged sub-basins in the Foothills Sub-basins, flow in Pincher Creek peaks in June. This sub-basin is unregulated, and flow patterns are similar to those observed in Beaver Creek sub-basin. The recorded and natural flows are approximately the same (Figure 3.15). A trend analysis indicates that flows are decreasing in all months, but there is a significant decreasing trend only during the months of April, November and December. The annual volumes are decreasing at a statistically non-significant rate of 0.3% per year (Figure 3.16).

Pincher Creek at Pincher Creek

Gross DA	km^2	158
Effective DA	km^2	158
Natural Discharge 1912-2001		
Mean Annual	dam^3	33,598
Upper Quartile	dam^3	40,226
Median	dam^3	28,938
Lower Quartile	dam^3	21,193
Median Yield		
Gross DA	dam^3/km^2	183.2
Effective DA	dam^3/km^2	183.2

DA = Drainage Area

Mean Discharge of Pincher Creek near Pincher Creek, 1992-2001.

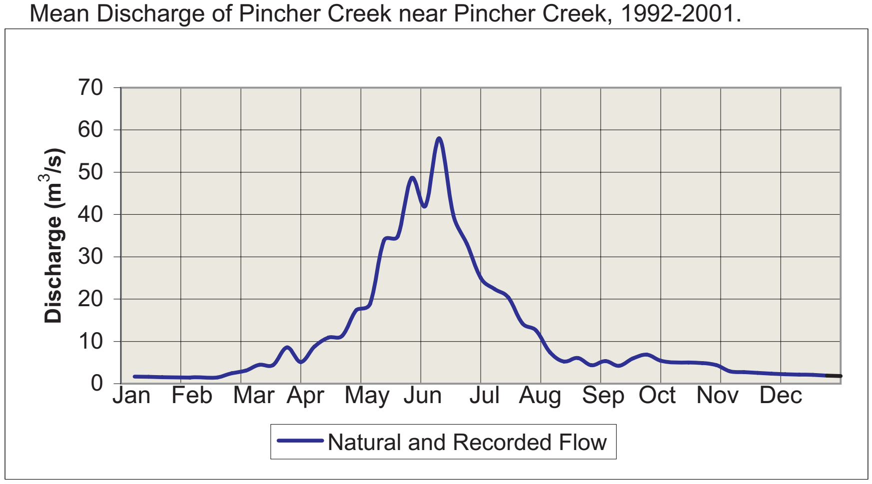


Figure 3.15: Hydrologic Characteristics – Pincher Creek at Pincher Creek

Pincher Creek at Pincher Creek

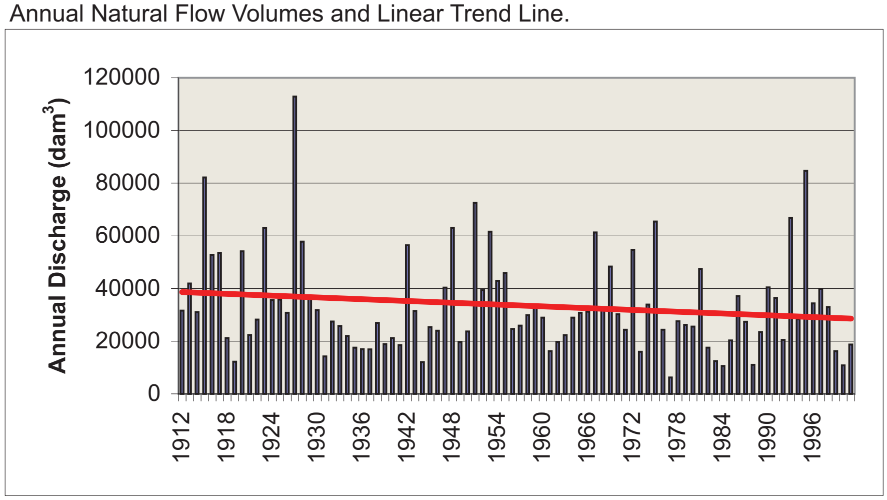
Mann-Kendall Trend Analysis

	MK Stat	p-value
Annual	-1.29	0.20
Jan	-1.84	0.07
Feb	-1.36	0.18
Mar	-0.60	0.55
Apr	-2.08	0.04
May	-1.08	0.28
Jun	-1.38	0.17
Jul	-0.52	0.60
Aug	-0.84	0.40
Sep	-0.89	0.38
Oct	-0.93	0.35
Nov	-1.92	0.05
Dec	-1.93	0.05

Significant Trend (Apr, Nov, Dec highlighted)

Probable Trend (Jan highlighted)

Annual Natural Flow Volumes and Linear Trend Line.



Average annual decrease in flow = 113 dam^3 based on trend line slope.

Figure 3.16: Trends in Natural Flow – Pincher Creek at Pincher Creek

Licensed Allocation and Actual Use

Willow Creek Sub-basin

Water is used for agricultural, municipal, commercial, industrial, and other uses (including evaporative losses at Pine Coulee, Diversion Pond, and Chain Lakes) within the Willow Creek sub-basin. Upstream of Claresholm, allocations are about 11% of natural flows. This increases downstream of Claresholm and near Nolan where approximately 25% of natural flow is allocated to users. Less than 10% of the natural flows are actually used upstream of Claresholm, while over 21% are used upstream of Nolan.

The largest user of water is the agricultural sector, with water being used primarily for irrigation (Figures 3.17 and 3.18). Irrigation accounts for about 55% of the allocated water upstream of Claresholm and 82% upstream of Nolan. Irrigation is 52% and 81% of estimated actual water use upstream of Claresholm and Nolan, respectively. Actual water withdrawal in the Willow Creek sub-basin is estimated to be about 80 to 85% of total allocations.

Willow Creek near Claresholm

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	4851	3976
Other Agric.	499	374
Municipal	1444	1227
Commercial	124	124
Industrial	0	0
Other	1949	1949
Totals	8,866	7,650
% of median flow	11.0%	9.5%

Distribution of Water Allocation and Actual Use by Purpose.

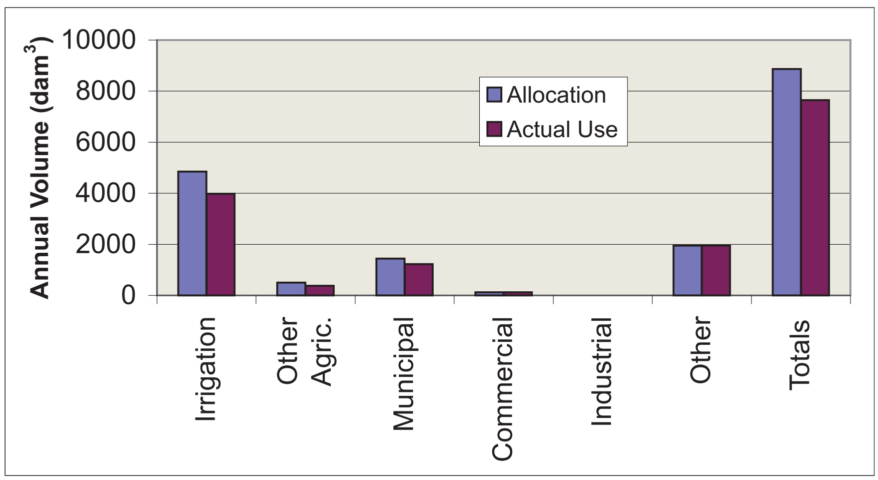


Figure 3.17: Water Allocation and Actual Use – Willow Creek Upstream of Claresholm

Willow Creek near Nolan

Purpose Sector	Allocation dam^3	Actual Withdrawal dam^3
Irrigation	21,160	17,343
Other Agric.	932	699
Municipal	1,629	1,332
Commercial	134	134
Industrial	-	-
Other	1,991	1,991
Totals	25,846	21,499
% of median flow	25.4%	21.1%

Distribution of Water Allocation and Actual Use by Purpose.

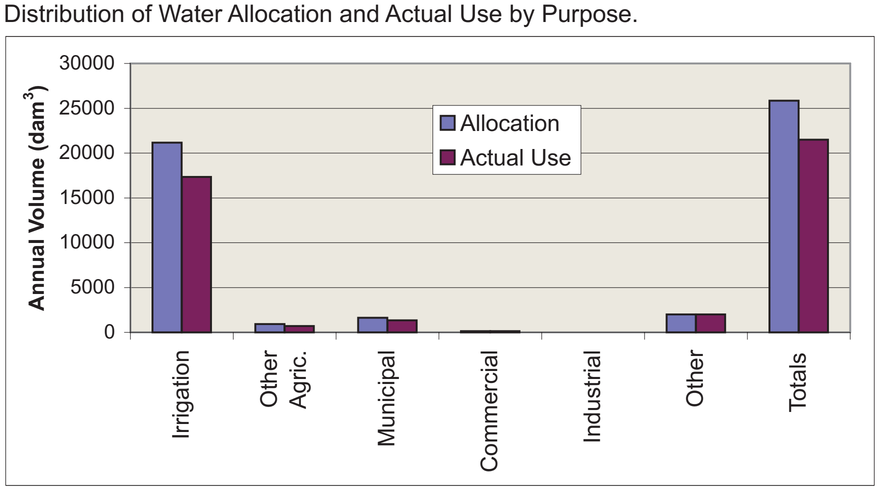


Figure 3.18: Water Allocation and Actual Use – Willow Creek Upstream of Nolan

Within the Willow Creek sub-basin, flows needed to meet the existing water uses, to provide sufficient water to meet the Instream Objectives (IO) or the Water Conservation Objectives (WCO), were assessed near Claresholm and near Nolan[4] (Figures 3.19 and 3.20). Near Claresholm, recorded flows fell short of the IO about 11% of the months assessed, and near Nolan, about 5% of the months assessed (April to September only). At both stations, WCO deficits occurred about 18% of the months assessed. For both stations, deficits to the IOs and WCOs occurred more frequently after 1999, when diversions to Pine Coulee Reservoir began. This may have occurred due to first-time filling of the Pine Coulee Reservoir.

Willow Creek near Claresholm

WCO = max(0.45 Qnat or 1.1(IO)) m^3/s
IO = 0.40 m^3/s Sept to June
= 0.79 m^3/s July, August

Comments:
1 IO deficits in 10.8% of the months
2 WCO deficits in 17.5% of the months

Performance in meeting the IO and WCO

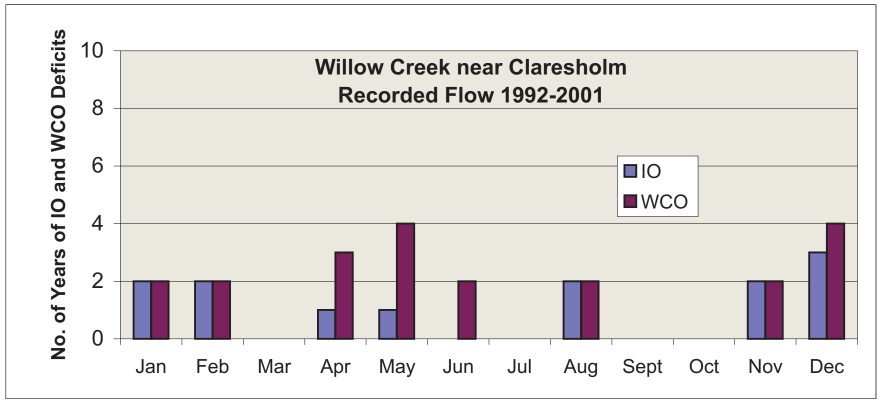


Figure 3.19: Performance in Meeting IOs and WCOs – Willow Creek Near Claresholm

Willow Creek near Nolan

WCO = MAX(0.45Qnat or 1.1(IO)) m^3/s
IO = 0.40 m^3/s Sept to June
= 0.79 m^3/s July, August

Comments:
1 Performance assessment is limited to months of April to September due to availability of recorded data.
2 IO deficits in 5.0% of the months assessed.
3 WCO deficits in 18.3% of the months assessed.
4 Ten of the 11 monthly deficits to the WCO occurred since 1999 when diversions to Pine Coulee began.

Performance in Meeting the WCO and IO, April to September 1992-2001

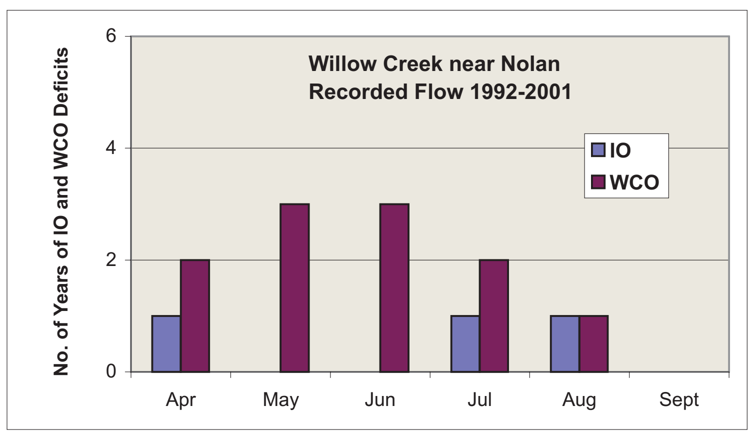


Figure 3.20: Performance in Meeting IOs and WCOs – Willow Creek Near Nolan

[4] IOs, WCOs, and IFNs are described in Section 1.2.7. Generally, the recommended WCO is 45% of the natural flow or the existing IO plus 10%, whichever is greatest at any point in time. These values vary for different reaches of each stream, and usually vary seasonally. The actual IO or WCO used to assess performance is shown on the appropriate figure. The months where data was available to assess performance is also shown on the appropriate figure.

Beaver Creek Sub-basin

The primary water use in the Beaver Creek sub-basin is irrigation (Figure 3.21), which accounts for 86% of total allocations and 87% of actual water use. Water actually withdrawn from the sub-basin is about 81% of total allocations. Approximately 12% of the natural flow is allocated, while the estimated actual use is just under 10% of the natural flow.

Within the Beaver Creek sub-basin, flows were less than IO flows in about 38% of the months assessed, much more frequently than occurrences in the Willow Creek sub-basin. Similarly, WCO deficits were observed in 40% of the months that were assessed. Deficits were most frequent in late summer months (Figure 3.22).

Beaver Creek near Brocket

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	547	448
Other Agric	91	68
Municipal	0	0
Commercial	0	0
Industrial	0	0
Other	0	0
Totals	638	516
% of median flow	11.9%	9.6%

Distribution of Water Allocation and Actual Use by Purpose.

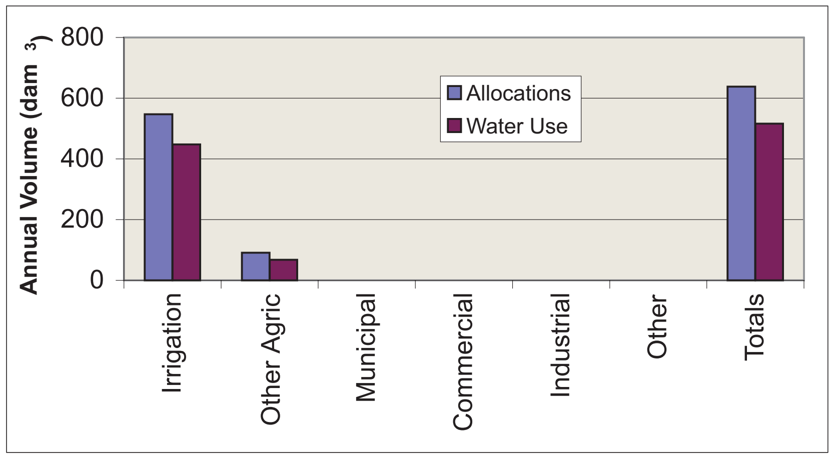


Figure 3.21: Water Allocation and Actual Use – Upstream of Beaver Creek Near Brocket

Beaver Creek near Brocket

WCO = MAX(0.45Qnat or 1.1(IO)) m^3/s

IO = 0.11 m^3/s

Comments:

1 Performance assessment is limited to months of April to September due to availability of recorded data.
2 IO deficits occurred in 38.3% of the months assessed.
3 WCO deficits occurred in 40.0% of the months assessed
4 Deficits are most numerous in the late summer months.

Performance in Meeting the WCO and IO from April to September, 1992 - 2001

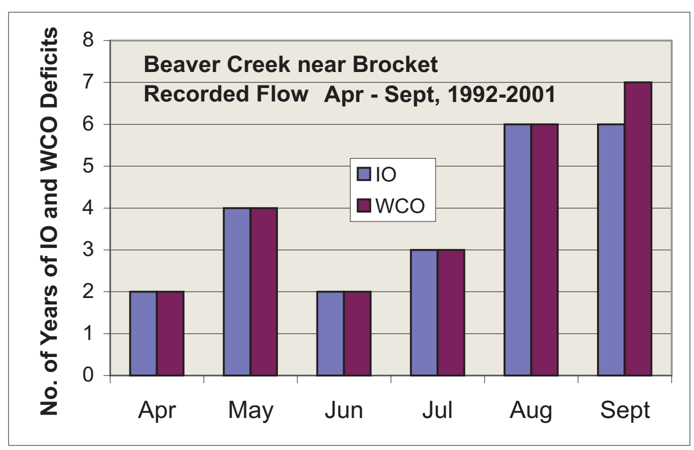


Figure 3.22: Performance in Meeting IOs and WCOs – Beaver Creek Near Brocket

Pincher Creek Sub-basin

While the primary water use in the Pincher Creek sub-basin is irrigation (Figure 3.23), other uses include municipal, commercial and other agriculture. Actual irrigation uses are about 86% of the total allocations. The Town of Pincher Creek is authorized to withdraw water from both the Castle River and Pincher Creek; in 2006, approximately 65% of the town's municipal water came from Pincher Creek.

The total allocations in this sub-basin equate to about 7% of the median natural flow. Estimated actual use is just over 5% of the median natural flow.

Flows less than WCO flows were observed at frequencies similar to that seen in the Beaver Creek sub-basin. Deficits were most frequent in the early spring and late summer months (Figure 3.24). Instream objectives deficits were infrequent, at about 4% of the months assessed.

Pincher Creek at Pincher Creek

Purpose Sector	Allocation dam^3	Actual Withdrawal dam^3
Irrigation	429	352
Other Agric.	244	183
Municipal	815	478
Commercial	519	519
Industrial		
Other	28	28
Totals	2035	1560
% of median flow	7.0%	5.4%

Distribution of Water Allocation and Demand by Purpose.

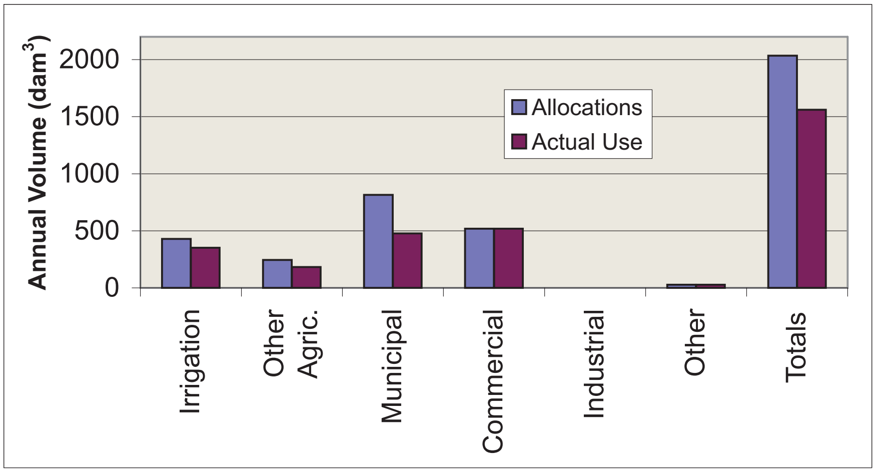


Figure 3.23: Water Allocation and Actual Use – Pincher Creek at Pincher Creek

Pincher Creek at Pincher Creek

IO is variable by week. Average IO is 0.55m^3/s

WCO = MAX(0.45Qnat or 1.1(IO)) m^3/s

Comments:

1 Performance assessment is limited to months of March to October due to availability of recorded data.
2 IO deficits occurred in 4.4% of the months assessed.
3 WCO deficits occurred in 42.3% of the months assessed.
4 Deficits are most numerous in spring and late summer.

Performance in Meeting the WCO and IO from April to September, 1992-2001

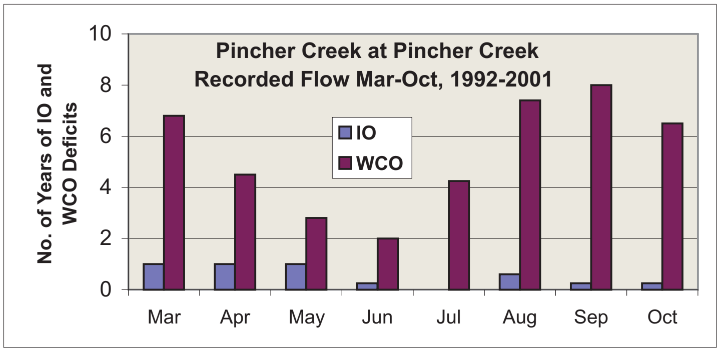


Figure 3.24: Performance in Meeting IOs and WCOs – Pincher Creek at Pincher Creek

Irrigation and Municipal Water Use

There are no irrigation districts within the Foothills Sub-basins. All irrigation projects are individually licensed private developments. The Lethbridge Northern Headworks Diversion Weir is located on the Oldman River in the reach of the river encompassed within the Foothills Sub-basins. Diversions from this weir to the Lethbridge Northern Irrigation District (LNID) are addressed as part of the Oldman River mainstem (Chapter 6).

Assessment of irrigation and municipal water use efficiency is completed for the Oldman watershed as a whole in Section 7.3. This involves nine irrigation districts and all urban municipalities using surface water. Communities using surface water in the Foothills Sub-basins are:

- Claresholm;
- Granum; and
- Pincher Creek.

3.1.3 Water Quality

Water quality monitoring stations are located throughout the Foothills Sub-basins (Figure 3.25), and data collected between 1982 and 2006 have been used for this report. Data collection intensity increased around 1998 for a number of parameters, including nitrogen, phosphorus, total suspended solids (TSS), and fecal coliforms. The increase in the number of collection sites and sampling frequencies was related to construction and subsequent initiation of operation of the Pine Coulee Reservoir (1998 to 1999), the potential impact of the reservoir on Willow Creek, and to broader concerns about the potential effects on water quality from increasing agricultural activities.

In some cases, data from stations located close to each other but sampled at different time were combined within the reaches to improve statistical analysis. Both individual and combined stations were assessed for annual trends and loadings within the sub-basins.

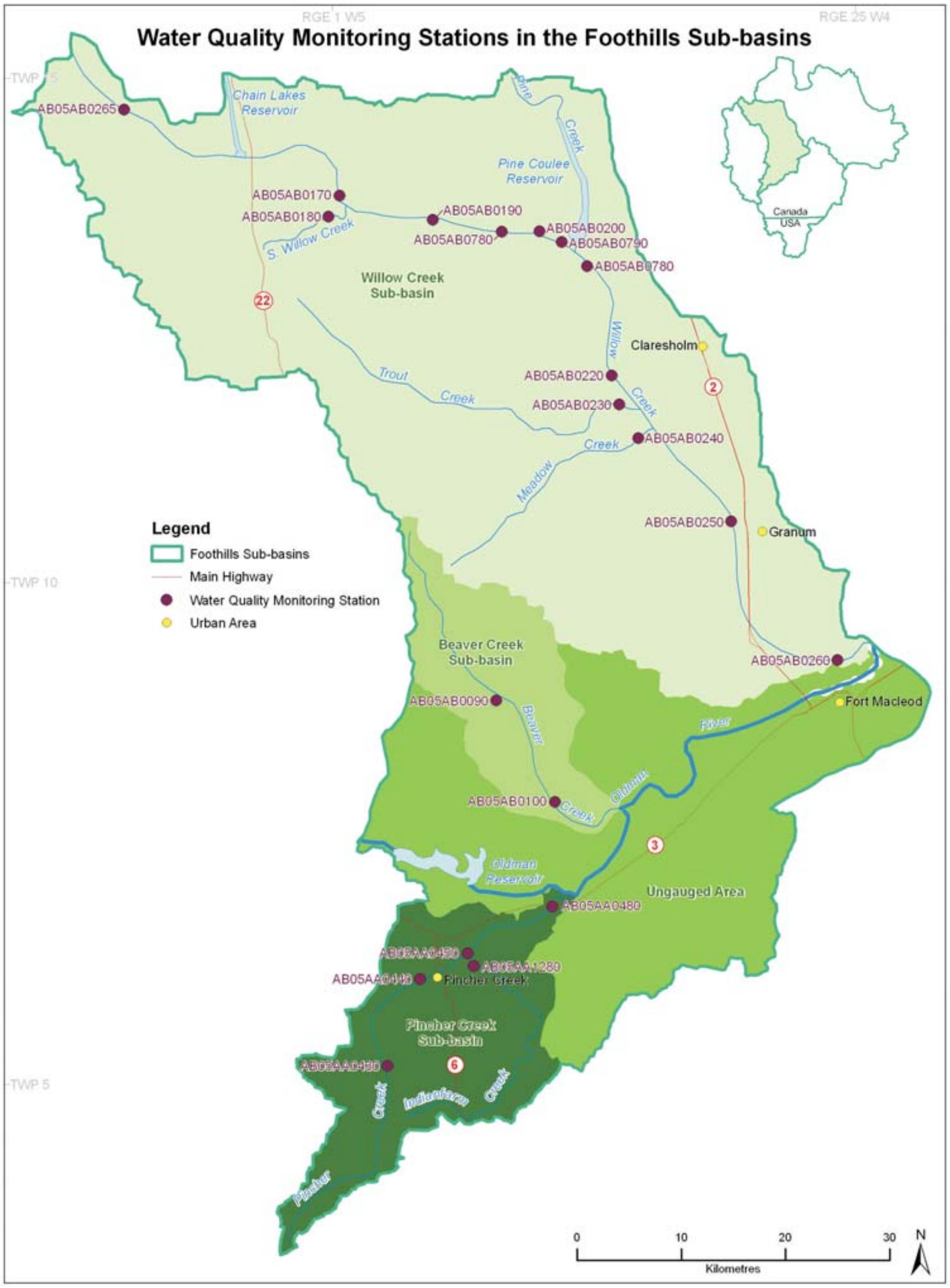


Figure 3.25: Water Quality Monitoring Stations – Foothills Sub-basins

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

Total Nitrogen

Data availability for total nitrogen is shown in Appendix D. Total nitrogen concentrations in surface water are fairly consistent within the Foothills Sub-basins. Table 3.9 shows where exceedances of the guideline occur for nitrogen (1.0 mg/L). Exceedances are relatively rare and have generally increased randomly and in smaller tributaries.

Table 3.9: Annual Median Total Nitrogen (mg/L) Guideline Adherence by Site

Monitoring Sites / Years	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
AB05AB0170-WILLOW CREEK D/S OF CHAIN LAKES									< 1.0	< 1.0																		
AB05AB0180-SOUTH WILLOW CREEK NEAR THE MOUTH									< 1.0	< 1.0																		
AB05AB0190-WILLOW CREEK BELOW LANE CREEK														< 1.0	< 1.0	< 1.0												
AB05AB0200-WILLOW CREEK ABOVE HWY 527									< 1.0	< 1.0																		
AB05AB0265-WILLOW CREEK WEST OF HWY 22 ON HWY 532																		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	
AB05AB0770-WILLOW CREEK U/S OF PINE COULEE DIVERSION																	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	
AB05AB0780-WILLOW CREEK D/S OF PINE COULEE RESERVIOR OUTLET																	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	
AB05AB0790-WILLOW CREEK AT WILLOW CREEK PROVINCIAL PARK																		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0					
AB05AB0220-WILLOW CREEK ABOVE CLARESHOLM WATER INTAKE									< 1.0	< 1.0							< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0					
AB05AB0250-WILLOW CREEK AT SEC HWY 519									< 1.0	< 1.0								< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0					
AB05AB0260-WILLOW CREEK AT SEC HWY 811			< 1.0	< 1.0 *					< 1.0	< 1.0	< 1.0	< 1.0 *		< 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	< 1.0	
TROUT CREEK									< 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		
MEADOW CREEK														< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			
BEAVER CREEK	< 1.0		< 1.0							< 1.0 *							< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.0 - 5.0 *	> 5.0 *				
PINCHER CREEK	< 1.0		< 1.0							< 1.0	< 1.0	1.0 - 5.0 *		< 1.0 *	< 1.0 *	1.0 - 5.0 *	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0				
INDIAN FARM CREEK	< 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

Exceedances occurred in Beaver Creek in 2005, and earlier in late 1990s in Pincher Creek sub-basins. This was likely related to an increase in total nitrogen concentrations as a result of flooding during very high runoff. In June 2005, Beaver Creek recorded the second highest mean daily flow (26.3 m^3/s).

Total nitrogen loadings for 1999, 2001 and 2004 are shown for all three sub-basins (Figure 3.26). Total nitrogen loadings are consistently higher in the upstream reach of Willow Creek compared to its lower portion in all years presented. The temporal changes in loadings between years in Pincher Creek and Beaver Creek have the same pattern with the highest loadings in 1991 and the lowest observed in 2000. Over these three representative years, the lowest loadings were observed in Beaver Creek, followed by Pincher Creek, and the highest in Lower Willow Creek.

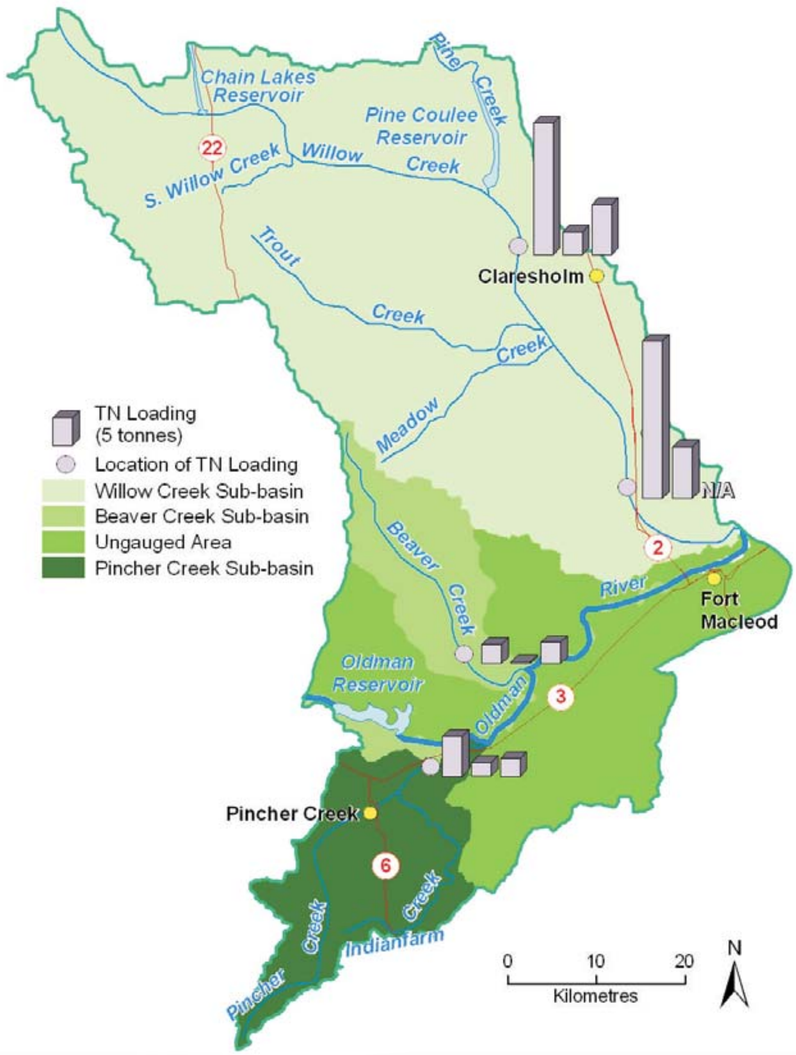


Figure 3.26: Total Nitrogen Loading in Foothills Sub-basins – 1999, 2000 and 2004

Oldman River Valley East of Oldman Dam – R. Coffey

Phosphorus

Phosphorus data were only collected on Pincher Creek and Beaver Creek for a short period of time (Appendix D). As a result, gaps in some data records were handled by combining data from stations within river reaches in these sub-basins.

Based on annual median values, total phosphorus concentrations were generally below the guideline of 0.05 mg/L, as shown in Table 3.10. Meadow Creek, in the Willow Creek sub-basin, and Beaver Creek consistently had phosphorus concentrations above the guideline level. The rest of the Foothills Sub-basins show fewer exceedances for total phosphorus, which occurred prior to the end of 1990s.

Table 3.10: Annual Median Total Phosphorus (mg/L) Guideline Adherence by Site

Monitoring Sites / Years	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
AB05AB0170-WILLOW CREEK D/S OF CHAIN LAKES									< 0.05	< 0.05																		
AB05AB0180-SOUTH WILLOW CREEK NEAR THE MOUTH									< 0.05	< 0.05																		
AB05AB0190-WILLOW CREEK BELOW LANE CREEK														0.05 - 1.00	0.05 - 1.00	< 0.05												
AB05AB0200-WILLOW CREEK ABOVE HWY 527									< 0.05	< 0.05																		
AB05AB0265-WILLOW CREEK WEST OF HWY 22 ON HWY 532																		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	
AB05AB0770-WILLOW CREEK U/S OF PINE COULEE DIVERSION																	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	
AB05AB0780-WILLOW CREEK D/S OF PINE COULEE RESERVIOR OUTLET																	0.05 - 1.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	
AB05AB0790-WILLOW CREEK AT WILLOW CREEK PROVINCIAL PARK																		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05					
AB05AB0220-WILLOW CREEK ABOVE CLARESHOLM WATER INTAKE									< 0.05	< 0.05							< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05					
AB05AB0250-WILLOW CREEK AT SEC HWY 519									< 0.05	< 0.05								< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05					
AB05AB0260-WILLOW CREEK AT SEC HWY 811			< 0.05	< 0.05 *					< 0.05	< 0.05	< 0.05	< 0.05 *		< 0.05 *	< 0.05 *	0.05 - 1.00 *	0.05 - 1.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	
TROUT CREEK									< 0.05	< 0.05				0.05 - 1.00	0.05 - 1.00	< 0.05		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05		
MEADOW CREEK														0.05 - 1.00	0.05 - 1.00	0.05 - 1.00		0.05 - 1.00	0.05 - 1.00	0.05 - 1.00	0.05 - 1.00	0.05 - 1.00	0.05 - 1.00	0.05 - 1.00	0.05 - 1.00			
BEAVER CREEK	0.05 - 1.00		< 0.05							0.05 - 1.00 *							0.05 - 1.00	< 0.05	0.05 - 1.00	0.05 - 1.00	< 0.05	< 0.05	0.05 - 1.00 *	0.05 - 1.00 *				
PINCHER CREEK	< 0.05		0.05 - 1.00							< 0.05	< 0.05	0.05 - 1.00 *		0.05 - 1.00 *	< 0.05 *	0.05 - 1.00 *	< 0.05	< 0.05	< 0.05			< 0.05	< 0.05	< 0.05				
INDIAN FARM CREEK	0.05 - 1.00																											

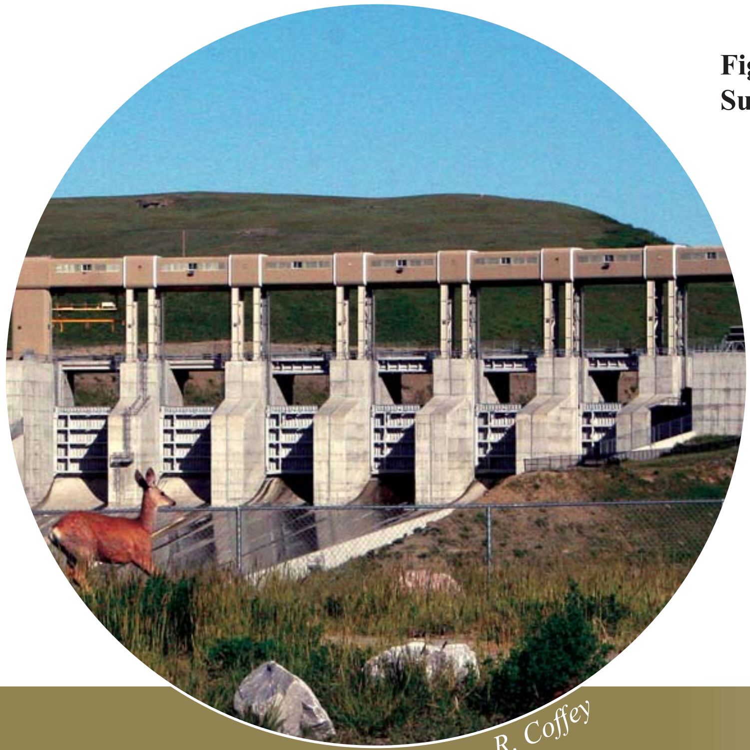
* median not calculated, results shown are based on less than 3 samples

No Data
< 0.05 mg/L (below guideline)
0.05 - 1.00 mg/L
> 1.00 mg/L

Total phosphorus loadings for 1991, 2001 and 2004 are shown in Figure 3.27. The highest loadings in 1991 within the Foothills Sub-basins were observed in Lower Willow Creek. Upper Willow Creek loadings were higher compared to Pincher and Beaver creeks. The overall pattern in phosphorus loadings is very similar to the one shown for nitrogen.

In 2005, loadings in Upper Willow Creek were much higher than observed in 1998 and were likely a result of the very high 2005 flows.

Figure 3.27: Total Phosphorus Loadings in Foothills Sub-basins – 1991, 2000 and 2004



Oldman Dam – R. Coffey

Total Suspended Solids

Total suspended solids (TSS) concentrations have been monitored in the Foothills Sub-basins since 1982, with an increase in the frequency of monitoring since 1998 (Appendix D).

The annual TSS concentrations of the available data set for stations and reaches are compared to the medians for the same locations in Table 3.11. Over all periods of observation, TSS concentrations were above typical median values in the sub-basins. In some instances, TSS concentrations were below the median, particularly in late 1990s and early 2000s. The watershed as a whole showed a greater range of variability when some of the smaller tributaries had much higher values than those observed in the large creeks.

Table 3.11: Annual Median TSS (mg/L) Compared to Data Set Median

Monitoring Sites / Years	Median	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
AB05AB0170-WILLOW CREEK D/S OF CHAIN LAKES	3									0-100%	0-100%																		
AB05AB0180-SOUTH WILLOW CREEK NEAR THE MOUTH	7									0-100%	<																		
AB05AB0190-WILLOW CREEK BELOW LANE CREEK	21														>100%	>100%	<												
AB05AB0200-WILLOW CREEK ABOVE HWY 527	5									0-100%	<																		
AB05AB0265-WILLOW CREEK WEST OF HWY 22 ON HWY 532	2																		<	0-100%	0-100%	>100%	0-100%	0-100%	0-100%	0-100%	0-100%	0-100%	
AB05AB0770-WILLOW CREEK U/S OF PINE COULEE DIVERSION	10																	>100%	0-100%	<	<	<	<	<	>100%	0-100%			
AB05AB0780-WILLOW CREEK D/S OF PINE COULEE RESERVIOR OUTLET	8																	>100%	<	<	<	<	<	0-100%	0-100%	<			
AB05AB0790-WILLOW CREEK AT WILLOW CREEK PROVINCIAL PARK	7																		<	<	<	0-100%	0-100%	0-100%					
AB05AB0220-WILLOW CREEK ABOVE CLARESHOLM WATER INTAKE	9									0-100%	<							>100%	0-100%	<	<	<	<	<					
AB05AB0250-WILLOW CREEK AT SEC HWY 519	7									0-100%	<								0-100%	<	<	<	0-100%	<					
AB05AB0260-WILLOW CREEK AT SEC HWY 811	7			0-100%	< *					0-100%	<	0-100%	< *		0-100% *	< *	>100% *	>100%	<	<	<	<	0-100%	0-100%	>100%	<			
TROUT CREEK	11									0-100%	<				>100%	>100%	0-100%		0-100%	<	<	0-100%	0-100%	<	<	0-100%	0-100%		
MEADOW CREEK	59														0-100%	>100%	0-100%		<	0-100%	<	0-100%	<	<	0-100%	0-100%			
BEAVER CREEK	17			<							0-100%							>100% *		>100% *			<	>100%	>100% *				
PINCHER CREEK	10	>100% *		0-100%							0-100%	<	0-100% *		< *	< *	>100% *	0-100% *					<	0-100%	<				

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

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

As with other water quality parameters observed in 2005, the TSS concentration higher than median in Beaver Creek is likely a result of the 2005 flood, which caused large amounts of sediment and minerals to enter the surface water through overland runoff.

Total suspended solids loadings are shown for 1991, 2000 and 2004, for the Beaver Creek, Pincher Creek and Willow Creek sub-basins (Figure 3.28). Lower Willow Creek has significantly higher loadings than observed elsewhere in the Foothills Sub-basins. These loadings may be related to high concentrations of TSS in the tributaries and upper watershed. Total suspended solids loadings are proportionally lower in Pincher Creek and Beaver Creek. These TSS patterns are spatially very similar to nitrogen and phosphorus loadings and have the same pattern between these three years. Nutrient indicators, such as nitrogen and phosphorus, are following TSS loadings and thus, are related to sediment loadings coming from the land.

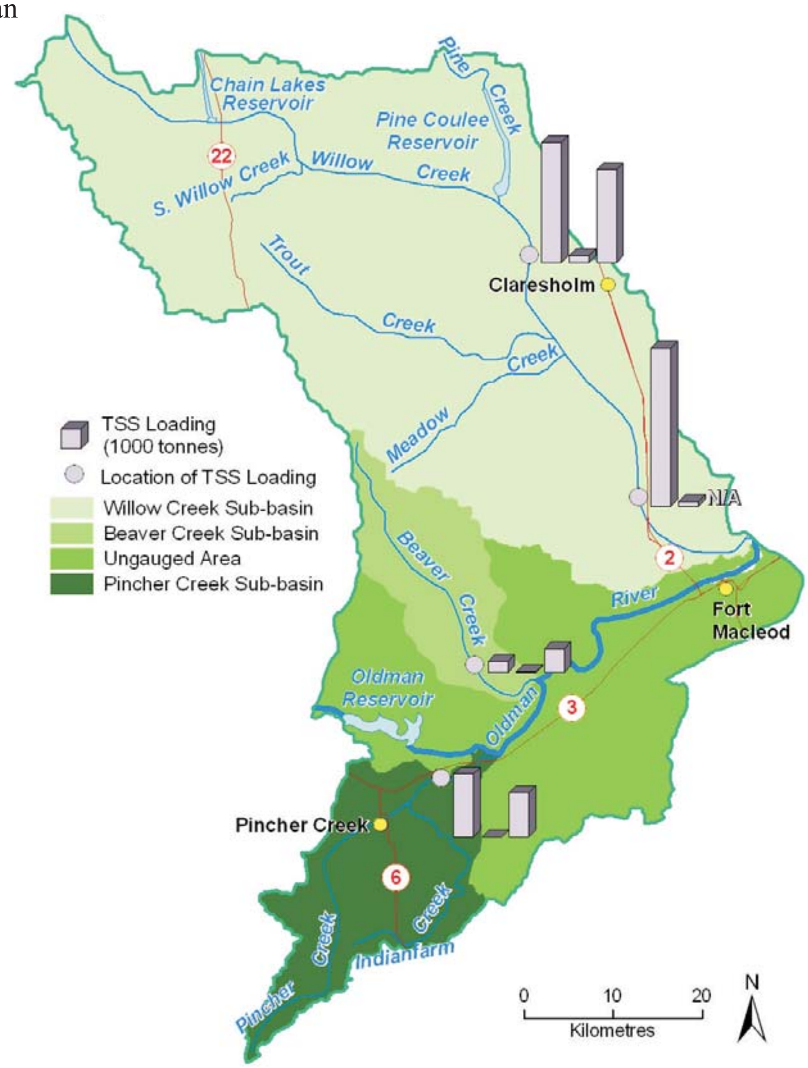


Figure 3.28: Total Suspended Solids Loadings in Foothills Sub-basins – 1991, 2000 and 2004

Fecal Coliforms

Alberta Environment Surface Water Quality Guidelines for Irrigation threshold:

Fecal Coliforms = 100 coliforms/100 mL

Fecal coliform concentrations have been monitored sporadically in the Foothills Sub-basins since 1982, with an increase in monitoring frequency occurring around 1998. Since then, data have been collected primarily from Willow Creek and its tributaries. There are few data for other streams in the Sub-basins (Appendix D).

Fecal coliform concentrations in surface water vary widely between creeks in the Foothills Sub-basins. Exceedances usually tended to occur in lower-flowing creeks (Table 3.12) for example, Trout, Meadow, Beaver, and Pincher creeks.

Loadings of fecal coliforms in 1991, 2000 and 2004 are shown in Figure 3.29. An increase in fecal coliform loading occurred across the Willow Creek

Table 3.12: Annual Median Fecal Coliform Count Guideline Adherence by Site

Monitoring Sites / Years	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
AB05AB0170-WILLOW CREEK D/S OF CHAIN LAKES									< 100	< 100																		
AB05AB0180-SOUTH WILLOW CREEK NEAR THE MOUTH									< 100	< 100																		
AB05AB0190-WILLOW CREEK BELOW LANE CREEK																												
AB05AB0200-WILLOW CREEK ABOVE HWY 527									< 100	< 100																		
AB05AB0265-WILLOW CREEK WEST OF HWY 22 ON HWY 532																		< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	
AB05AB0770-WILLOW CREEK U/S OF PINE COULEE DIVERSION																		< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	
AB05AB0780-WILLOW CREEK D/S OF PINE COULEE RESERVIOR OUTLET																		< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	
AB05AB0790-WILLOW CREEK AT WILLOW CREEK PROVINCIAL PARK																		< 100	< 100	< 100	< 100	< 100	< 100					
AB05AB0220-WILLOW CREEK ABOVE CLARESHOLM WATER INTAKE									< 100	< 100								< 100	< 100	< 100	< 100	< 100	< 100					
AB05AB0250-WILLOW CREEK AT SEC HWY 519									< 100	< 100								< 100	< 100	< 100	< 100	< 100	< 100					
AB05AB0260-WILLOW CREEK AT SEC HWY 811			< 100	< 100 *					< 100	< 100	< 100	< 100 *		100 - 1000 *	< 100 *	< 100 *	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	
TROUT CREEK									< 100	< 100								100 - 1000	100 - 1000	100 - 1000	100 - 1000	100 - 1000	< 100	100 - 1000	100 - 1000	100 - 1000		
MEADOW CREEK																		> 1000	> 1000	100 - 1000	100 - 1000	100 - 1000	100 - 1000	100 - 1000	100 - 1000			
BEAVER CREEK	100 - 1000		< 100							< 100 *							100 - 1000	< 100	100 - 1000	100 - 1000	< 100	< 100	< 100 *	> 1000 *				
PINCHER CREEK	< 100		< 100							< 100	< 100	< 100 *		< 100 *	100 - 1000 *	100 - 1000 *	100 - 1000	< 100	< 100			100 - 1000	< 100	100 - 1000				
INDIAN FARM CREEK	< 100																											

* 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

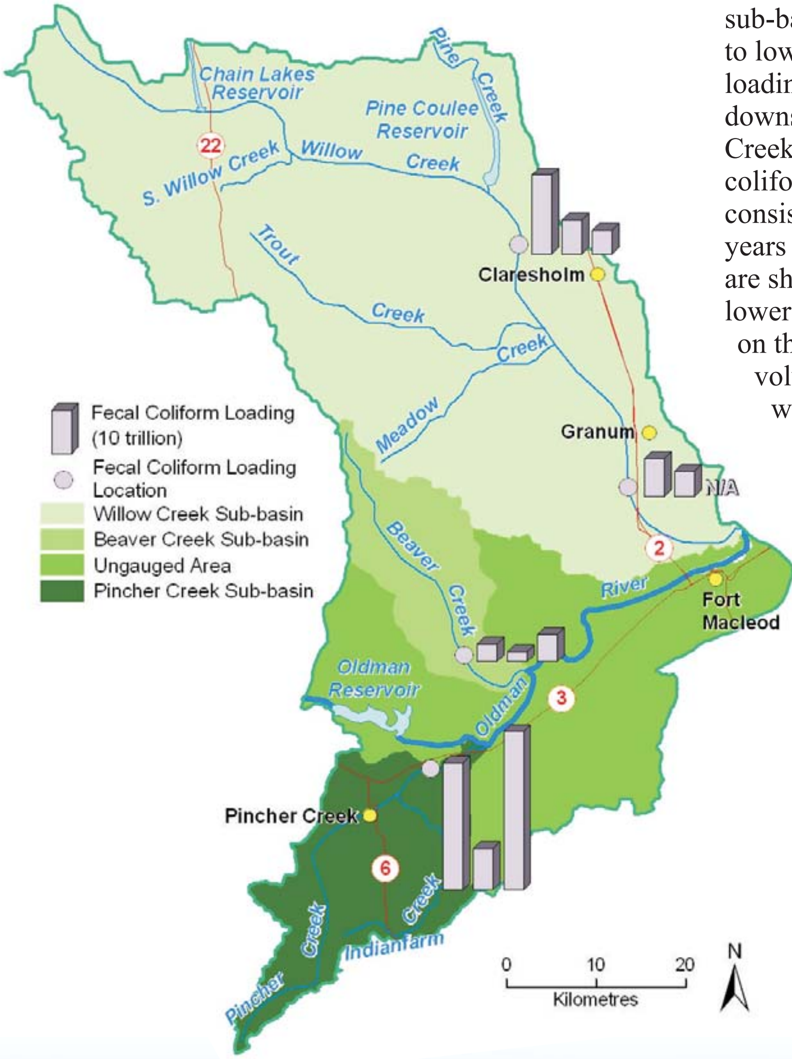


Figure 3.29: Fecal Coliform Loadings in Foothills Sub-basins – 1991, 2000 and 2004

sub-basin with higher values in the upstream compared to lower reaches of this stream. Considering that loadings depend on flows and usually flows increase downstream, the higher loadings in the Upper Willow Creek may be caused by higher counts of fecal coliform. The highest fecal coliform loadings are consistently observed in Pincher Creek through the years presented. In comparison, the lowest loadings are shown in Beaver Creek, which usually equates to lower flows in this stream. Loadings vary depending on the level of concentrations as well as flow volumes. A decrease in 2004 from 1991 and 2000 was observed on Willow Creek.

Large and prolonged rain events, such as the one in 2005, tend to increase loadings of pollutants, which enter the receiving waters through surface runoff. The high fecal coliform loadings in 2005 were likely caused by the extensive sheet flow and surface runoff which effectively flushed out sources of fecal coliforms.

Cattle in the MD Ranchlands – S. Palechek

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

Temperature[2]

The median temperature in Beaver Creek, from 1998 to 2003, was 10.1°C, and Pincher Creek had a median temperature of 11.0°C, both considerably warmer than the median temperature of the Oldman River near Brocket (6.9°C) from 1998 to 2003. Since Beaver Creek and Pincher Creek are shallower than the Oldman River, they warm up faster during the summer months, giving a larger range of temperature than that observed in the mainstem.

Willow Creek temperatures were measured from 1998 to 2003 with a median temperature of 10.6°C. The median temperature of the Oldman River at Fort MacLeod, from 1998 to 2003, was 9.5°C. The temperature between Willow Creek and the Oldman River, is very similar. The warm tributaries entering the Oldman River downstream of Brocket contribute to the temperature increase in the mainstem observed at Fort MacLeod.

pH[1]

The pH of Pincher Creek, Beaver Creek and Willow Creek is slightly more alkaline than the mainstem between Brocket and Fort MacLeod. The tributaries median pH ranges from 8.2 to 8.31 while the median mainstem pH is between 8.13 and 8.19.

Dissolved Oxygen[1]

Dissolved oxygen levels, from 1998 to 2002, in Beaver Creek, Pincher Creek and Willow Creek ranged from 8.02 mg/L to 20.0 mg/L. Guidelines set 5 mg/L as a 1-day minimum, so these tributaries were well above the guidelines.

Hardness[1]

Beaver Creek, Pincher Creek and Willow Creek had median hardness of 300 mg $CaCO_3$/L, 210 mg $CaCO_3$/L and 210 mg $CaCO_3$/L, respectively while the Oldman River through the Foothills Sub-basins had a hardness level of 150 mg $CaCO_3$/L. This may indicate a groundwater source for the tributaries and more surface water runoff contribution to the mainstem since it is carrying water from the mountain headwaters.

Metals and Ions[1]

Metals were very low in all three major tributaries in the Foothills Sub-basins with median values of dissolved iron and manganese either below detection or well below guideline levels. Ions measured between 1998 and 2003 included fluoride, chloride, and sulphate. Dissolved fluoride median concentrations were naturally above the Guidelines for the Protection of Aquatic Life in Beaver Creek and Willow Creek. Median chloride and sulphate concentrations were well below all guideline levels for the protection of aquatic life, irrigation and livestock watering.

Pesticides[1]

Pesticide concentrations in Beaver Creek, Willow Creek and Pincher Creek were generally well below guideline levels for the during the sampling period between 1998 and 2003. In Willow Creek, one exceedance of the guideline was observed for MCPA.

Water Quality Indices[1]

Often water quality studies use a Water Quality Index. This approach 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. Based on studies in the Oldman watershed which used water quality indices, the water quality in Beaver Creek was moderate and remained relatively consistent between 1998 and 2002. Beaver Creek is notable among the upper Oldman River tributaries as its water quality is somewhat poorer than other incoming streams and creeks. Pincher Creek, upstream of its confluence with the Oldman River, showed water quality, based on the Water Quality Index, slightly worse than moderate. Sampling was not done in 2002 at this site for comparison. The water quality in Willow Creek, according to the index presented, improved from moderate to good between 1998 and 2002.

Sources:

[1] Beaver Creek Watershed Group, OWC, 2006. Water Quality in the Beaver Creek Watershed – 2006.

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

Guidelines: AENV 1999; CCME 2005.

Water Monitoring along Beaver Creek – ARD

3.2 Current Issues and Trends

3.2.1 Terrestrial and Riparian Indicators

Land cover in the Foothills Sub-basins is a mix of native grassland, cultivated land and forest land. The amount of cultivated land increases and native grassland decreases as you move east across the area. Soil erosion is rated as negligible over most (60%) of the area with small areas of moderate risk near Claresholm and south of Fort Macleod. Riparian health is slightly better than the average for the Oldman watershed and is comparable to that found throughout Alberta. Confined feeding operations are found mostly along the Oldman River near Fort Macleod and Granum as well as along the lower reaches of Willow Creek. Between 1996 and 2006, population has increased slightly primarily due to growth in Claresholm.

3.2.2 Water Quantity Indicators

Annual flows and most of the monthly flows measured in the Foothills Sub-basins show declining volumes. Whether this is a result of external causes (e.g., climate change) or natural variation within the Sub-basins is unknown. There are some monthly deficits in the WCOs and IOs due to water use for irrigation.

Trends in decreasing annual volumes were evident throughout the Foothills Sub-basins, but only the decreasing trend for Beaver Creek sub-basin was statistically significant at the 95% level of confidence. The flow reductions in Beaver Creek may be due to natural variation and possibly agricultural land use.

The frequency of deficits to the WCOs on Willow Creek was greatest in May upstream of Claresholm and greatest in May, June and July near Nolan. These deficits appear to be related to diversions to first time filling of the Pine Coulee Reservoir.

On Pincher Creek and Beaver Creek, the IO and WCO values often exceed the natural flow in the early spring and late summer. These periods are classified as deficits in the analysis. They represent periods when licencees that are subject to the instream constraints would not be permitted to withdraw water from the stream.

Surface water from the rivers and streams located throughout the Foothills Sub-basins are necessary for municipal, agricultural, industrial and recreation activities. The Foothills Sub-basins are home to approximately 20 000 people, most of who live in the urban municipalities of Claresholm, Fort Macleod, Pincher Creek, and the surrounding MDs of Willow Creek No. 26 and Pincher Creek No. 9. In the municipalities where population continues to increase, additional water use demands will also occur.

Chain Lakes Reservoir – ARD

3.2.3 Water Quality Indicators

Total nitrogen and phosphorus levels have exceeded guidelines in recent years for both Beaver and Pincher creeks likely due to agricultural activities and high surface runoff, e.g., during the 2005 flood event. High TSS levels in Beaver Creek are also attributed to the 2005 flood. Total concentrations of fecal coliforms in Trout and Meadow creeks, and less often in Pincher Creek and Beaver Creek, have exceeded guidelines in several years recently.

Water quality is changing through the Foothills Sub-basins. The most upstream site on upper Willow Creek shows an increasing trend in phosphorus concentrations and no trends for other indicators (Figure 3.30). Upstream from its confluence with Pine Creek, no trends were observed in Willow Creek for any indicators. This pattern changes in the middle reach of Willow Creek, where increasing trends are present in TSS and phosphorus immediately downstream of its confluence with Pine Creek. Further downstream on Willow Creek, the water quality changes again and shows a decreasing or neutral trend. By its mouth, no trends for water quality were observed on Willow Creek. Phosphorus showed an increasing trend in Trout Creek upstream of the confluence with Willow Creek.

Other streams within the Sub-basins, namely Beaver Creek and Pincher Creek, have different trend patterns. Pincher Creek does not show a trend in TSS or fecal coliforms but has decreasing nitrogen and phosphorus concentrations. Beaver Creek shows an increasing trend in nitrogen concentrations and fecal coliforms counts but no trend in the other two indicators.

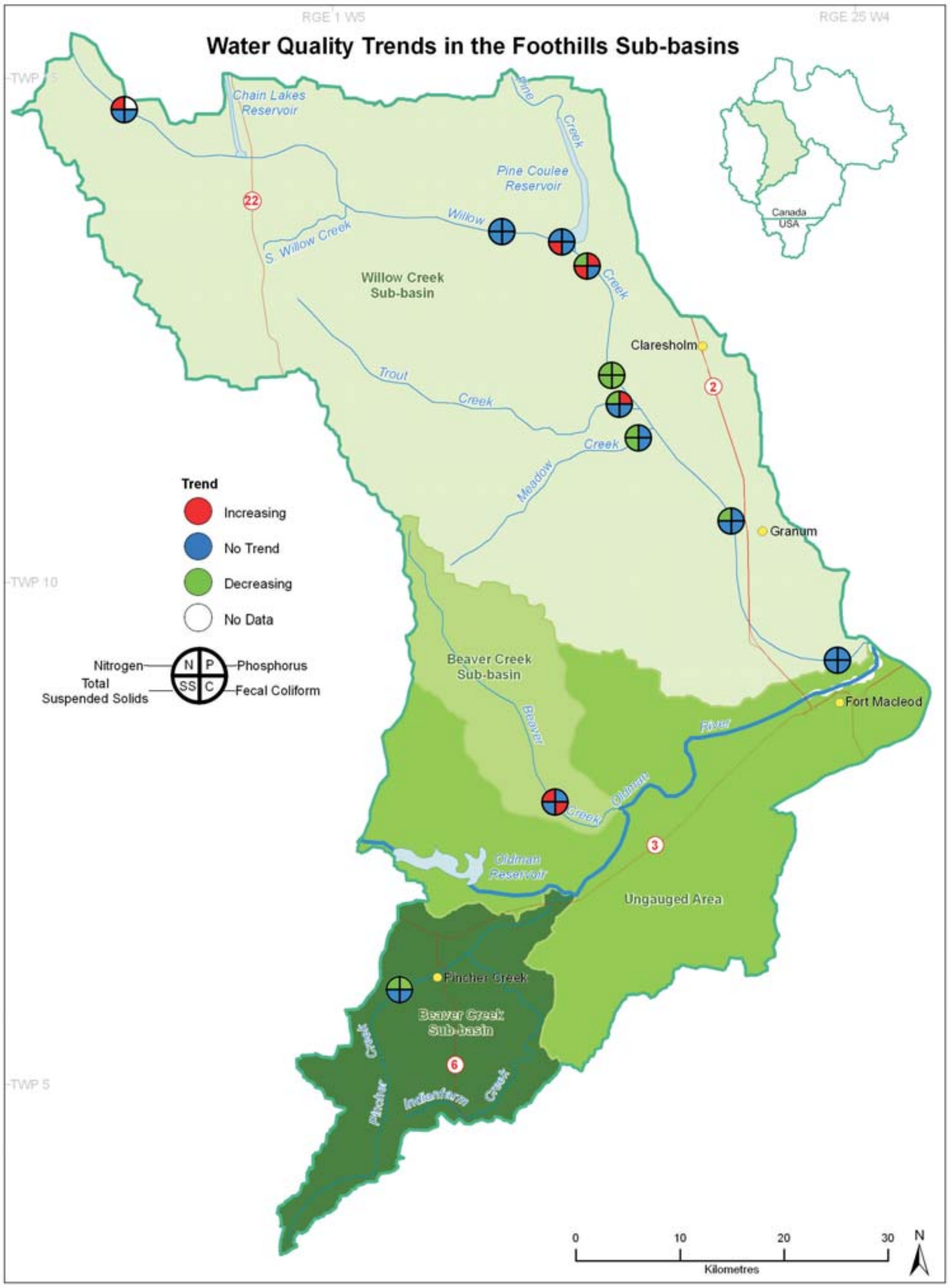


Figure 3.30: Water Quality Trends in the Foothills Sub-basins

3.3 Summary

Overall, the Foothills Sub-basins is rated as **Fair**. A summary of the observations and analyses of indicators in the Foothills Sub-basins follows.

Terrestrial (Good)

- Land cover of natural grassland and forest is 60%, rated good.
- Soil erosion risk is low to moderate, rated good.
- Riparian health is healthy but with problems, rated fair.
- Linear developments cover 2.6% of area, rated fair.
- Total land use at 40%, rated good.

Water Quantity (Fair)

- Beaver and Pincher creeks have relatively high unit yields; Willow Creek has a low unit yield.
- No significant trends in annual volumes are apparent in Willow and Pincher Creeks, but decreasing monthly trends occur in April, November and December. Beaver Creek has a significant decreasing annual trend in most months.
- Willow Creek has a moderate level of allocation and use. Pincher and Beaver creeks have low levels of allocations and uses.
- Willow and Pincher creeks have low levels of deficits to the IO, but frequent deficits to the WCO. Beaver Creek has a high level of deficits to both the IO and WCO.

Water Quality (Fair)

- Total nitrogen and phosphorus exceeded guidelines in 2005 and 2006 for both Beaver and Pincher creeks, likely due to agricultural activities and high surface runoff during the 2005 flood.
- High TSS levels in Beaver Creek are also attributed to the 2005 flood.
- Total concentrations of fecal coliforms in Trout and Meadow creeks have exceeded guidelines from 1999 to 2007 and exceedances have also occurred occasionally in Pincher Creek.
- Pine Coulee Reservoir appears to be a substantial source of nutrients based on increasing trends in both total nitrogen and phosphorus concentrations.
- Nutrients showed an increasing trend in some reaches of Willow Creek and Beaver Creek. The same is true for TSS at the confluence of Pine Creek and Willow Creek.
- Annual phosphorus levels show increasing trends on Trout Creek.
- Increasing trends in nitrogen and fecal coliforms were observed in Beaver Creek.

The Beaver Creek sub-basin demonstrated a statistically significant trend toward decreasing flows. This trend could be the result of naturally high flow variability combined with the small size of the sub-basin, changes in land use, climate change, or a combination of these factors.

At this point in time, it is difficult to attribute this decline to any single factor or combination of factors. Given this uncertainty, and the fact that other streams do not reflect the same trend probability, management plans should:

- continue to monitor flows in Beaver Creek and assess trends periodically;
- 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.

Within the Foothills Sub-basins nutrient (nitrogen and phosphates) trends are increasing in upper Willow Creek and downstream of Pine Coulee Reservoir. In upper Willow Creek, there is little apparent link to current land use activities. Monitoring is recommended to continue for all water quality indicators, and changes in land use.

Additional management recommendations are provided in Chapter 10.