CHAPTER 4: THE SOUTHERN TRIBUTARIES SUB-BASINS

Payne Lake – ARD

Chapter 4: The Southern Tributaries Sub-Basins

The Southern Tributaries Sub-basins include the Waterton, Belly and St. Mary rivers. The Belly and St. Mary rise in the mountains of Glacier National Park in Montana. The St. Mary begins as a stream on Gunsight Mountain and, after leaving the park, flows through the Blackfoot Indian Reservation and crosses into Canada. The source of the Belly River is Helen Lake at the foot of Mount Merritt. The source of the Waterton River is Upper Waterton Lake, the deepest lake in the Canadian Rockies, which straddles the border. These three rivers run roughly parallel from south-southwest to north-northeast until the Waterton and Belly rivers merge north of Standoff. The Belly flows on into the Oldman mainstem west of Coalhurst. The St. Mary flows into the St. Mary Reservoir west of Spring Coulee, and then joins the Oldman mainstem at Lethbridge (Figure 4.1). Drainage into these rivers defines the three sub-basins shown on Figure 4.1.

In 1903 and most significantly between 1906 and 1911, storage works and the St. Mary Canal were constructed in northern Montana to divert most of the spring flow from the St. Mary River into the Milk River. Southern Alberta farmers who were dependent on irrigation were faced with serious shortages. This lead to an international dispute over water rights that was finally addressed in Article VI of the 1909 Boundary Waters Treaty, and was subsequently

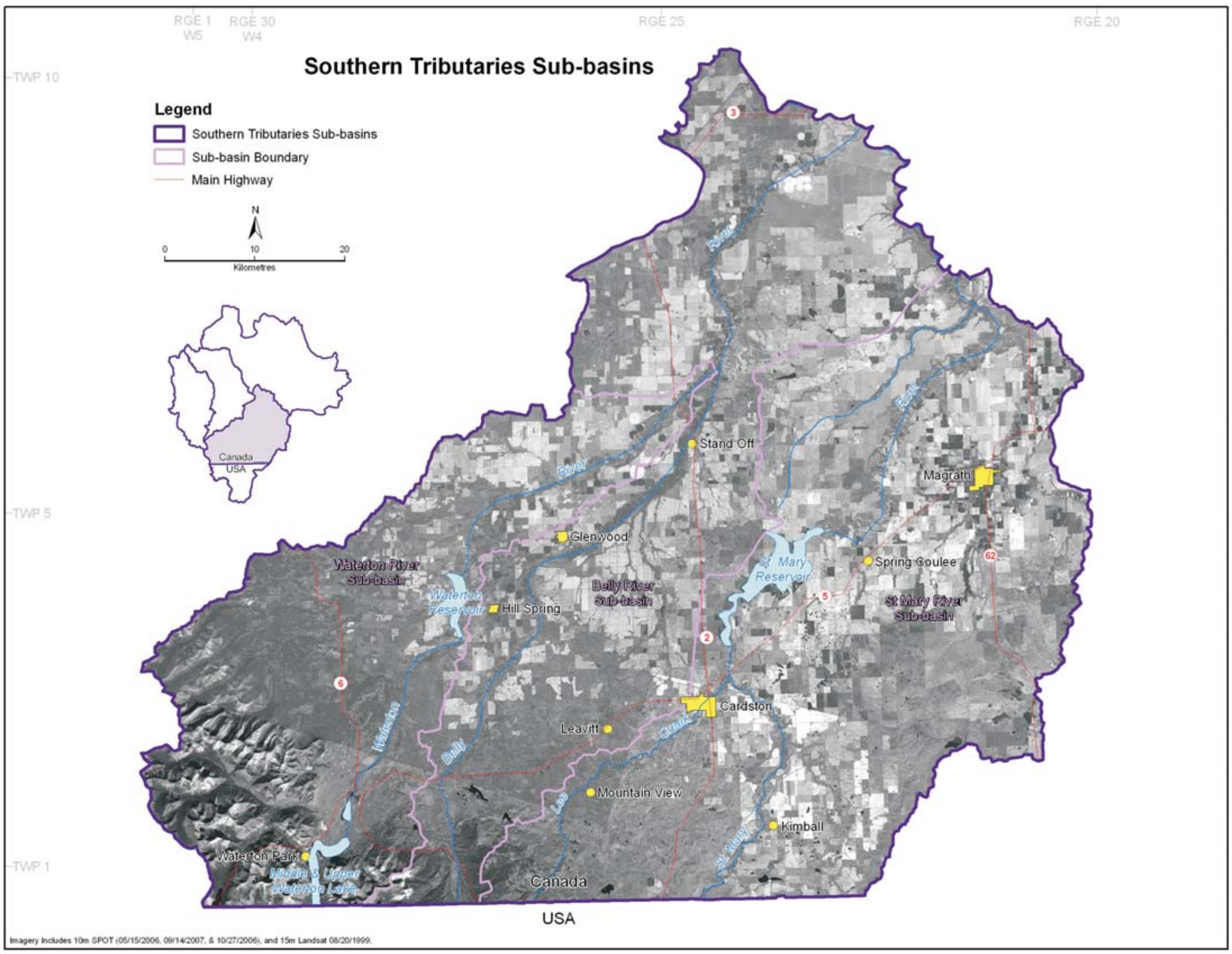


Figure 4.1: Southern Tributaries Sub-basins

adjudicated in the 1921 Order (see Section 4.1.2). The 1921 Order set out an apportionment formula for the irrigation season that provided Canada with more than half the flow of the St. Mary River and the United States with more than half the flow of the Milk River.

Discharge in the Belly River is regulated by the Waterton Reservoir and the Waterton-Belly and the Belly-St. Mary portions of the Waterton-St. Mary Headworks System (Figure 4.2). These two diversions feed water to the Blood First Nation Irrigation Project and to the St. Mary Reservoir. Water from the St. Mary Reservoir is diverted eastward to provide irrigation water to the Magrath Irrigation District, and then to the Milk River Ridge Reservoir, from where it is distributed to the Raymond, St. Mary River and Taber irrigation districts. A significant portion of water use extends into the Prairie Sub-basins, the South Saskatchewan River watershed and a small portion is in the Milk River watershed (the latter two areas are outside of the Oldman watershed). The Belly River also provides water to the Mountain View, Leavitt, Aetna and United irrigation districts.

The extreme southwestern corner of the Southern Tributaries Sub-basins is protected as Waterton Lakes National Park, established in 1911. The park has varied in size since its creation, but today occupies about 526 km^2. It adjoins Glacier National Park in Montana, and in 1932, the two parks were joined to create Waterton-Glacier International Peace Park. In 1979, Waterton Lakes National Park was designated a World Biosphere Reserve, preserving mountains, highland, lakes and freshwater wetlands ecosystems. In 1995, the Peace Park was also designated a World Heritage Site in recognition of its distinctive climate, physiographic setting, mountain-prairie interface, and tri-ocean hydrographical divide. It is an area of significant scenic values with abundant and diverse flora and fauna (Parks Canada 2009). The park helps protect the unique and unusually diverse physical, biological and cultural resources found in the Crown of the Continent: one of the narrowest places in the Rocky Mountains. The park contains 45 different habitat types, including grasslands, shrublands, wetlands, lakes, spruce-fir, pine and aspen forests, and alpine areas. This means Waterton Lakes National Park has an unusually rich and varied number of plants for its size, with more than 1000 vascular plant species, 182 bryophytes and 218 lichen species. Many of these are rare or threatened. More than half of Alberta's plant species can be found in the park (Parks Canada 2009).

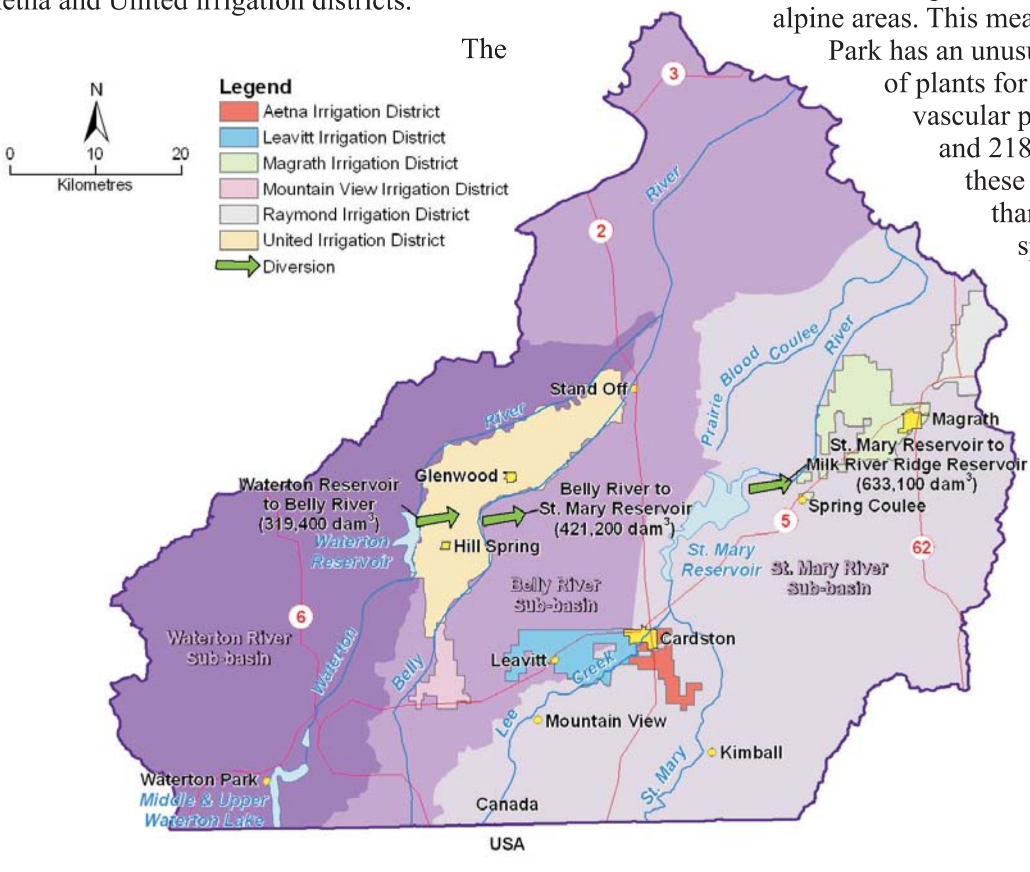


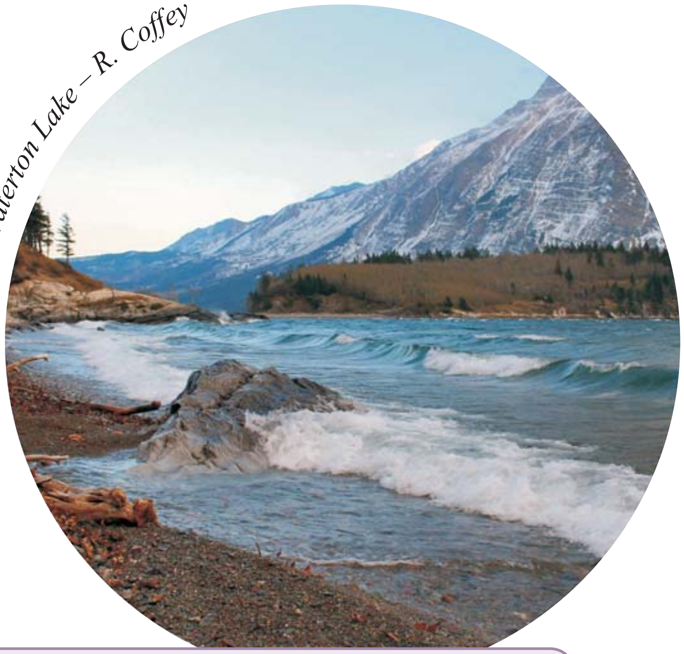
Figure 4.2: Irrigation Districts and Diversions in the Southern Tributaries Sub-basins

World Heritage Sites

The *Convention Concerning the Protection of the World Cultural and Natural Heritage* (the *World Heritage Convention*, for short) was adopted by the UNESCO General Conference in 1972. Canada ratified the convention in 1976; in total 177 countries have joined. The Convention recognizes that some places, either natural or cultural, are of sufficient importance to be the responsibility of the international community as a whole. By joining the Convention, States and Parties pledge to care for World Heritage Sites in their territory and to avoid deliberate measures that could damage World Heritage Sites in other countries. As such, the World Heritage List serves as a tool for conservation.

Canada currently has 14 world heritage sites, 5 of which are in Alberta (Head-Smashed-In Buffalo Jump, Waterton-Glacier International Peace Park, Canadian Rocky Mountain Parks, Dinosaur Provincial Park, and Wood Buffalo National Park (partly in NWT)). Canada has recently updated its list of potential world heritage sites and has named 11 new sites, including Writing-on-Stone Provincial Park that may be recognized formally over the next decade. (Parks Canada, http://www.pc.gc.ca/eng/progs/spm-whs/page7c.aspx).

Within Waterton Lakes National Park, some of the oldest sedimentary rocks in the Canadian Rockies are exposed along the Lewis Thrust Fault. These white Precambrian limestones date from 1.5 billion years ago, and about 15 million years ago were uplifted and thrust over much younger brown Cretaceous shale. Displacement is about 100 km at Waterton Lakes National Park, much larger than is usual for thrust faults (van Dijk 2009). The structure of the thrust fault can be seen on Mount Crandell (University of Lethbridge 2009). The rocks that would normally comprise the foothills in this region have been covered by the older Precambrian, making the transition from mountains to prairie particularly sharp. This compression of natural regions also results in a great diversity of plants and animals over a short distance. Waterton Lakes National Park is part of the Crown of the Continent ecosystem which provides a vital north-south movement corridor for large species, such as grizzly bears.



Waterton Lake – R. Coffey

Crown of the Continent Ecosystem

The Crown of the Continent Ecosystem covers approximately 44 000 km^2 of mountainous terrain and contiguous wildlife habitat in British Columbia, Alberta and Montana. It includes Waterton-Glacier International Peace Park and is an integral part of the much larger Yellowstone to Yukon (Y2Y) conservation initiative.

The objective of Y2Y is to secure the ecological health of the area and to enable the Crown of the Continent to fulfill its dual role within the Y2Y region – securing high-quality wildlife habitat, and enabling wide-ranging species to move from those areas into neighbouring areas.

The Southern Tributaries Sub-basins are unique in the extent of protection afforded to the headwaters of the Oldman watershed. The Waterton Park Front Project enhances that protection by creating a buffer between the eastern boundary of the park and other land uses in the Sub-basins. It is the largest private conservation initiative in Canada. The Nature Conservancy of Canada, in conjunction with the W. Garfield Weston Foundation, John and Barbara Poole, and local ranchers and landowners, began the project in 1997 and to date have created a protected area of over 11 000 ha. Within this protected area, some land has been purchased outright from ranchers, and other lands continue to be ranched but the owners have placed conservation easements on their properties. The outcome of the project is protection of wildlife habitat and the protection of the ranching way of life for families that have stewarded this land for three generations. The Waterton Park Front Project received an Emerald Award for Environmental Excellence in 2007 (Nature Conservancy of Canada 2009).

The Southern Tributaries Sub-basins span virtually all the natural regions that occur in the Oldman watershed (Figure 4.3) from Mixedgrass south of Lethbridge to the Alpine sub-region in the mountains of Waterton Lakes National Park. Over the 100 km or so, as the crow flies, from Magrath to Waterton townsite, temperatures, precipitation, vegetation, wildlife and land use change profoundly. Changes in mean annual temperature and precipitation are summarized in Table 4.1 for the natural sub-regions, showing a decrease in temperature and an increase in precipitation toward the southwest.

Mixedgrass and Foothills Fescue cover a large proportion of the Sub-basins, and agriculture, supported by irrigation, is concentrated in these regions.

Deciduous forests occur in the Foothills Parkland and Montane natural sub-regions, while coniferous forests predominate in the Sub-Alpine.

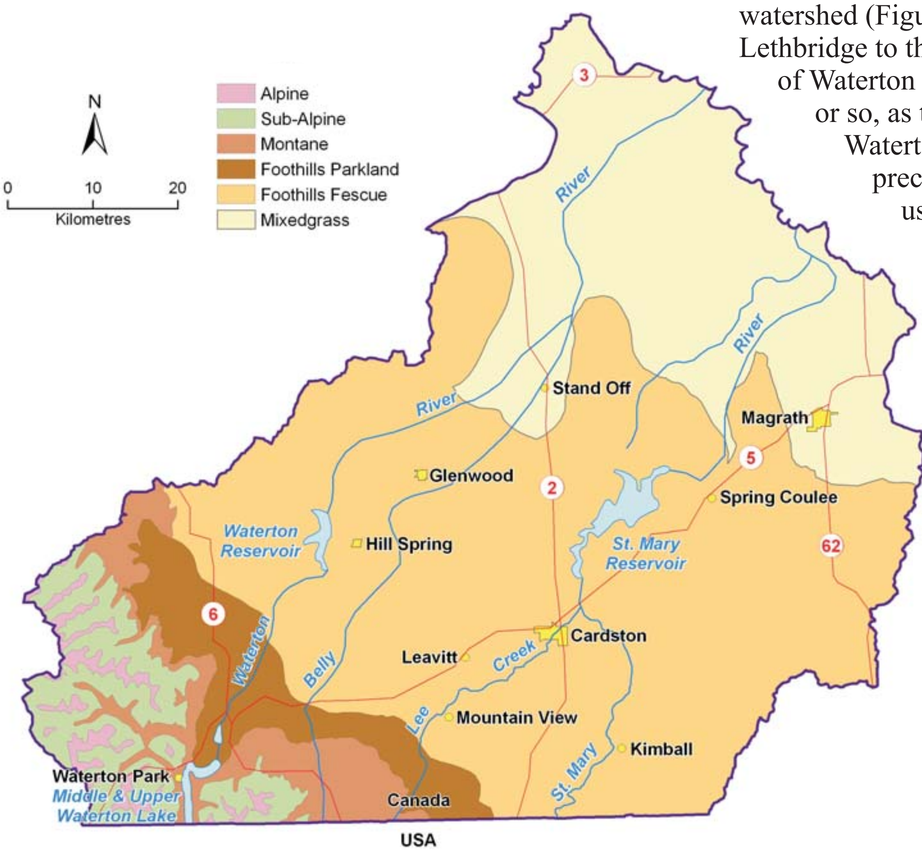


Figure 4.3: Natural Sub-Regions in the Southern Tributaries Sub-basins

Table 4.1: Variation of Temperature and Precipitation Across Natural Sub-regions

Sub-Region	Mean Annual Temperature (°C)	Mean Annual Precipitation (mm)
Mixedgrass	4.4	394
Foothills Fescue	3.9	470
Foothills Parkland	3.0	517
Montane	2.3	589
Sub-Alpine	-0.1	755
Alpine	-2.4	989

Source: Natural Regions of Alberta.

A number of environmentally significant areas (ESAs) occur in the Southern Tributaries Sub-basins (Sweetgrass 1997). These include:

- *Dungarvan Wetlands (ESA #121)* – one of the most diverse and significant beaver wetlands in southern Alberta;
- *Mokowan Butte (ESA #1)* – lush montane woodland supporting several rare plants; area includes buried soils dating from before the last (Wisconsin) glaciation;
- *Upper St. Mary River (ESA #320)* – extensive narrow-leafed cottonwood habitat; great blue heron colony; exceptional exposed Pleistocene geology sections; rare fish including the Rocky Mountain sculpin;
- *Lower Belly River (ESA #301)* – some of the most extensive narrow-leafed cottonwood habitat in Canada; great blue heron colony;
- *St. Mary Reservoir (ESA #148)* – nationally significant California gull breeding area and breeding and production area for a number of waterfowl species; and
- *Glenwoodville Erratic (ESA #155)* – a large boulder (7 m x 9 m) left behind by retreating glaciers; part of the Foothills Erratics Train – a trail of boulders that dropped onto mountain glaciers near Jasper and were carried by the ice to southern Alberta and deposited when the glaciers melted.

The Southern Tributaries Sub-basins also provide evidence of the meeting of Cordilleran and continental ice sheets during the last glaciation. Cordilleran ice grew in the mountains and moved eastward through the mountain valleys onto the prairies. At the same time, the large mass of continental ice was moving southwestward. The Foothills Erratics Train marks the direction of flow of Cordilleran ice as it was deflected southeastward by the larger continental ice mass.

Today, the towns of Cardston (population 3452 (2006)) and Magrath (population 2081 (2006)) are the largest communities in the mainly rural Southern Tributaries Sub-basins. Both towns were established by Mormon settlers from Utah around the turn of the last century and have developed as centres to service the agricultural communities in the area.

4.1 Overview of Indicators

4.1.1 Terrestrial and Riparian Ecology

Land Cover

The dominant land cover includes cultivated land, grassland and forests (Figure 4.4 and Table 4.2).

Cultivated Land

Cultivated land is the dominant cover throughout the Southern Tributaries Sub-basins. These lands occur within the Mixedgrass and Foothills Fescue natural sub-regions and within the five counties and municipal

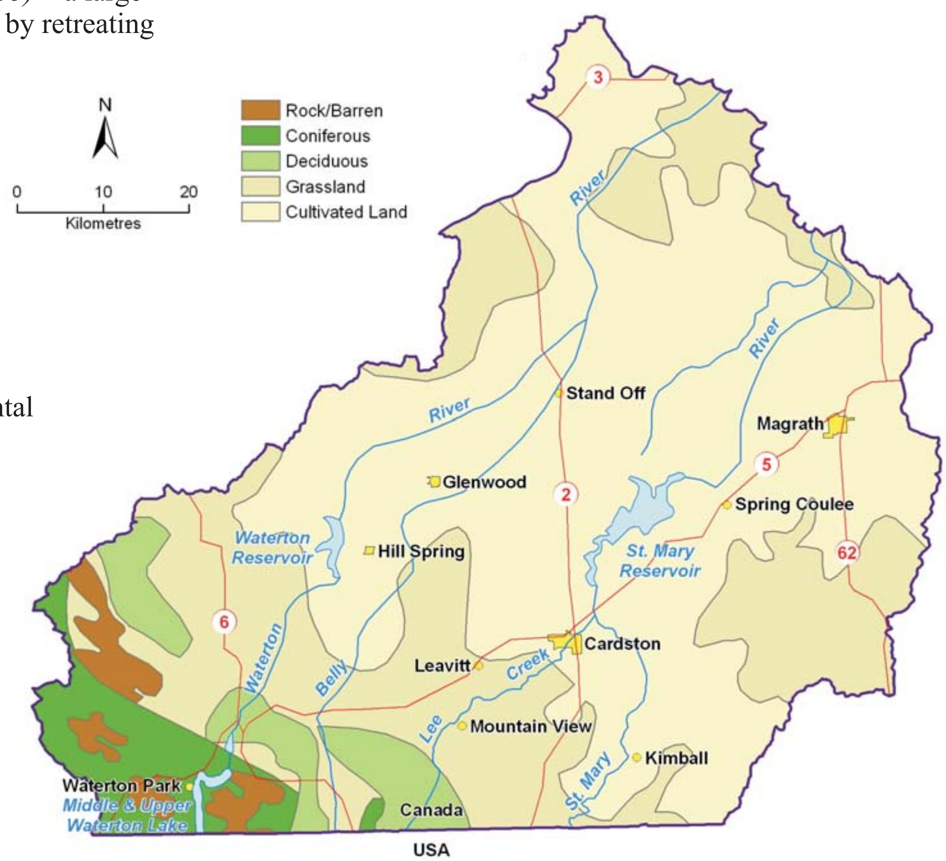


Figure 4.4: Land Cover in the Southern Tributaries Sub-basins

Table 4.2: Land Cover in the Southern Tributaries Sub-basins

Land Cover	Area of Southern Tributaries Sub-basins (%)
Cultivated Land (Agriculture)	45
Grassland	38
Forest (Coniferous & Deciduous)	10
Rock/Barren	3
Water (including Reservoirs)	3
Shrubland	1
Urban	<1
Total	**100**

districts (MD) (Figure 4.5). Cultivated lands increase and native grassland decrease moving east across the area (Table 4.3). Irrigated lands occupy a small area in Cardston County. Cereal followed by forage are the most common crops grown within each MD based on the 2006 census (Statistics Canada 2006) (Table 4.4). Agricultural data from the Counties of Lethbridge and Warner No. 6 have been omitted because only small portions are located within the Sub-basins. The Improvement District No. 4 Waterton, made up mainly of Waterton Lakes National Park (no agricultural activity) and Blood (Kainai) 148A Indian Reserve (no information available), have also been omitted.

Common livestock raised in the Southern Tributaries Sub-basins includes cattle, hogs, horses, sheep, bison, goats, llamas and alpacas, and poultry.

Grassland

Native grassland communities are found within the Foothills Fescue natural sub-region in the hilly uplands west and south of Cardston and south of Magrath where grazing predominates. These grassland communities consist of mountain rough fescue and Parry oat grass. Within the Mixedgrass natural sub-region along the lower Waterton and St. Mary rivers, needle-and-thread, porcupine grass, June grass and northern and western wheatgrasses form communities on remnant native grassland sites on the lower elevation plains with average moisture conditions. While blue grama grass, needle grasses and northern wheat grass communities dominate native grasslands in moister areas. Approximately half of the Mixedgrass area has been converted to agriculture (Natural Regions Committee 2006).

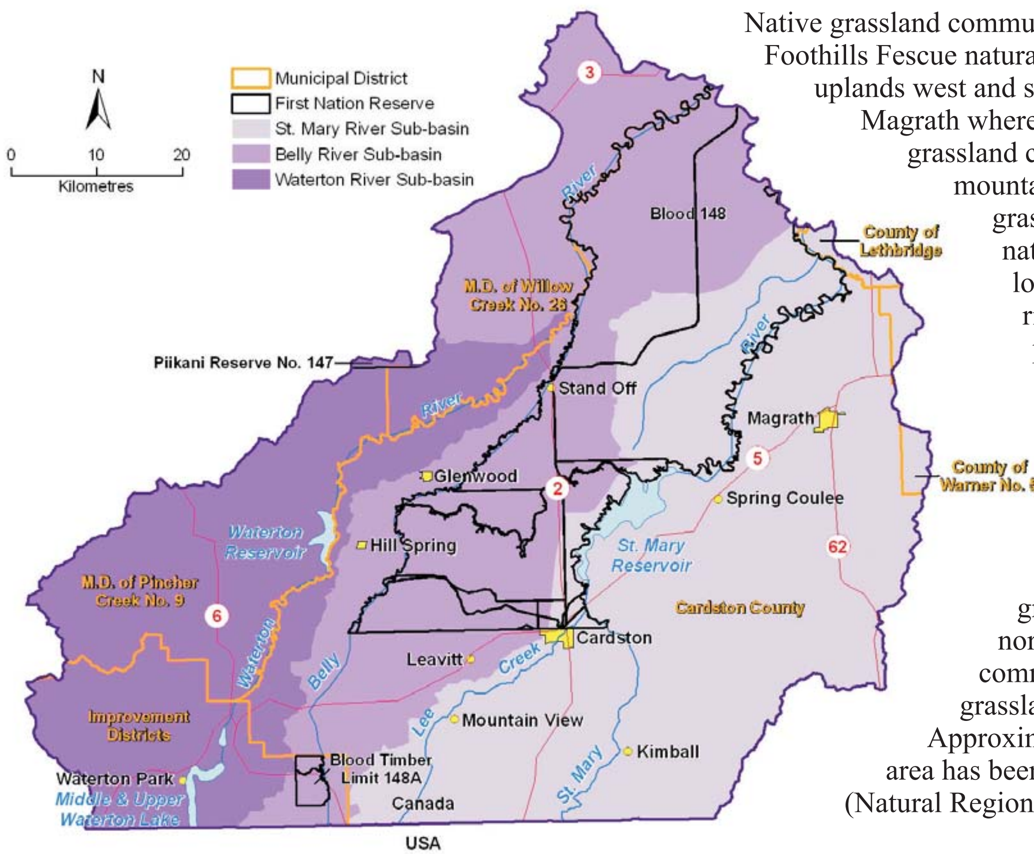


Figure 4.5: Municipal Districts and First Nation Reserves in the Southern Tributaries Sub-basins

Table 4.3: Land Cover by Municipal District or County (%)

Land Cover	MD Pincher Creek No. 9 (%)	MD Willow Creek No. 26 (%)	Cardston County (%)
Native Grassland	57	33	34
Cultivated:			
– Cropped	27	51	55
– Summerfallow	1	1	1
– Seeded pasture	8	12	7
Subtotal	36	64	63
Other (water/treed)	7	3	3
Irrigation (included in cultivated)	1	4	5
Total	**100**	**100**	**100**

Table 4.4: Types of Crops by Municipal District or County

Agricultural Land Use	MD Pincher Creek No. 9 (% Area)	MD Willow Creek No. 26 (% Area)	Cardston County (% Area)
Cereal (wheat, oats, barley, rye)	60	37	67
Forage (alfalfa, hay)	38	10	15
Canola	1	3	4
Other	1	50	14
Total	**100**	**100**	**100**

Forest

Coniferous and deciduous forests cover approximately 10% of the Southern Tributaries Sub-basins. Most of the coniferous trees are found in the high elevations of the Sub-Alpine natural sub-region.

The western portion of the Sub-basins are included within Forest Management Units (FMUs) made up of the larger CO1 (management unit of the Crowsnest Forest) with smaller areas of C4 and C5. Commercial forest harvesting operations are conducted by a few quota holders. As discussed in the Mountain Sub-basins, the characteristics of forest harvesting, reforestation, fire and management of mountain pine beetle are similar.

The Southern Tributaries Sub-basins within the Green Zone has a carrying capacity of 1758 animal unit months (AUMs) (C. Piccin, pers. comm.). This consists of one grazing disposition, covering about 16 018 ha.

The Castle Special Management Area is located in the west just north of Waterton Lakes National Park and covers approximately 13 000 ha (2%) of the Southern Tributaries Sub-basins. In this zone, motorized access to certain areas is restricted to protect ecologically sensitive backcountry areas. Operation of motorized vehicles is prohibited except on trails designated for that purpose. Other protected areas include recreation areas, natural areas, and provincial and national parks (Figure 4.6). Combined, these areas cover approximately 9% with Waterton Lakes National Park occupying most of the area (Table 4.5). Human activities in these areas create disturbances such as camp sites, roads, and trails.

Riparian poplar forests along rivers in the grasslands of southern Alberta are important for wildlife, fish, recreation and aboriginal culture (Bradley et al. 1991, Willms 1998). Three poplar species–balsam poplar, plains cottonwood and narrowleaf cottonwood–converge and hydridize in southern Alberta. All species are adapted to regenerate and survive under the naturally dynamic regimes of the Waterton, Belly, St. Mary and Oldman rivers. Both the Waterton and Belly river valleys are characterized by moderately dense riparian poplar forests, while the St. Mary has only scattered stands of trees. There have been some declines of riparian forests below dams on the St. Mary and Waterton rivers, but overall the extent of these forests has been relatively unchanged since the 1880s (Bradley et al. 1991, Hardy BBT et al. 1992).

In 1995 and 2005, high natural flows provided areas for the establishment of cottonwood seedlings. As well, the practice of flow management from dams called "ramping" has resulted in good survival of cottonwood seedlings particularly along the Waterton and lower St. Mary rivers (Rood and Mahoney 2000, Gill et al. 2007, Palechek 2009).

Rock and Barren Land

Approximately 3% of the Southern Tributaries Sub-basins consists of the rock and barren land found on the high mountain elevations.

Water

Reservoirs cover approximately 1% of the land, with the natural water bodies accounting for an additional 2%.

Shrubland

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

Urban Centers

The communities of Cardston, Magrath and Glenwood cover less than 1% of the Southern Tributaries Sub-basins.

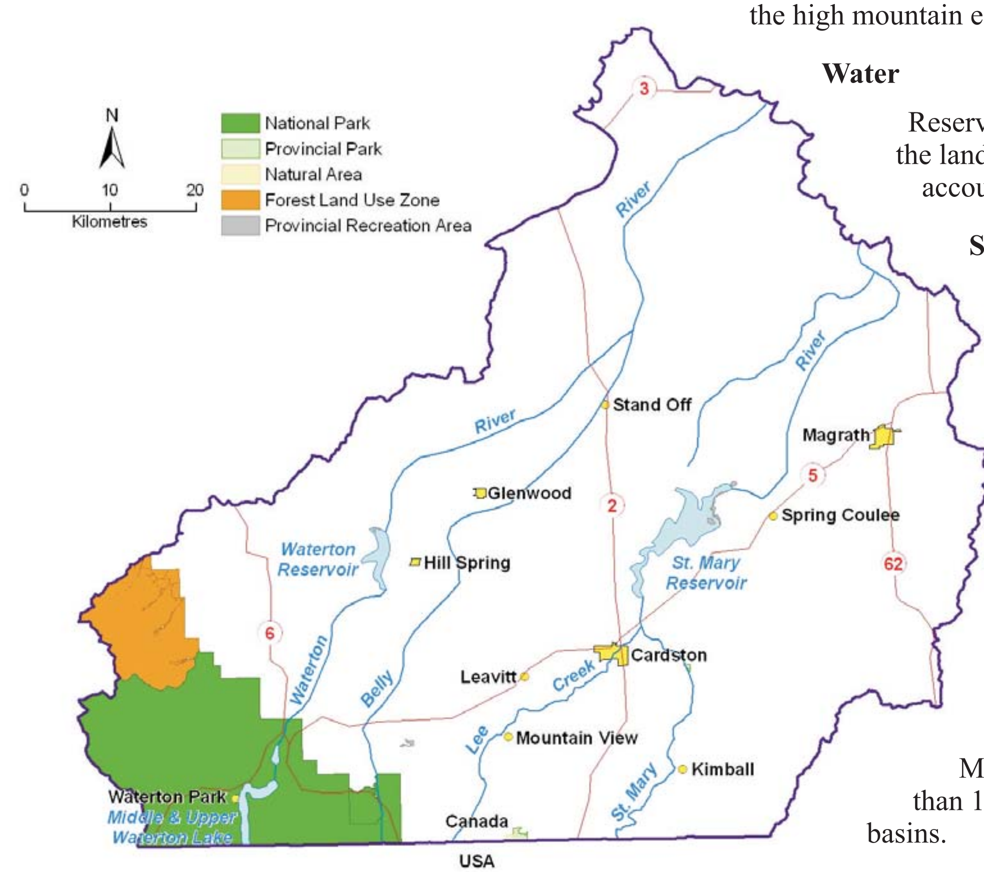


Figure 4.6: Parks, Protected Areas and Forest Land Use Zones in the Southern Tributaries Sub-Basins

Table 4.5: Recreational Areas, Ecological Reserves and Parks

Protected Area Type	Name	Area (ha)
Provincial Recreation Area	Seven different areas	235
Natural Area	Ross Lake Outpost Wetlands	58
Provincial Park	Woolford Police Outpost	217
National Park	Waterton	50 700
	Total	**51 210**

Soil Erosion

The risk of soil erosion due to both wind and water is rated as low for 68% of the Southern Tributaries Sub-basins (Figure 4.7 and Table 4.6). Small areas of moderate risk occur in the agricultural areas along the Waterton River valley and east of Magrath.

A number of techniques have been implemented for reducing soil erosion losses. In agricultural areas, soil conservation practices have been adopted to minimize soil erosion rates. Three most common practices are crop rotation, rotational grazing and shelterbelts (Table 4.7). The use of chemicals other than tillage in summerfallow operations has also helped in reducing soil erosion losses. Modification to tillage practices, such as zero-till and mini-till, have also been implemented to reduce soil erosion.

Riparian Health

In the Southern Tributaries Sub-basins, 446 sites were reviewed as part of the Riparian Health Assessment Program. The results indicate that 20% are healthy, 53% are healthy but with problems, and 27% are unhealthy (Cows and Fish Program 2009). The Southern Tributaries Sub-basins are healthier than the average in the Oldman watershed where 15% are healthy, 55% are healthy but with problems, and 30% are unhealthy.

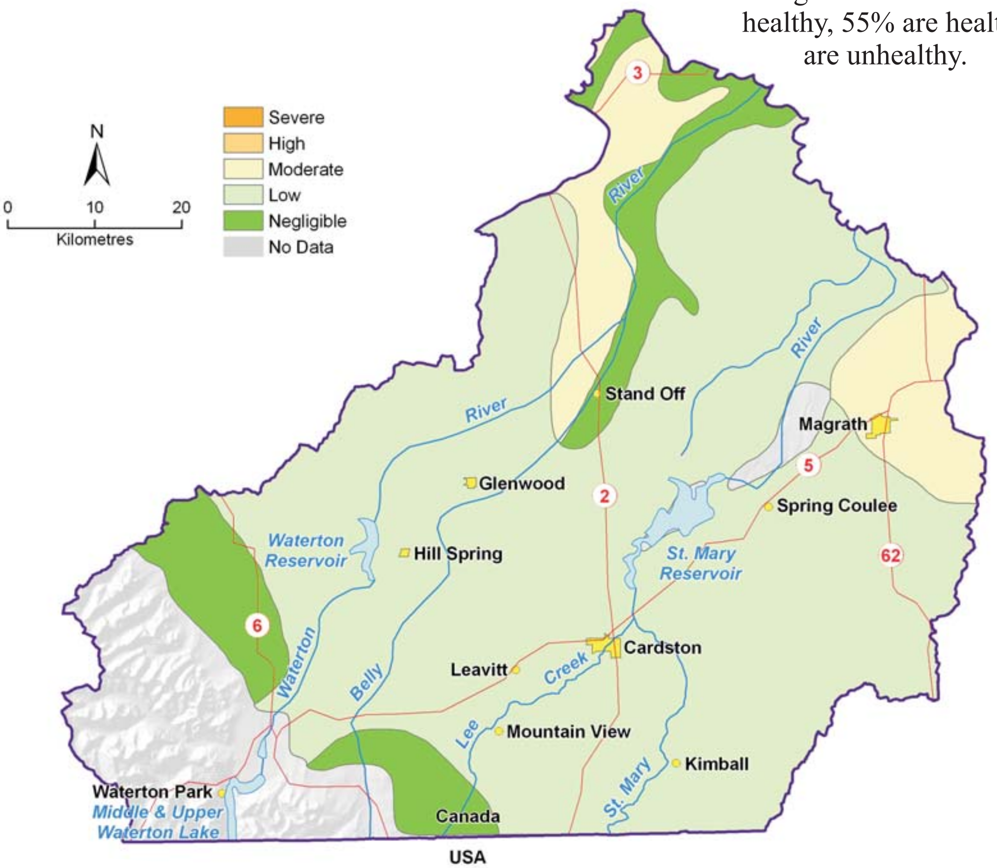


Figure 4.7: Soil Erosion Rating in the Southern Tributaries Sub-basins

Table 4.6: Soil Erosion Risk Area (ha)

Soil Erosion Risk Rating Class	Area (ha)	% of Total Area
Negligible	61 154	10
Low	410 550	68
Moderate	55 371	10
No data	75 143	12
Total	**602 218**	**100**

Table 4.7: Erosion Control Techniques by Municipality

Erosion Control Practice	MD of Willow Creek (% of Farms[1])	MD of Pincher Creek (% of Farms[1])	Cardston County (% of Farms[1])
Crop rotation	46	43	44
Rotational grazing	54	57	53
Windbreaks or shelterbelts	45	52	38
Buffer zones around water bodies	19	25	11
Winter cover crops	6	6	4
Plowing down green fields	2	2	<1
Weed Control:			
– chemfallow	34	22	39
– combined chemicals & tillage	44	41	24
– summerfallow only	24	41	39

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

Land Use

Human activities on the land create different disturbances throughout the Southern Tributaries Sub-basins. Agricultural activities are the dominant land use followed by infrastructure (Figure 4.8 and in Table 4.8).

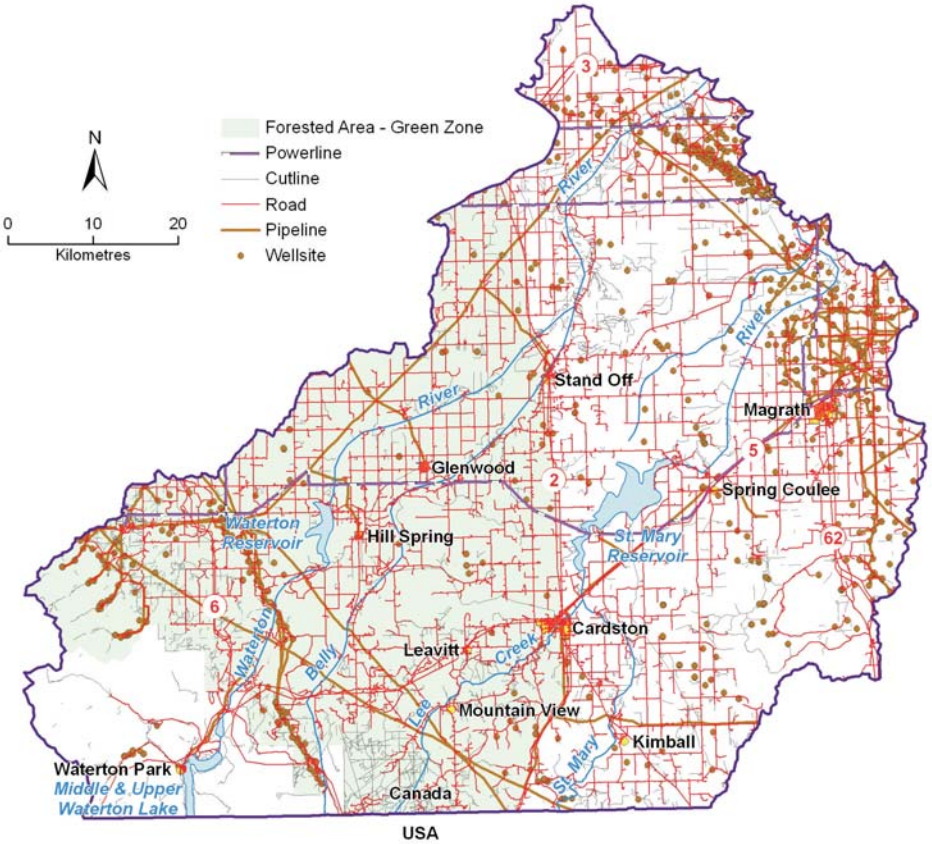


Figure 4.8: Land Use in the Southern Tributaries Sub-basins

Belly River near Waterton – R. Coffey

Table 4.8: Land Use in the Southern Tributaries Sub-basins

Disturbance	Length (km)	km/km^2	Total Area Disturbed (ha)	% of Total Area
Agriculture				
Crops			278 870	46
Summerfallow			11 390	2
Grazing – seeded			106 090	18
Irrigation[1]			24 515	4
Subtotal			*396 350*	*66*
Infrastructure				
Roads	5 024	0.84	2 694	0.5
Railways	187	0.03	187	<0.1
Powerlines	202	0.03	404	0.1
Pipelines	888	0.15	2 663	0.4
Cutlines	3 024	0.51	2 117	0.4
Wells – oil and gas			800	<0.1
Airfields and runways			34	<0.1
Sewage lagoons			0	0
Gravel pits			20	<0.1
Subtotal			*8 919*	*1.5*
Urban				
Residential, commercial and light industrial developments			1 160	0.2
Recreation				
Parks, recreation areas and campgrounds			510	<0.1
Surface Water Supply Sources				
Reservoirs			5 965	1
Total Disturbance			**437 419**	**69**

[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.)

Cameron Lake – J. Charest

Agriculture

Approximately 66% of the area is used for agricultural activities. Most (48%) is annually cropped or summerfallowed, while 18% is tame or seeded pasture land.

Outside of the Green Zone, public land in the Southern Tributaries Sub-basins has a carrying capacity of 13 005 AUMs (J. Best, pers. comm.). Fifty-seven grazing dispositions cover approximately 13 329 ha. Additionally, one cultivation permit has been issued covering about 9 ha.

The locations of 205 confined feeding operations (CFOs) are shown on Figure 4.9. Most are located along the lower Belly River valley west of Lethbridge. However, additional CFOs are found east of the St. Mary River. Minimal information is available on the number of animals contained by these operations.

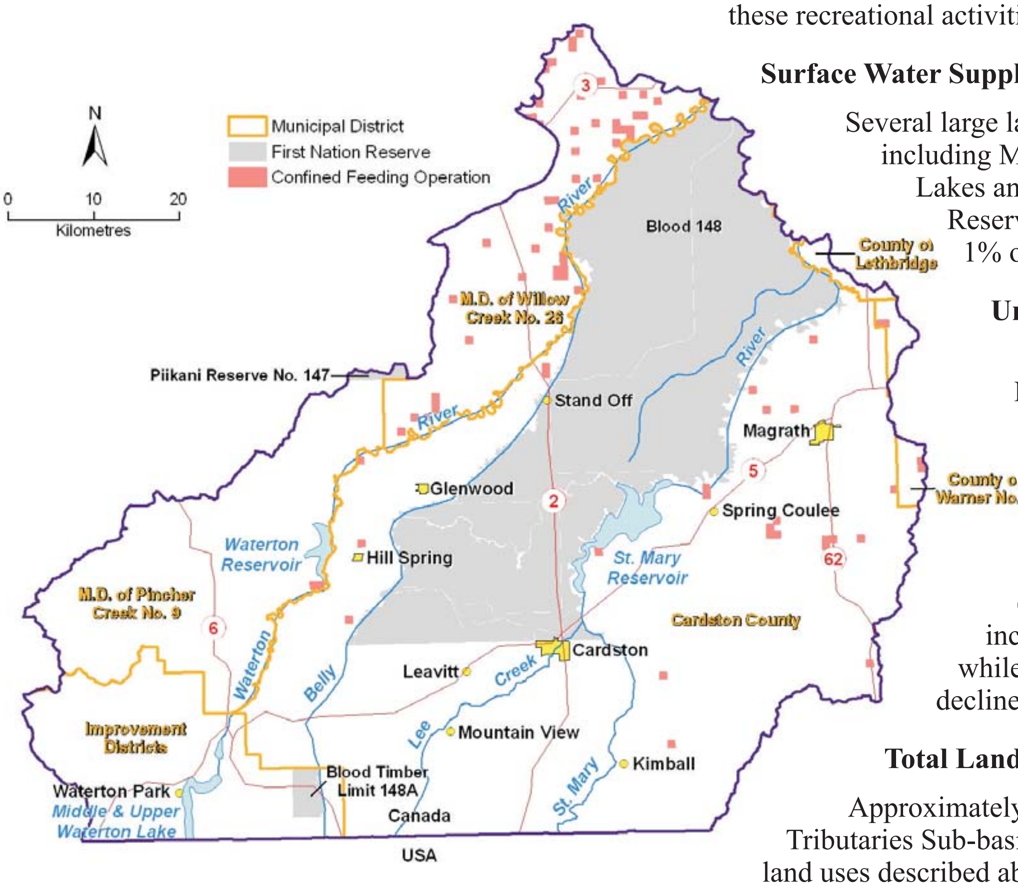


Figure 4.9: Confined Feeding Operations in the Southern Tributaries Sub-basins

Infrastructure

Infrastructure, primarily linear development, comprises 1.7% of the Southern Tributaries Sub-basins. Roads (0.5%) produce the most linear disturbance within the Sub-basins, followed by pipelines (0.4%) and cutlines (0.4%). Most of the roads are part of the rural grid road system and include paved, gravel, unimproved and truck trails.

Recreation

Most of the human disturbance recreational activities such as camping, fishing and hiking occur within Waterton Lakes National Park, and the provincial parks and recreation areas scattered throughout the area. Waterton Lakes National Park is most developed with a village, golf course, roads, trails and several campgrounds. The provincial parks and recreation areas are smaller with campgrounds and picnic areas. Less than 1% of the area is disturbed by these recreational activities.

Surface Water Supply Sources

Several large lakes and irrigation reservoirs, including Middle and Upper Waterton Lakes and Waterton and St. Mary Reservoirs, occupy approximately 1% of the area.

Urban

The towns of Cardston and Magrath and village of Glenwood occupy only 0.2% of the area.

The overall population has increased by only 1% over the period 1996 to 2006 (Table 4.9). The most rapid increase was in Magrath (12%), while Glenwood had a population decline of 5%.

Total Land Use

Approximately 69% of the Southern Tributaries Sub-basins is affected by the various land uses described above. Agricultural activities make up the largest component (66%).

Table 4.9: Population of Municipalities within Southern Tributaries Sub-basins

Municipality	1996	2006	% Population Change (1996 to 2006)
MD Pincher Creek No. 9	3 172	3 309	7
MD Willow Creek No. 26	5 106	5 337	5
Carston County	4 565	4 325	5
Blood (Kainai) 148A Indian Reserve	4 326	4 177	-3
Cardston	3 417	3 452	6
Magrath	1 867	2 081	12
Glenwood	295	280	-5
Total	**22 748**	**22 961**	**1**

4.1.2 Water Quantity

The Southern Tributaries Sub-basins consist of three primary rivers, the Waterton, the Belly and the St. Mary, along with numerous smaller contributing streams. Natural and recorded flows have been analyzed and trends in natural flows assessed at select locations along the three primary rivers and at one location on Lee Creek, the primary tributary to the St. Mary River. The eight hydrometric stations assessed are shown in Figure 4.10. Either recorded or reconstructed natural flow is available at all stations shown.

One long-term natural flow hydrometric station (Figure 4.10) and one reconstructed natural flow station are located in the Waterton River sub-basin. These are, respectively:

- Waterton River near Waterton Park; and
- Waterton River near Standoff.

One long-term recorded natural flow hydrometric station, one reconstructed natural flow station, and one estimated flow station are located in the Belly River sub-basin. These are, respectively:

- Belly River near Mountain View;
- Belly River near Glenwood; and
- Belly River at the Mouth (estimated by Alberta Environment (AENV) without the benefit of a hydrometric station recording flow at that location).

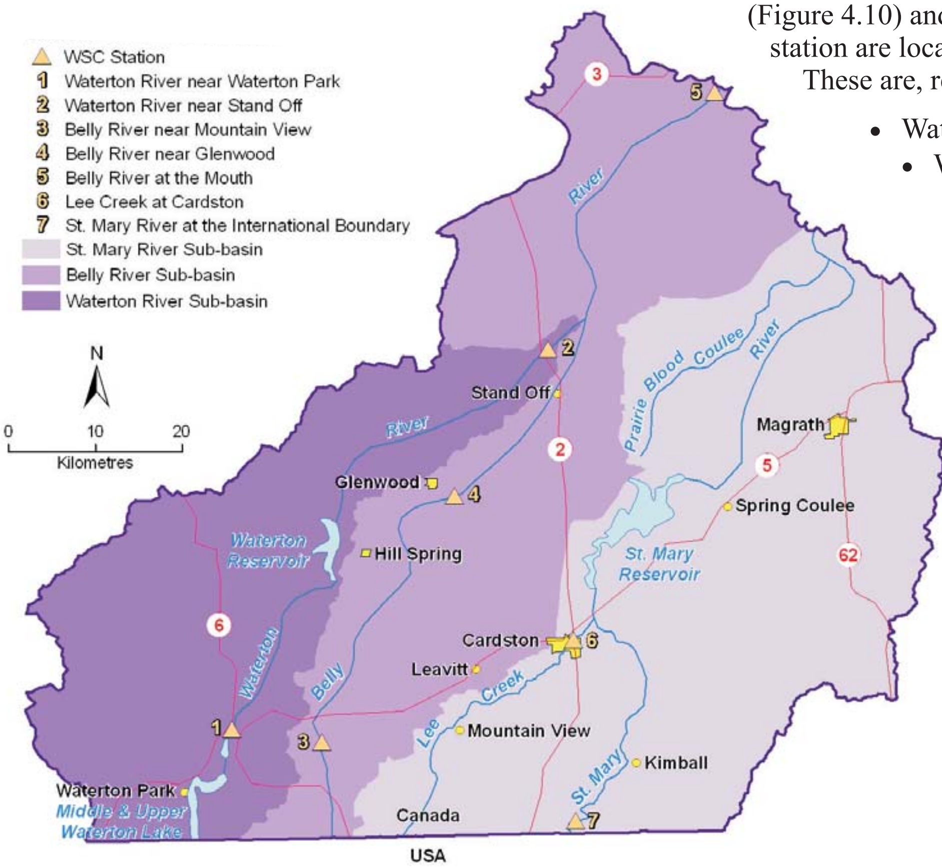


Figure 4.10: WSC Stations in the Southern Tributaries Sub-basins

Hydrometric Stations

- Long-term natural flow: streams with an insignificant amount of water use or regulation: recorded flow equals natural flow.
- Reconstructed natural flow: recorded or estimated actual use is added to recorded flow to approximate natural flow.
- Estimated flow: a station where there are few or no records and natural flow is estimated using hydrologic techniques.

One long-term near-natural flow hydrometric station and two reconstructed natural flow stations are located in the St. Mary River sub-basin. These are, respectively:

- Lee Creek at Cardston;
- St. Mary River at the International Boundary; and
- St. Mary River near Lethbridge

Terms used in this Section are defined in Section 1.3.2.

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

There are many diversions from and between the primary waterways, and eight irrigation districts supplied from the waters of the Southern Tributaries Sub-basins (shown previously on Figure 4.2). The locations and destinations of the diversions with the licensed allocations to the districts are shown in Table 4.10 (IWMSSC 2002).

There are eight irrigation districts that draw water from the Waterton and Belly rivers: United, Mountain View, Leavitt, Aetna, Magrath, Raymond, St. Mary River and Taber. The St. Mary River and Raymond Irrigation Districts are only partially located within the Southern Tributaries Sub-basins, and the Taber Irrigation District is entirely outside the Southern Tributaries Sub-basins. However, all are licensed to divert water from the Waterton, Belly, and St. Mary Rivers via the Waterton-St. Mary Headworks System which links the three rivers.

Table 4.10: Irrigation Districts Drawing Water from the Southern Tributaries Sub-basins

Irrigation District	Location	Water Source	Licensed Allocation
Mountain View Irrigation District	East of the Belly River and north of the hamlet of Mountain View	Belly River	9 868 dam^3
Leavitt Irrigation District	Between the Belly and St. Mary rivers including the hamlet of Leavitt	Belly River	14 802 dam^3
Aetna Irrigation District	West of the St. Mary River and south of the town of Cardston	Belly River	11 101 dam^3
United Irrigation District	Between the Waterton and Belly rivers including the villages of Hill Spring and Glenwood	Belly and Waterton rivers	83 879 dam^3
Magrath Irrigation District	East of the St. Mary River and west of the town of Magrath	St. Mary, Belly and Waterton rivers	41 940 dam^3
Raymond Irrigation District	Town of Raymond and the villages of Stirling and Welling	SMRID main canal which contains water from the Waterton, Belly and St. Mary rivers	99 913 dam^3
St. Mary River Irrigation District	Between Lethbridge and Medicine Hat	Waterton, Belly and St. Mary rivers	890 587 dam^3
Taber Irrigation District	South of the Oldman River, including the Town of Taber	Waterton, Belly and St. Mary rivers	194 893 dam^3

Historic Note – The Irrigation Districts of the Southern Tributaries Sub-basins

The United Irrigation District (UID) was formed by local landowners in 1921, and the first water was diverted from the Belly River into the district in 1923 with the goal of irrigating 14 000 ha between the Belly and Waterton rivers. The system fell into disrepair and was eventually only able to service about one-third of its intended area. In 1978, AENV installed a turnout to Cochrane Lake from the Waterton-St. Mary Headworks System to ensure adequate water supply to the district even during low-flow years (AENV 1994). Presently, this irrigation district provides water to 6 992 ha (ARD 2009).

The Mountain View Irrigation District (MVID) was formed in 1923, and construction began on the conveyance works in 1925. Water was first diverted from the Belly River (upstream of the Waterton-St. Mary Headworks System) in 1931 (ARD 2009). This relatively small irrigation district services about 426 ha of agricultural land. In 1937, the federal government began rehabilitation of the main canal from the Belly River to Payne Lake and proceeded to construct the extension of the MVID main canal to eventually service the Leavitt Irrigation District (LID). The LID was formed in 1936 and brought online in 1944 to service 1 862 ha of land. The Aetna Irrigation District (AID) was the last district to be formed along the Belly River system in 1945 when an extension to the main canal from the MVID and LID was constructed by the federal government to provide water to the area. The AID services 781 ha. Control of the MVID, LID and AID headworks was transferred to the Alberta Government in the early 1950s.

Following much negotiation and hard work by Mormon settlers in the Cardston area and William Pearce, a local political figure, construction began in 1899 to divert water from the St. Mary River near Cardston across southern Alberta for irrigation of more than 51 000 ha of cropland. Construction of the Waterton-St. Mary River Headworks System was initiated in 1946, by the federal and provincial governments. This addition increased the irrigation capacity to over 202 000 ha. In 1974, the federal government turned control of the headworks over to AENV (1994). It currently provides water to the Raymond, Magrath, Taber and St. Mary River irrigation districts and is the main supply of irrigation water for the Blood Tribe Irrigation Project.

The Raymond and Magrath Irrigation Districts were formed in 1925 and 1926, respectively. The Raymond Irrigation District provides water to 13 055 ha of land. The Magrath Irrigation District services 4 528 ha of agricultural land (ARD 2009).

The St. Mary River Irrigation District (SMRID) provides water to the largest area of all of the irrigation districts in Alberta. Water is diverted from the Waterton, Belly and St. Mary rivers and stored in 15 reservoirs of varying capacities. Formed in 1968 from areas that had been under irrigation since 1900, the SMRID provides water to 138 712 ha of irrigated land (ARD 2009).

Main canal at Magrath 1911 – ARD

Canada shares the natural flow of the St. Mary River with the United States. The mean annual diversion (1992 to 2001) from the St. Mary River prior to entering Canada was 192 288 dam^3. More information on the sharing agreement, the Boundary Waters Treaty (1909), and historical diversions is provided in Section 4.1.2 St. Mary River sub-basin.

Waterton - St. Mary Headworks System Irrigation Diversions in the Southern Tributaries Sub-basins

Since 1968, water was diverted from the Waterton River into the Waterton-Belly Canal for irrigation use within the United Irrigation District and east of the Belly River (Figure A). From 1992 to 2001, the diversion averaged 319 400 dam^3 per year. The diverted water is used for irrigation and other purposes.

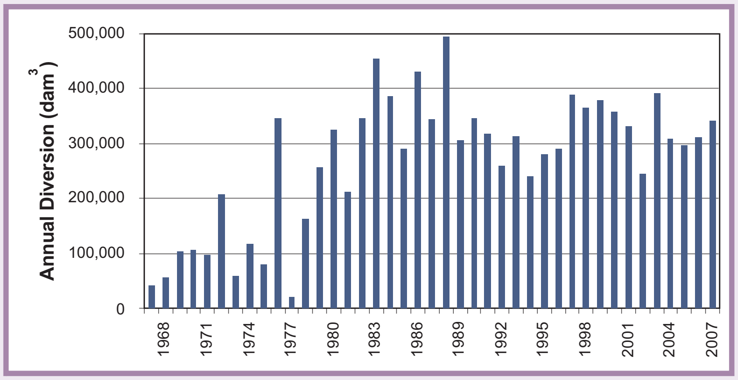


Figure A: Diverted Volumes From the Waterton River to the St. Mary Reservoir Through the Waterton Belly Diversion Canal from 1968 to 2008

Annual diversions from the Belly River into the Belly-St. Mary Canal are shown in Figure B. The average annual diversion from 1992 to 2001 was 101 791 dam^3.

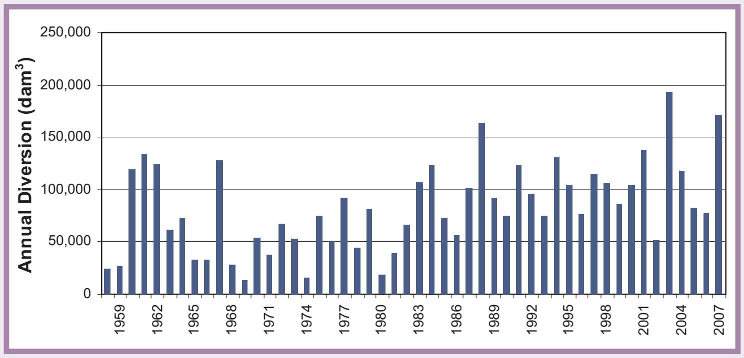


Figure B: Diverted Volumes from the Belly River to the St. Mary Reservoir Through the Waterton-Belly Diversion Canal from 1959 to 2008

Figure C shows the combined diversion from both the Waterton and Belly rivers eastward to the St. Mary River Sub-basin from 1959 to 2008. The recorded annual diversions from 1992 to 2001 averaged 421 196 dam^3. The diverted water is used for irrigation on the Blood Indian Irrigation Project and irrigation districts north and east of the St. Mary Reservoir. A relatively small amount of water is used for purposes other than irrigation.

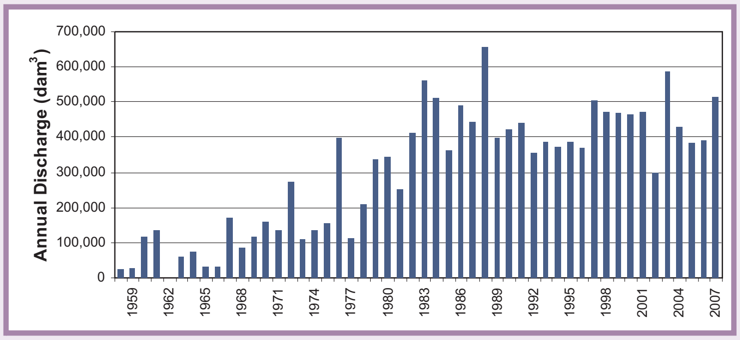


Figure C: Annual Combined Volumes Diverted from the Waterton and Belly Rivers to the St. Mary Reservoir from 1959 to 2008

The annual diversion from the St. Mary Reservoir for use within and beyond the Oldman watershed is show in Figure D. From 1992 to 2001, the diversion has averaged 663 141 dam^3. The diverted water is used for irrigation and other purposes north and east of the St. Mary Reservoir.

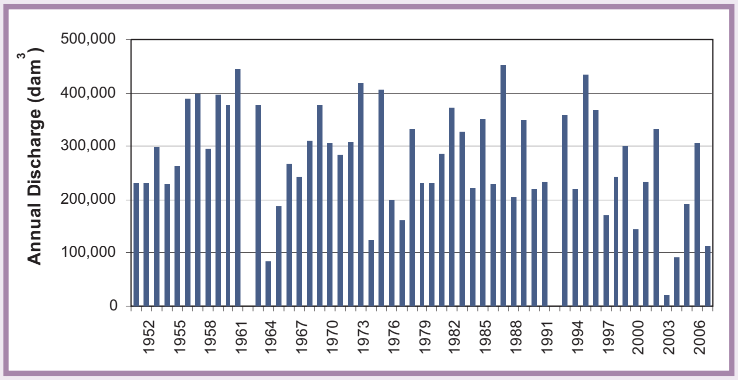


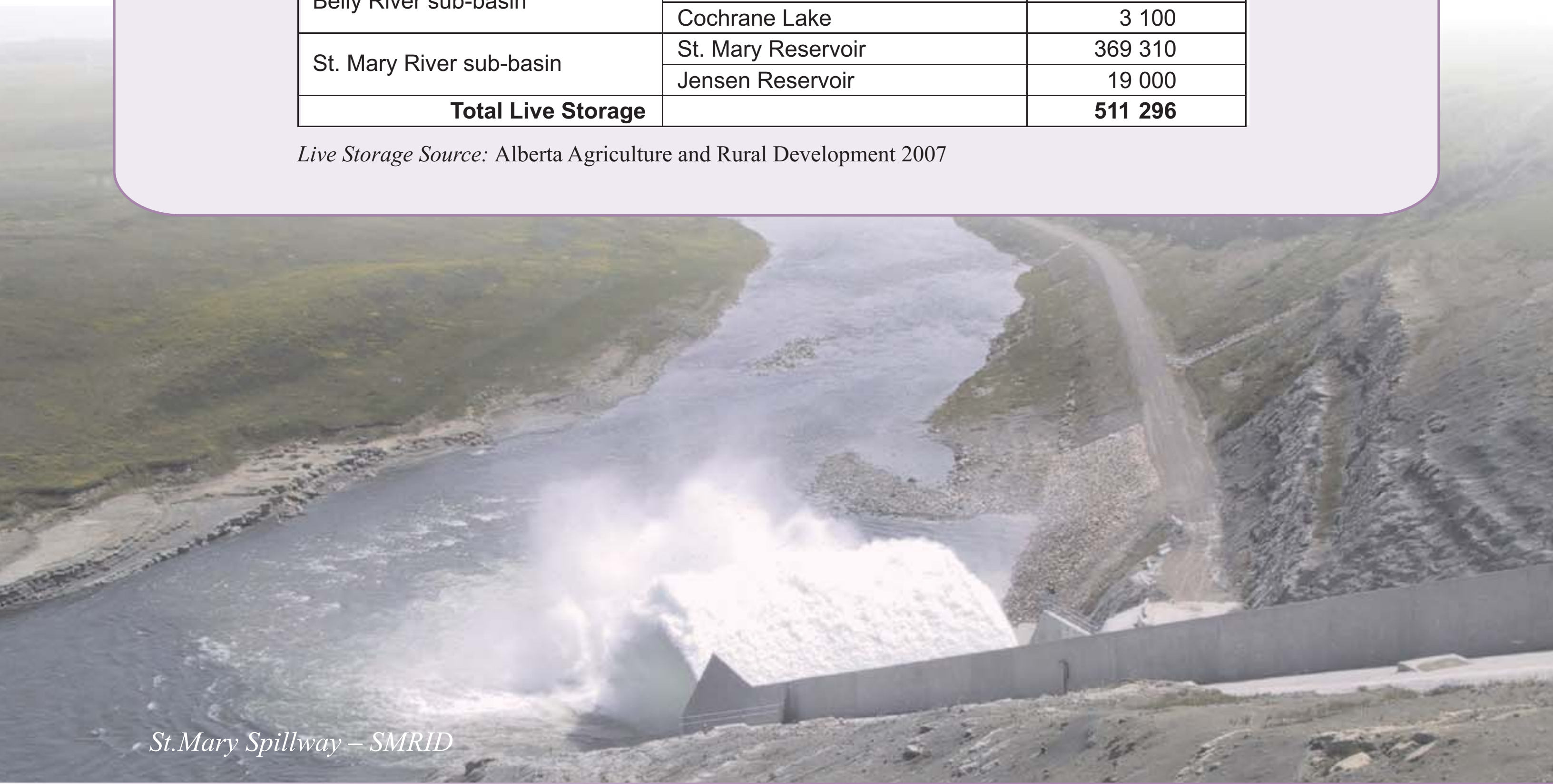
Figure D: Net Diversion from the St. Mary River Sub-basin for Irrigation and Other Uses Within and Beyond the Oldman Watershed

The Southern Tributaries Sub-basins has several reservoirs associated with irrigation and other uses. Figure 4.2 identifies the locations of reservoirs in the Southern Tributaries Sub-basins and Table A summarizes the live (usable) storage capacity of the reservoirs. Other irrigation reservoirs that are used to store water diverted from the Southern Tributaries Sub-basins are located in the Prairie Sub-basins south of the Oldman River (Section 5.1.2). Still others are located outside the Oldman watershed.

Table A: Reservoirs Associated with Irrigation and Other Uses in the Southern Tributaries Sub-basins

Location	Reservoir	Live Storage (dam^3)
Waterton River sub-basin	Waterton Reservoir	111 196
Belly River sub-basin	Paine Lake	8 690
	Cochrane Lake	3 100
St. Mary River sub-basin	St. Mary Reservoir	369 310
	Jensen Reservoir	19 000
Total Live Storage		**511 296**

Live Storage Source: Alberta Agriculture and Rural Development 2007



St.Mary Spillway – SMRID

Hydrologic Characteristics

Recorded flows at many stations within the Southern Tributaries Sub-basins are highly impacted by diversions, reservoir regulations and unmonitored water use. Current flows at the mouths of the Waterton, Belly and St. Mary rivers are substantially lower than natural flows. Natural flows in these sub-basins are difficult to determine because of continuing changes to diversion rates, timing of withdrawals, and return flow volumes.

Waterton River Sub-basin

The recorded flow near Waterton Lakes National Park is considered natural flow because upstream of this site the river is unregulated and has little water use. Alberta Environment has extended natural flows for the period from 1912 to 2001 using statistical methods. Since the recorded flows near the park are very close to natural flows, the AENV extension simply filled in the gaps in the recorded period. The hydrologic characteristics of the Waterton River near the park are shown on Figure 4.11. The major peak in early June is likely the result of melting snowpack runoff entering the water course.

Recorded flows on the Waterton River near Standoff (1992 to 2001) are quite different from the natural flows determined by AENV (1912 to 2001), especially during the summer months when irrigation demand is at its peak. The Waterton Reservoir is situated between the Waterton Park and Standoff monitoring stations and has regulated the flows downstream of the park since 1964. Additionally, the diversions into the irrigation districts and upstream water uses affect recorded flows in this reach of the river.

Recorded flow measurements have been discontinued at the monitoring station near Standoff and so the recorded flow hydrograph for 1992 to 2001 (Figure 4.12) is based on flows recorded at Waterton River near Glenwood.

The monthly distributions of flow at both Waterton River monitoring stations show a major peak in early June. The peak is likely caused by a combination of meltwater from the winter snow pack and spring precipitation events.

Waterton River near Waterton Park

Gross DA	km^2	613
Effective DA	km^2	613
Natural Discharge 1912-2001		
Mean Annual	dam^3	557,217
Upper Quartile	dam^3	635,773
Median	dam^3	557,832
Lower Quartile	dam^3	472,529
Median Yield		
Gross DA	dam^3/km^2	910
Effective DA	dam^3/km^2	910

DA = Drainage Area

Mean Discharge of of the Waterton River near Waterton Park, 1992-2001

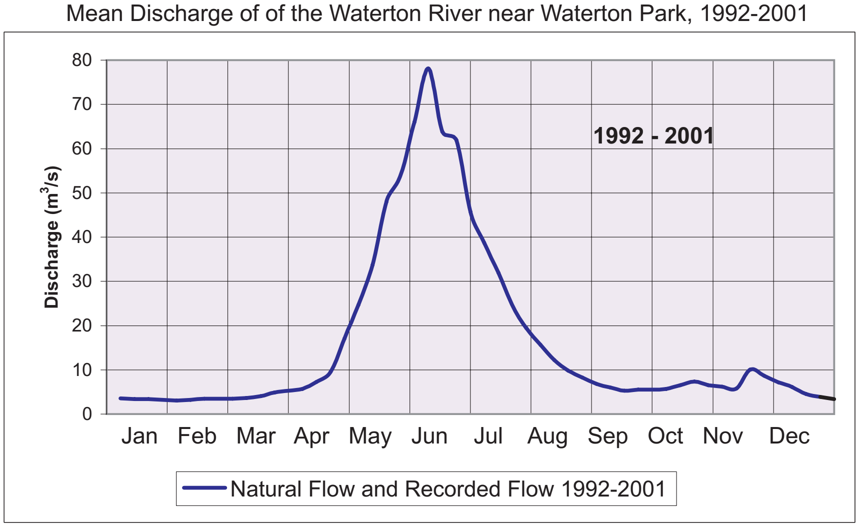


Figure 4.11: Waterton River Near Waterton Park Hydrologic Characteristics

Waterton River near Stand Off

Gross DA	km^2	1730
Effective DA	km^2	1710

Natural Discharge 1912-2001

Mean Annual	dam^3	755,562
Upper Quartile	dam^3	858,599
Median	dam^3	736,485
Lower Quartile	dam^3	634,024

Median Yield

Gross DA	dam^3/km^2	426
Effective DA	dam^3/km^2	431

DA = Drainage Area

Mean Discharge of of the Waterton River near Stand Off, 1992-2001

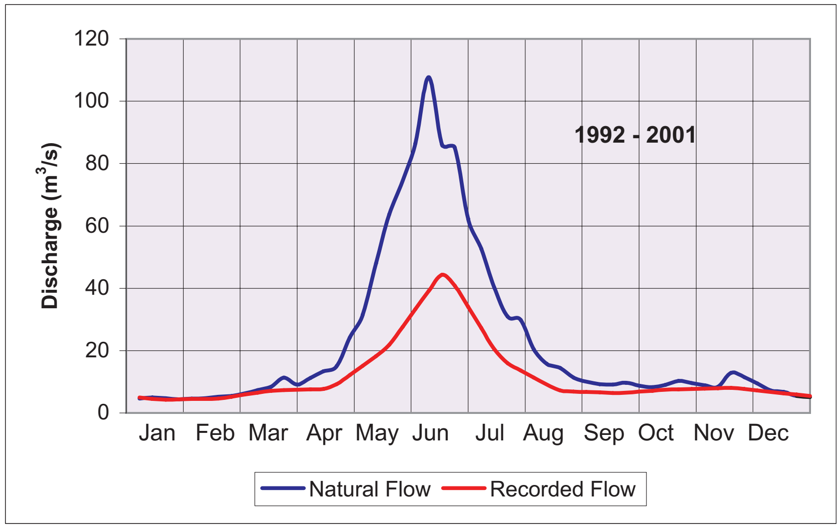


Figure 4.12: Waterton River Near Standoff Hydrologic Characteristics

Based on the Mann-Kendall test, annual and monthly flows on the Waterton River did not show any significant trends (Figures 4.13 and 4.14) for the period from 1912 to 2001. This conclusion for the Waterton Park station differed from the findings of Rood et al. (2005) possibly due to the different periods used in the analyses. Rood et al. based their analysis on a 77 year period of recorded flows (1909 to 2002, with gaps). Figure 4.13 is based on 90 years of recorded and estimated flows, 1912 to 2001.

(A supplemental trend analysis for the period 1912 to 2008 did not yield results significantly different from those of the standard period 1912 to 2001.) Annual flows were observed to decrease slightly over the natural flow period at both Waterton River monitoring stations; however, neither site displayed statistically significant changes. Annual flow at the Waterton River near Waterton Park station decreased by an average of 0.08% per year, according to trend line slopes, while near Standoff, flow decreased by about 0.1% per year.

Waterton River near Waterton Park

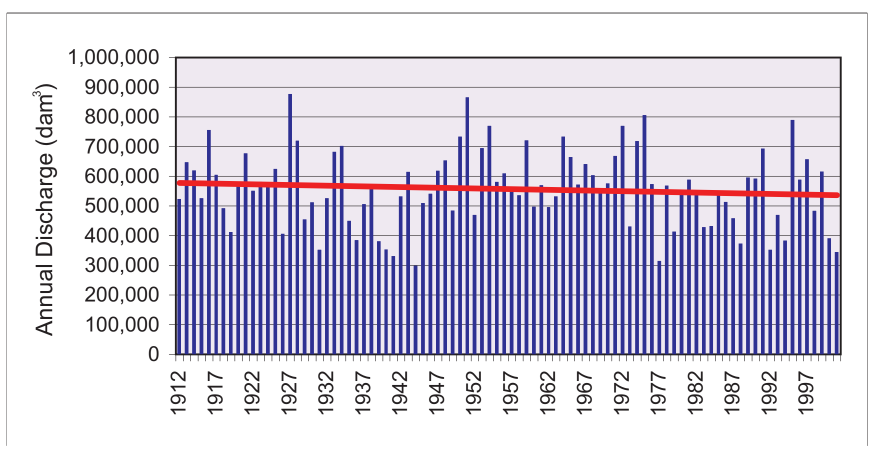
Mann-Kendall Trend Analysis

	MK-Stat	p-value
Annual	-0.82	0.41
Jan	-0.81	0.42
Feb	-1.13	0.26
Mar	0.77	0.44
Apr	-0.01	0.99
May	-0.83	0.40
Jun	-0.85	0.39
Jul	-0.24	0.81
Aug	-0.02	0.99
Sep	-1.45	0.15
Oct	-1.07	0.28
Nov	-0.74	0.46
Dec	-1.29	0.20

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line



Average annual decrease in flow = 459 dam^3, based on trend line slope.

Figure 4.13: Trends in Natural Flow – Waterton River Near Waterton Park

Waterton River near Stand Off

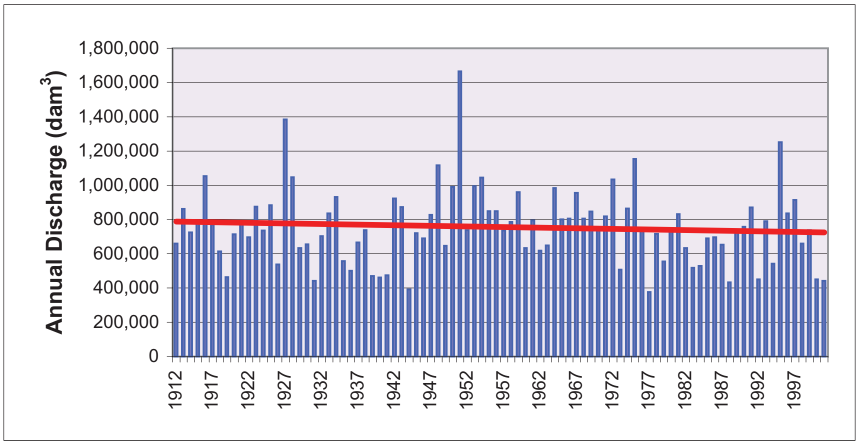
Mann-Kendall Trend Analysis

	MK-Stat	p-value
Annual	-0.76	0.45
Jan	-0.92	0.36
Feb	-0.64	0.52
Mar	0.23	0.82
Apr	-1.03	0.30
May	-0.46	0.65
Jun	-0.97	0.33
Jul	-0.10	0.92
Aug	-0.50	0.62
Sep	-1.21	0.23
Oct	-1.04	0.30
Nov	-0.52	0.60
Dec	-1.32	0.19

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line



Average annual decrease in flow = 705 dam^3, based on trend line slope.

Figure 4.14: Trends in Natural Flow – Waterton River Near Standoff

Belly River Sub-basin

The recorded flow in the Belly River near Mountain View is very similar to natural flow with very high median yields (dam^3/km^2 of drainage area) (Figure 4.15). The differences between natural and recorded flow are primarily due to the diversions to Payne Lake for irrigation purposes. Alberta Environment has reconstructed natural flows and extended the period to the standard 1912 to 2001 period using statistical methods.

The hydrologic characteristics of the Belly River near Mountain View are shown on Figure 4.15.

A single peak in flow occurs in early June, coinciding with the peak runoff from the melting snowpack.

Recorded flows on the Belly River near Glenwood (1992 to 2001) are somewhat different from the natural flows determined by AENV, especially during the summer months when irrigation demand is at its peak (Figure 4.16). Water is diverted from the Belly River into Payne Lake, the United Irrigation District via Cochrane Lake, and the St. Mary Reservoir for irrigation purposes, and these diversions affect the flows at this site.

Belly River near Mountain View

Gross DA		km^2	319
Effective DA		km^2	319
Natural Discharge 1912-2001			
	Mean Annual	dam^3	285,958
	Upper Quartile	dam^3	321,877
	Median	dam^3	287,803
	Lower Quartile	dam^3	240,132
Median Yield			
	Gross DA	dam^3/km^2	902
	Effective DA	dam^3/km^2	902

DA = Drainage Area

Mean Discharge of of the Belly River near Mountain View, 1992-2001

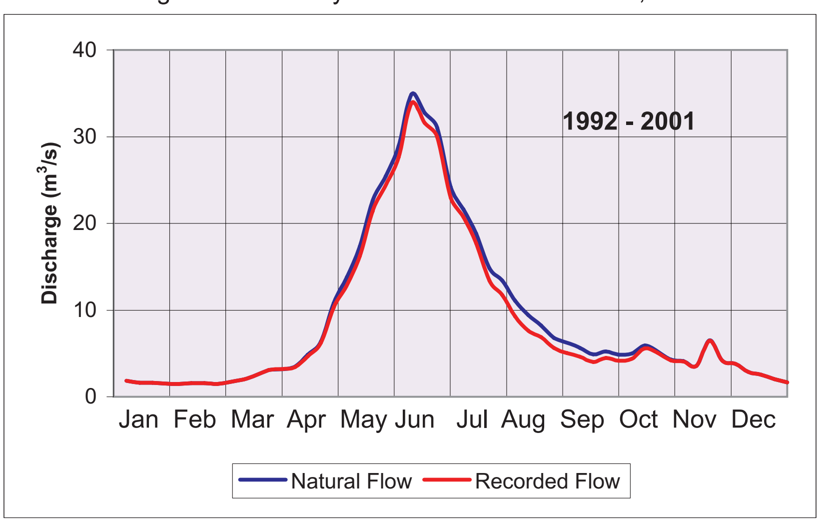


Figure 4.15: Belly River Near Mountain View Hydrologic Characteristics

Belly River near Glenwood

Gross DA	km^2	653
Effective DA	km^2	538
Natural Discharge 1912-2001		
Mean Annual	dam^3	298,719
Upper Quartile	dam^3	333,721
Median	dam^3	297,072
Lower Quartile	dam^3	251,203
Median Yield		
Gross DA	dam^3/km^2	455
Effective DA	dam^3/km^2	552

DA = Drainage Area

Mean Discharge of of the Belly River near Glenwood, 1992-2001

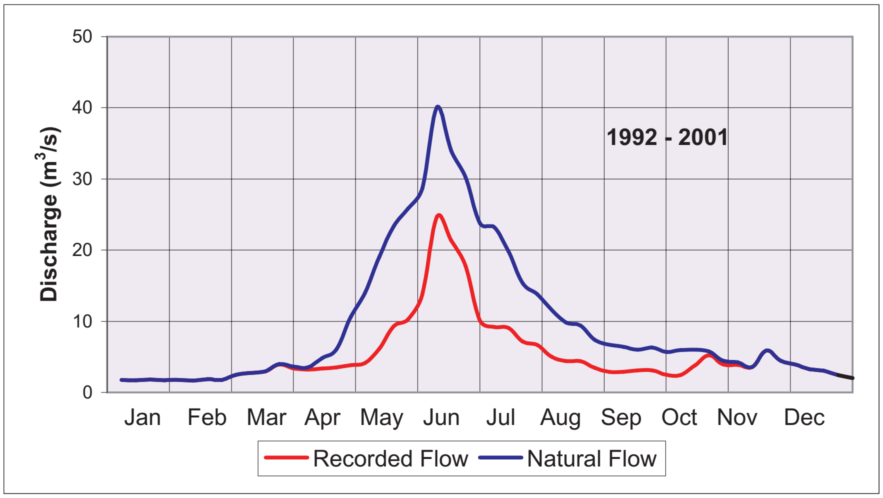


Figure 4.16: Belly River Near Glenwood Hydrologic Characteristics

In the absence of recorded data, natural flows on the Belly River near the Mouth (1912 to 2001) were estimated by AENV. Average natural flow for the most recent ten years (1992 to 2001) is shown on Figure 4.17. Two peaks are observed during June at this flow station. The first peak is similar to the single peak observed upstream and is likely a result of melting snowpack runoff entering the Belly River. The second peak is likely due to the slightly delayed runoff from the Waterton River headwaters at a higher elevation and west of the Belly River headwaters. The timing of the Waterton River peak would be delayed due to the impact of storage in the Waterton Lakes.

Based on both the linear trend analysis and the Mann-Kendall test, annual flows on the Belly River did not show significant trends (Figures 4.18 to 4.20) for the period from 1912 to 2001. A probable decreasing trend was observed in December flows on the Belly River near Mountain View. No other monthly significant or probable trends were observed in the natural flows at any sites along the Belly River for the period from 1912 to 2001.

Belly River near the Mouth

Gross DA	km^2	3850
Effective DA	km^2	N/A
Natural Discharge 1912-2001		
Mean Annual	dam^3	1,103,670
Upper Quartile	dam^3	1,242,408
Median	dam^3	1,062,525
Lower Quartile	dam^3	895,872
Median Yield		
Gross DA	dam^3/km^2	276
Effective DA	dam^3/km^2	N/A

DA = Drainage Area

Mean Discharge of of the Belly River near the Mouth, 1992-2001

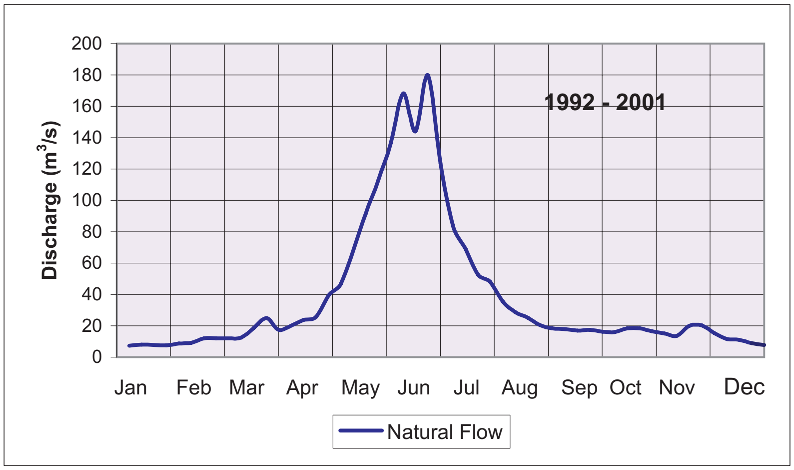


Figure 4.17: Belly River Near the Mouth Hydrologic Characteristics

Belly River near Mountain View

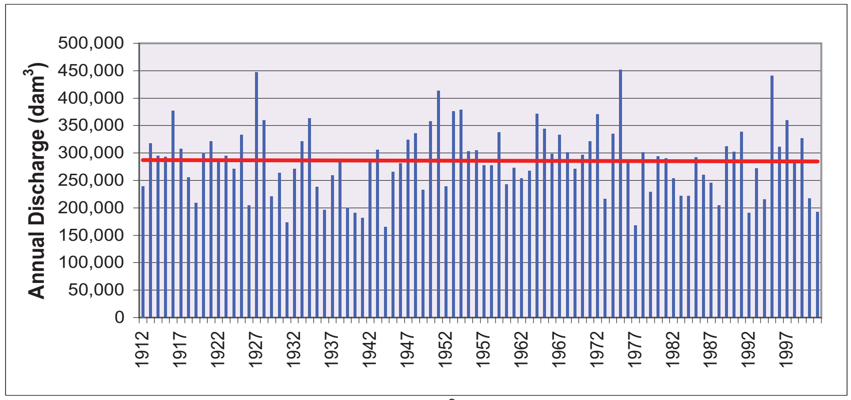
Mann-Kendall Trend Analysis

	MK-Stat	p-value
Annual	-0.21	0.84
Jan	-1.08	0.28
Feb	-1.18	0.24
Mar	1.38	0.17
Apr	0.98	0.33
May	-0.29	0.77
Jun	-0.44	0.66
Jul	-0.13	0.90
Aug	0.66	0.51
Sep	0.11	0.91
Oct	-0.83	0.40
Nov	0.02	0.99
Dec	-1.66	0.10

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line



Average annual decrease in flow = 23 dam ^{3}, based on trend line slope.

Figure 4.18: Trends in Natural Flow – Belly River Near Mountain View

Belly River near Glenwood

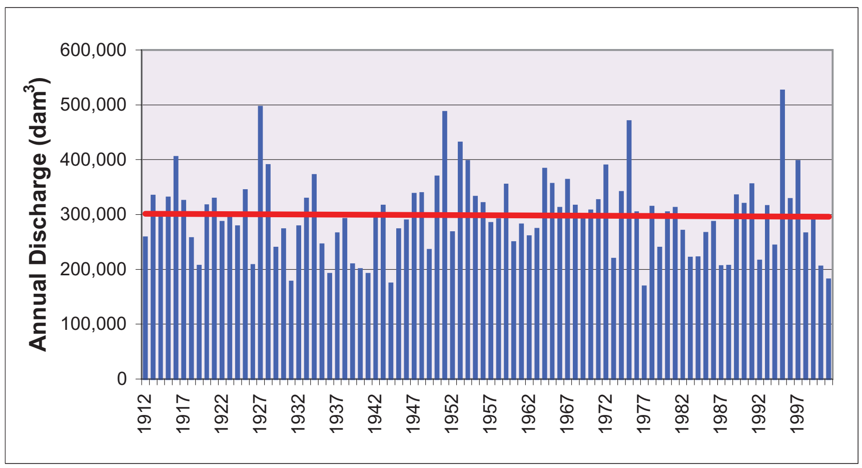
Mann-Kendall Trend Analysis

	MK-Stat	p-value
Annual	-0.43	0.67
Jan	-0.30	0.76
Feb	0.23	0.82
Mar	1.46	0.14
Apr	-0.07	0.94
May	-0.80	0.42
Jun	-0.74	0.46
Jul	-0.21	0.83
Aug	0.97	0.33
Sep	0.43	0.67
Oct	-0.72	0.47
Nov	-0.03	0.97
Dec	-0.70	0.48

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line



Average annual decrease in flow = 62 dam ^{3}, based on trend line slope.

Figure 4.19: Trends in Natural Flow – Belly River Near Glenwood

Belly River near the Mouth

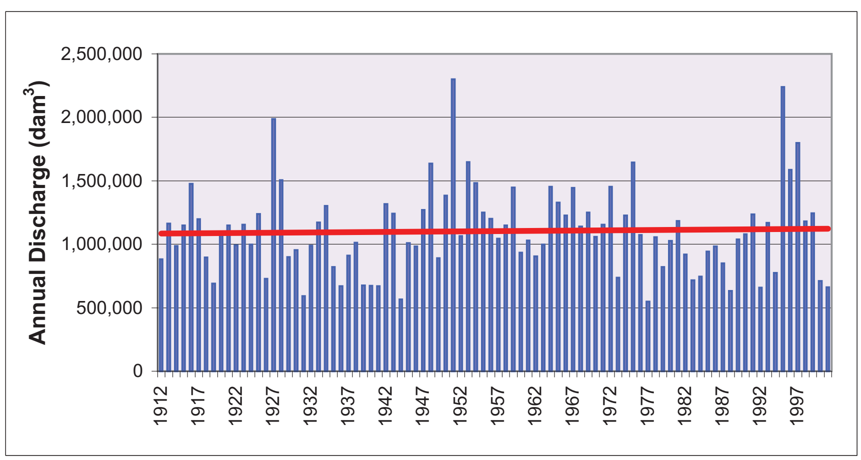
Mann-Kendall Trend Analysis

	MK-Stat	p-value
Annual	0.08	0.94
Jan	-0.23	0.82
Feb	0.83	0.41
Mar	0.56	0.57
Apr	-0.93	0.35
May	-0.25	0.80
Jun	-0.35	0.72
Jul	0.12	0.90
Aug	0.55	0.58
Sep	-0.07	0.95
Oct	-0.35	0.72
Nov	0.14	0.89
Dec	-0.79	0.43

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line



Average annual increase in flow = 413 dam ^{3}, based on trend line slope.

Figure 4.20: Trends in Natural Flow – Belly River Near the Mouth

St. Mary River Sub-basin

Lee Creek is a low yielding foothills and prairie tributary to the St. Mary River. Recorded flow equals natural flow near Cardston (Figure 4.21) because there is an insignificant amount of water use or storage facilities on this creek. The hydrologic characteristics of Lee Creek differ from the St. Mary River since its source is in the foothills. A minor peak is observed in early spring resulting from meltwater or early season precipitation. The major peak in early June corresponds with the major peaks seen in other rivers in the Southern Tributaries Sub-basins and is likely due to runoff from the melting snowpacks.

Recorded flow in the St. Mary River near the International Border is impacted by storage and diversions to the Milk River occurring south of the United States-Canada border (Figure 4.22). These activities have been occurring since 1917. Canada's share of natural flow is subject to provisions of the Boundary Waters Treaty and the 1921 Order of the International Joint Commission. There is an insignificant amount of water use in Canada upstream of this hydrometric station. Calculated natural flows on the St. Mary River near the International Border (1992 to 2001) were determined by AENV (1912 to 2001).

Lee Creek at Cardston

Gross DA	km^2	312
Effective DA	km^2	312
Natural Discharge 1912-2001		
Mean Annual	dam^3	54,256
Upper Quartile	dam^3	66,407
Median	dam^3	46,857
Lower Quartile	dam^3	32,072
Median Yield		
Gross DA	dam^3/km^2	150
Effective DA	dam^3/km^2	150

DA = Drainage Area

Mean Discharge of of the Lee Creek at Cardston, 1992-2001

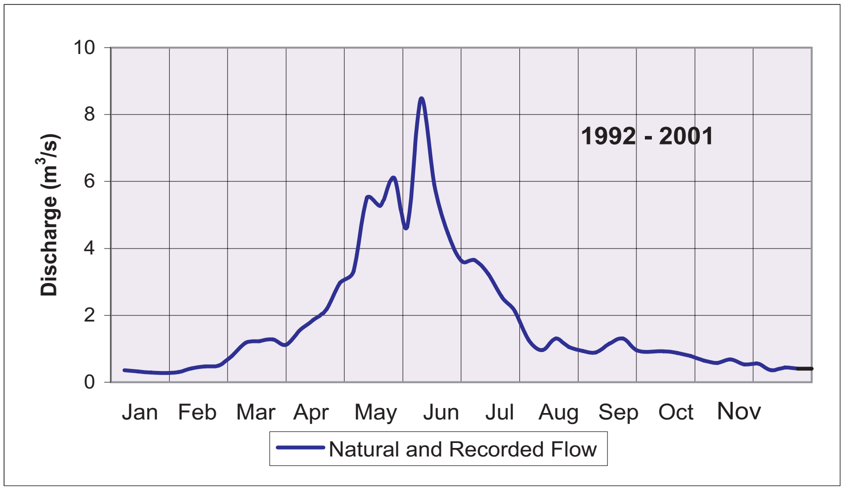


Figure 4.21: Lee Creek at Cardston Hydrologic Characteristics

Lee Creek at Cardston

Gross DA	km^2	312
Effective DA	km^2	312
Natural Discharge 1912-2001		
Mean Annual	dam^3	54,256
Upper Quartile	dam^3	66,407
Median	dam^3	46,857
Lower Quartile	dam^3	32,072
Median Yield		
Gross DA	dam^3/km^2	150
Effective DA	dam^3/km^2	150

DA = Drainage Area

Mean Discharge of of the Lee Creek at Cardston, 1992-2001

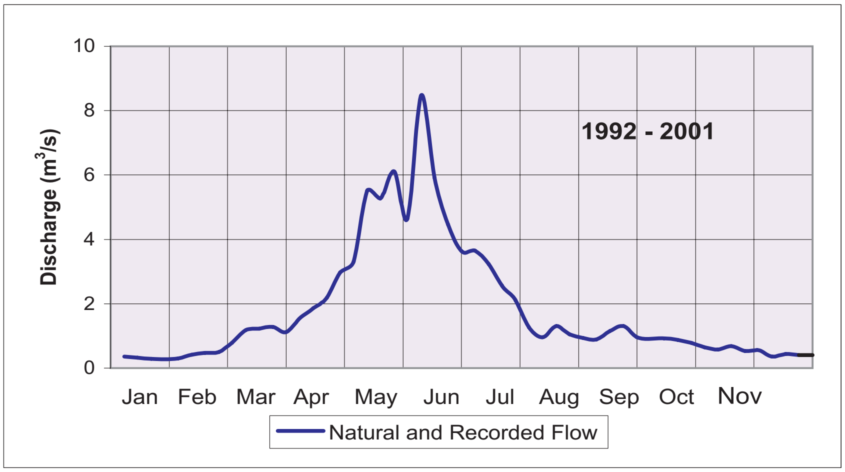


Figure 4.22: St. Mary River Near the International Boundary Hydrologic Characteristics

The Boundary Waters Treaty

The Boundary Waters Treaty was signed by Canada and the United States in 1909. It sets out the principles by which the countries manage the waters they share. It also provides mechanisms to help resolve disputes, and to prevent future ones, concerning water quantity and water quality along the boundary between Canada and the United States. The treaty states that waters shall not be polluted on either side of the boundary to the injury of health or property on the other side and requires that both countries agree to projects that would change the natural levels or flows of boundary waters (International Joint Commission (IJC) 2009).

The St. Mary and Milk rivers arise adjacent to one another in the eastern slopes of the Rocky Mountains; both rivers flow north from Montana into Alberta. Actions taken by American interests to develop irrigated agriculture in the lower Milk River watershed and by Canadian interests to develop irrigation, both using St. Mary River water, led to a significant water dispute. This resulted in Article VI of the 1909 Boundary Waters Treaty which provides a sharing arrangement for the waters of the two rivers. In short, the Treaty allowed that during the irrigation season when the natural flow of the St. Mary River at the International Boundary is 666 cfs (18.86 m^3/s) or less, Canada is entitled to 75% of the flow. Any portion of the natural flow in excess of 666 cfs, and all natural flow outside the irrigation season is shared equally among the two countries. Reciprocal arrangements were made for sharing Milk River natural flows.

The 1921 Order of the International Joint Commission

When diversions began in 1917, the administration of Article VI came into question. The matter was referred to the IJC which led to a ruling in 1921. The Treaty and the 1921 Order of the IJC provided each nation with a secure understanding of their respective shares of the waters thus permitting the planning and development of irrigation. Historical diversions from the St. Mary River to the Milk River upstream of the International Boundary are shown in Figure A.

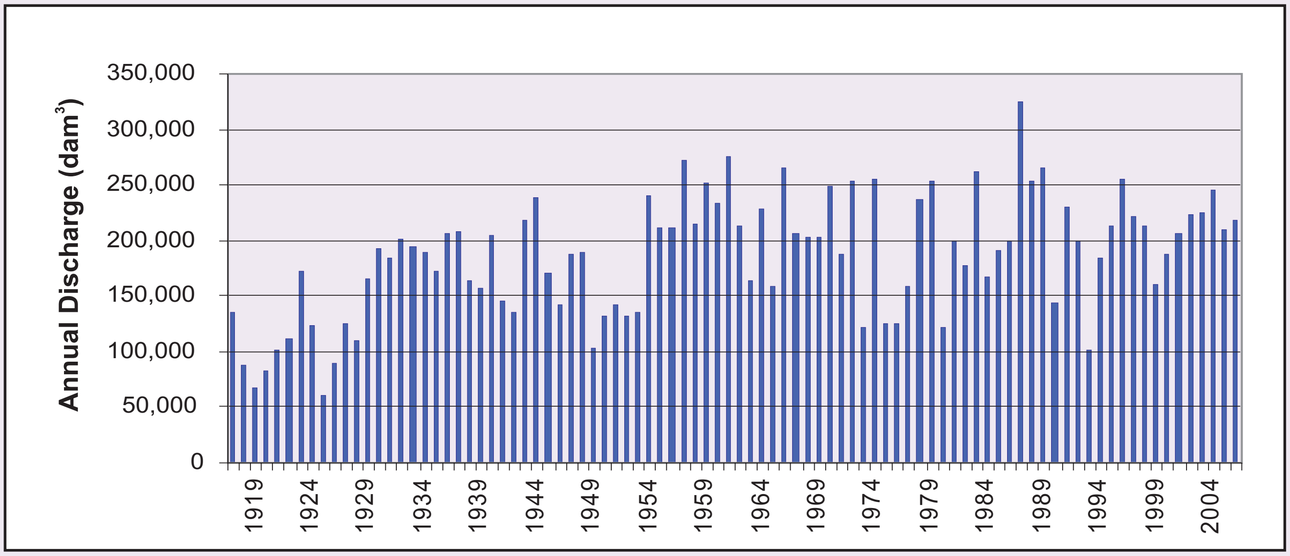


Figure A: United States Diversions from the St. Mary River to the Milk River

The hydrologic characteristics of the St. Mary River near the International Border are shown on Figure 4.22. A single peak in flow occurs in early June, coinciding with the peak runoff from the melting snowpack.

Within Canada, the St. Mary River is highly impacted by diversions and storage. It is also impacted by use south of the United States-Canada border. Diversions into the Sub-basins from the Waterton-Belly Diversion are around 422 500 dam^3 annually while annual withdrawals from the river in the United States are around 192 300 dam^3. Additionally, water is diverted from the St. Mary River to irrigate land to the north and east, and to provide water for the Raymond, Magrath, St. Mary River and Taber irrigation districts. The recorded flows are quite different from the natural flows as a result of these activities (Figure 4.23). The major peak in early June is likely a result of melting snowpack in the higher regions in the St. Mary River headwaters (Figure 4.23).

Based on both the linear trend analysis and the Mann-Kendall test, neither annual nor monthly flows in Lee Creek changed significantly (Figure 4.24) for the period from 1912 to 2001.

St. Mary River near Lethbridge

Gross DA	km^2	3530
Effective DA	km^2	3310
Natural Discharge 1912-2001		
Mean Annual	dam^3	881,851
Upper Quartile	dam^3	1,014,494
Median	dam^3	848,949
Lower Quartile	dam^3	742,091
Median Yield		
Gross DA	dam^3/km^2	134
Effective DA	dam^3/km^2	143

DA = Drainage Area	dam^3
Mean divertion out of the basin in US, 1992-20	192,288
Mean divertion from Belly and Waterton	422,500
Net diversion into the St Mary River Basin	230,212

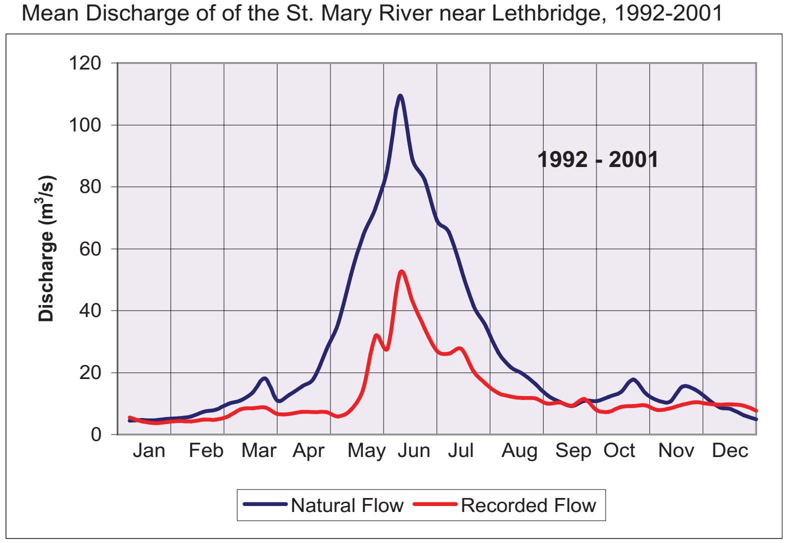


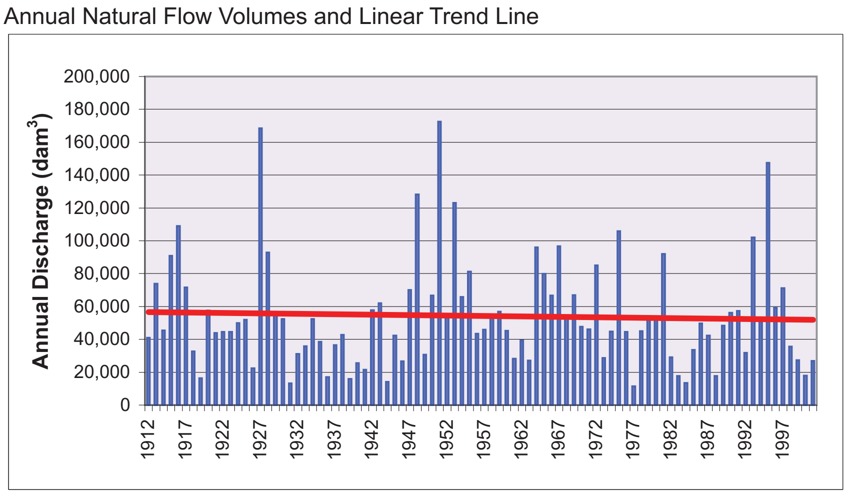
Figure 4.23: St. Mary River Near Lethbridge Hydrologic Characteristics

Lee Creek at Cardston

Mann-Kendall Trend Analysis

	MK-Stat	p-value
Annual	-0.26	0.79
Jan	-1.18	0.24
Feb	-0.37	0.71
Mar	0.16	0.88
Apr	-0.92	0.36
May	-0.98	0.33
Jun	-0.71	0.48
Jul	0.34	0.74
Aug	1.15	0.25
Sep	0.92	0.36
Oct	-0.39	0.69
Nov	-0.82	0.41
Dec	-1.08	0.28

Significant Trend
Probable Trend



Average annual decrease in flow = 53 dam^3, based on trend line slope.

Figure 4.24: Trends in Natural Flow – Lee Creek at Cardston

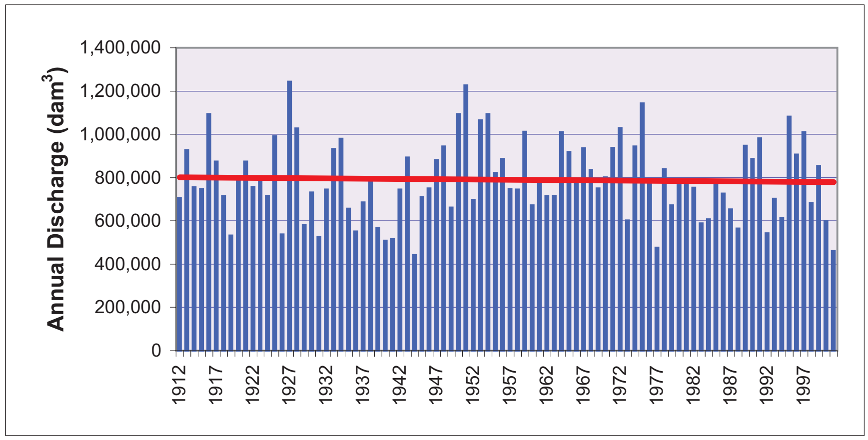
Annual flows on the St. Mary River were observed to be decreasing by an average of 0.03% per year near the International Border and by 0.1% per year near Lethbridge (Figures 4.25 and 4.26) according to linear trend analysis for the period from 1912 to 2001. These annual decreases do not represent statistically significant trends. The St. Mary River near Lethbridge shows a statistically significant decreasing trend in September flows using the Mann-Kendall test (Figure 4.26). No monthly trends were observed near the International Border.

St. Mary near the International Boundary

	MK-Stat	p-value
Annual	-0.21	0.83
Jan	0.02	0.98
Feb	-0.16	0.88
Mar	0.44	0.66
Apr	0.35	0.73
May	-0.34	0.74
Jun	-0.34	0.74
Jul	-0.22	0.83
Aug	0.16	0.87
Sep	-0.96	0.34
Oct	-0.62	0.53
Nov	-0.44	0.66
Dec	-0.82	0.41

Significant Trend

Probable Trend



Average decrease in flow = 239 dam^3, based on trend line slope.

Figure 4.25: Trends in Natural Flow – St. Mary River Near the International Boundary

St. Mary River near Lethbridge

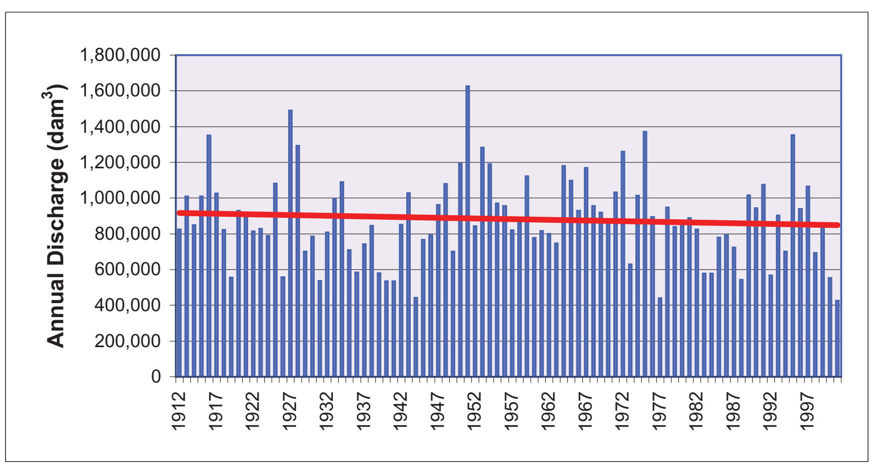
Mann-Kendall Trend Analysis

	MK-Stat	**p-value**
Annual	-0.76	0.45
Jan	-0.34	0.74
Feb	0.71	0.48
Mar	0.47	0.64
Apr	-0.71	0.47
May	-0.39	0.69
Jun	-0.80	0.42
Jul	-0.41	0.68
Aug	-1.04	0.30
Sep	-2.36	0.02
Oct	-0.46	0.64
Nov	-0.58	0.57
Dec	-0.87	0.39

Significant Trend

Probable Trend

Annual Natural Flow Volumes and Linear Trend Line



Average annual decrease in flow = 767 dam^3, based on trend line slope.

Figure 4.26: Trends in Natural Flow – St. Mary River Near Lethbridge

Licensed Allocation and Actual Use

Waterton River Sub-basin

Irrigation is the primary water use within the Waterton River sub-basin. Near Waterton Lakes National Park, irrigation allocations are the only water use and are negligible (<0.1%) compared to the median annual flows (Figure 4.27).

Surface water allocations on the Waterton River near Standoff are about 8% of the median natural flows with much of the allocation devoted to irrigation use, which includes irrigation district and private irrigation use. There are 42 private irrigation licences in the Waterton River sub-basin. Actual use includes the diversion to the St. Mary Reservoir. Including the diverted water, actual use from the Waterton River near Standoff is about 49% of the median natural flow. Irrigators hold, and use, about 94% of the total allocations and uses, not including the diversion to the St. Mary Reservoir (Figure 4.28). Municipal, commercial, agricultural and other uses accounts for the remaining 6% of the allocated water near Standoff. Commercial development includes the Waterton Gas Plant in the Drywood Creek basin, a tributary to Waterton Reservoir. From 1992 to 2001 the approximate annual diversion from the Waterton River to the St. Mary Reservoir was 319 000 dam^3. (A number of allocations at St. Mary Reservoir for diversions from all three rivers have been made without specifying specific volumes from each river.)

Waterton River near Waterton Park

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	883	724
Other Agric	0	0
Municipal	0	0
Commercial	0	0
Industrial	0	0
Other	0	0
Totals	883	724
% of median flow	0.2%	0.1%

Distribution of Water Allocation and Actual Use by Purpose.

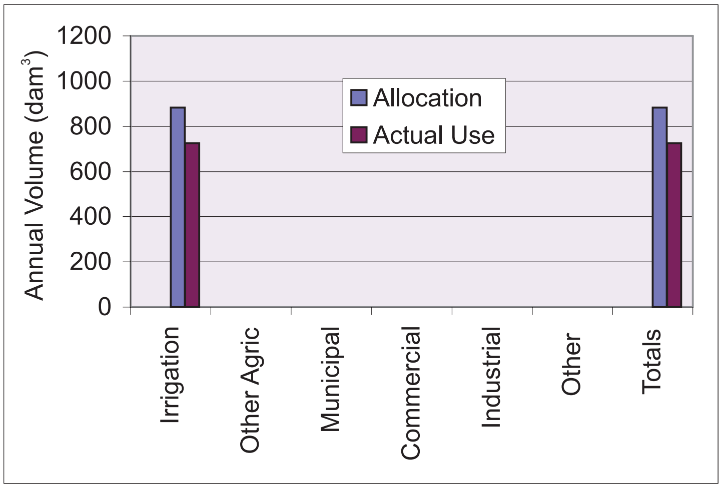


Figure 4.27: Water Demand – Waterton River Near Waterton Park

Waterton River near Stand Off

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	55,219	41,739
Other Agric	908	710
Municipal	14	8
Commercial	3,355	2,393
Industrial	-	-
Other	97	97
Diversion to St.		319,405
Totals	59,593	364,353

Use of water diverted to St. Mary Reservoir is not reflected in the allocations

% of median flow	8.1	49.5

Distribution of Water Allocation and Actual Use by Purpose.

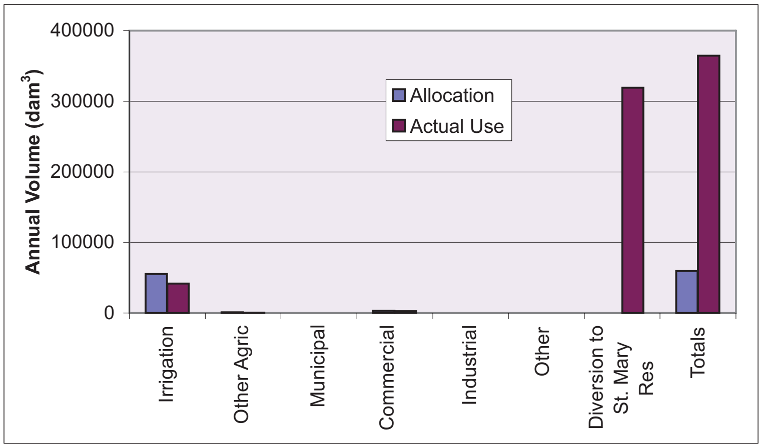


Figure 4.28: Water Demand – Waterton River Near Standoff

Belly River Sub-basin

Irrigation is the primary water use within the Belly River sub-basin. Upstream of the Mountain View monitoring station, a diversion from the Belly River into Payne Lake provides water for the Mountain View, Leavitt and Aetna Irrigation Districts. Near Mountain View, nearly 13% of the annual median flow is allocated for irrigation though only about 2% of the median flow is actually being used (Figure 4.29). The irrigation allocation is primarily for the three irrigation districts. These districts often divert less than their allocation and their return flows are high, which accounts for their low water use. Return flows are re-captured and utilized downstream in the St. Mary system. Municipal and commercial use is minimal in this reach of the Belly River.

Near Glenwood, irrigation allocation is higher than at Mountain View, comprising about 98% of the total allocation. Actual use for irrigation is about 92% of the total water use in this reach. Municipal use makes up most of the remaining 8% with commercial and agricultural use also contributing. Water allocations upstream of the Glenwood station are about 29% of the annual median natural flow. With the diversion to the St. Mary Reservoir, actual withdrawals from the Belly River are around 40% of the median annual natural flow (Figure 4.30). From 1992 to 2001, an annual average of 101 800 dam^3 was diverted to the St. Mary Reservoir for irrigation and other purposes.

Belly River near Mountain View

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	35,888	5,653
Other Agric		0
Municipal	463	30
Commercial	9	9
Industrial		0
Other		0
Totals	36359	5691
% of median flow	12.6	2.0

Distribution of Water Allocation and Actual Use by Purpose.

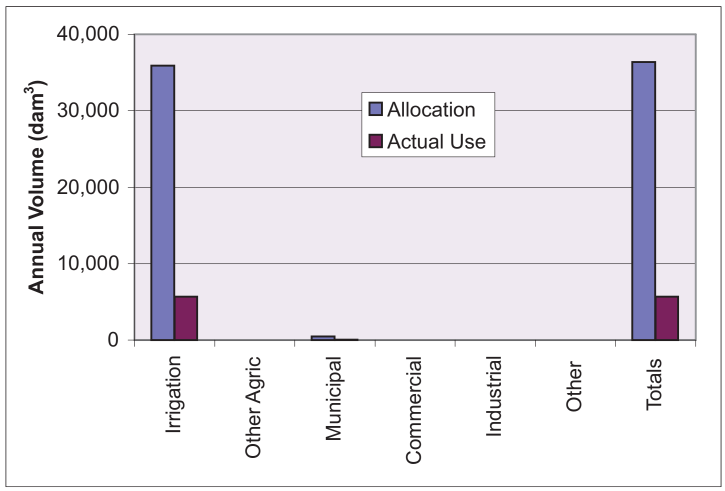


Figure 4.29: Water Demand – Belly River Near Mountain View

Belly River near Glenwood

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	82,901	14,471
Other Agric	60	45
Municipal	2,652	1,591
Commercial	9	9
Industrial		-
Other		-
Net Diversion to St Mary Res		101,791
Totals	85,622	117,907
% of median flow	28.8	39.7

Use of water diverted to the St. Mary Reservoir is not reflected in the allocations

Distribution of Water Allocation and Actual Use by Purpose.

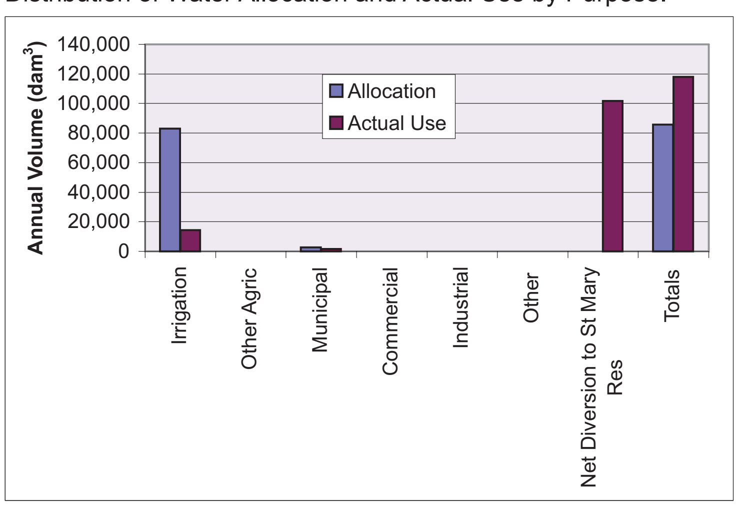


Figure 4.30: Water Demand – Belly River Near Glenwood

Irrigation is the dominant allocation and use in the Belly River upstream of the mouth, representing about 97% of total allocations and actual use. About 13.5% of the median natural flow is allocated to irrigation (not considering the allocations to the Waterton, Belly and St. Mary rivers for use east and north of the St. Mary Reservoir). There are 90 private irrigation licences in the Belly River sub-basin. Municipal, agricultural, commercial and other uses make up the remaining 3% of the allocated use (Figure 4.31). Actual use, including the diversion of the Belly River to the St. Mary Reservoir, represents 13.3% of the median annual natural flow near the mouth. The annual average diversion to the St. Mary Reservoir (from 1992 to 2001) was about 101 791 dam^3.

St. Mary River Sub-basin

Water use along Lee Creek is minimal with less than 6% of the median flows allocated. Allocation is dominated by municipal and irrigation use with some commercial and agricultural uses as well. Actual uses are much less than the allocations, comprising only about 3% of the annual median flow (Figure 4.32). The Town of Cardston uses water from both Lee Creek (about 30%) and the St. Mary River (about 70%) with a total use of 1 046 dam^3 annually.

There is not a significant amount of water use in Canada on the St. Mary River upstream of the hydrometric station near the United States-Canada boundary. Flows on the St. Mary River are subject to

Belly River near the Mouth

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	139,946	37,473
Other Agric	634	475
Municipal	2,839	1,703
Commercial	9	9
Industrial	-	-
Other	81	81
Diversion to St Mary Reservoir		101,791
Totals	143,509	141,533
Use of water diverted to St. Mary Reservoir is not reflected in the allocations		
% of median flow	13.5	13.3

Distribution of Water Allocation and Actual Use by Purpose.

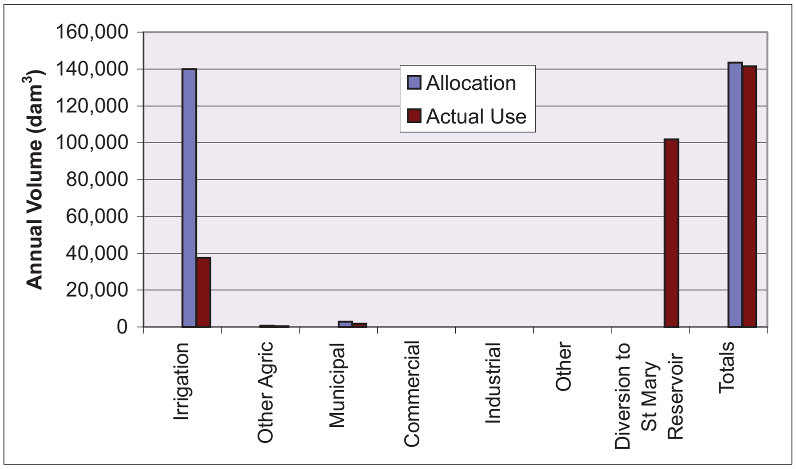


Figure 4.31: Water Demand – Belly River Near the Mouth

Lee Creek at Cardston

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	952	737
Other Agric	166	124
Municipal	1500	314
Commercial	121	121
Industrial	0	0
Other	0	0
Totals	2739	1297
% of Median Flow	5.8	2.8

Distribution of Water Allocation and Actual Use by Purpose.

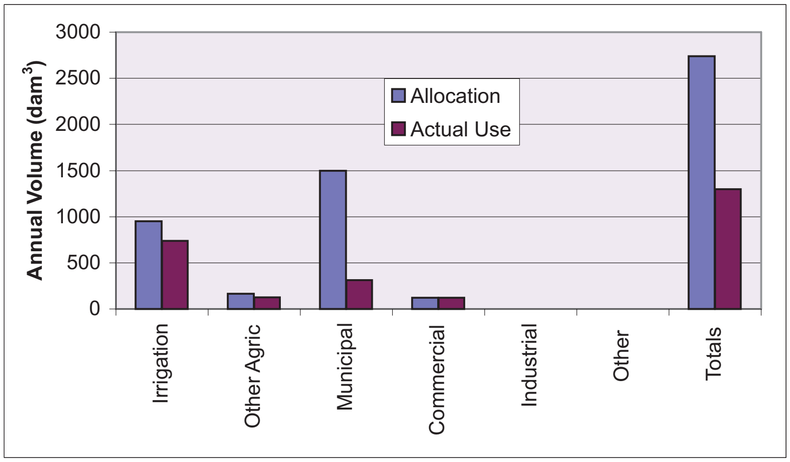


Figure 4.32: Water Demand – Lee Creek at Cardston

water sharing between Canada and the United States as per the Boundary Waters Treaty and the 1921 Order of the International Joint Commission. The United States entitlement of the median natural flow is about 45% however actual use has historically (1950 to 2004) been only about 30% (Figure 4.33).

Allocation and use on the Canadian portion of the St. Mary River is heavily dominated by irrigation, which comprises about 95% of allocations and 90% of actual use. There are 60 private irrigation licences in the St. Mary River sub-basin. Some of the diversions of water from the St. Mary River are used to irrigate lands beyond the Oldman watershed. Allocations are around 151% of the median natural flows, however, actual uses are only around 69%. Diversions from the Waterton and Belly rivers help to support water uses in the St. Mary River sub-basin and the irrigation districts to the east. Allocations for water from the St. Mary River are greater than the total of the median natural flows plus the diversions from the Waterton and Belly rivers (Figure 4.34); however actual use is well below the annual median flows.

St. Mary at the International Boundary

No water use in Canada upstream of the hydrometric

US -- Canada Water Sharing 1950 to 2004

	Entitlement	Use
US Average (dam^3)	332,600	206,500
Canadian Average (dam^3)	478,600	604,600
US % of median natural flow	43.6	27.1

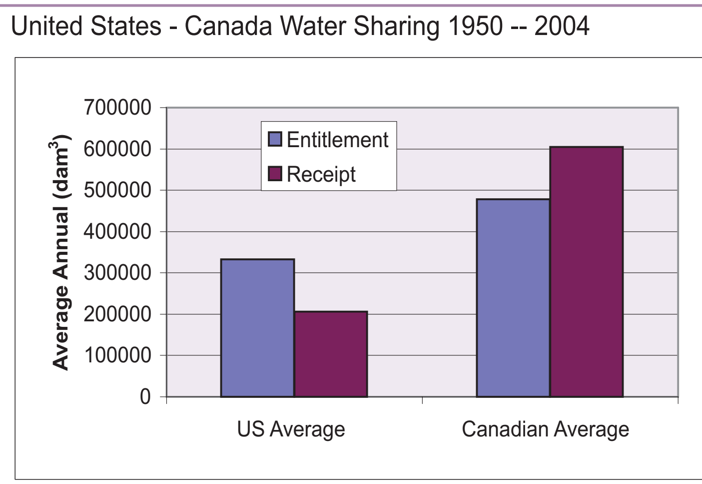


Figure 4.33: Water Demand – St. Mary River at the International Boundary

St. Mary River near Lethbridge

Purpose Sector	Allocation dam^3	Est. Actual Use dam^3
Irrigation	1,214,006	525,205
Other Agric	2,044	1,533
Municipal	12,573	5,049
Commercial	49,939	46,750
Industrial	1,373	1,373
Other	3,733	3,733
Totals	1,283,668	583,643
% of median flow	151.2	68.7
% of median natural flow plus net diversion into the basin	119.0	54.1

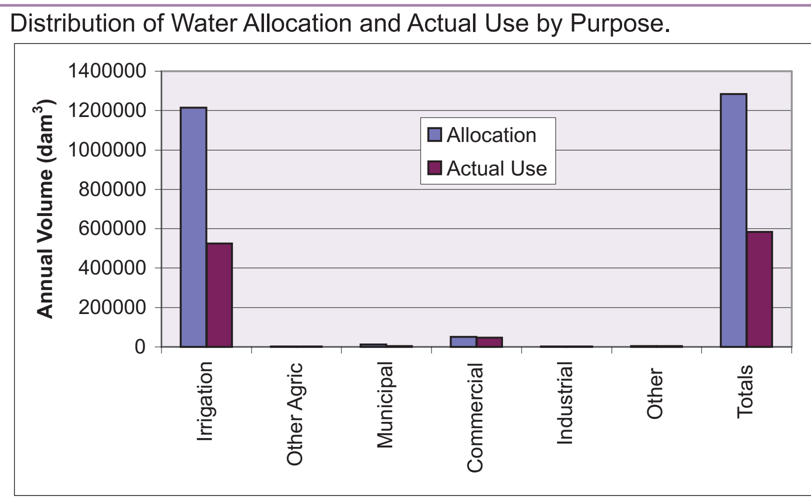


Figure 4.34: Water Demand – St. Mary River Near Lethbridge

Performance in Meeting Instream Needs

Instream objectives (IO) were established for the Waterton, Belly and St. Mary rivers in the early 1980s recognizing the commitments made for consumptive uses and requirements for protection of fish habitat (Oldman River Basin Study Management Committee 1978)[5]. The single minimum flow values established provide limited environmental protection.

Recorded flows for the Waterton River near Waterton Park are approximately equal to natural flows, so good performance in meeting instream requirements would be expected. Instream objectives deficits occurred in 5.8% of the 120 months assessed (1992 to 2001). Water Conservation Objectives (WCO) deficits were observed in 9.2% of the months assessed. Deficits in meeting the instream requirements at this location occurred primarily in the winter months (Figure 4.35).

At Waterton River near Standoff, IO deficits occurred in 1.7% of the 120 months assessed, and WCO deficits occurred in 37.5% of the months assessed (Figure 4.36). Instream objectives deficits occurred in February and March. Water conservation objectives deficits occurred primarily during the summer months and could be attributed to diversions to storage in Waterton Reservoir and diversions to St. Mary Reservoir.

Waterton River near Waterton Park

IO and WCO

IO = 2.27m³/s

WCO = MAX(1.1*(IO); 0.45*Qnat) m³/s

Comments:

1 IO deficits occurred in 5.8% of the months
2 WCO deficits occurred in 9.2% of the months
3 Deficits are most numerous in winter months.

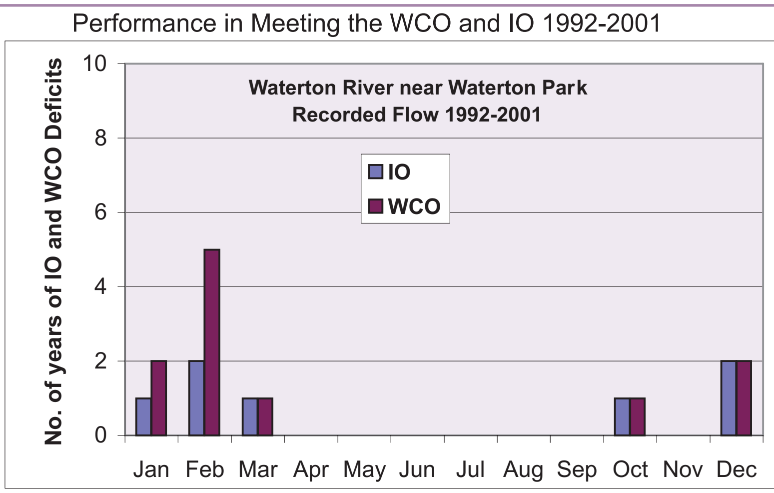


Figure 4.35: Performance in Meeting IO and WCO – Waterton River Near Waterton Park

Waterton River near Stand Off

IO and WCO

IO = 2.27m³/s

WCO = MAX(1.1*(IO); 0.45*Qnat) m³/s

Comments:

1 Recorded flow at Stand Off has been discontinued.
2 IO deficits occurred in 1.7% of the months assessed.
3 WCO deficits occurred in 37.5% of the months assessed
4 Deficits are most numerous in summer months.

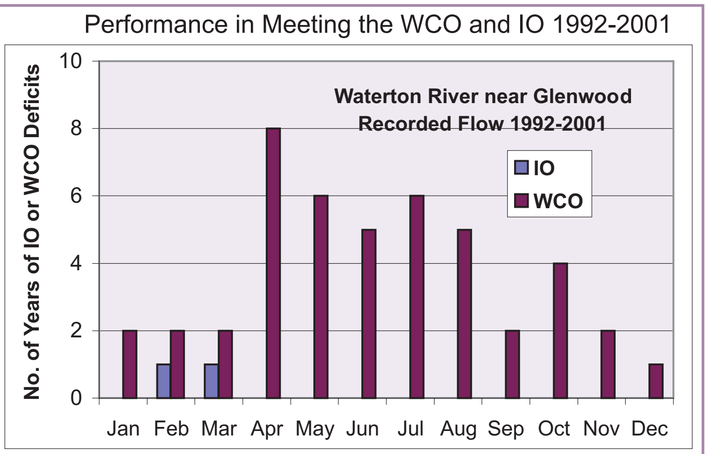


Figure 4.36: Performance in Meeting IO and WCO – Waterton River Near Standoff

[5] 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.

Recorded flow in the Belly River near Mountain View is near natural flow. Deficits to the IOs occurred in only 1.7% and deficits to the WCOs occurred in only 3.3% of the months assessed (Figure 4.37). Deficits occurred in February and December.

Near Glenwood, there was only one month, or 0.8% of the months assessed, that the IO was not met. However, deficits to the WCO occurred in 35.0% of the months assessed (Figure 4.38). Water conservation objectives deficits occurred primarily in the summer months when water was being diverted to the St. Mary Reservoir.

There are no recorded flow data for the Belly River near the Mouth for period 1992 to 2001, so the performance in meeting instream requirements cannot be assessed.

Belly River near Mountain View

IO and WCO

IO = $0.93 m^3/s$

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

Comments:

1 IO deficits occurred in 1.7% of the months
2 WCO deficits occurred in 3.3% of the months
3 Deficits occurred in winter months.

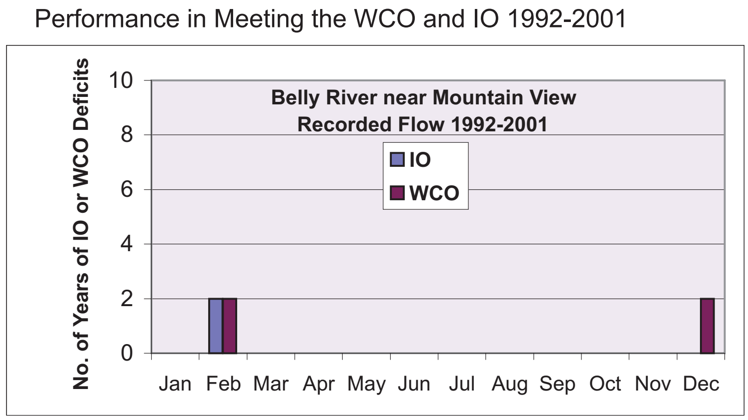


Figure 4.37: Performance in Meeting IO and WCO – Belly River Near Mountain View

Belly River near Glenwood

IO and WCO

IO = $0.93 m^3/s$

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

Comments:

1 IO deficits occurred in 0.8% of the
2 WCO deficits occurred in 35.0% of the
3 Deficits occurred primarily in spring and

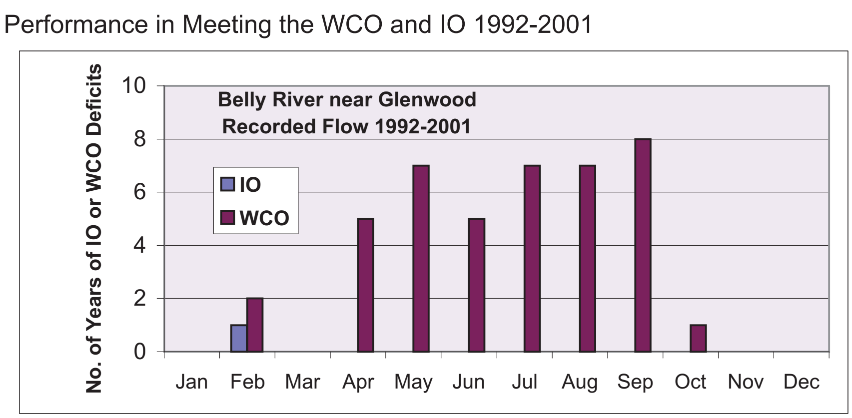


Figure 4.38: Performance in Meeting IO and WCO – Belly River Near Glenwood

Lee Creek at Cardston had high frequency of IO and WCO deficits, at 52.8 and 56.0% of months, respectively. Deficits occurred primarily in late summer, fall and winter months. (Figure 4.39).

Deficits to the IO and WCO for the St. Mary River at the International Boundary occurred in 5.8 and 10.8% of the months, respectively (Figure 4.40). Deficits occurred primarily in the winter months.

The St. Mary River near Lethbridge had deficits to the IOs in only 4.2% of the months. However, deficits to the WCO were much more frequent, occurring in 40.0% of the months (Figure 4.41). Water conservation objectives deficits occurred primarily during summer months when water was being stored in St. Mary Reservoir and large diversions were made, primarily for irrigation purposes.

Lee Creek at Cardston

IO and WCO

IO is variable weekly with an average of 0.91 m^3/s.

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

Comments:

1 IO deficits occurred in 52.8% of the months
2 WCO deficits occurred in 56.0% of the months
3 Deficits were most frequent in late summer, winter

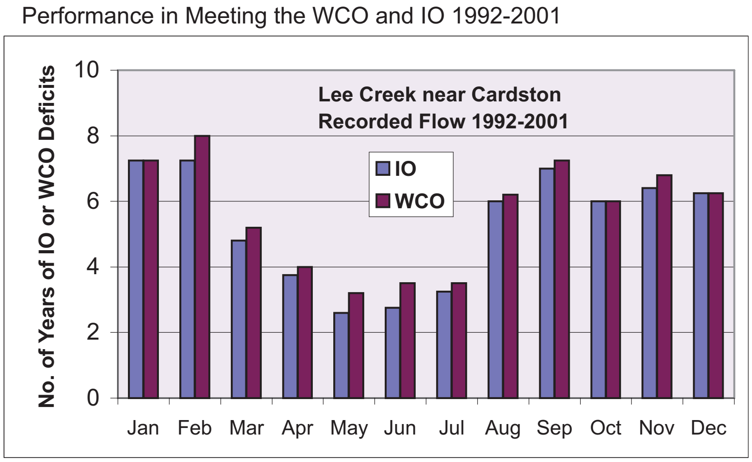


Figure 4.39: Performance in Meeting IO and WCO – Lee Creek at Cardston

St. Mary at the International Boundary

IO and WCO

IO = 0.93m^3/s

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

Comments:

1 IO deficits occurred in 5.8% of the months
2 WCO deficits occurred in 10.8% of the months
3 Deficits occurred in winter months.

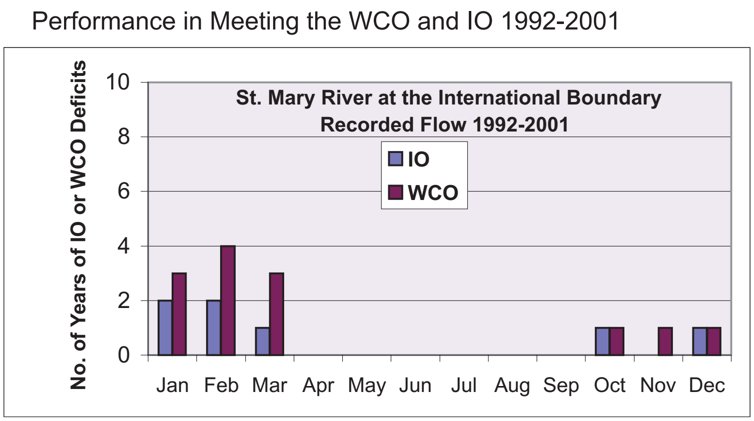


Figure 4.40: Performance in Meeting IO and WCO – St. Mary River at International Boundary

St. Mary River near Lethbridge

IO and WCO

$IO = 0.93 m^3/s$

$WCO = MAX(1.1*(IO); 0.45*Qnat)\ m^3/s$

Comments:

1 IO deficits occurred in 4.2% of the months
2 WCO deficits occurred in 40.0% of the months
3 WCO deficits occurred primarily in the spring and

Performance in Meeting the WCO and IO 1992-2001

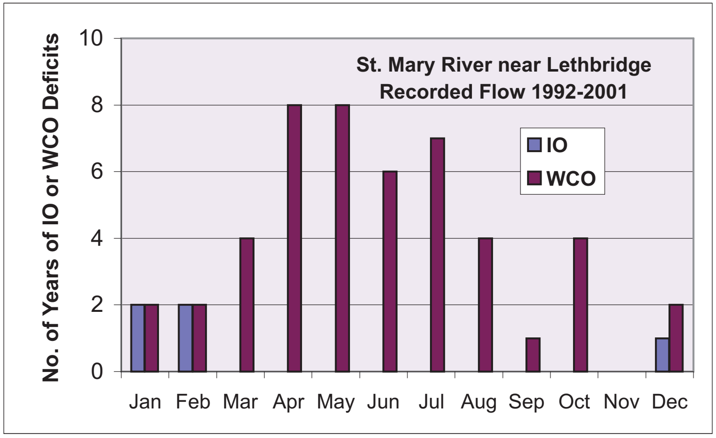


Figure 4.41: Performance in Meeting IO and WCO – St. Mary River Near Lethbridge

Municipal Water Use

Communities using surface water sourced from within the Southern Tributaries Sub-basins are listed below, with the water source:

- Cardston (St. Mary River and Lee Creek);
- Magrath (Jensen Reservoir);
- Raymond (Milk River Ridge Reservoir);
- Stirling (Milk River Ridge Reservoir);
- Bow Island (SMRID canal);
- Foremost (SMRID canal);
- Glenwood (UID canal);
- Hill Spring (UID canal); and
- Warner (Milk River Ridge Reservoir).

Raymond, Stirling and Warner are outside the Southern Tributaries Sub-basins boundaries.

Jensen Reservoir – ARD

4.1.3 Water Quality

Water quality monitoring is sporadic, both spatially and temporally, in the Southern Tributaries Sub-basins. The water quality monitoring stations assessed are shown on Figure 4.42 and listed below:

- Lee Creek upstream of Cardston;
- Lee Creek downstream of Cardston;
- St. Mary River near confluence with the Oldman River;
- Prairie Blood Coulee near Lethbridge;
- Waterton River upstream of confluence with Belly River; and
- Belly River near the Oldman River.

Total Nitrogen

Total nitrogen was analyzed throughout the Southern Tributaries Sub-basins from 1976 until 2005. The temporal distribution of total nitrogen data collected at water quality monitoring sites in the Southern Tributaries Sub-basins is shown in Appendix D. An increase in total nitrogen monitoring coverage occurred in 1995 and continued until 2002 at a few sites. The Belly and St. Mary rivers were monitored sporadically from 1975 until 2005.

In the Belly River, Lee Creek, Waterton River and St. Mary River, the median annual total nitrogen concentrations did not exceed the guideline during the period from 1984 to 2006 (Table 4.11). Exceedances were observed in Prairie Blood Coulee, with a noticeable increase in the frequency of occurrence since 2002.

Total nitrogen loadings were determined, based on available data, for 1984 to 1985, 1991 to 1993, 1995 to 1998 and 2005.

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

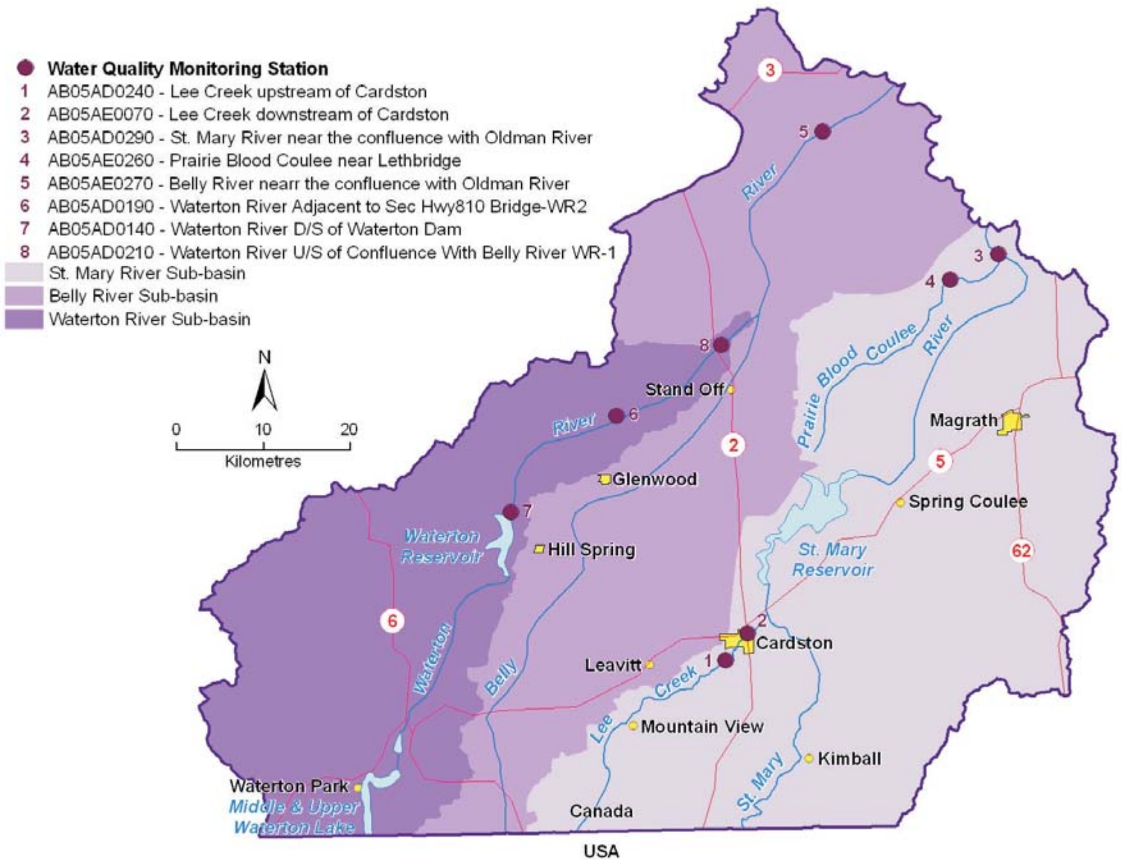


Figure 4.42: Water Quality Monitoring Stations in the Southern Tributaries Sub-basins

Table 4.11: Annual Median Total Nitrogen (mg/L) Guideline Adherence by Site

Monitoring Sites / Years	1970	1971	1972	1973	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
BELLY RIVER NEAR OLDMAN 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					< 1.0	< 1.0			
PRAIRIE BLOOD COULEE NEAR LETHBRIDGE																										< 1.0	1.0 - 5.0			< 1.0	< 1.0	< 1.0	1.0 - 5.0	1.0 - 5.0	< 1.0	< 1.0	1.0 - 5.0			
AB05AE0070 - ST. MARY RIVER NEAR OLDMAN 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	< 1.0			
LEE CREEK U/S OF CARDSTON																																		< 1.0	< 1.0	< 1.0				
LEE CREEK D/S OF CARDSTON																																		< 1.0	< 1.0	< 1.0				
WATERTON RIVER D/S of WATERTON DAM																				< 1.0 *																				
WATERTON RIVER ADJACENT TO HWY 810																				< 1.0 *																				
WATERTON RIVER U/S OF CONFLUENCE WITH BELLY RIVER																				< 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

Loadings are shown on Figure 4.43 for Lee Creek, Belly River and St. Mary River. Total nitrogen loadings on the Belly River were highest in 1997 due to a combination of high nitrogen concentrations and high flows. On the St. Mary River, loadings were relatively stable with increased loadings due to high concentrations of nitrogen observed in 1985 and 1992. Lee Creek loadings were assessed upstream and downstream of Cardston in 2005. Downstream concentrations of total nitrogen were higher downstream of Cardston than those observed both above Cardston and in the St. Mary River. However, total nitrogen loadings in 2005 were greatest in the St. Mary River: loadings increased as flows increased.

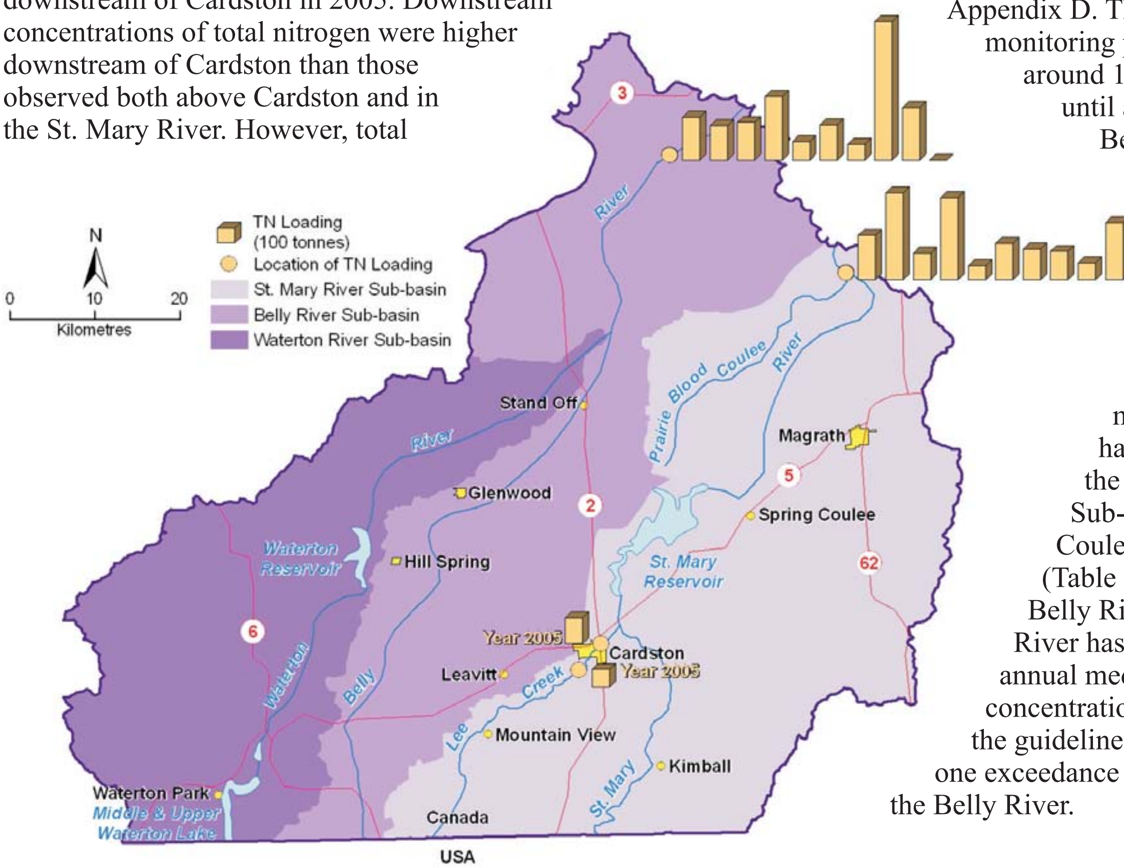


Figure 4.43: Total Nitrogen Loadings in the Southern Tributaries Sub-basins (1984, 1985, 1991, 1992, 1993, 1995, 1996, 1997, 1998, 2005)

Phosphorus

Total phosphorus was analyzed at several locations in the Southern Tributaries Sub-basins over the period from 1976 to 2008. The temporal distribution of total phosphorus data collected since 1976 is in Appendix D. The water quality monitoring program intensified around 1991 and continued until around 2007 on the Belly River, Prairie Blood Coulee, the St. Mary River, and Lee Creek upstream of Cardston.

Since 1998, exceedances in annual median concentrations have occurred at sites in the Southern Tributaries Sub-basins in Prairie Blood Coulee and Lee Creek (Table 4.12). Neither the Belly River nor the St. Mary River has experienced any annual median total phosphorus concentrations in exceedance of the guidelines since 1998, however, one exceedance occurred in 1993 in the Belly River.

Table 4.12: Annual Median Total Phosphorus (mg/L) Guideline Adherence by Site

Monitoring Sites / Years	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
BELLY RIVER NEAR OLDMAN RIVER							* < 0.05						* < 0.05		< 0.05	< 0.05				
PRAIRIE BLOOD COULEE NEAR LETHBRIDGE																				
AB05AE0070 - ST. MARY RIVER NEAR OLDMAN RIVER													* < 0.05		< 0.05	< 0.05				
LEE CREEK U/S OF CARDSTON																				
LEE CREEK D/S OF CARDSTON																				
WATERTON RIVER D/S of WATERTON DAM																				* < 0.05
WATERTON RIVER ADJACENT TO HWY 810																				* < 0.05
WATERTON RIVER U/S OF CONFLUENCE WITH BELLY RIVER																				* < 0.05

Monitoring Sites / Years	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BELLY RIVER NEAR OLDMAN RIVER		< 0.05	< 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		
PRAIRIE BLOOD COULEE NEAR LETHBRIDGE						< 0.05	0.05 - 0.5			< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05 - 0.5		
AB05AE0070 - ST. MARY RIVER NEAR OLDMAN RIVER		< 0.05	< 0.05	< 0.05	* < 0.05	* < 0.05	* < 0.05	* < 0.05	< 0.05	< 0.05	< 0.05					< 0.05	< 0.05	< 0.05		
LEE CREEK U/S OF CARDSTON														< 0.05	< 0.05	< 0.05			< 0.05	
LEE CREEK D/S OF CARDSTON														< 0.05	< 0.05	0.05 - 0.5				
WATERTON RIVER D/S of WATERTON DAM																				
WATERTON RIVER ADJACENT TO HWY 810																				
WATERTON RIVER U/S OF CONFLUENCE WITH BELLY RIVER																< 0.05	< 0.05			

* 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

The elevated total phosphorus concentrations in Prairie Blood Coulee and Lee Creek are likely observed due to runoff from irrigated and agricultural land.

Total phosphorus loadings for 1982, 1984 to 1985, 1991 to 1993, 1995 to 1998 and 2005 are indicated on Figure 4.44 for the Belly and St. Mary rivers and Lee Creek. Loadings of total phosphorus were higher in the Belly River than in the St. Mary River with the exceptions of 1982 and 1992. Total phosphorus loadings in Lee Creek downstream of Cardston were considerably higher in 2005 than those observed either upstream of Cardston or in the St. Mary River. These increased loadings are related to higher phosphorus concentrations: downstream concentrations were almost double those observed upstream of Cardston and were nearly eight times those sampled in the St. Mary River. However, 2005 was a high flow year so increased flows likely contributed, along with increased concentrations, to the high loadings. High loadings observed in 1993 and 1997 in the St. Mary and Belly rivers, near their respective confluences with the Oldman River, were greater than those observed in 2005.

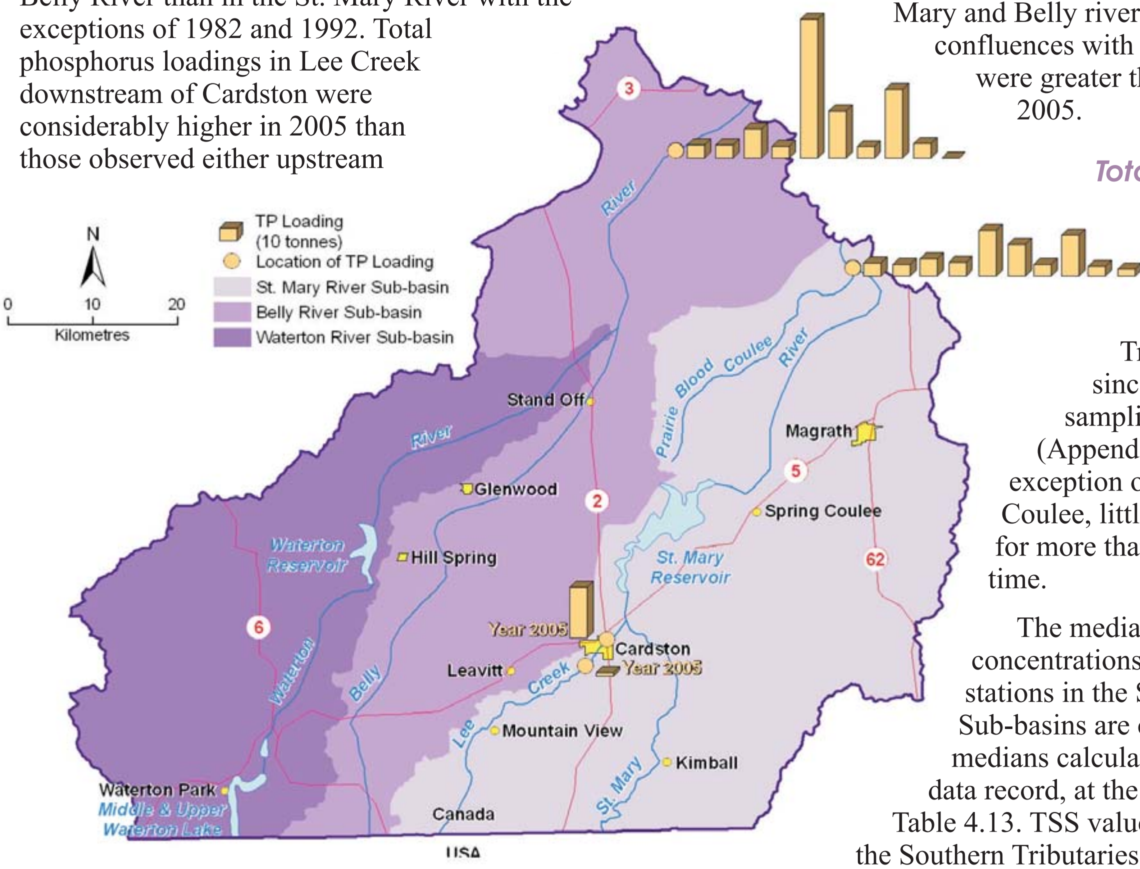


Figure 4.44: Total Phosphorus Loadings in the Southern Tributaries Sub-basins (1984, 1985, 1991, 1992, 1993, 1995, 1996, 1997, 1998, 2005)

Total Suspended Solids

Total suspended solids (TSS) have been analyzed in the Southern Tributaries Sub-basins since 1971, however, sampling has been sporadic (Appendix D). With the exception of Prairie Blood Coulee, little TSS data is available for more than one or two years at a time.

The median annual TSS concentrations for monitoring stations in the Southern Tributaries Sub-basins are compared to the medians calculated for the available data record, at the same locations in Table 4.13. TSS values are generally low in the Southern Tributaries Sub-basins as represented by data set medians.

Table 4.13: Annual Median TSS (mg/L) Compared to Data Set Median

Monitoring Sites / Years	Median	1970	1971	1972	1973	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
BELLY RIVER NEAR OLDMAN RIVER	7													< median *		0%-100%	< median						< median	0%-100%	< median *	0%-100% *	< median *	0%-100% *	< median *							0%-100%	0%-100% *				
PRAIRIE BLOOD COULEE NEAR LETHBRIDGE	6																									0%-100%	>100%			< median	< median	< median	0%-100%	0%-100%	< median	< median	0%-100%				
AB05AE0070 - ST. MARY RIVER NEAR OLDMAN RIVER	10													< median *		0%-100%	< median						< median	0%-100%	0%-100% *	0%-100% *	0%-100% *	< median *	< median *							0%-100%	0%-100% *				
LEE CREEK U/S OF CARDSTON	15																																	< median	0%-100%	>100%					
LEE CREEK D/S OF CARDSTON	22																																	< median	>100%	0%-100%					
WATERTON RIVER D/S of WATERTON DAM	N/A																																								
WATERTON RIVER ADJACENT TO HWY 810	N/A																																								
WATERTON RIVER U/S OF CONFLUENCE WITH BELLY RIVER	23																																				< median	0%-100%			

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

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

Elevated annual median TSS concentrations above existing data sets values were noticed in all streams randomly and in most cases were based on less than three observations during the that year. The only statistically significant TSS values above medians were observed in Lee Creek, where values were more than double those usually observed, and were greater than 100% above the median.

Total suspended solids loadings were determined in the Southern Tributaries Sub-basins for the years 1982, 1984 to1985, 1991 to 1993, 1995 to 1998 and 2005 (Figure 4.45). Total suspended solids loadings in the St. Mary River were generally higher than in the Belly River with the exceptions of 1984, 1995 and 1997. The higher loadings in the Belly River in 1984 and 1995 were due to high flows rather than high concentrations.

Similarly, higher loadings in Lee Creek also occurred in conjunction with increased flow. Downstream of Cardston, Lee Creek had higher loadings than upstream and higher loadings than the St. Mary River in 2005. However, in 2005, concentrations of TSS were lower in Lee Creek downstream than upstream. Therefore, the higher downstream loadings are likely due to high volumes of stormwater runoff associated with the large rain events in the early summer of 2005.

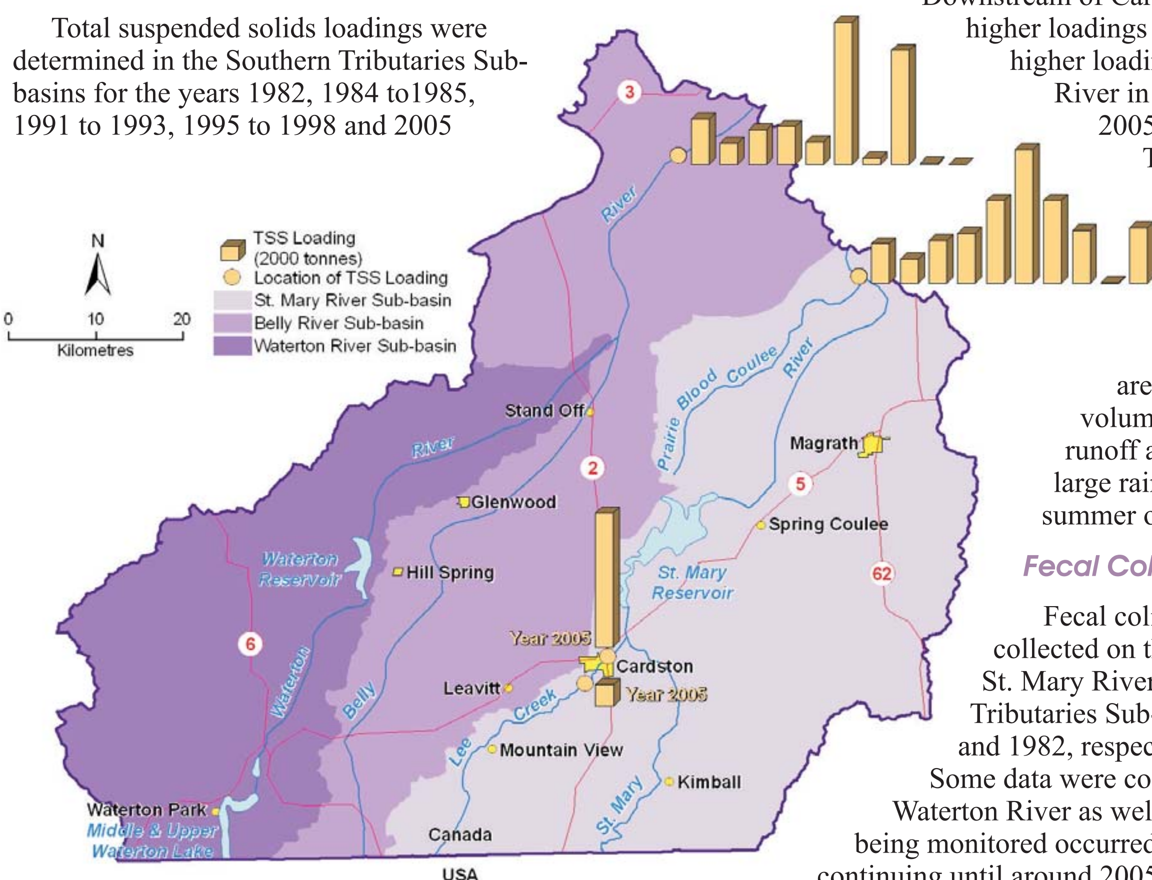


Figure 4.45: Total Suspended Solids Loadings in the Southern Tributaries Sub-basins (1984, 1985, 1991, 1992, 1993, 1995, 1996, 1997, 1998, 2005)

Fecal Coliforms

Fecal coliform data were collected on the Belly River and St. Mary River in the Southern Tributaries Sub-basins from 1975 and 1982, respectively, until 2005. Some data were collected in the Waterton River as well. An increase in sites being monitored occurred around 1997, continuing until around 2005 (Appendix D).

Fecal coliform counts vary throughout the Southern Tributaries Sub-basins; however, exceedances in median annual counts occur infrequently. Median annual fecal coliform values exceeded the guidelines in Lee Creek and St. Mary River during the period of record 2003 to 2004 and 2005 (Table 4.14). The extreme exceedances which occurred in 2005 are likely associated with the large spring rain events that year. No exceedances were observed in the Waterton River in 2005 to 2006 and no observation occurred in the earlier years.

Annual loadings of fecal coliforms in the Southern Tributaries Sub-basins were assessed for 1984 to 1985, 1991 to 1993, 1995 to 1998 and 2005 (Figure 4.46). Higher fecal coliform loadings were present in the

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

Table 4.14: Annual Median Fecal Coliform Count Guideline Adherence by Site

Monitoring Sites / Years	1970	1971	1972	1973	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
BELLY RIVER NEAR OLDMAN RIVER							< 100 *								< 100	< 100						< 100	< 100	< 100 *		< 100 *	< 100 *	< 100 *	< 100	< 100	< 100					< 100	< 100			
PRAIRIE BLOOD COULEE NEAR LETHBRIDGE																														< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100			
AB05AE0070 - ST. MARY RIVER NEAR OLDMAN RIVER															< 100	< 100						< 100	< 100	< 100 *		100 - 1000 *	< 100 *	100 - 1000 *	< 100	< 100	< 100					< 100	< 100			
LEE CREEK U/S OF CARDSTON																																		100 - 1000	100 - 1000	> 1000				
LEE CREEK D/S OF CARDSTON																																		100 - 1000	100 - 1000	> 1000				
WATERTON RIVER D/S of WATERTON DAM																																								
WATERTON RIVER ADJACENT TO HWY 810																																								
WATERTON RIVER U/S OF CONFLUENCE WITH BELLY RIVER																																				< 100	< 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

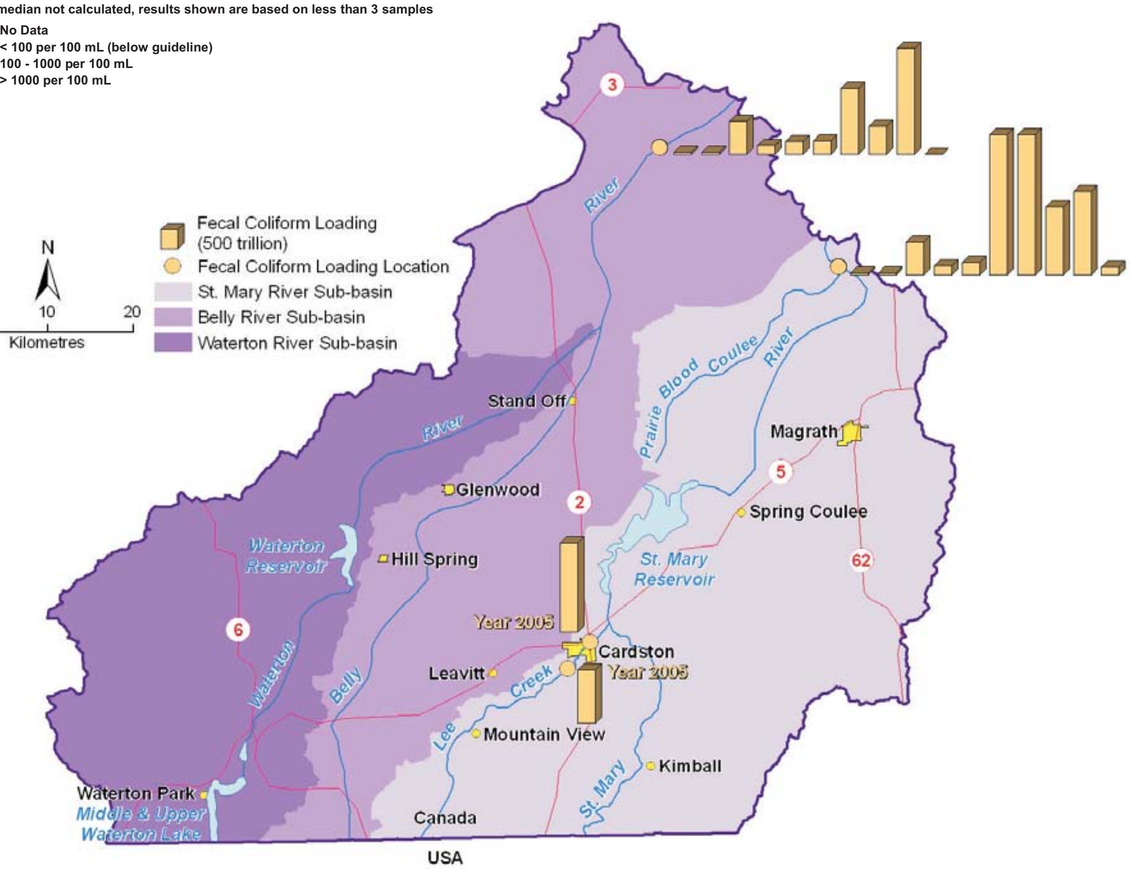


Figure 4.46: Fecal Coliform Loadings in the Southern Tributaries Sub-basins (1984, 1985, 1992, 1992, 1993, 1995, 1996, 1997, 1998, 2005)

Southern Tributaries Sub-basins Water Quality Overview for Non-indicator Parameters

Temperature[1]

The median water temperature in the Belly River from 1998 to 2003 was 12.9°C, that is similar to conditions in the St. Mary River where the median temperature was 12.6°C. The maximum temperature over the same time frame ranged from 21.9°C in the St. Mary River to 24.0°C in the Belly River.

pH[1]

In the Southern Tributaries Sub-basins, the pH ranged from 7.3 to 8.8 between 1998 and 2003. A median pH value of 8.3 was observed in both the Belly and St. Mary rivers.

Dissolved Oxygen[1]

Median dissolved oxygen concentrations were similar throughout the Southern Tributaries Sub-basins, with a value of 10.4 mg/L in both the Belly and St. Mary rivers. The minimum dissolved oxygen levels in the Belly and St. Mary rivers were 8.1 mg/L. Low dissolved oxygen levels can result in fish kills if prolonged and typically a target minimum of 5 mg/L is desirable.

Hardness[1]

During the period from 1998 to 2003, the Belly and St. Mary rivers had median hardness levels of 130 mg $CaCO_3$/L and 120 mg $CaCO_3$/L, respectively; classified as "hard" by Health Canada[1]. Maximum hardness values in the Belly and St. Mary rivers were between 160 and 170 mg $CaCO_3$/L.

Metals and Ions[1]

Metals concentrations were very low in the Southern Tributaries Sub-basins from 1998 to 2003, with median values of dissolved iron and manganese generally below detection levels. Ions measured between 1998 and 2003 included fluoride, chloride, and sulphate. Median dissolved fluoride concentrations in the Southern Tributaries Sub-basins were not measured in the Belly or St. Mary rivers. Median chloride and sulphate concentrations in the Southern Tributaries were well below guideline levels.

Pesticides[1]

Pesticide concentrations of both MCPA and Dicamba were observed to exceed guidelines in the Belly and St. Mary rivers in 1998.

Water Quality Indices[2]

Water quality indices combine several indicators and, using a predetermined scale, assign a rating to the overall water quality. In the Southern Tributaries Sub-basins, the Water Quality Index was only determined in 1998. At that time, all sites were found to have good water quality.

Sources:

[1] Health Canada 2009.
[2] Oldman Watershed Council (OWC) 2005.
Guidelines: AENV 1999; CCME 2005.

Belly and St. Mary rivers during the period from 1995 to 1998 than during the earlier periods. In the Belly River, the increased loadings are due to both increased fecal coliform counts and increased flows. In the St. Mary River, the increases are primarily related to higher fecal coliform counts. In 2005, Lee Creek fecal coliform counts were very high, and the loadings were therefore high. In contrast, annual loadings in Belly River and Prairie Blood Coulee were among the lowest of these records.

4.2 Current Issues and Trends

4.2.1 Terrestrial and Riparian Indicators

Land use in the Southern Tributaries Sub-basins is primarily agricultural (66% of land base) and dominated by crop production. Cultivated land increases and native grassland decreases moving east across the area. Confined feeding operations, which are areas of high livestock density, are found mostly along the lower Belly River valley west of Lethbridge, and east of the St. Mary River. Along the Belly River and east of Magrath, soil erosion is rated as moderate risk. Soil erosion is low within the rest of the Sub-basins. Riparian health is slightly better than the average for the Oldman watershed and is comparable to that found throughout Alberta. Between 1996 and 2006, population increased slightly.

4.2.2 Water Quantity

Since 1917, recorded flow in the St. Mary River near the International Border has been impacted by storage and diversions to the Milk River occurring south of the United States-Canada boundary. Canada's share of natural flow is subject to the provisions of the Boundary Waters Treaty and the 1921 Order of the International Joint Commission.

Natural flow shows a major peak in early June on all three rivers, Waterton, Belly and St. Mary, that is likely caused by a combination of meltwater from the winter snow pack and spring precipitation events. Recorded flows are approximately equal to natural flows upstream of major storage projects or diversions to irrigation districts, but are substantially less than natural flow in the lower reaches of the Waterton, Belly and St. Mary rivers.

Flows are heavily managed throughout the Southern Tributaries Sub-basins. Construction of diversion works began in 1899. Diversion and storage works have been constructed and expanded since that time. Currently water from the Southern Tributaries Sub-basins supplies eight irrigation districts, including five located within the Sub-basins and three irrigation districts located only partially within or completely outside of the area. Irrigation is the primary water use within the Southern Tributaries Sub-basins. Eleven reservoirs are located within the Southern Tributaries Sub-basins or within irrigation districts supplied from the Southern Tributaries. These reservoirs have a total storage capacity of 1 020 000 dam^3. In addition to irrigation water use, several municipalities rely on surface water for domestic, commercial and industrial uses. Nine communities are licensed to withdraw water from the Southern Tributaries Sub-basins for municipal use. Total water use allocations are much higher than actual use. If license holders were to withdraw the total amount of water that is allocated, water shortages would be more common. In addition, the provincial government has an agreement to supply sufficient water to irrigate 10 120 ha (25 000 acres) on the Blood (Kainai) Indian Reserve 148. Currently, approximately 7290 ha (18 000 acres) have been developed.

No statistically valid trends in annual or monthly natural flows on the Waterton River are evident. A probable decreasing trend was observed in December flows on the Belly River near Mountain View, however, no significant trends in annual natural flows on the Belly River were observed. On the St. Mary River, no significant trends in annual natural flows were observed but a decreasing trend in September flows near Lethbridge was statistically significant.

The waters of the Southern Tributaries Sub-basins are heavily allocated and used, primarily for irrigation purposes. Total allocations in the Southern Tributaries Sub-basins are about 1 427 000 dam^3, representing about 75% of the total natural flow. However, actual water use (diversions minus return flows) is about 33% of the total natural flow. Return flows are not always available for use in the source stream or watershed. Almost all return flows from districts diverting water from the Southern Tributaries Sub-basins are available for use in either the Oldman River or South Saskatchewan River watersheds.

Recorded flows along the lower portions of the Waterton, Belly and St. Mary rivers are severely impacted by flow regulations and diversions (Figures 4.12, 4.16 and 4.23).

4.2.3 Water Quality

Water quality in the Southern Tributaries depends mostly on land use and stream hydrology.

Water quality monitoring for major indicators, nitrogen, phosphorus, TSS and fecal coliforms, is sporadic, spatially and temporally, in the Southern Tributaries Sub-basins.

The median annual total nitrogen concentrations on the Belly River, Lee Creek and St. Mary River have never exceeded the guideline of 1.0 mg/L. However exceedances were observed in Prairie Blood Coulee, with a noticeable increase in frequency since 2002. The highest recorded total nitrogen loadings on the Belly River occurred in 1997 and were due to a combination of high concentrations and high flows. On the St. Mary River, levels were generally stable.

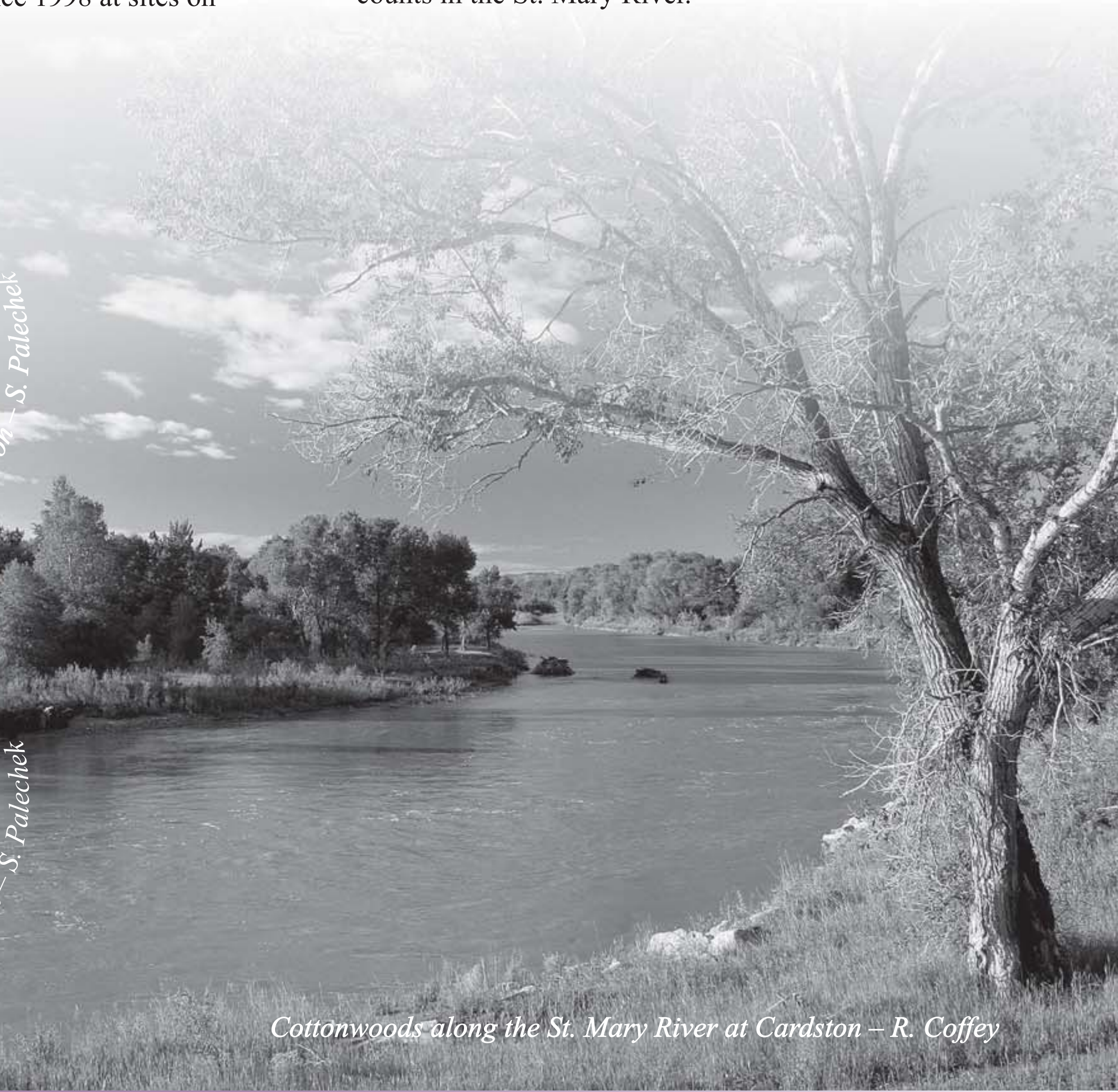
For phosphorus, exceedances in annual median concentrations have occurred since 1998 at sites on Prairie Blood Coulee and Lee Creek. Phosphorus concentrations exceeding the guideline have not been observed on the Belly or St. Mary rivers. High phosphorus loadings observed in the Belly River in 2005 could be related to the high flow run off as well as elevated concentrations.

Values for TSS within the Southern Tributaries Sub-basins are generally low. Increased loadings in the Belly River, compared to St. Mary River, are likely due to high flows rather than high concentrations.

Fecal coliform counts vary throughout the Southern Tributaries Sub-basins; however, exceedances in median annual counts occur relatively frequently. Extreme exceedances in 2005 are likely associated with the large spring rain events that year. Increases in record annual loadings from 1995 to 1998 are likely a result of increased fecal coliform counts and increased flows in the Belly River and higher fecal coliform counts in the St. Mary River.

Belly River Diversion – S. Palechek

Waterton Shell Plant – S. Palechek



Cottonwoods along the St. Mary River at Cardston – R. Coffey

Total nitrogen trends in the Belly and St. Mary rivers were assessed over the period 1991 to 2000 while trends in Prairie Blood Coulee were assessed from 1996 to 2005, based on data availability. No trends in total nitrogen concentrations were observed in the Belly River or Prairie Blood Coulee (Figure 4.47). The St. Mary River demonstrated a decreasing trend at an 80% confidence level for both nutrients.

Decreasing trends in total phosphorus concentrations were observed in the Belly and St. Mary rivers between 1991 and 2000 at 80% and 90% confidence levels, respectively. This decreasing trend in the primary tributaries indicates an improvement in total phosphorus concentrations in the natural flow systems.

Trends in TSS concentrations were not observed in the Belly or St. Mary rivers between 1991 and 2000 or in Prairie Blood Coulee from 1996 to 2005 (Figure 4.47).

Trends in fecal coliform counts in Prairie Blood Coulee demonstrated an increasing trend at the 80% confidence level. No trends in fecal coliform counts were observed in the Belly River or the St. Mary River.

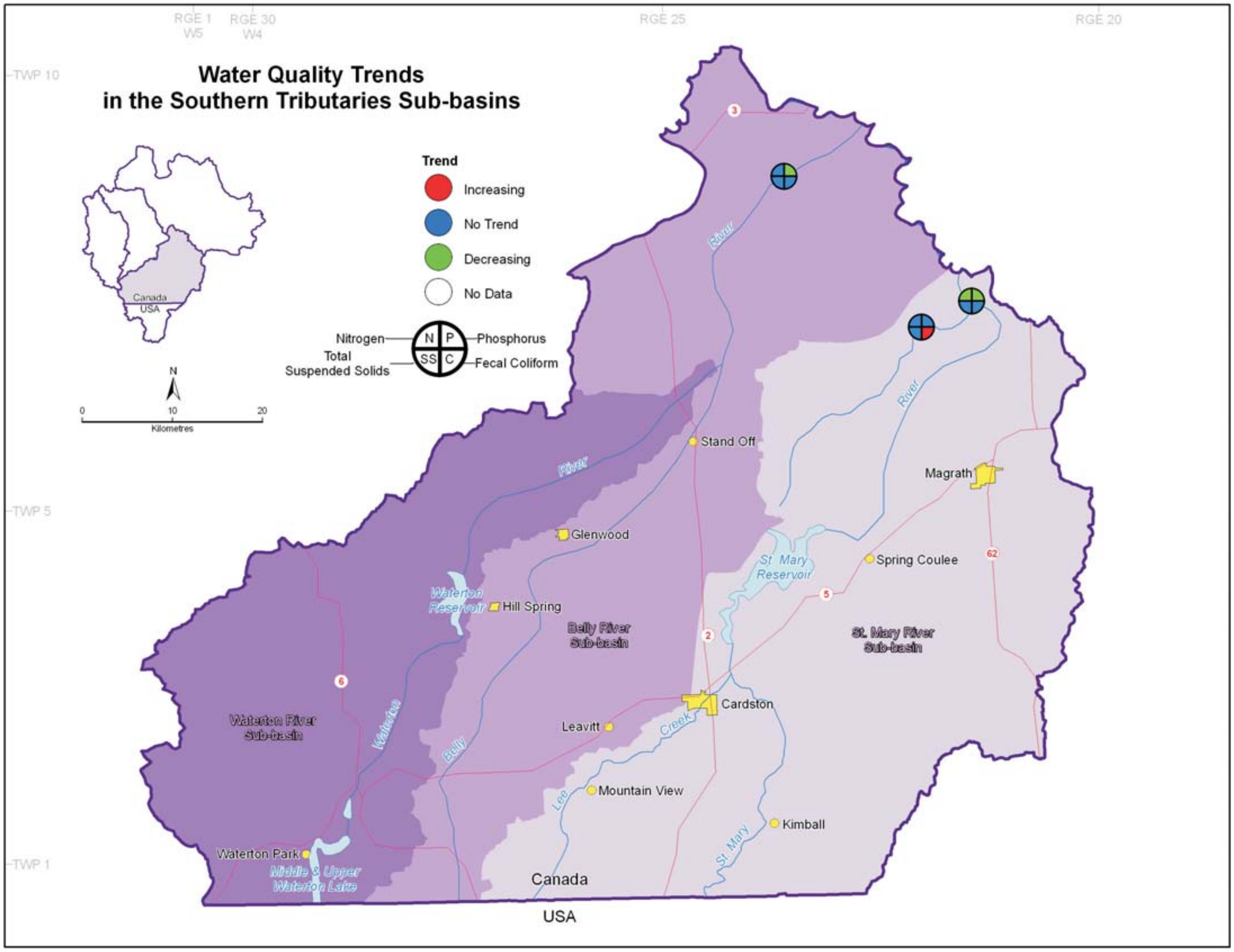


Figure 4.47: Water Quality Trends in the Southern Tributaries Sub-basins

4.3 Summary

Overall, Southern Tributaries Sub-basins is rated as **Fair**. A summary of the observations and analyses of indicators and trends in the Southern Tributaries Sub-Basins is provided.

Terrestrial (Fair)

- Land cover of natural grassland and forest is 48%, rated fair.
- Soil erosion risk is low, rated good.
- Riparian health is healthy but with problems, rated fair.
- Linear developments cover 1.5% of area, rated good.
- Total land use at 69%, rated fair.

Water Quantity (Poor)

- All Southern Tributaries streams with headwaters in the mountains have very high unit yields in their upper reaches.
- There are no significant trends in natural flow.
- Water use in the Southern Tributaries Sub-basins is very high, dominated by district irrigation. Some allocations are to the combined flow of all three of the main streams, Waterton, Belly and St. Mary rivers, making it difficult to summarize the water use status for individual streams. Considering all streams in the Southern Tributaries, about 75% of the median flow is allocated, and about 33% is currently being used. Only about 51% of total allocations are being used, indicating that there is expansion potential within existing allocations.
- There are minor deficits to IO and WCO upstream of storage projects and the Waterton-St. Mary Headworks System. Downstream of the Headworks System, deficits to the IO are minor, but the frequencies of deficits to the WCOs increase substantially during summer months.

Water Quality (Fair)

- The Belly and St. Mary rivers did not exceed guidelines for nitrogen or phosphorus concentrations, although Prairie Blood Coulee experienced nitrogen and phosphorus exceedances and Lee Creek has experienced phosphorus exceedances.

Water Sampling– ARD

- High loadings recorded for nitrogen and phosphorus are likely due to a combination of high concentrations and high flows.
- No trends in total nitrogen concentrations were observed in the Belly River or Prairie Blood Coulee. The St. Mary River demonstrated a decreasing trend at an 80% confidence level.
- Decreasing trends in total phosphorus concentrations were observed in the Belly and St. Mary rivers between 1991 and 2000.
- Total suspended solids are generally low and trends in TSS concentrations were not observed in the Belly or St. Mary rivers between 1991 and 2000 or in Prairie Blood Coulee from 1996 to 2005.
- Increasing trend in fecal coliform counts in Prairie Blood Coulee. No trends in fecal coliform counts were observed in the Belly River and the St. Mary River.

Water quantity is an issue within much of the Oldman watershed. Within the Southern Tributaries Sub-basins, there is potential for expansion within existing allocations. Expansion of water use by users with high priority (senior) licences may increase deficits to instream flow needs and consumptive water users with junior priority licences.

Land use, primarily agriculture, has altered 69% of the land base. While nitrogen and fecal coliforms demonstrated exceedances of guidelines, these were related to the high flow event in 2005. No overall trends were observed for water quality indicators.

Management actions should be focused on continuing to monitor diversion rates, timing of withdrawals, and return flow volumes. This information is required to develop plans to manage future growth within existing allocations. Management plans need to consider options to achieve a sustainable level in the future. Simulation modeling of water supply and demand should be carried out to determine the feasibility and implications of water demand increases.

Additional management recommendations are presented in Chapter 10.