

4.0 CLIMATIC AND HYDROLOGIC CHARACTERIZATION OF THE ATHABASCA OIL SANDS REGION IN 2006

The following general description of the 2006 climate and hydrology of the Athabasca oil sands region and comparison with long-term values provides a context for the results of the monitoring activities in RAMP in 2006. The comparison with long-term values is based primarily on federal and provincial hydrologic monitoring stations because of the long data records available at those stations.

Total precipitation at Fort McMurray and northward was below normal in 2006 for the third consecutive year. The Fort McMurray Airport recorded 346 mm of precipitation during the water year (November 1, 2005 to October 31, 2006) and 362.5 mm during the 2006 calendar year. For comparison, the long-term (since 1944) annual average precipitation at Fort McMurray is 442 mm (Figure 4.1-1). Figure 4.1-2 compares the water year monthly precipitation to average and extreme historical monthly values. Precipitation was below average in winter, near average for the spring and early summer, and then below average from August 2006 onward.

A more detailed view of the distribution of precipitation throughout the calendar year and across the Athabasca oil sands region is shown on Figure 4.1-3. The largest rainfall event of the year occurred on July 10-11, when 47.5 mm of rain was recorded at Fort McMurray Airport (Fort McMurray A), and over 65 mm was recorded at Mildred Lake and at the Aurora Climate Station. Only 32 mm of rain fell during those same two days at the Christina Lake station.

Precipitation at the Aurora climate station was slightly lower than at Fort McMurray (Figure 4.1-3), particularly during the winter months. 2006 precipitation was slightly higher to the west of the Athabasca River than at Fort McMurray, both at Mildred Lake and at the RAMP S19 station (Tar River Lowland Tributary near the Mouth). The total annual precipitation was 470 mm at the Christina Lake station, south of Fort McMurray, Alberta.

The spring snowpack was smaller than average in 2006, and melted earlier than usual, with spring runoff peaks recorded in mid-April 2006 or earlier. Spring runoff peaks were below normal north of Fort McMurray, but well above normal south of Fort McMurray on the Christina River.

The annual runoff and maximum and minimum daily discharge observed at four selected regional Water Survey of Canada (WSC) streamflow stations are compared with historical values in Table 4.1-1. The stations are selected to represent four main areas of interest: the Athabasca River itself, the Muskeg River to represent watersheds east of the Athabasca River, the MacKay River to represent watersheds west of the Athabasca River, and the Christina River to reflect conditions south of Fort McMurray.

Flows in the Athabasca River measured at WSC station 07DA001 (Athabasca River below McMurray) were well below average, with a total annual volume of 73% of the long-term average (Table 4.1-1, Figure 4.1-4). Since 1997, annual flow volume in the Athabasca River has been above the long-term average only once, in 2005. Winter discharges on the Athabasca River were close to historical median values. Athabasca River flows were below normal except for two brief events in mid-April and late May (Figure 4.1-5). Athabasca River flows were below the historical low quartile, and several times below

previously-recorded lowest flows for July, August and most of September. The maximum daily Athabasca River discharge for 2006, 1,590 m³/s on May 30 2006, was almost 40% less than the mean annual flood (i.e., the mean of the series of annual maximum daily discharges) of 2,500 m³/s. The minimum daily discharge of 146 m³/s on March 24 2006 was slightly greater than the historical average minimum value of 138 m³/s.

In the Muskeg River basin, total runoff in 2006 was only 45 mm (Table 4.1-1), about half of normal, and was the lowest recorded since 1999 (Figure 4.1-6). Daily discharges were close to normal in spring, but fell below normal early in June 2006 and were close to the lower quartile during the early summer. Several rainfall events early in July 2006 raised the streamflow to the upper-quartile range, but by mid-August 2006 the flow subsided to median values and early in September 2006 returned to the lower quartile level (Figure 4.1-7). The annual maximum daily discharge of 10.3 m³/s for the Muskeg River was less than half of the mean annual flood of 25.5 m³/s, and the minimum winter discharge of 0.27 m³/s was about 20% higher than the historical average minimum flow.

The MacKay River basin was even drier than the Muskeg River basin, with only 34 mm of runoff, less than half of its normal yield (Table 4.1-1, Figure 4.1-8). Annual runoff has been below average in the MacKay River basin every year since 1990 with the exception of 1996, 1997 and 2005. The spring peak on the MacKay River was earlier and lower than usual and flows remained near or below the low quartile after the freshet until the heavy rainfall event in July 2006 (Figure 4.1-9). The maximum daily discharge of 38.6 m³/s in July 2006 was only about one third of the mean annual flood of 126 m³/s, and the minimum discharge of 0.095 m³/s was less than half of the historical average minimum flow.

By contrast, the 2006 annual runoff was 111 mm south of Fort McMurray in the Christina River basin, well above average (Table 4.1-1), and the fourth-highest recorded annual runoff since 1982 (Figure 4.1-10). Spring runoff peaked on April 18 2006, but the highest discharge of the year occurred on May 26 2006 as a result of high rainfall. The maximum daily discharge of 63.5 m³/s was slightly lower than the mean annual flood of 78.9 m³/s (Figure 4.1-11). Daily discharges were in the upper quartile range for most of the year, except in late June and early July, when they subsided to the lower quartile. The minimum discharge of 2.76 m³/s was considerably higher than the historical average minimum flow; however, the historical average minimum flow was computed using only four years of year-round records.

In summary, 2006 was relatively dry at Fort McMurray and northward, especially in regards to winter precipitation. The spring runoff was early and small. South of Fort McMurray, 2006 was wetter than normal throughout the year. In the Athabasca River, both runoff volume and the annual maximum discharge were well below historical average values, but the minimum flow was not below the historical average minimum.

Figure 4.1-1 Historical annual precipitation at Fort McMurray (1946 to 2006).

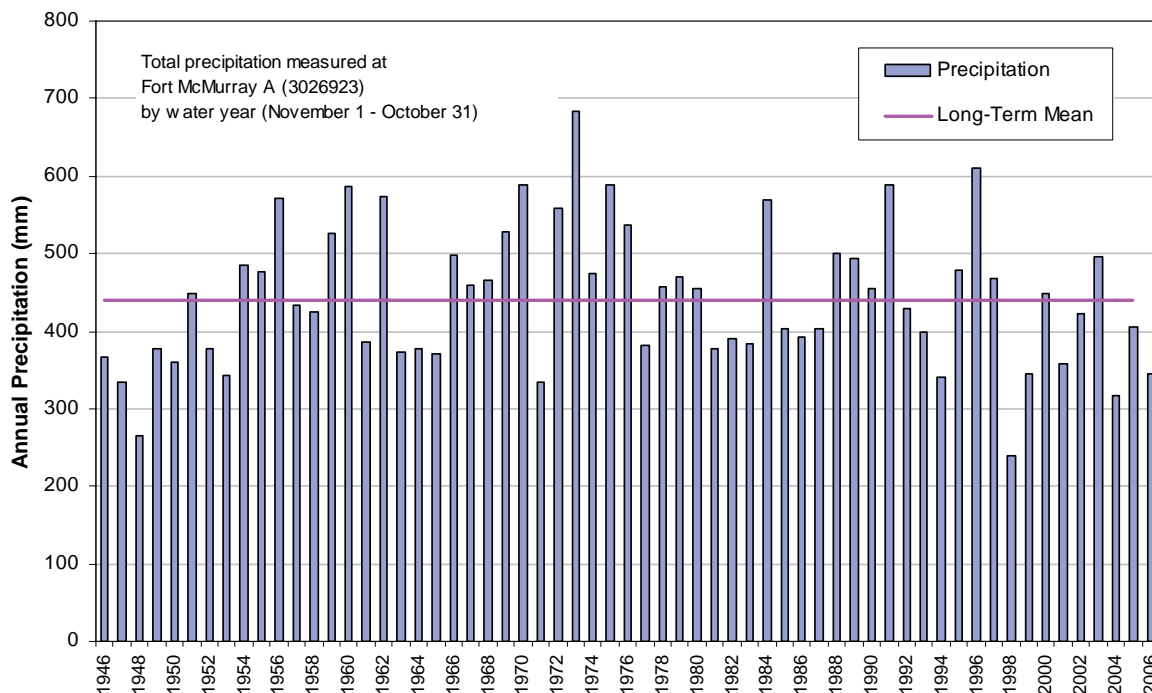


Figure 4.1-2 Monthly precipitation at Fort McMurray in the 2006 water year (November 1, 2005 to October 31, 2006).

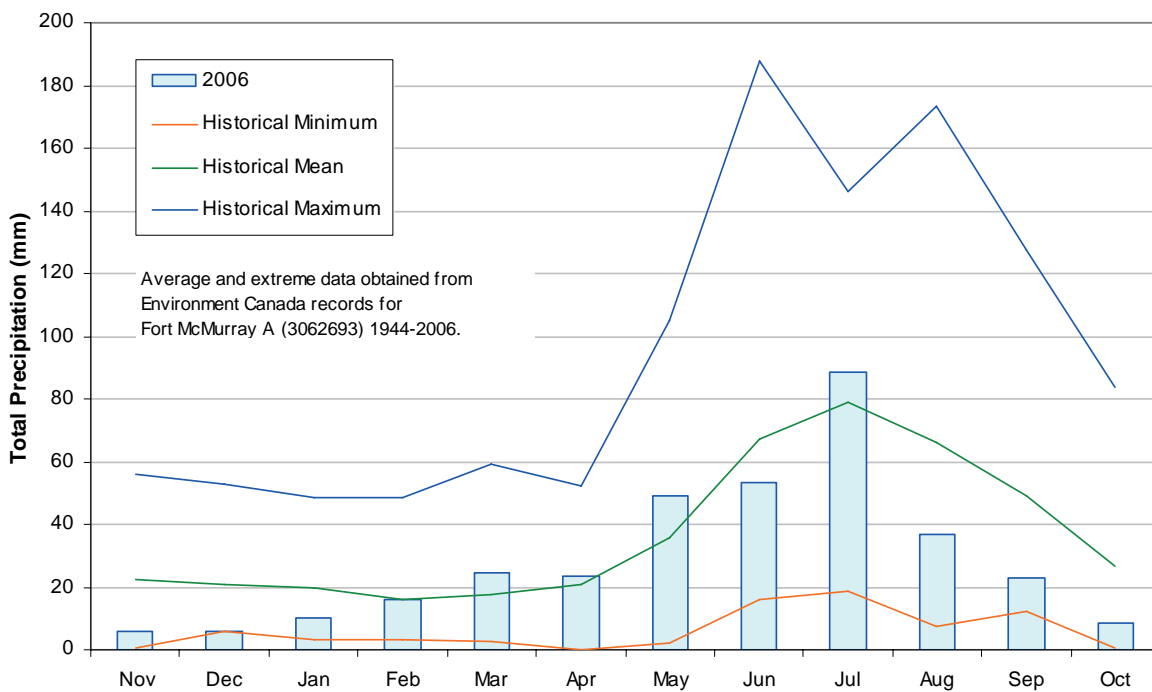


Figure 4.1-3 Cumulative total precipitation at climate stations in the Athabasca oil sands region in 2006.

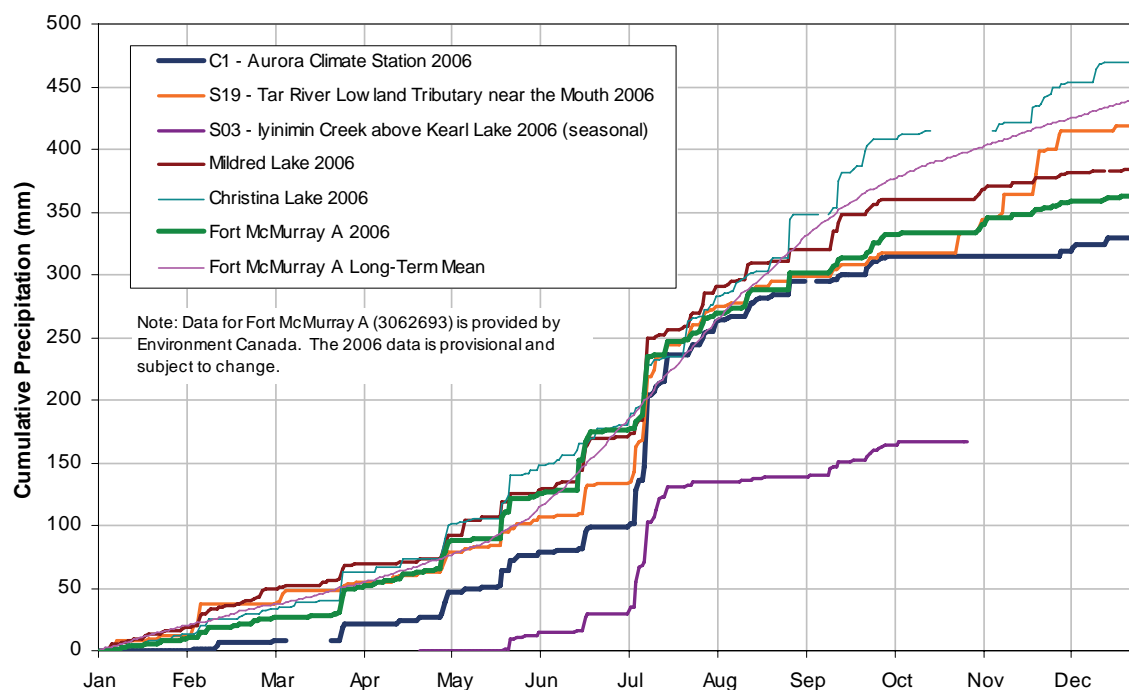


Table 4.1-1 A summary of 2006 streamflow variables compared to historical values measured in the Athabasca oil sands region.

	Athabasca River below McMurray (07DA001)	Muskeg River near Fort McKay (07DA008)	MacKay River near Fort McKay (07DB001)	Christina River near Chard (07CE002)
Effective Drainage Area (km²)	131,000	1,460	5,570	4,851
Period of Record	1957 - 2006	1974 - 2006	1972 - 2006	1982 - 2006
Annual Runoff Depth				
Historical mean (mm)	151	82 ¹	76 ¹	84 ¹
2006 (mm)	110	44 ¹	34 ¹	111 ¹
Annual Maximum Daily Discharge				
Historical mean (m ³ /s)	2,500	25.5	123	78.9
2006 (m ³ /s)	1,590	10.3	38.6	63.5
Annual Minimum Daily Discharge²				
Historical mean (m ³ /s)	138	0.228	0.239	1.61 ³
2006 (m ³ /s)	146	0.272	0.095	2.76

¹ March 1 – October 31 volumes.

² Based on November 1 – October 31 water year; WSC data supplemented by RAMP records.

³ Minimum discharge for the Christina River is computed from only four years of year-round records.

Figure 4.1-4 Historical annual runoff in the Athabasca River basin (1974 to 2006).

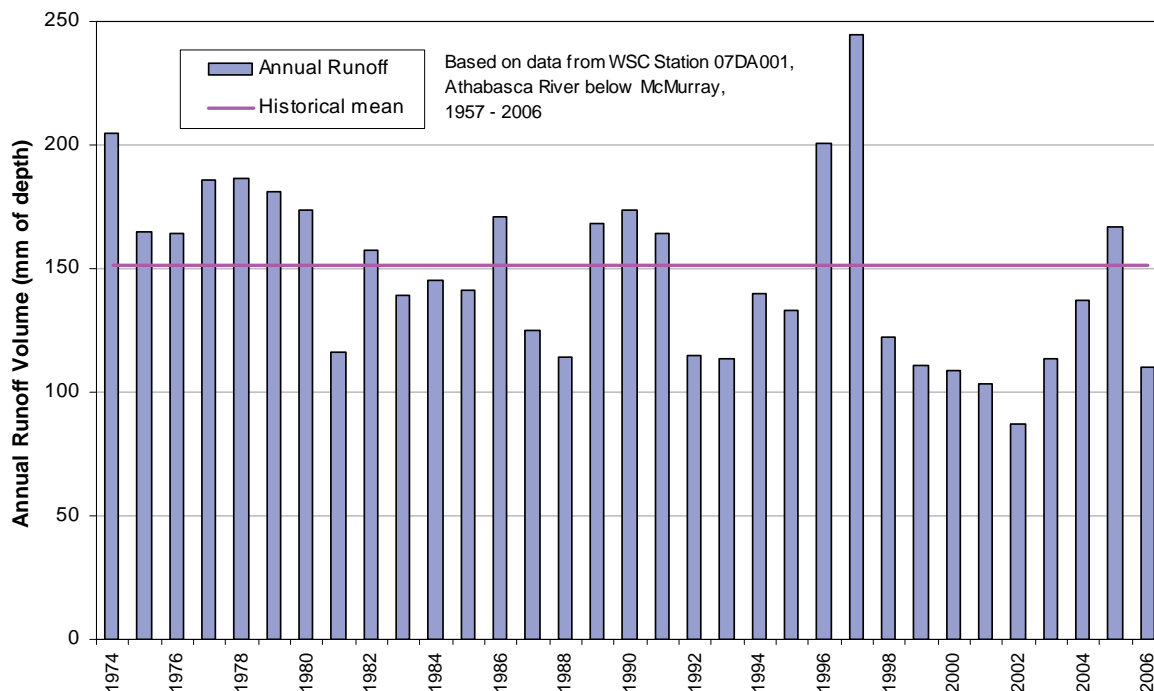


Figure 4.1-5 The 2006 Athabasca River hydrograph compared to historical values.

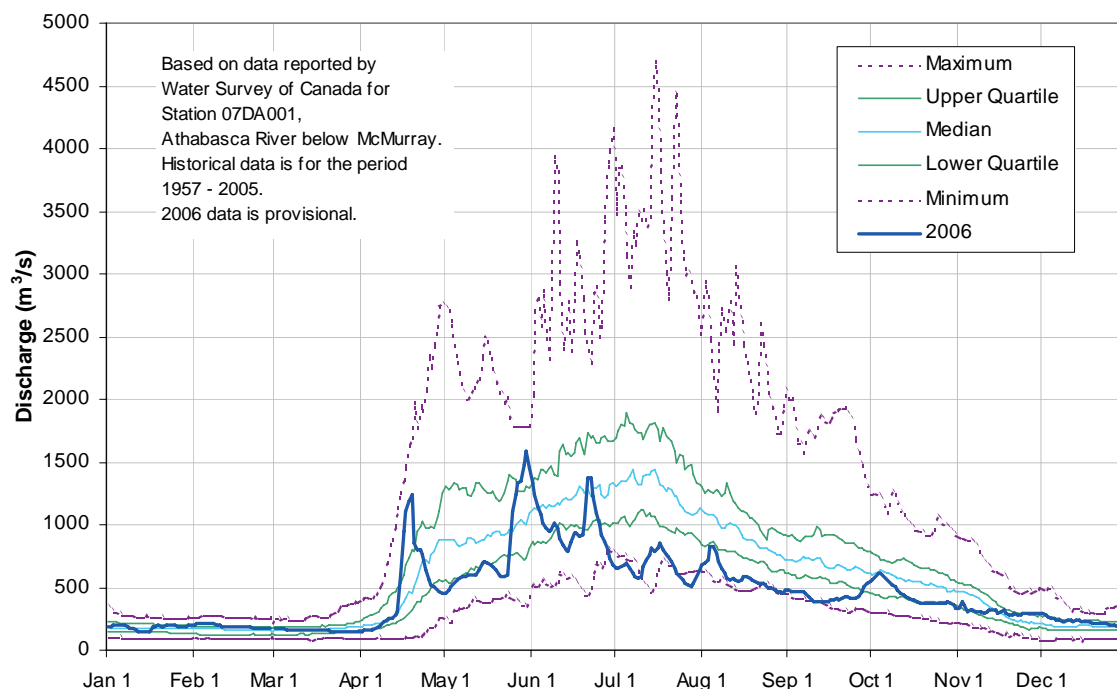


Figure 4.1-6 Historical annual runoff in the Muskeg River basin (1974 to 2006).

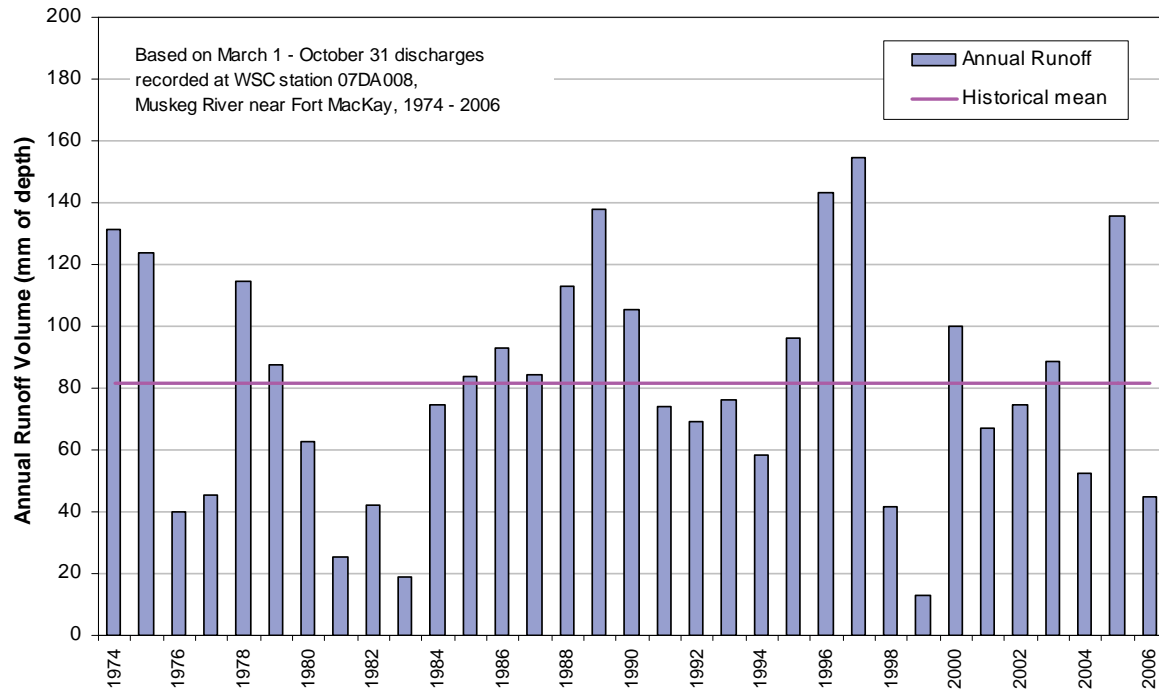


Figure 4.1-7 The 2006 Muskeg River hydrograph compared to historical values.

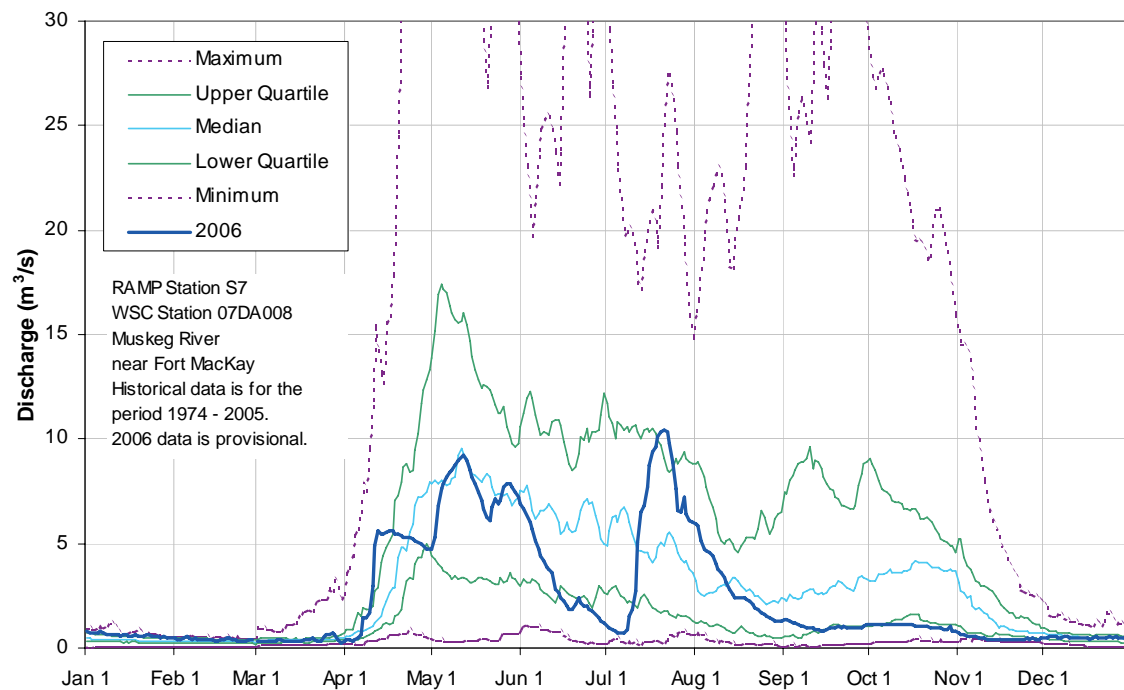


Figure 4.1-8 Historical annual runoff in the MacKay River basin (1974 to 2006).

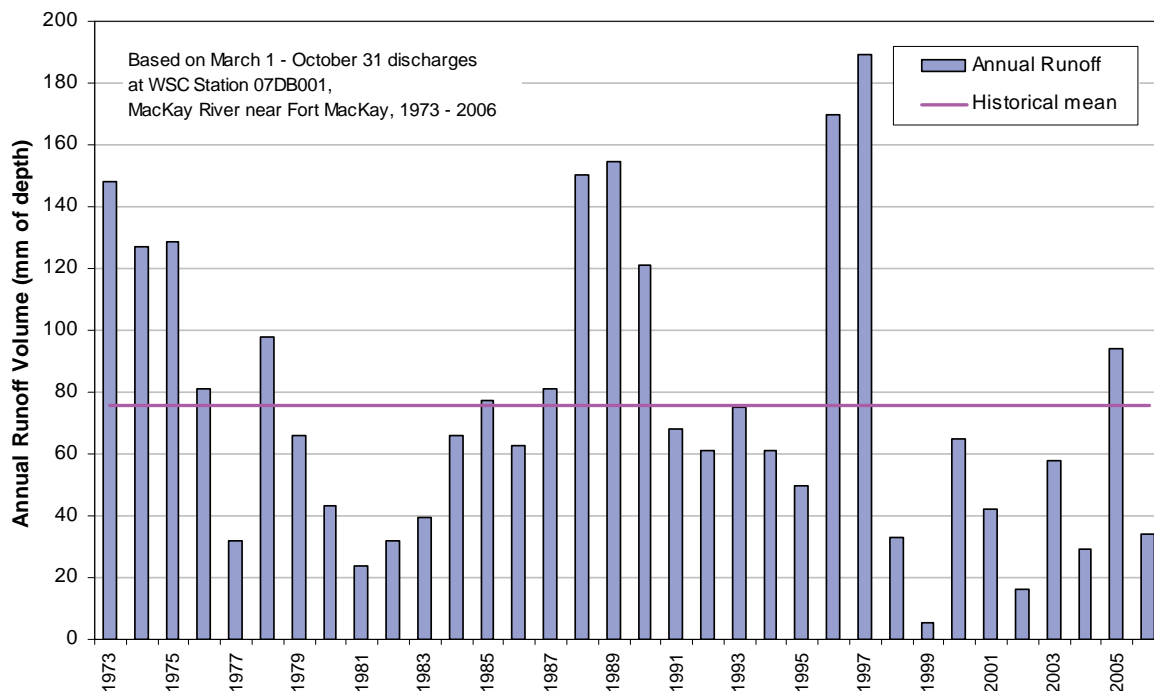


Figure 4.1-9 The 2006 MacKay River hydrograph compared to historical values.

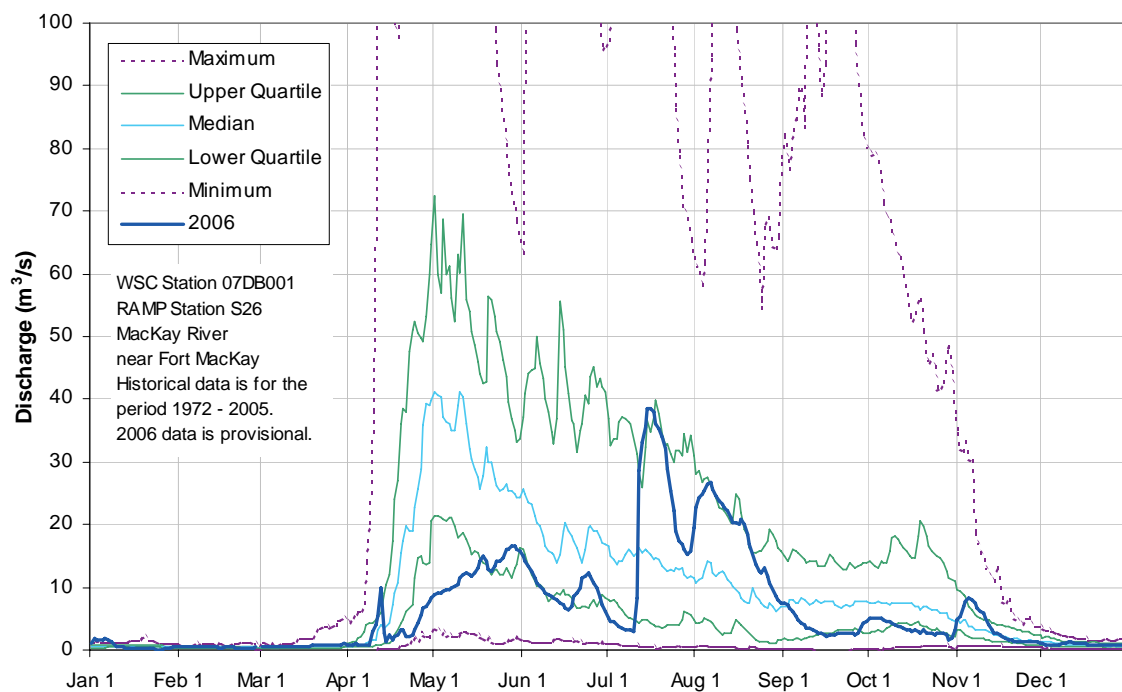


Figure 4.1-10 Historical annual runoff in the Christina River basin (1983 to 2006).

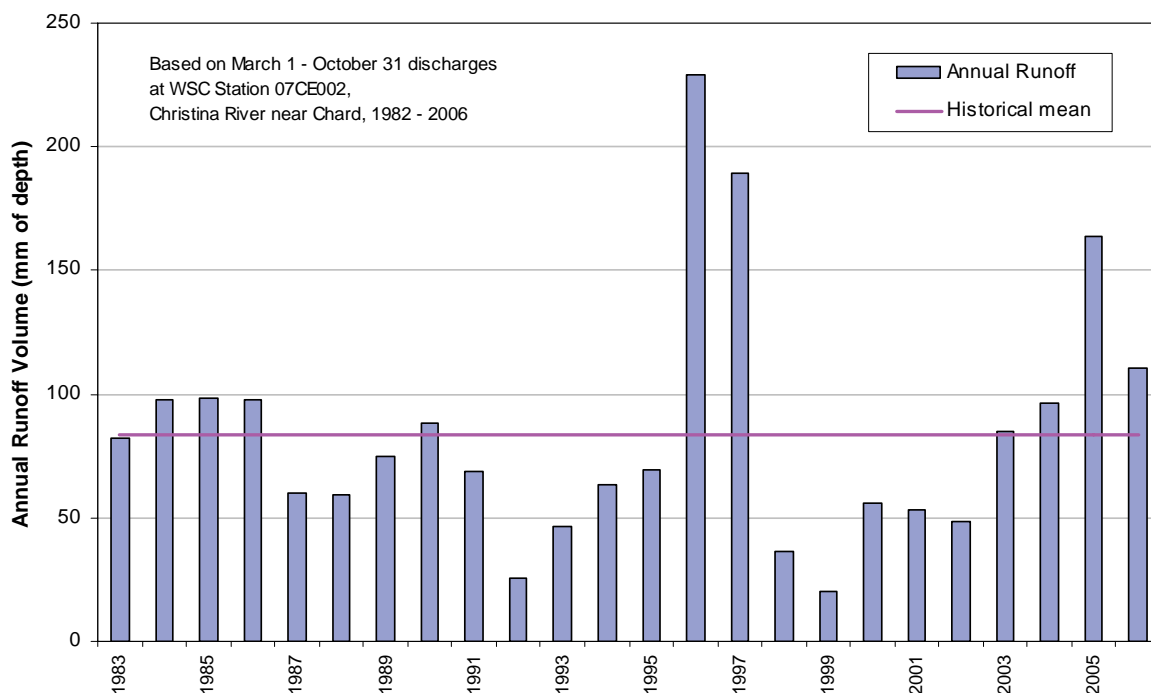


Figure 4.1-11 The 2006 Christina River hydrograph compared to historical values.

