base of the Oldman Aquifer (HCL, Dec 1998). In September 1999, the water test hole was subsequently licensed as a water source well to divert 80 m^3/day.

An extended aquifer test conducted with a water test hole completed in the Oldman Aquifer for the Village of Consort has a long-term yield of 250 m^3/day (Pretula, 1981). The Village is licensed to divert up to 330 m^3/day from three water supply wells completed in the Oldman Aquifer in 15-035-06 W4M.

c) Quality

The groundwaters from the Oldman Aquifer are mainly a sodium-sulfate type (see CD-ROM). The TDS concentrations are mainly more than 1,000 mg/L. The sulfate concentrations are mainly more than 500 mg/L in the eastern part of the project area. Chloride concentrations in the groundwaters from the Oldman Aquifer are mainly less than 250 mg/L in the eastern part of the project area. The TDS and chloride concentrations in the western part of the project area tend to be higher because of the depth of burial of the Oldman Formation.

The groundwater from the Best Pacific water source well is a sodium-chloride type water with TDS of 3,257 mg/L; the sulfate concentration was less than 1 mg/L and the chloride concentration was 1,821 mg/L (HCL, December 1998).

The TDS concentration in the groundwater from a Village of Consort water supply well completed in the Oldman Aquifer was 1,230 mg/L; the sulfate concentration was 10 mg/L and the chloride concentration was 124 mg/L (Pretula, 1981). The chemical data from a second groundwater sample collected and analyzed in 1986 indicated no significant changes in the chemical quality of the groundwater quality had occurred over five years.

8) Birch Lake Aquifer

The Birch Lake Aquifer comprises the porous and permeable parts of the Birch Lake Member. Structure contours have been prepared for the top and bottom of the Member, which underlies all of the project area. The structure contours show the Member is generally less than 80 metres thick.

a) Depth to Top

The depth to the top of the Birch Lake Member ranges from less than 50 metres below ground level where the Member subcrops in the vicinity of the Buried Calgary Valley to more than 550 metres below ground level in the west-central part of the project area.

b) Apparent Yield

There are 23 apparent yield control points in the project area from the groundwater database. More than 40% of the control points for individual water wells completed through the Birch Lake Aquifer have apparent yields of more than 100 m³/day. However, all of the control points are from areas where the depth to the top of the Member is less than 200 metres. In areas where the depth of burial is more than 200 metres, water well yields may be less than 100 m³/day. Also, in the western part of the area, the Birch Lake Aquifer is part of a continental sequence of sediments and water-well yields would be more variable and mainly less than 50 m³/day.

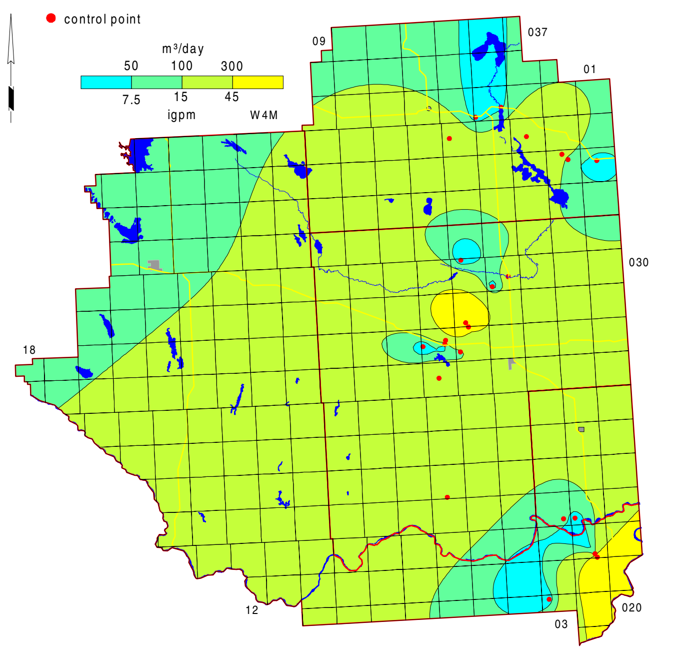

Figure 25. Apparent Yield for Water Wells Completed through Birch Lake Aquifer

c) Quality

The groundwaters from the Birch Lake Aquifer have no dominant chemical type; however, sodium is the main cation (see CD-ROM). The TDS concentrations for groundwaters from the Birch Lake Aquifer range from less than 1,000 to more than 2,000 mg/L. The lower values of TDS occur mainly in the western part of the project area, which could be a result of the gridding procedure used to process a limited number of data points. When TDS values in the groundwaters from the Birch Lake Aquifer exceed 1,200 mg/L, the sulfate concentrations exceed 400 mg/L.

The chloride concentrations of the groundwaters from the Birch Lake Aquifer range from less than 10 to more than 250 m³/day; more than 60% of the control points have chloride concentrations of more than 250 mg/L.

VI. Groundwater Budget

A. Hydrographs

There are 19 locations in the project area where water levels are being measured and recorded with time. These sites are observation water wells (Obs WWs) that are part of the AE regional groundwater-monitoring network. These 19 Obs WWs are in ten different parts of the project area as shown on the adjacent map. Five of the hydrographs discussed in the text below are included in Appendix A; hydrographs for the other 14 AE Obs WWs are included on the CD-ROM.

Water-level data are available from 19 observation water wells. Of the 19 data sets, 17 extend over a time interval of eight to 14 years, with the remaining two records being for 32 years. There is no obvious trend in the water-level fluctuations in all of the AE observation water wells. The type of water-level fluctuations has been placed in seven groups as shown in the table below.

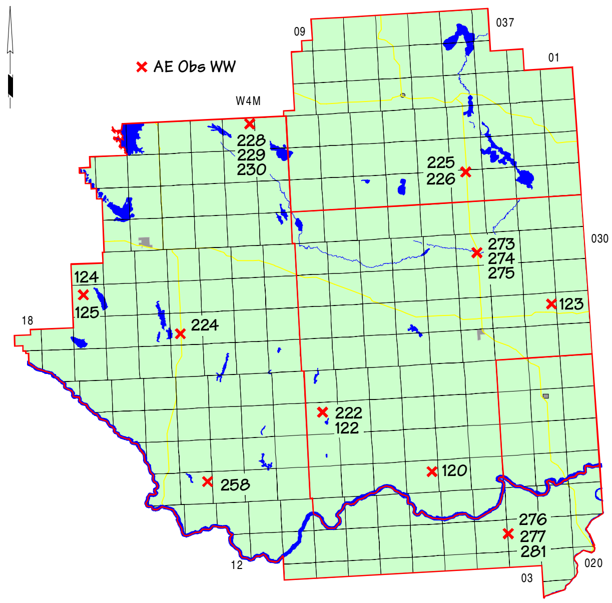

Figure 26. Observation Water Well Locations

Number of Data Sets	General Description of Water-level Change	Type of Aquifer Bedrock	Surficial
2	Unreliable record	1	1
8	Not much change	2	6
3	General decline	2	1
2	Annual fluctuation	1	1
2	Multi-year fluctuation	1	1
1	Recovering	0	1
1	Rising	1	0

Table 7. Water-Level Fluctuations in AE Obs WWs

The eight data sets indicated in the adjacent table with *not much change* in water level generally have fluctuations of less than 0.25 metres over the entire length of the record.

Two observation water wells, AE Obs WW Nos. 225 and 274, are completed in aquifers in the bedrock. AE Obs WW No. 225 is completed in the Oldman Aquifer and AE Obs WW No. 274 is completed in the Birch Lake Aquifer. There has been a *general decline* in water level in these two observation water wells. The Obs WWs are located in the eastern part of the study area and are less than 30 kilometres apart. There is no apparent reason for the water-level declines, which are between 0.5 and 0.6 metres. The only other recorded water-level decline is in AE Obs WW No. 281 (see CD-ROM), completed in surficial deposits near the Red Deer River; this decline is 0.4 metres over the nine years of the water-level record.

The water levels in two observation water wells, AE Obs WW Nos. 229 and 230, show a "typical" *annual fluctuation* as illustrated in the adjacent graph. The water level rises in late spring/early summer and then declines until the next late spring/early summer. This type of fluctuation is associated with recharge to the aquifer as the frost leaves the ground, with there being no recharge during the remainder of the year. When there is no recharge, the water level gradually declines. Both of the observation water wells are at the same site near Kirkpatrick Lake in the northwestern part of the study area.

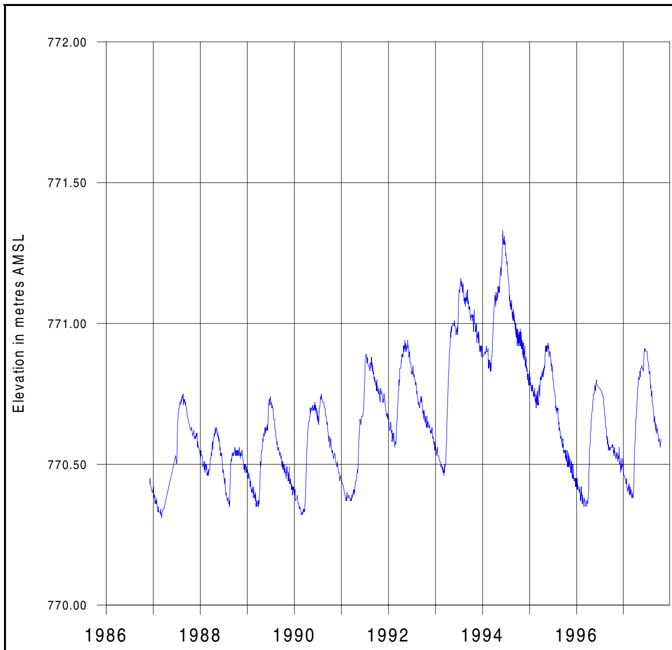

Figure 27. AE Obs No. 229 - Hydrograph

The water-level records that show a *multi-year fluctuation* involve a water-level change of less than one metre. This condition occurs in AE Obs WW Nos. 123 and 273 (see CD-ROM) in the east-central part of the study area; these observation water wells are less than 30 kilometres apart. The reason for the multi-year changes is not understood.

The water-level record in AE Obs WW No. 224 (see CD-ROM) that is designated in Table 7 as *recovering* is close to the Hamlet of Sheerness and may be responding to a cessation of pumping at a nearby site. After the water level recovered, there was *not much change*.

AE Obs WW No. 125 (see CD-ROM) located at the western limit of the study area and completed in a bedrock aquifer was the only location where a *rise* in water level was recorded over the entire monitoring interval. The water-level rise is close to one metre over 32 years. Half of the water-level rise occurred between 1970 and 1976.

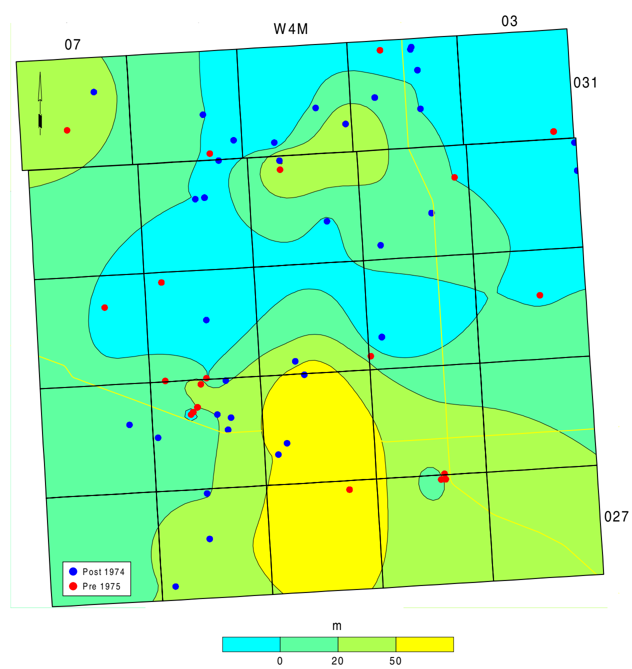

Figure 28. Water-Level Lowering in the Oldman Aquifer

In a 25-township area that includes townships 027 to 031, ranges 03 to 07, W4M, there are records for 76 water wells that are completed at a depth of greater than 90 metres. These water wells are mainly completed in the Oldman Aquifer and have a value for NPWL. Of the 76 water wells, 34 were completed before 1975 and 42 were completed after 1974. The elevations of the NPWLs in the 42 water wells drilled after 1974 are between 30 metres higher and 84 metres lower than the elevations of the non-pumping water levels in the water wells drilled before 1975. Unfortunately, there is no more than one water level associated with each water well. The adjacent map shows the result of subtracting the elevations of the water levels in the post-1974 water wells from the pre-1975 water-level elevations. This water-level decline may be a result of limited recharge to the bedrock aquifers.