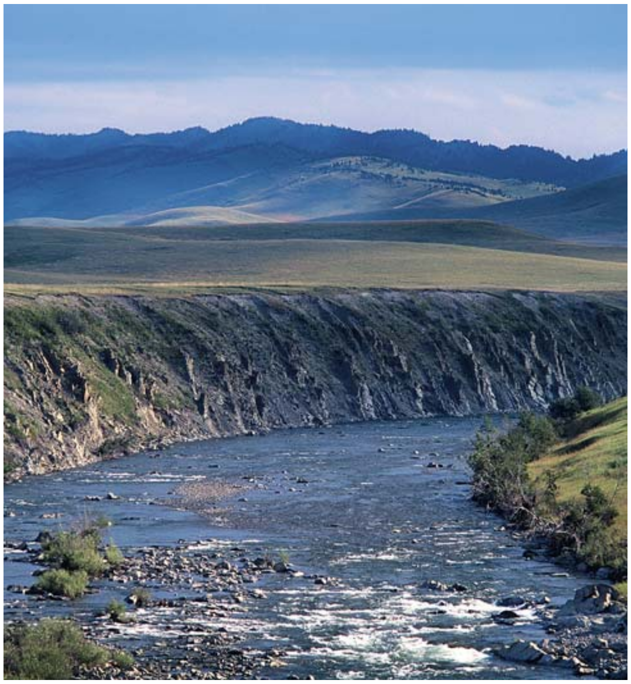
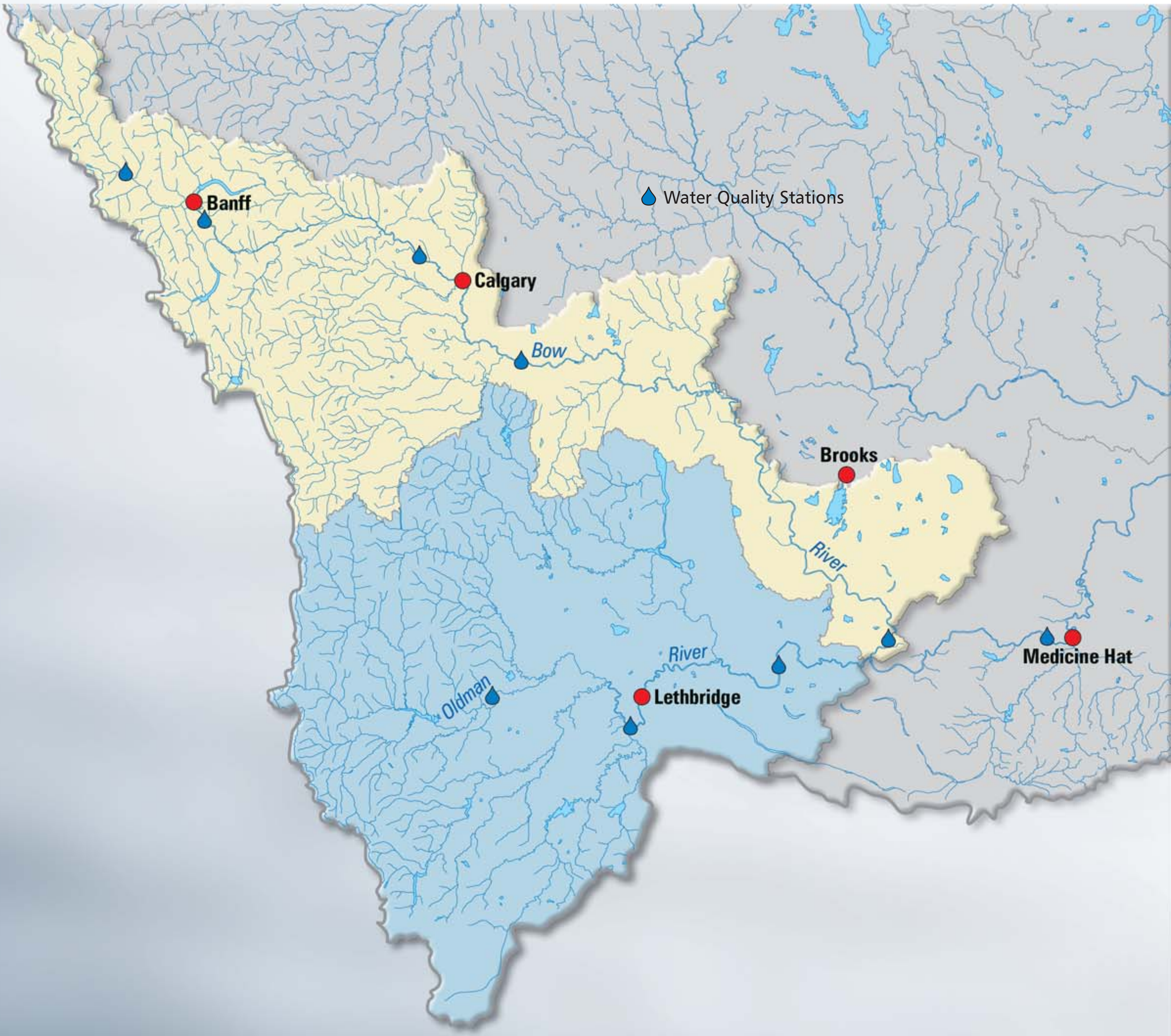


CHAPTER EIGHT
THE BOW AND OLDMAN RIVER SUB-BASINS

Figure 8.1. *The Bow and Oldman River Sub-basins*



CHAPTER EIGHT

THE BOW AND OLDMAN RIVER SUB-BASINS

Bow Sub-basin Summary

Characteristics
- high alpine to plains
- length – 637 km
- gross drainage area – 25 611 km^2
- effective drainage area – 19 304 km^2

Hydrology
- reliable flow on headwaters tributaries and mainstem
- ephemeral flow on plains tributaries
- highly regulated

Water Quality
- excellent for headwaters
- good for lower reaches
- poor for plains tributaries

Biodiversity
- headwaters protected
- riparian zones healthy, but problems

Key Issues
- agricultural land use
- irrigation water use
- municipal effluents
- interprovincial water apportionment
- drought

Oldman Sub-basin Summary

Characteristics
- high alpine to plains
- length – 443 km
- gross drainage area – 28 270 km^2
- effective drainage area – 20 990 km^2

Hydrology
- reliable flow on headwaters tributaries and mainstem
- ephemeral flow on plains tributaries
- highly regulated

Water Quality
- excellent for headwaters
- good for lower mainstem
- poor for plains tributaries

Biodiversity
- riparian zones healthy, but problems
- few remaining wetlands

Key Issues
- agricultural land use
- irrigation water use
- international and interprovincial water apportionment
- drought

The Bow River sub-basin (Figure 8.1) originates in the montane cordillera ecozone on the eastern slopes of the Rocky Mountains. The river itself flows southeasterly through the communities of Lake Louise and Banff. Crossing the foothills forest of the boreal plains, it then emerges onto the prairie, flowing through aspen parkland to Calgary. It then crosses grasslands, meandering southeasterly through an ancient glacial spillway to join the Oldman River. Important mountain tributaries include the Spray, Cascade Kananaskis, Elbow, Sheep, and Highwood rivers. Plains tributaries are few, but include Nose, Fish, West Arrowhead, Arrowhead and Crowfoot creeks.[1]

The steep mountain gradients of about 7 m/km in the mountains become less than 0.5 m/km at the confluence with the Oldman River. The river channel is wide and relatively shallow, and is composed of boulders, cobble and gravel. It has well-developed riffle, run and pool sequences that provide fish habitat.[2]

The Oldman River sub-basin (Figure 8.1) also originates on the eastern slopes of the Rocky Mountains, and makes a rather abrupt transition from mountains to prairie. The Oldman River itself rises near Mount Lyall and flows generally eastward through fescue grasslands and moist mixed grasslands to Lethbridge. It continues to meander through grasslands to its confluence with the Bow River. Important mountain tributaries include the Livingstone, Crowsnest, Castle, Waterton, Belly, and St. Mary rivers. These last three rise in the United States, in Glacier National Park, Montana. In their northward path the Waterton and Belly rivers pass through Waterton Lakes National Park. The Little Bow River is an important plains tributary.

The headwaters of the Bow and Oldman sub-basins descend from alpine tundra through forests of lodgepole pine, spruce, fir and trembling aspen. The undulating prairie consists of open grassland. The high natural fertility and good moisture-holding capacity of the underlying dark soils, high in organic matter, have given rise to productive agriculture.

Over 80 percent of these sub-basins is devoted to agriculture. In some cases, there are significant riparian cottonwood forests. Wetland areas in the Bow River sub-basin are much more significant than those in the Oldman sub-basin. According to PFRA data, about 1000 wetlands cover 94 km^2 in the Bow sub-basin, and about 500 cover 10 km^2 in the Oldman sub-basin.

The headwaters of the Bow sub-basin lie within Banff National Park, and in several provincial parks and wilderness areas. As mentioned earlier, some headwaters tributaries of the Oldman sub-basin lie in national parks but, in general, park areas in the upper sub-basin are small. The dominant population centre of the sub-basins is Calgary with a population of over one million, representing 85 percent of the overall population of Bow and Oldman sub-basins. The largest city in the Oldman sub-basin is Lethbridge, with a population of 74 637 in 2006. There are three First Nations reserves in the Bow sub-basin and two in the Oldman sub-basin. The Kainaiwa Reserve, southwest of Lethbridge, is the largest single reserve in the entire Saskatchewan River basin.

HYDROLOGY

The Bow River begins at Bow Glacier at an elevation of 3400 m and drops to an elevation of 740 m at its confluence with the Oldman River. The highest point in the Oldman sub-basin is Mount Cleveland in Montana. The channels of the two rivers have the typical concave longitudinal profile of all the mountain-fed streams of the Saskatchewan River basin. The rivers are significantly regulated by both hydroelectric and water management dams.

The Bow and Oldman sub-basins are subject to the temperature extremes associated with a cold continental climate. They lie in a region where dry westerly chinook winds, warmed by their descent from the mountain slopes, can produce dramatic mid-winter temperature changes. Mid-winter snowmelts in the lower elevations of these sub-basins are not uncommon.

The annual precipitation in the headwaters valleys of the sub-basin is about 500-700 mm, with about half of that falling as snow. Precipitation at higher elevations is even greater, as is the proportion falling as snow. Entering the plains, precipitation drops in the rain shadow of the mountains and decreases even further at the downstream end of the sub-basins. At Calgary, annual precipitation is only 412 mm, with almost 78 percent of that falling as rain. At Lethbridge, annual precipitation is 386 mm, with 70 percent of that falling as rain. About one-half of the annual precipitation falls as rain in the months of May through August. These rains, while sustaining crops, produce very little runoff. It is snowmelt and rain during the snowmelt period that produce the runoff to replenish water supplies and sustain ecosystems.

Mountain runoff accounts for most of the flow in the Bow and Oldman sub-basins. The combined naturalized median monthly flow is shown in Figure 8.2. Both rivers have similar flow characteristics. The small increase in flow in March and April can be attributed to plains runoff, while the pronounced annual peak in June is from the mountain snowmelt.

As mountain-fed streams, the natural flows of the Bow and Oldman rivers themselves are much more reliable than those of plains-fed tributaries. The Bow River has a particularly reliable flow.

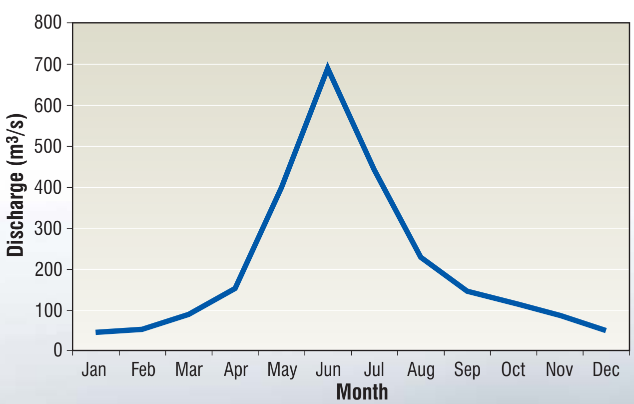


Figure 8.2. Combined Bow and Oldman Median Monthly Naturalized Flows.

Hydroelectric generating stations were installed on the Bow River as early as 1911 to support the growth of the city of Calgary. At present, TransAlta Utilities operates stations at 11 locations in the Bow River headwaters. These stations are used to provide electricity to meet morning and evening power demands. Bearspaw Dam, just upstream of Calgary, acts to smooth short-duration fluctuations in flow caused by the hydroelectric stations. Its reservoir provides one-half of the city's municipal supply. Despite the use of the system for daily peaking, the overall effect on the annual hydrograph is to increase winter flows and reduce summer flows. Increased winter flows facilitate operation of downstream water intakes and assist waste assimilation. Glenmore Reservoir on the Elbow River captures water that supplies about one-half the municipal demand for Calgary. Further downstream, the Western Irrigation District operates a water diversion weir within Calgary, and the Bow River Irrigation District operates a weir at Carseland. A dam at Bassano provides water for the Eastern Irrigation District. These structures significantly reduce the summer flows of the Bow River, so that the flushing flows that enhance ecosystems occur less frequently than before regulation.

Unlike the Bow River, the initial modification of the natural flows of the Oldman sub-basin was driven by agricultural water demands. Irrigation development in the lower Milk River in the Mississippi River basin began with minor diversions in 1887. To meet irrigation water demands, the United States began diverting the St. Mary River, an Oldman River tributary, into the Milk River in 1916. The United States developed Lake Sherburne on Swiftcurrent Creek in 1917 then built a canal to the Milk River with a design capacity of 24 m^3/s. The actual quantity of water that may be diverted in a year is subject to the *Boundary Waters Treaty*. Flow requirements are calculated every 15 days from April to October, and there are no specified minimum flows.

Canada completed major infrastructure developments as well. These included regulation of the Waterton River and diversion of the Waterton

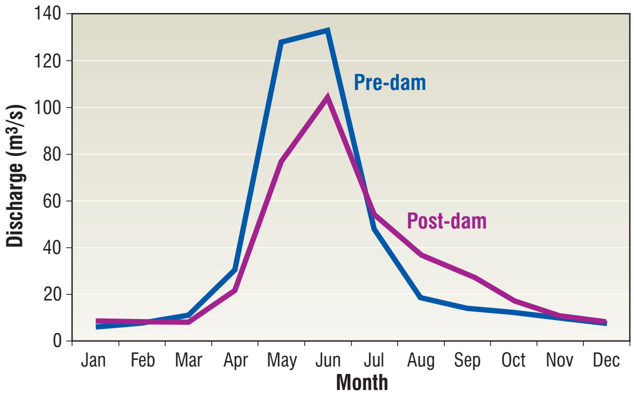


Figure 8.3. Effect of River Regulation on Median Monthly Flows for the Oldman River near Brocket.

and Belly rivers into the St. Mary River. Many water management dams, diversions or conveyance facilities were constructed or expanded in the latter half of the last century. This development culminated with completion of Oldman Dam in 1991. Figure 8.3 shows flows before and after construction of the dam. Downstream flows tend to mimic the natural hydrograph, although flows are reduced because of water withdrawals. Depending on the exact operation of the diversion, this is not always the case elsewhere in these sub-basins.

Streamflows are monitored at 112 sites and lake or reservoir levels at 24 sites in the two sub-basins. The work is carried out for the most part by the Water Survey of Canada under a cost-sharing arrangement with Alberta Environment. The irrigation districts also conduct extensive monitoring within the districts.

WATER USE

The licensed annual surface water allocation in the Bow and Oldman sub-basins in 2005 was 4 792 670 dam^3, and the groundwater allocation was 97 624 dam^3. Almost four million cubic decametres of the surface water allocation relate to licences for irrigated agriculture. Surface water consumption in the sub-basins is calculated to be 2 247 044 dam^3, and groundwater to be 118 040 dam^3.[3] This is 35 percent of the median naturalized flow of the South Saskatchewan River at the Alberta-Saskatchewan boundary – by far the highest water consumption in any sub-basin of the Saskatchewan River basin. Figure 8.4 shows the water allocation and actual water consumption from surface waters. Water consumption in the two sub-basins is almost identical.

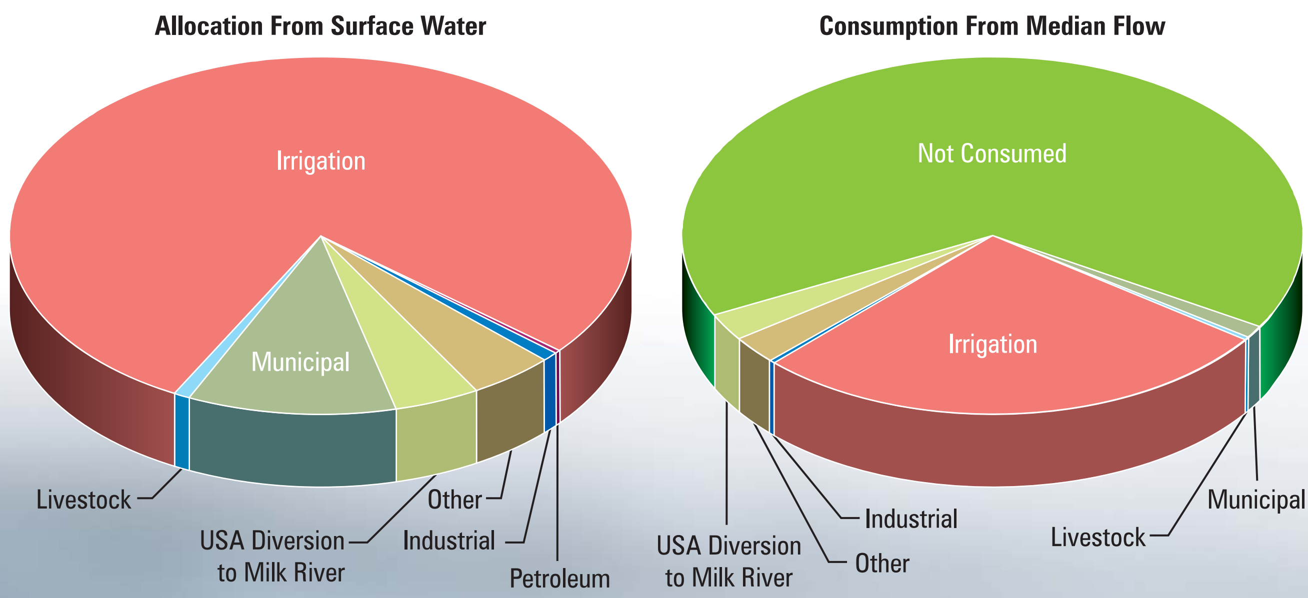


Figure 8.4. Water Allocation and Water Consumption from Surface Water.

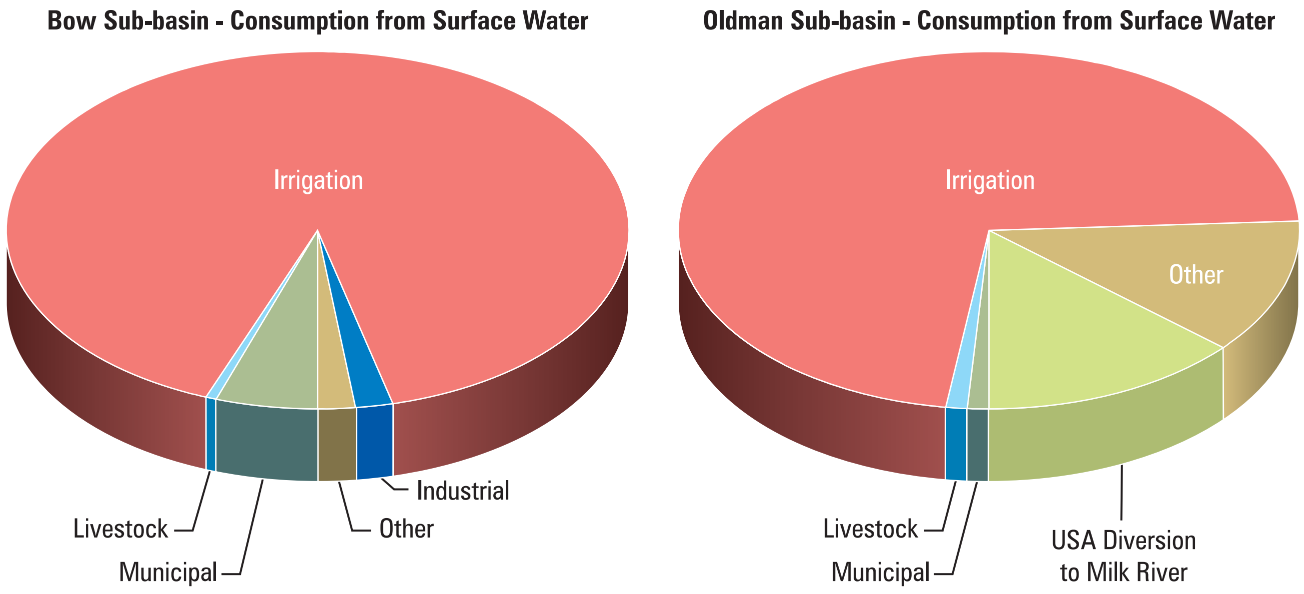


Figure 8.5. Water Consumption from Surface Water in the Bow and Oldman Sub-basins.

Under an Order of the International Joint Commission arising from the *Boundary Waters Treaty* of 1909, the waters of the St. Mary River are shared with the United States, with the American share being diverted to the Milk River.[4] The historical median United States annual entitlement is 228 000 dam^3, while the median annual diversion has been 177 200 dam^3, which represents about 30 percent of the annual streamflow of the St. Mary River, but only about one percent of the Saskatchewan River's annual flow.[5] From a Saskatchewan River basin perspective, all of the waters diverted to the Milk River within Montana are considered to be consumed. The diversion is included in Figure 8.4 and 8.5.

As of 2006, Alberta no longer accepts applications for new surface water allocations from the Bow and Oldman rivers. The Minister of Environment will specify through a Crown Reservation how currently unallocated water will be used. Crown Reservation waters can be allocated only to water conservation objectives; storage of peak flows to mitigate impacts on the aquatic environment; and support to existing licences, including licences pending at the time of the Crown Reservation and allocations for First Nations reserves.[6] Although the waters of the Bow and Oldman sub-basins can be considered as fully allocated, they are not entirely used. Depending on the situation, existing licence holders could expand operations or, under recent legislation, transfer part of an existing licence to another user.

Water consumption from surface water in the Bow and Oldman sub-basins is shown separately in Figure 8.5. Groundwater consumption is very small and is related primarily to stockwatering and domestic use.

Irrigated agriculture is by far the most significant water user in the Bow and Oldman sub-basins. The irrigated area of Alberta is some 6500 km^2, most of that being in these sub-basins. This represents 65 percent of all irrigated agriculture in Canada. Within the 13 irrigation districts in southern Alberta, 5364 km^2 are irrigated. Table 8.1 identifies the districts. Even those districts not physically within the Bow or Oldman sub-basins depend on water infrastructure within the sub-basins for their water supply. There are an additional 1200 km^2 in private irrigation and First Nations irrigation. The project on the Kainaiwa Reserve, which irrigates 100 km^2 using water from the Oldman sub-basin, is the largest private licence holder in Alberta. A map of the Alberta irrigation districts, most of which are in the Bow and Oldman sub-basins, appears in Figure 8.6.[7]

Table 8.1. Irrigation Districts in Alberta.

Map Location	Name	Length of Distribution System (km)	Irrigated Land (km^2)
1	Mountain View	35	4
2	Leavitt	56	19
3	Aetna	27	8
4	United	227	70
5	Magrath	106	45
6	Raymond	247	131
7	Lethbridge Northern	650	495
8	Taber	364	311
9	St. Mary River	1719	1390
10	Ross Creek	20	4
11	Bow River	1058	802
12	Western	1077	274
13	Eastern	1784	1113

Irrigation accounts for about 80 percent of the water consumption in the two sub-basins. The quantity of water consumed in any given year will vary, depending on weather conditions. Return flows from the Western Irrigation District are conveyed by the Rosebud River to the Red Deer River. Water diverted from the Highwood River in the Bow River sub-basin is transferred to the Little Bow River in the Oldman sub-basin. Irrigation water is drawn from surface water; groundwater use is minor. There is still some scope to expand irrigation development within the present water allocations.

The water diverted from the St. Mary River to the Milk River in Montana in a given year depends on the natural flow of the river. It is not an allocation licensed by Alberta; rather, the annual quantity is defined by the *Boundary Waters Treaty*.

The next largest consumer of water is the ‘other’ sector. Water is allocated for management for flood control and lake stabilization, and for fish, wildlife and habitat enhancement. Most of the licences in the Oldman sub-basin are for water management, while habitat enhancement licences dominate in the Bow sub-basin. Most of the water allocated is consumed by evaporation.

Municipal applications account for the next largest water consumption. Less than five percent of municipal use is from groundwater. The apparent consumption shown for the Bow River in Figure 8.5 relates to city of Calgary licences, but is likely overestimated. Allocations and water consumption related to stockwatering, petroleum and industrial applications are also small. Most of the water allocated for these purposes is consumed.

The flows in the Bow and Oldman are subject to the PPWB *Master Agreement on Apportionment*. Under the agreement, the waters of the South Saskatchewan River, including the Red Deer River, are treated as one stream for apportionment purposes. Because of relatively high water use in the Bow and Oldman sub-basins, the apportionment of the Saskatchewan River at the interprovincial boundary is more complex than for other streams subject to the Master Agreement. This is discussed in Chapter Nine.

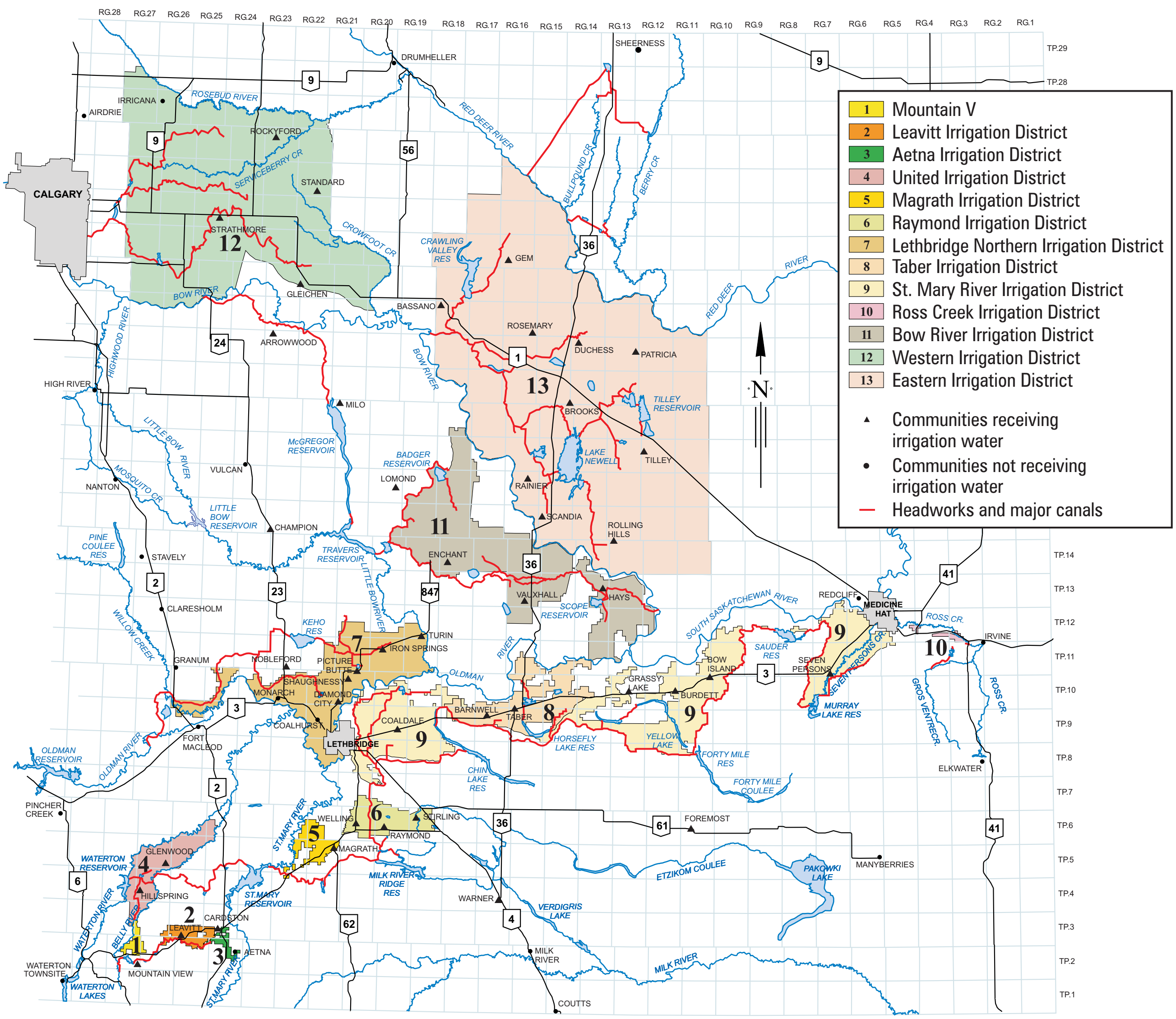


Figure 8.6. Alberta's Irrigation Districts (Alberta Agriculture, Food and Rural Development).

WATER QUALITY

Water quality of the streams, lakes and reservoirs of Bow and Oldman sub-basins is influenced by the landscape through which the streams flow and by human uses. As the headwater tributaries originate in the Rocky Mountains and most of the water flowing in the river constitutes mountain runoff, the water quality of these streams is generally good. This water tends to be naturally hard and nutrient poor. Natural mineralization and nutrient levels gradually increase downstream. On the other hand, the tributaries and small lakes of the plains tend to have water that is naturally highly mineralized and nutrient rich. The natural quality of the waters of the sub-basins is influenced by runoff from agricultural lands, and by municipal and industrial effluents.

Water quality is routinely monitored at several locations on the Bow and Oldman river mainstems, as well as on the Elbow River. Table 8.2 lists these locations. Periodic assessments have also been conducted at other locations. In general, water quality is found to be excellent in headwaters

Table 8.2. Water Quality Monitoring Locations.

Stream	Location	Agency	Remarks
Bow River	Lake Louise	Environment Canada	Upstream of Lake Louise
Bow River	Canmore	Environment Canada	Near National Park Boundary
Bow River	Upstream Exshaw Creek	Alberta Environment	
Bow River	Cochrane	Alberta Environment	Upstream of Calgary
Bow River	Carseland Dam	Alberta Environment	Downstream of dam
Bow River	Cluny	Alberta Environment	
Bow River	Bow City	Alberta Environment	At bridge
Bow River	Ronalane	Alberta Environment	Downstream of Bassano Dam
Elbow River	9th Ave. Bridge, Calgary	Alberta Environment	Downstream of Glenbow Reservoir
Oldman River	Brocket	Alberta Environment	Headwaters
Oldman River	at Highway 3	Alberta Environment	Upstream of Lethbridge
Oldman River	at Highway 36	Alberta Environment	Near confluence with Bow River

reaches and good further downstream. Water quality in the lower reaches of these rivers is influenced by agriculture, irrigation, and natural processes, such as channel erosion.

In the case of the Bow River, there was a noticeable improvement in water quality following the completion of the Banff wastewater treatment plant in 1989.[8] Further improvements aimed at reducing sediments, nutrients and micro-organisms were completed in 2003 at both Lake Louise and Banff.[9] Nutrient reduction measures taken by Calgary have reduced phosphorous loading to the Bow River. Despite the application of full tertiary treatment, the city remains the largest single source of nutrients in the Bow and Oldman sub-basins. These nutrients support aquatic plant growth and increased biological productivity downstream of the city; they can lead to daily fluctuations in dissolved oxygen because of respiration and photosynthesis.[10]

Water quality assessments of three Bow River tributaries have been conducted. The quality of the Ghost River – a mountain-fed stream – is excellent, although there are short-term, high-suspended sediment concentrations at times. The quality of the Elbow River – also a mountain-fed stream – is good near its confluence with the Bow River and better upstream, although there are indications water quality is degrading over time. The water quality of Nose Creek, a plains stream entering the Bow River at Calgary, is poor. Nutrient concentrations are high and bacteria and pesticide concentrations are also elevated.[11] The creek is degraded by both urban and agricultural runoff.

The water quality of the Oldman sub-basin is strongly linked to water withdrawals for irrigation and irrigation return flows, as well as to agricultural runoff caused by summer rains. Eight wastewater treatment plants discharge effluent into the river. Before a wastewater treatment plant upgrade in 1999, Lethbridge was a significant point source. The Oldman River is well oxygenated throughout its length, in part because of winter releases from the Oldman dam. Water quality assessments in the Oldman sub-basin have not been as extensive as those in the Bow sub-basin. The overall water quality of the Oldman River itself is considered excellent in the headwaters and good for the rest of its length. Although limited water quality assessments have been carried out for the St. Mary and Belly rivers, no overall rating is available. The quality can be considered to be good to excellent. The quality of the Little Bow River, where some water quality assessments have been conducted, generally degrades from the headwaters to its confluence with the Oldman River. The quality also varies considerably from year to year, ranging from good to poor.[12]

The upper reaches of the Bow and Oldman rivers and their tributaries are oligotrophic, while the plains tributaries are eutrophic. The Bow mainstem becomes mesotrophic at Calgary, while the Oldman River is considered oligotrophic throughout its length. Plains tributaries in the Bow sub-basin are eutrophic. Chestermere Lake, an off-stream reservoir immediately east of Calgary, is mesotrophic. St. Mary Reservoir in the Oldman sub-basin is oligotrophic. The irrigation reservoirs in the sub-

The Development of Irrigation in the Saskatchewan River Basin

European settlement of the West led to two major demands on available water supplies: irrigation and hydropower. In semi-arid southern Alberta, the first successful irrigation project took place in 1880 when John Glenn irrigated six hectares at Fish Creek south of Calgary. In 1889 the first diversion permit was issued for water from the St. Mary River. Mormon settlers constructed many small-scale projects based on their earlier experience in Utah. They also brought an approach to water allocation that was new to Canada – the concept of an exclusive right to water.

A significant drought and increased demands for irrigation development led to The *North-west Irrigation Act* of 1894. The Act, which applied to the area that is now Alberta, Saskatchewan and part of Manitoba, vested ownership of water in the federal crown and suppressed riparian rights. The ability of the government to grant exclusive rights to water enabled investments in irrigation development. Irrigation in the Milk River basin in southwest Saskatchewan began at roughly the same time but did not extend into the Saskatchewan River basin until later.

Large-scale irrigation got underway with the completion in 1900 of a 184 km canal from the St. Mary River to land near Lethbridge to deliver water to what is now known as the western block of the St. Mary Irrigation District. The Alberta Irrigation Company received a water right for almost the entire flow of the St. Mary River.

In 1903, the Canadian Pacific Railway (CPR) began construction of a weir on the Bow River near Calgary and a system of water delivery canals to what is now the Western Irrigation District. Six years later the CPR diverted the Bow River near Bessano and constructed a water delivery system to what is now the Eastern Irrigation District.

These early irrigation projects eventually failed, in part because of relatively wet weather during this era. In 1914, the Government of Alberta passed legislation that allowed landowners to organize themselves into co-operatives. The Taber Irrigation District, established in 1917, was the first to be organized. The federal and provincial governments supported major capital investments in the districts. With the creation of the Prairie Farm Rehabilitation Administration in 1935, the federal government became a major developer of reservoirs and water delivery systems. The Government of Alberta assumed this role in the 1970s, making major investments in new and refurbished infrastructure.

The irrigation infrastructure in southern Alberta now includes over 50 reservoirs and 8000 km of conveyance channels. The irrigation districts themselves contain 38 off-stream reservoirs. This infrastructure not only meets the needs of irrigators but also provides water to 42 000 people in 50 municipalities and 12 major industrial users. The infrastructure has also been used to create or enhance 350 km^2 of wetland habitat. Small-scale hydro has been added to some irrigation canals.

basins tend to have high flow-through rates, so it is not surprising that their trophic status is the same as their source waters.

Monitoring data have been used to calculate water quality indices for the mainstems of both the Bow and Oldman rivers. Figures 8.7 and 8.8 show the trends in water quality in the downstream reaches of both. Nutrient levels in the Bow River have improved since 1999, while other components of the index remain unchanged. Nutrient levels for the Oldman River have also improved overall, but nutrients and pesticides are still major concerns.

As measures to reduce the impacts of urban wastewater effluents on receiving waters have taken effect, the impacts of stormwater runoff have become more evident. In Calgary, stormwater runoff accounts for about 20 percent of the nutrient load to the Bow River. Unlike some of the other cities in the sub-basin, Calgary's sanitary sewers are separate from the stormwater system. Some stormwater runoff is captured in settling ponds in new developments, and efforts are also underway to reduce runoff, two steps to improving water quality. Stormwater runoff from the relatively impermeable urban environment, if uncontrolled, will be much greater than the runoff from an undeveloped landscape. One examination of Nose Creek in Calgary demonstrated that the increase in runoff due to urbanization was equivalent to a four-fold increase in the catchment area. The increased volume of water leads to increased scour and channel-widening, in turn leading to bank instability and the introduction of much larger sediment loads downstream.[13]

Following the improvements to Lethbridge's wastewater treatment system in 1999, the city has relatively little effect on downstream water quality. The more recent water quality index values are the result of both urban and agricultural runoff or return flows.

BIODIVERSITY AND ECOSYSTEMS

The headwaters of the Bow and Oldman sub-basins lie in a relatively undisturbed landscape. Banff National Park and several provincial parks provide considerable protection for the Bow River headwaters; however, a portion lies within the Spray Lake Forest Management Area. The United States' Glacier National Park, Waterton Lakes National Park and Bob Creek Provincial Park provide some protection for Oldman sub-basin headwaters. Both rivers are highly regulated by dams, weirs and water diversion structures. These structures fragment aquatic habitat, but, at the same time, river regulation provides opportunities to replenish

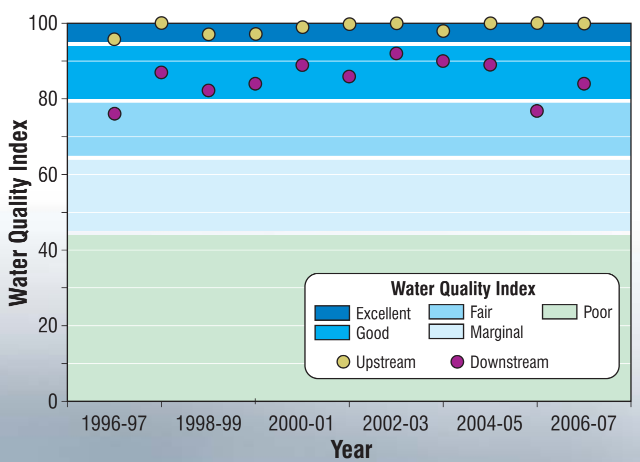


Figure 8.7. Water Quality Index - Bow River Upstream and Downstream of Calgary.

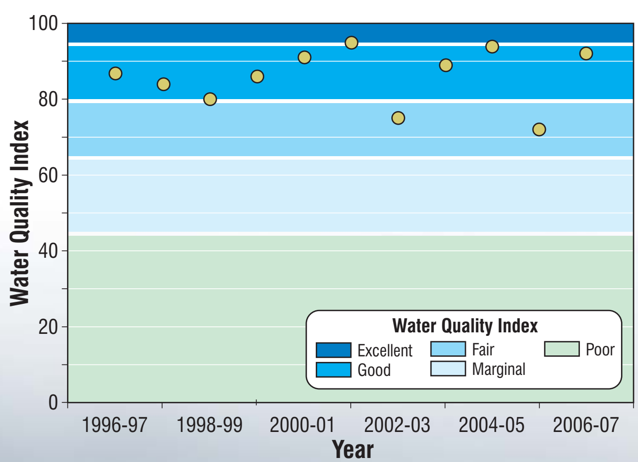


Figure 8.8. Water Quality Index - Oldman River Downstream of Lethbridge.

wetlands in the lower sub-basin. Alberta has established water conservation objectives for these sub-basins – either 45 percent of the naturalized flow, or the instream flow objective plus 10 percent, whichever is greater.[14] In the case of the Bow River below Bassano dam, the objective is 17.1 m^3/s.

The grassy slopes and forests of the sub-alpine portion of the upper part of both sub-basins provide habitat for many mammals, large and small. The foothills forest supports many migratory songbirds and non-migratory birds, such as owls and woodpeckers. Several species are threatened by habitat fragmentation and the loss of old-growth forest. The ecological resources of the upper sub-basin provide extensive outdoor recreation and ecotourism opportunities.

The fish species of the Bow and Oldman sub-basins are shown in Table 8.3. The upper Bow River and its mountain tributaries provide coldwater fish habitat. In the case of the Bow River, this habitat extends to Carseland Weir, where it becomes cool water habitat. Mountain whitefish, rainbow trout, brown trout, and bull trout are common. The Bow River is a renowned rainbow trout fishery. The combination of stable flows downstream of Bearspaw Dam and nutrients from Calgary municipal effluent and Highwood River increases fish production. The lack of fish passage facilities at Bassano dam, much reduced summer flows, high water temperatures, and oxygen-depleting aquatic growth significantly deplete fish stocks.[15]

The Oldman River and its mountain tributaries provide coldwater fish habitat. Mountain whitefish is the most common species in the upper sub-basin. The eastslope sculpin, a threatened species, is found in the St. Mary River. The operation of Oldman Dam, which began in 1991, has led to establishment of a bull trout fishery downstream, a result of the changed water temperature regime caused by the dam. Further downstream, flow reductions at the Lethbridge Northern Irrigation District (LNID) Weir affect the fishery. Although both the LNID Weir and the weir at Lethbridge have fish passage facilities, it is not certain how effective they are. In the lower sub-basin, fish habitat can also be affected by irrigation return flows.[16]

The effect of the city of Calgary on the Bow River has been monitored for many years. In general, the health of aquatic ecosystems is good upstream of the city, is degraded by the city, and then recovers further downstream. Both algal and rooted plant biomass increase downstream of Calgary, then decline from Carseland Weir to the confluence with the Oldman River. Plant biomass declined following

Table 8.3. Fish Species of the Bow and Oldman Rivers.

Species Type	Common Name
Coldwater Species ** Introduced Species*	Brook Trout (Bow) Brown Trout* Bull Trout Cutthroat Trout (Bow) Lake Trout (Bow) Rainbow Trout* Mountain Whitefish
Coolwater Species	Goldeye Mooneye Lake Whitefish Northern Pike Sauger walleye Yellow Perch Burbot Lake Sturgeon
Non-game Species	Brook Stickleback Emerald Shiner Fathead Minnow Lake Chub Longnose Dace Pearl Dace (Oldman) River Shiner Spottail Shiner Longnose Sucker Mountain Sucker Quillback Sucker Shorthead Redhorse Silver Redhorse Spoonhead Sculpin Trout-Perch White Sucker

implementation of tertiary treatment. Benthic invertebrate communities increase as the river moves through Calgary – an effect of increased nutrients from municipal and industrial effluents. Community structure also changes to more pollution-tolerant species. Benthic communities downstream of Calgary were previously affected by a contaminated industrial site, now contained. Benthic communities at the confluence of the Bow and Oldman rivers are similar in composition to those downstream of Calgary. This is a general effect of the nutrient content of the water in this reach. Generally, benthic species in the Bow River are healthy and diverse. Not enough information is available to define the state of the tributary communities.[17]

Assessments of aquatic biomass in the Oldman sub-basin indicate the highest concentrations are in the middle reach of the sub-basin. Dense growth of rooted plants are found downstream of Lethbridge to the confluence with the Bow River, possibly a consequence of both elevated nutrient levels and reduced flushing flows. Benthic communities in the Oldman River are diverse, but there is a tendency to more stress-tolerant communities as we move downstream. It is also evident that the Oldman Dam has perturbed the benthic communities and that they continue to change.[18]

Riparian health of the middle and lower reaches of the principal streams in the Bow and Oldman sub-basins has been assessed under Alberta's Cows and Fishes Program. In general, riparian areas are healthy, but with problems: for example, the presence of undesirable plant species, including invasive species such as purple loosestrife.[19]

Riparian vegetation can also be sensitive to the effects of river regulation. The collapse of the cottonwood population along the lower St. Mary River has been well documented. Consequently, with the completion of Oldman Dam, Alberta implemented an operating plan for the reservoir that closely mimicked the natural hydrograph.[20]

ENDNOTES

[1] Bow River Basin Council 2005. *The 2005 Report on the State of the Bow River Basin.* Bow River Basin Council, Calgary, AB.

[2] Rosenburg *et al.* 2005. Rosenburg, D.M., P.A. Chambers, J.M. Culp, W.G. Franzin, P.A. Nelson, A.G. Salki, M.P. Stainton, R.A. Bodly, and R.W. Newbury 2005. "Nelson and Churchill River Basins". Chapter 19 in *Rivers of North America*, edited by A.C. Benke and C.E. Cushing. Elsevier Academic Press.

[3] Alberta Environment 2007a. *Current and Future Water Use in Alberta.* Prepared by AMEC Earth & Environmental. Alberta Environment. Edmonton, AB

[4] Halliday, R. and G. Faveri 2007. "The St. Mary and Milk Rivers: The 1921 Order Revisited." *Canadian Water Resources Journal.* 32(1): 75–92.

[5] International St. Mary - Milk Rivers Administrative Measures Task Force 2006. *Report to the International Joint Commission.* International Joint Commission, Washington, DC and Ottawa, ON.

[6] Alberta Environment 2006. *Approved Water Management Plan for the South Saskatchewan River Basin (Alberta)*. Alberta Environment. Edmonton, AB.

[7] Alberta Agriculture and Food 2000. *Irrigation in Alberta.* Alberta Agricuture and Food, Edmonton, AB.

[8] Glozier, N.E., R.W. Crosley, L.A. Mottle, and D.B. Donald 2004. *Water Quality and Trends for Banff and Jasper National Parks: 1973-2002.* Environment Canada, Saskatoon, SK.

[9] Bow River Basin Council 2005. *supra*

[10] Alberta Environment 2007b. *Information Synthesis and Initial Assessment of the Status and Health of Aquatic Ecosystems in Alberta.* Technical Report 278/279-01. Alberta Environment, Edmonton, AB.

[11] Alberta Environment 2007b. *ibid*

[12] Alberta Environment 2007b. *ibid*

[13] van Duin, B. and J. Garcia 2005. "Impacts of Urbanization on West Nose Creek – a Canadian Experience". *Water Science and Technology* 53(10): 237-245

[14] Alberta Environment 2006. *supra*

[15] Clipperton, G.K., C.W. Koning, A.G,H. Locke, J.M. Mahoney and B. Quazi 2003. *Instream Flow Needs Determinations for the South Saskatchewan River Basin.* Alberta Environment, Edmonton, AB.

[16] Clipperton *et al.* 2003. *ibid*

[17] Alberta Environment 2007b. *ibid*

[18] Alberta Environment 2007b. *ibid*

[19] Bow River Basin Council 2005. *supra*

[20] Rood, S.B., G.M. Samualson, J.H. Braatne, C.R. Gourley, F.M.R. Highs, and J.M Mahoney 2005. "Managing River Flows to Restore Floodplain Forests." *Frontiers in Ecology and the Environment.* 3:193-201.