4.0 CLIMATIC AND HYDROLOGIC CHARACTERIZATION OF THE ATHABASCA OIL SANDS AREA IN 2007

The following general description of the 2007 climate and hydrology of the Athabasca oil sands area and comparison with long-term values provides a context for the results of the monitoring activities in RAMP in 2007. The comparison is based primarily on federal and provincial hydrologic monitoring stations because of the long history available for those stations.

Total precipitation at Fort McMurray was below normal in 2007 for the fourth consecutive year, and the least precipitation since 1998. The Environment Canada station Fort McMurray A recorded 302 mm of precipitation during the water year (November 1, 2006 to October 31, 2007) and 307 mm during the calendar year. For comparison, the long-term (since 1944) annual average precipitation at Fort McMurray is 439 mm (Figure 4.1-1). The water year monthly precipitation is compared to average and extreme historical monthly values on Figure 4.1-2. Winter precipitation was near average, but summer precipitation was well below average. Slightly more than normal precipitation occurred in August, but all of the other summer months were much drier than normal.

A more detailed view of the distribution of precipitation throughout the calendar year and across the region is shown on Figure 4.1-3. Higher than average precipitation was recorded from mid-February to mid-March of this year at stations north of Fort McMurray, yet the period of October through December was quite dry throughout the entire region. The largest rainfall event of the year occurred on August 19-22, when 55 mm of rain was recorded at Fort McMurray A, and 74.5 mm at RAMP Station S3 - Iyinimin Creek above Kearl Lake. Precipitation at the stations north of Fort McMurray was higher than at Fort McMurray in February and March. Through the summer, the rainfall recorded at the RAMP stations was fairly consistent, except for the station L1 - McClelland Lake, which recorded significantly more rainfall than the other stations (Figure 4.1-3).

The spring snowpack was above the average of the past four years, and was roughly twice that of 2006, as shown in Table 4.1-1. The snowmelt produced a significant spring freshet peaking in late April or early May. 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, the MacKay River to represent watersheds west of the Athabasca, and the Christina River to reflect conditions south of Fort McMurray.

Annual runoff volume in the Athabasca River basin was near the historical mean of the period of record (Figure 4.1-4). The spring peak runoff in the Athabasca River measured at Water Survey of Canada (WSC) station 07DA001 (Athabasca River below McMurray) was the highest May discharge in the period of record (1957 – 2007, Figure 4.1-5). The river experienced a second peak flow above the upper quartile in June, but subsided in July to lower-quartile levels and remained there for the rest of the summer, recovering to near median values in November and December. As a result, total runoff was the second highest since 1997 (Figure 4.1-4). In the last decade, Athabasca River flow volumes have been above the long-term average only once, in 2005. The 2007 maximum daily discharge of 3,170 m^3/s was 25% higher than the mean annual flood (i.e. the mean of the series of annual maximum daily discharges) of 2,520 m^3/s. The 2007 May - October minimum daily discharge of 119 m^3 was 10% below the historical average of 132 m^3/s.

In the Muskeg River basin, runoff was well below normal, much like 2006, as shown on Figure 4.1-6. The seasonal (Mar - Oct) runoff of 48.4 mm was 40% below the average value of 80.9 mm. Between mid April and mid May the discharge was consistently within the upper quartile, but by early June it fell to the lower quartile and remained there until the rain in mid-August, as shown in Figure 4.1-7. Flows in the early part of August were the lowest recorded for that time of year. A rainy September brought slightly higher than normal flow from early September to early October. The annual maximum daily discharge of 18.7 m^3/s was 25% below the mean annual flood of 25.3 m^3/s, while the minimum March - October discharge of 0.22 m^3/s compared well with the historical average of 0.26 m^3/s.

The seasonal (March – October) runoff in the MacKay River basin was 77.5 mm, close to the historical average of 76.1 mm, as shown on Figure 4.1-8. The runoff volume was the second-highest in the past decade. Most of the runoff occurred in spring, with flows in the upper quartile from mid-April until the end of May, as shown on Figure 4.1-9. The flow for the remainder of the year was near or slightly below normal. The maximum daily discharge of 114 m^3/s was approximately equal to the mean annual flood of 123 m^3/s. The minimum March - October discharge of 0.45 m^3/s was 50% higher than the historical average minimum flow of 0.31 m^3/s.

South of Fort McMurray in the Christina River basin, the 2007 seasonal runoff was 95.2 mm, above average for the fourth consecutive year, as shown on Figure 4.1-10. Spring runoff peaked in late April, and produced the highest April discharges in the 1982 - 2007 period of record. Flows remained within the upper quartile for all of May. For the remainder of the year, flow values were near normal, dipping into the lower quartile in the last half of July. The August rainfall event had a significant effect on the Christina River flow, in contrast to the MacKay and Muskeg Rivers, where it was barely noticeable. The Christina River maximum daily discharge of 104 m^3/s was 30% higher than the mean annual flood of 79.9 m^3/s (Figure 4.1-11). The minimum seasonal discharge of 1.99 m^3/s was slightly lower than the historical average minimum flow of 2.21 m^3/s.

In summary, 2007 began with a wet spring but was relatively dry thereafter, resulting in low summer flows. A significant rainfall event in August had little effect on river flows. Overall, runoff volumes were near normal except in the Muskeg River basin, which was much below normal.

Figure 4.1-1 Historical annual precipitation at Fort McMurray (1946 to 2007).

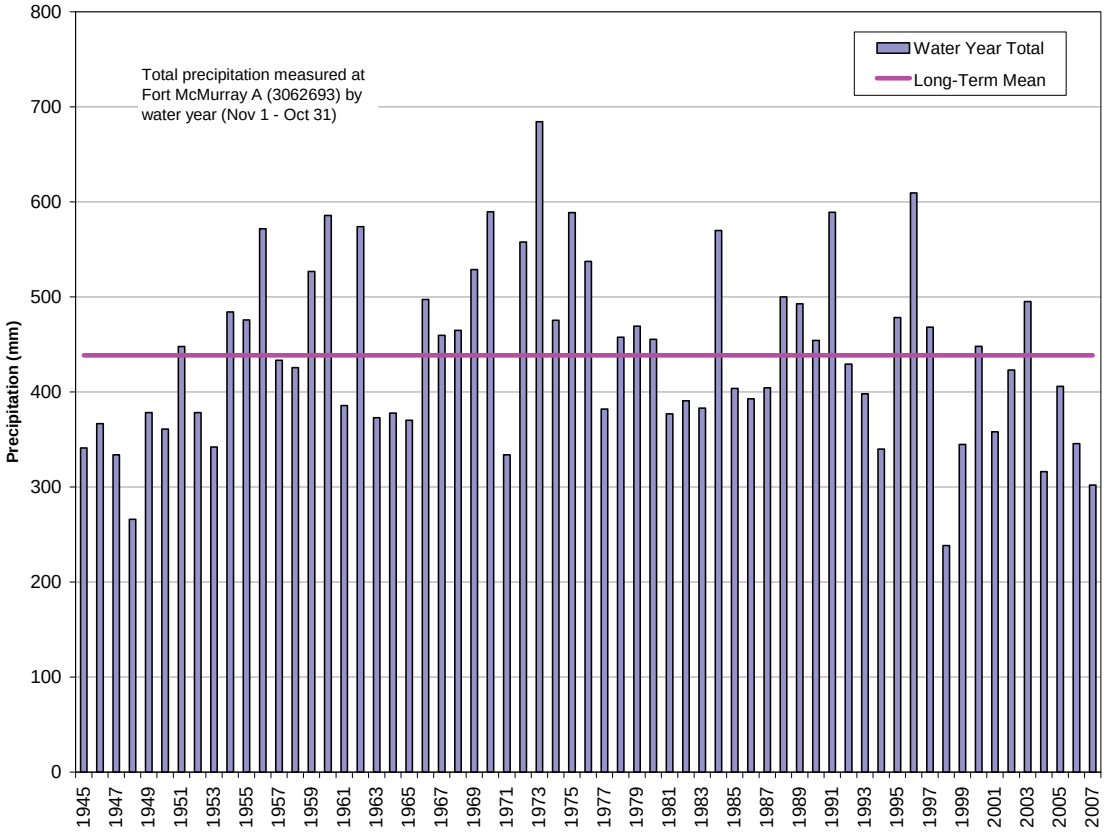

Figure 4.1-2 Monthly precipitation at Fort McMurray in the 2007 water year (November 1, 2006 to October 31, 2007).

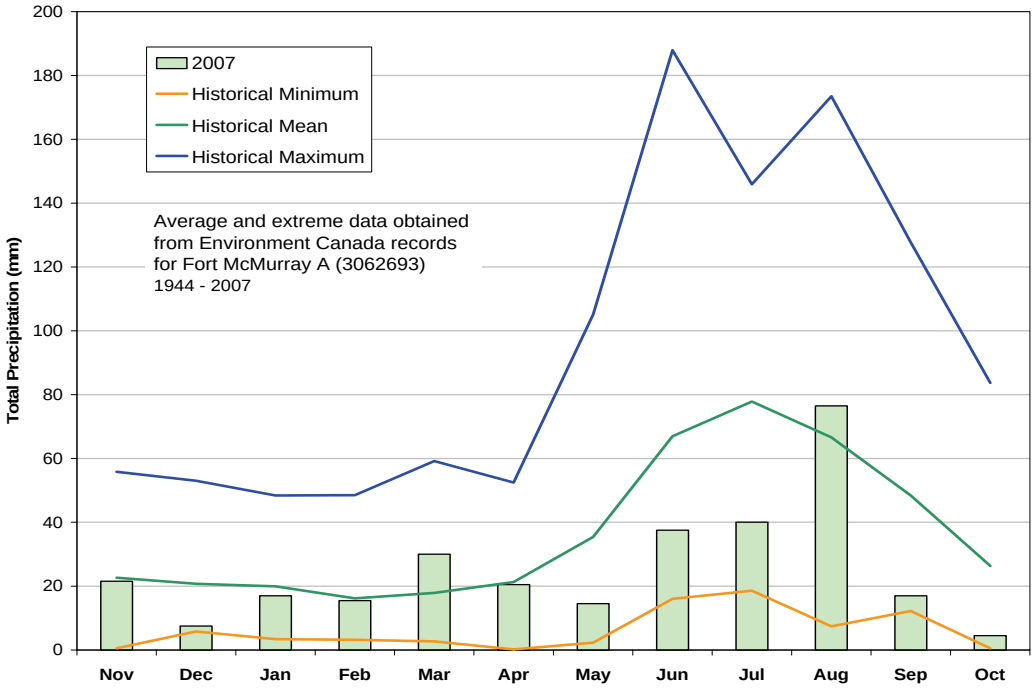

Figure 4.1-3 Cumulative total precipitation at climate stations in the Athabasca oil sands region in 2007.

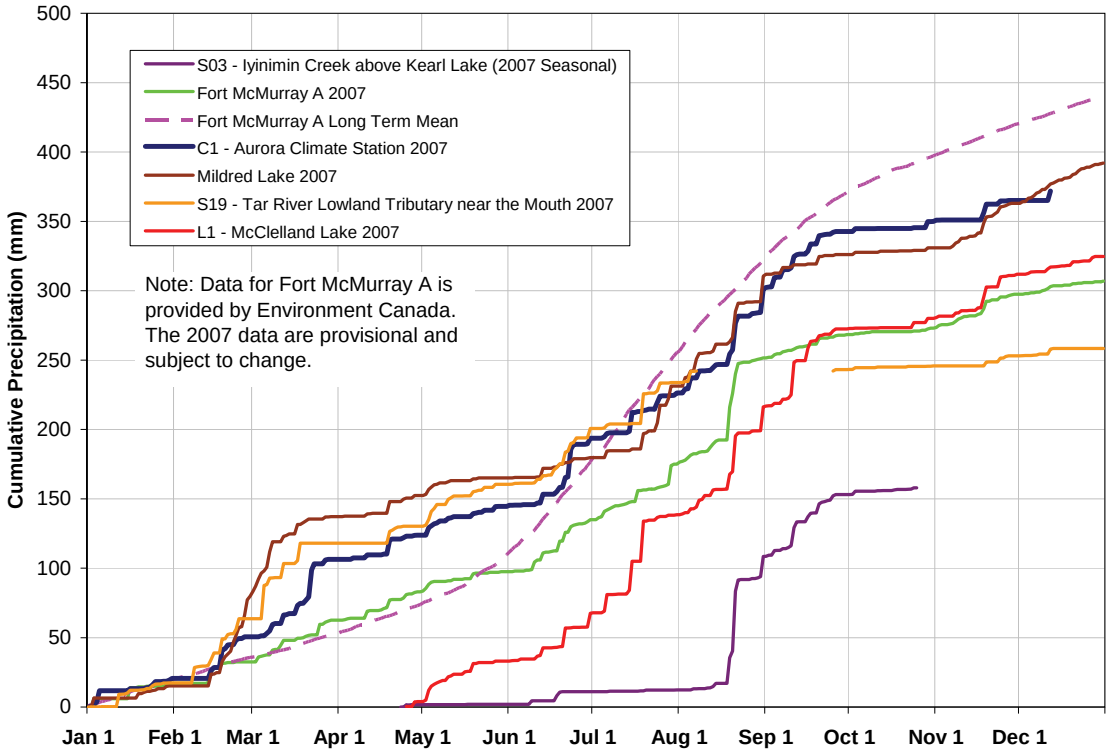

Table 4.1-1 Historical maximum measured snowpack.

Year	Maximum Measured Snowpack (mm water equivalent) in Different Terrain Types[1]			
	Jack Pine	Mixed Deciduous	Flat, Low-Lying	Open Land/Lake
2004	71	58	71	57
2005	108	102	112	75
2006	48	49	49	45
2007	92	98	98	104
Average	80	77	83	70

[1] Terrain types originally defined in Golder (2001) for the Muskeg River watershed. “Open Land” and “Open Lake” have been combined into a single category for the purposes of presentation, but the data are gathered and stored separately.

Data source: RAMP regional snowcourse surveys. Multiple snowcourses were sampled in each terrain type, three times during the winter (usually in February, March and April). The values shown in the table were obtained by averaging the measurements obtained for each terrain type during each month, and then selecting the values for the month with the greatest average water equivalent.

Table 4.1-2 A summary of 2007 streamflow variables compared to historical values measured in the Athabasca oil sands area.

	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 (km^2)	131,000	1,460	5,570	4,851
Period of Record	1957 - 2007	1974 - 2007	1972 - 2007	1982 - 2007
Annual Runoff Depth				
Historical mean (mm)	151	80.9[1]	76.1[1]	85.0[1]
2007 (mm)	146	48.4[1,2]	77.5[1,2]	98.2[1,2]
Annual Maximum Daily Discharge				
Historical mean (m^3/s)	2,520	25.3	123	79.9
2007 (m^3/s)	3,170	18.7	114	104
Annual Minimum Daily Discharge[1]				
Historical mean (m^3/s)	132	0.26	0.31	2.21
2007 (m^3/s)	119	0.22	0.45	1.99

[1] March 1 to October 31.

[2] 2007 data is incomplete.

Figure 4.1-4 Historical annual runoff in the Athabasca River basin (1970 to 2007).

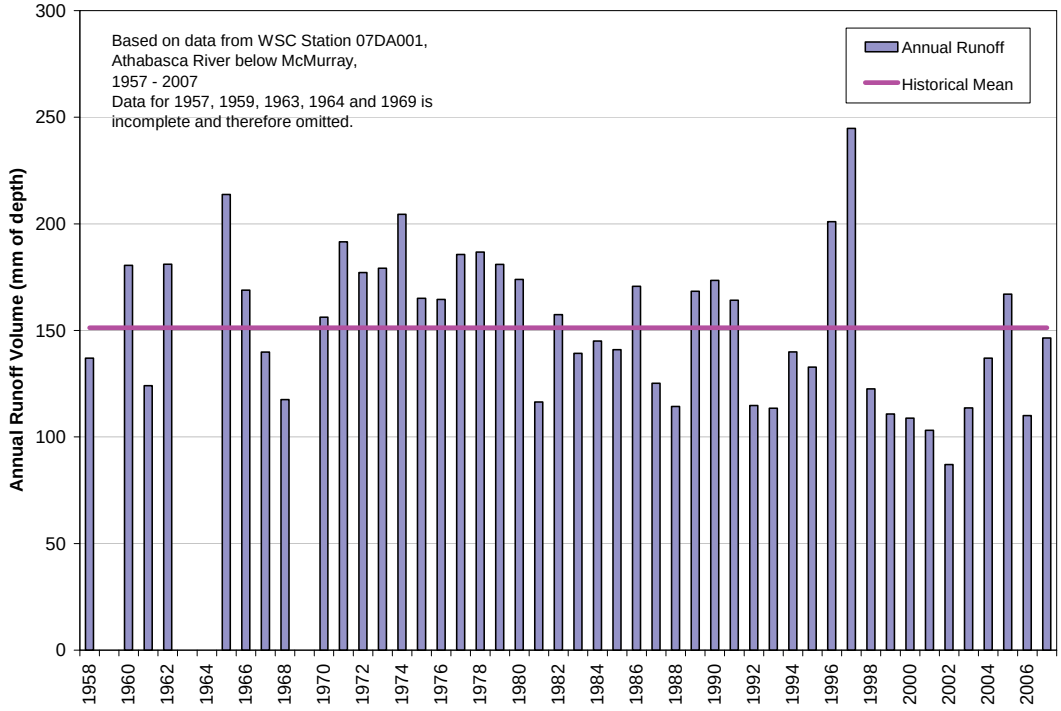

Figure 4.1-5 The 2007 Athabasca River hydrograph compared to historical values.

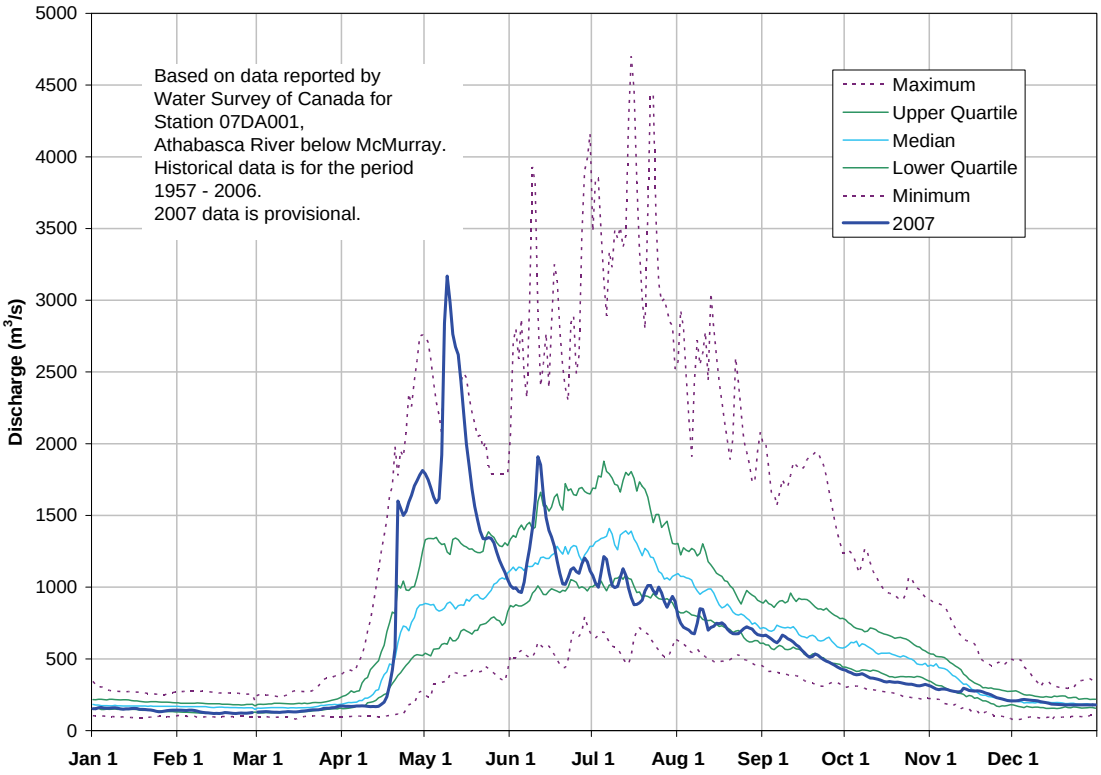

Figure 4.1-6 Historical annual runoff in the Muskeg River basin (1974 to 2007).

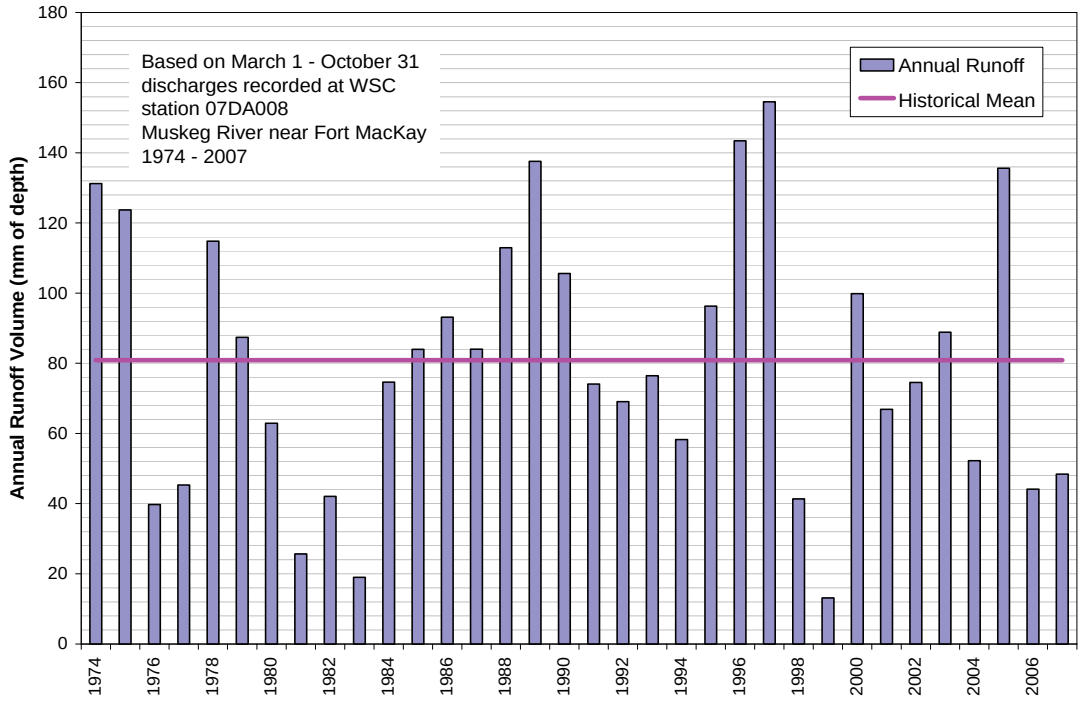

Figure 4.1-7 The 2007 Muskeg River hydrograph compared to historical values.

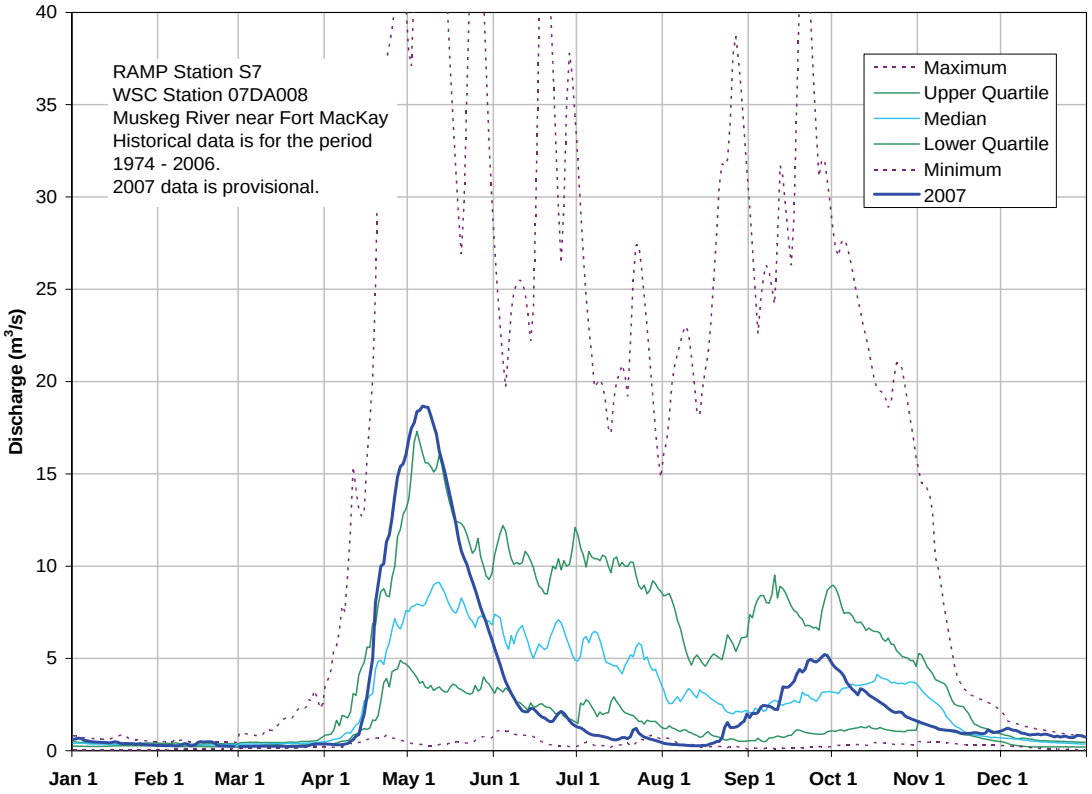

Figure 4.1-8 Historical annual runoff in the MacKay River basin (1973 to 2007).

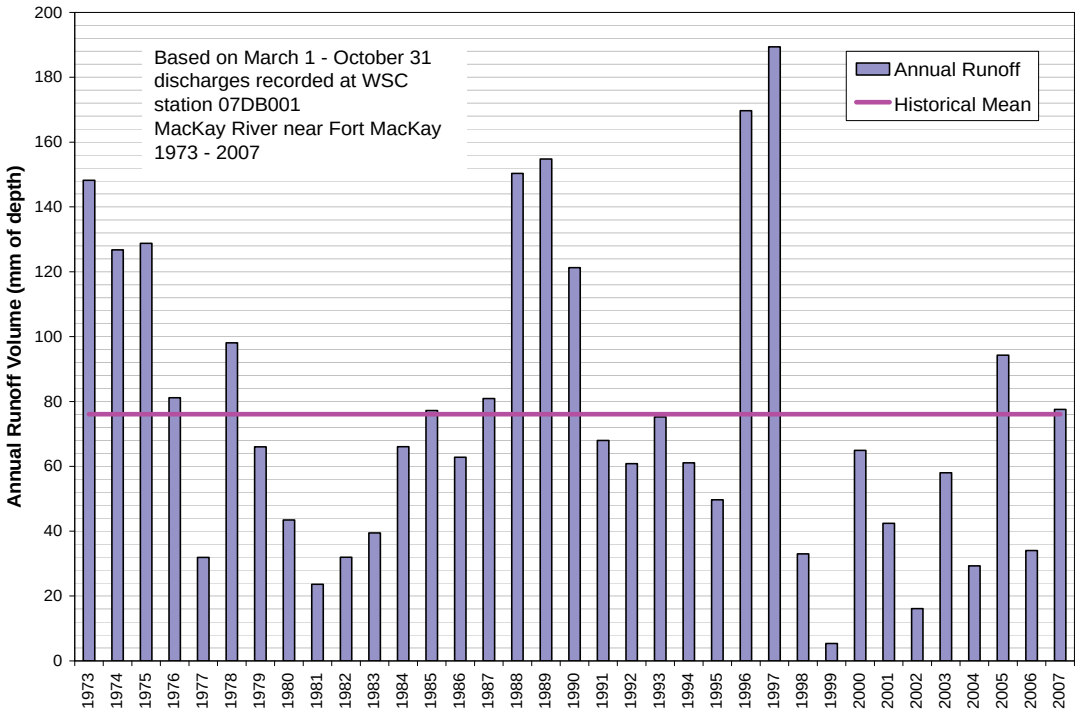

Figure 4.1-9 The 2007 MacKay River hydrograph compared to historical values.

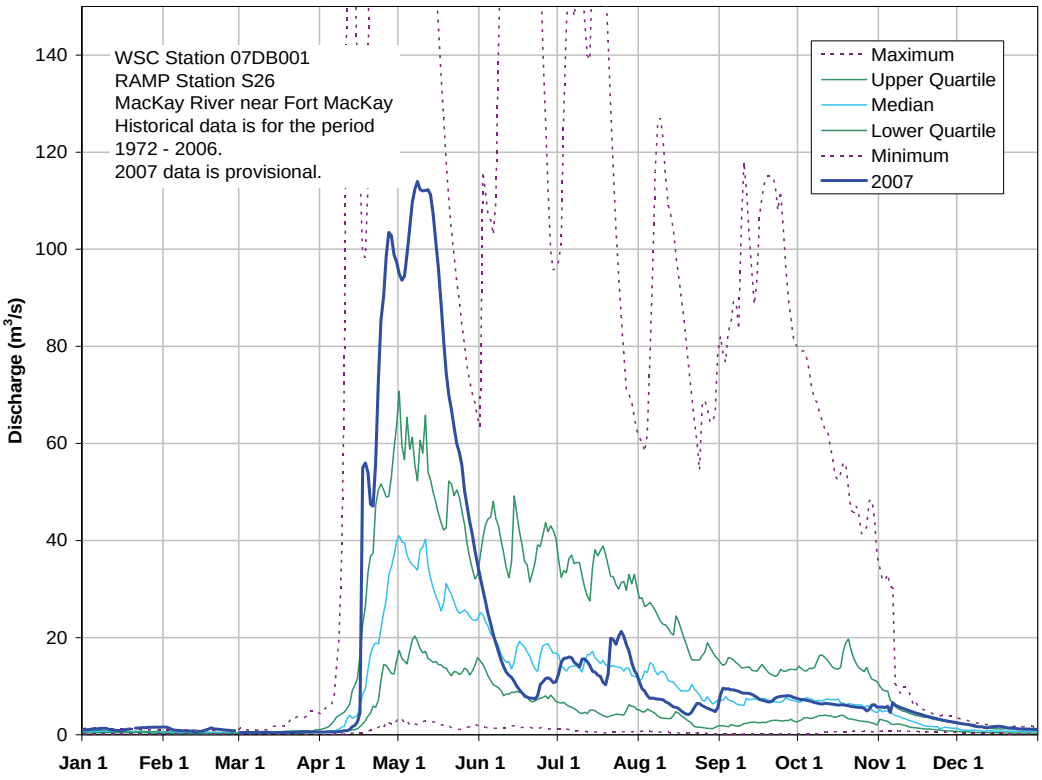

Figure 4.1-10 Historical annual runoff in the Christina River basin (1982 to 2007).

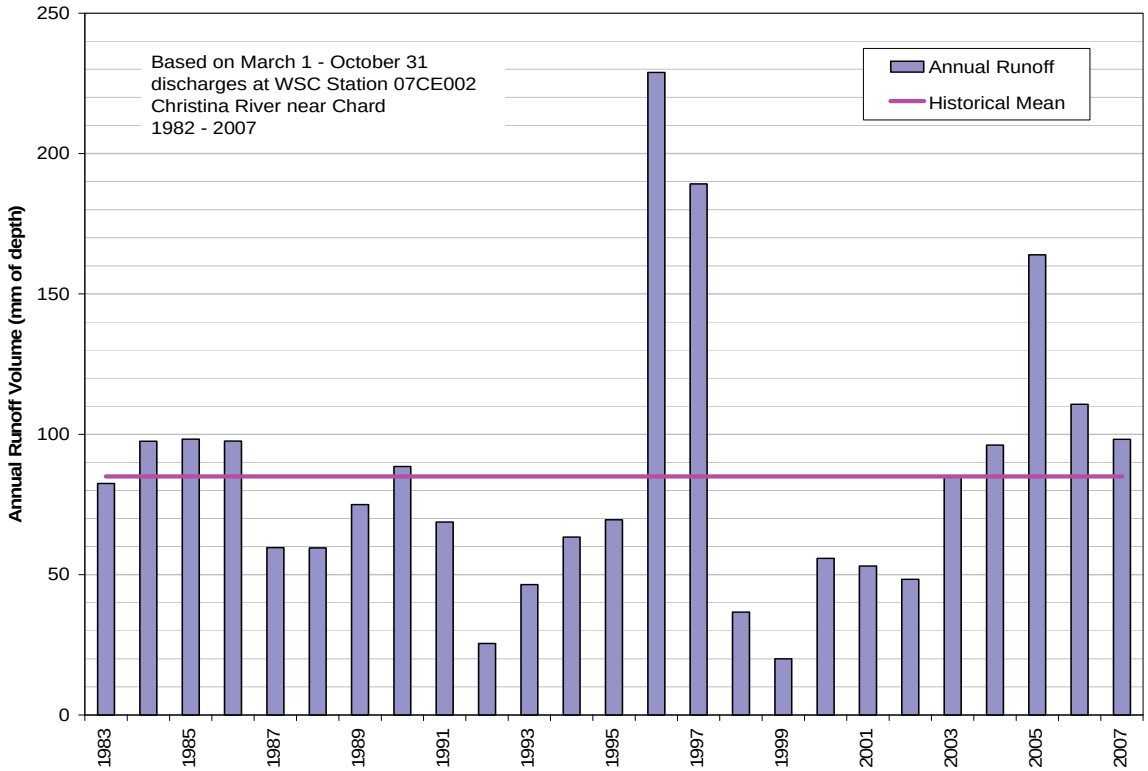

Figure 4.1-11 The 2007 Christina River hydrograph compared to historical values.