

### 5.3.9 Middle Horseshoe Canyon Aquifer

The Middle Horseshoe Canyon Aquifer comprises the permeable parts of the Middle Horseshoe Formation that underlie the Upper Horseshoe Canyon Formation, and subcrops under the surficial deposits. Structure contours have been prepared for the top of the Formation, which underlies most of the County. The structure contours show the Middle Horseshoe Canyon Formation ranges in elevation from less than 600 to more than 880 metres AMSL and has an average thickness of 70 metres. The non-pumping water level in the Middle Horseshoe Canyon Aquifer is downgradient to the north toward the Rosebud River and toward the Bow River in the southern part of the County.

#### 5.3.9.1 Depth to Top

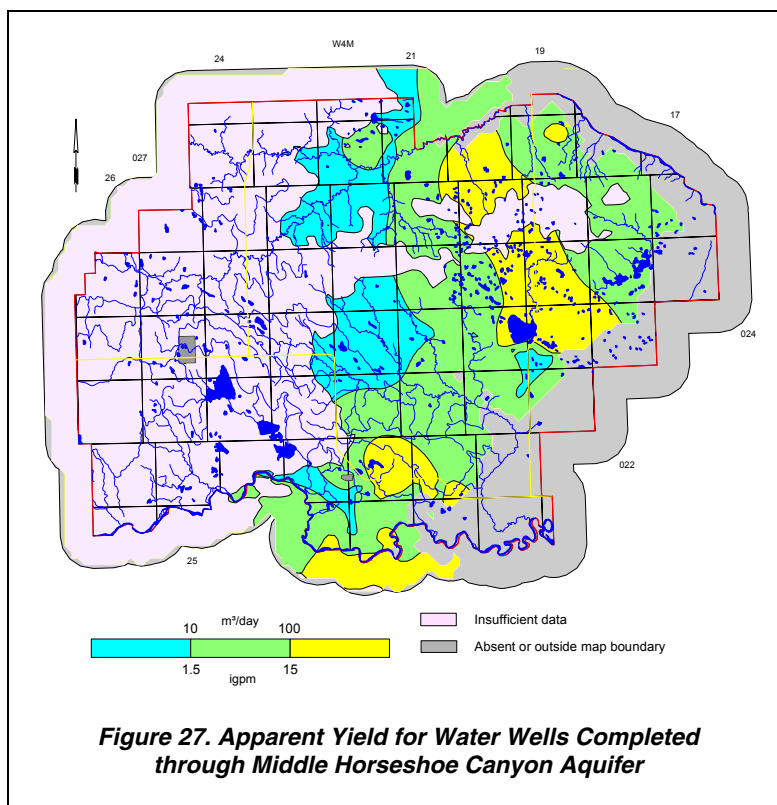
The depth to the top of the Middle Horseshoe Canyon Formation is variable, ranging from less than ten metres at the eastern extent to more than 350 metres in the western part of the County (page A-49).

#### 5.3.9.2 Apparent Yield

The apparent yields for individual water wells completed through the Middle Horseshoe Canyon Aquifer range mainly from 10 to 100 m<sup>3</sup>/day, with more than 70% of the values being greater than ten m<sup>3</sup>/day.

In the County, there are 15 licensed water wells completed in the Middle Horseshoe Canyon Aquifer, for a total authorized diversion of 147 m<sup>3</sup>/day; the highest single diversion of 43.9 m<sup>3</sup>/day is for a County of Wheatland water supply well in 16-14-027-22 W4M used for municipal purposes. This water supply well is presumably licensed to divert groundwater for the Hamlet of Redland, but this water supply well could not be linked to a water well in the AENV groundwater database. Thirteen of the fifteen licensed water wells could be linked to a water well in the AENV groundwater database.

Six water test holes were drilled in 1982 for Dynamar Energy Ltd. in sections 10, 15, and 22, township 027, range 20, W4M. The main source of groundwater supply was expected to come from shallow sand and gravel deposits associated with the buried bedrock valley; however, because a significant quantity of clay-size particles were encountered during the drilling, five of the six water test holes were drilled deeper and were completed in the Middle Horseshoe Canyon Aquifer. Of the five water test holes completed in the Middle Horseshoe Canyon, two did not have sufficient groundwater entering each of the water test holes to conduct an aquifer test. Extended aquifer tests conducted with the remaining three water test holes indicated long-term yields ranging from less than 60 to more than 165 m<sup>3</sup>/day. The water test hole having the highest long-term yield is in 06-15-027-20 W4M (WTH Ni, 6-82) and was completed from 13.5 to 21.5 metres below ground surface in the Middle Horseshoe Canyon Aquifer (HCL, November 1982).



**Figure 27. Apparent Yield for Water Wells Completed through Middle Horseshoe Canyon Aquifer**

### 5.3.9.3 Quality

The groundwaters from the Middle Horseshoe Canyon Aquifer are mainly a sodium-bicarbonate or sulfate type (see Piper diagram on CD-ROM). Total dissolved solids concentrations range mainly between 500 and 1,000 mg/L, with only two values of TDS being less than 500 mg/L. The sulfate concentrations range mainly between 100 and 500 mg/L. Eighty percent of the chloride concentrations from the Middle Horseshoe Canyon Aquifer are less than 100 mg/L. The areas showing water wells with elevated fluoride concentrations are mainly associated with the edge of the Aquifer.

The groundwater from a water test hole in 14-10-027-20 W4M is a sodium-bicarbonate type, having a TDS concentration of 1,038 mg/L, a sulfate concentration of 160 mg/L, a chloride concentration of 21 mg/L, and a fluoride concentration of 0.45 mg/L (HCL, November 1982).

The minimum, maximum and median concentrations of TDS, sodium, sulfate, chloride and fluoride in the groundwaters from water wells completed in the Middle Horseshoe Canyon Aquifer in the County have been compared to the SGCDWQ and median concentrations from all upper bedrock aquifer(s) in the adjacent table. Of the five constituents that have been compared to the SGCDWQ, the median values of **TDS** and **sodium** exceed the guidelines. The median concentrations of TDS, sodium and chloride from water wells completed in the Middle Horseshoe Canyon Aquifer are greater than the median concentrations from water wells completed in all upper bedrock aquifer(s).

Constituent	No. of Analyses	Range for County in mg/L			All Bedrock Median	Recommended Maximum Concentration SGCDWQ
		Minimum	Maximum	Median		
Total Dissolved Solids	165	99	4160	1304	1069	500
Sodium	106	18	1275	460	350	200
Sulfate	162	0	2049	183	285	500
Chloride	164	0	1100	22	13	250
Fluoride	149	0	2	0.4	0.7	1.5

Concentration in milligrams per litre unless otherwise stated  
 Note: indicated concentrations are for Aesthetic Objectives except for Fluoride, which is for Maximum Acceptable Concentration (MAC)  
 SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality  
 Federal-Provincial Subcommittee on Drinking Water, March 2001

**Table 13. Apparent Concentrations of Constituents in Groundwaters from Middle Horseshoe Canyon Aquifer**

### 5.3.10 Lower Horseshoe Canyon Aquifer

The Lower Horseshoe Canyon Aquifer comprises the permeable parts of the Lower Horseshoe Canyon Formation that underlie the Middle Horseshoe Canyon Formation, and subcrops under the surficial deposits. Structure contours have been prepared for the top of the Formation. The structure contours show the Lower Horseshoe Canyon Formation ranges in elevation from less than 475 to more than 850 metres AMSL and has an average thickness of 170 metres. The non-pumping water level in the Lower Horseshoe Canyon Aquifer is downgradient to the north toward the Red Deer River and toward the Bow River in the southern part of the County.

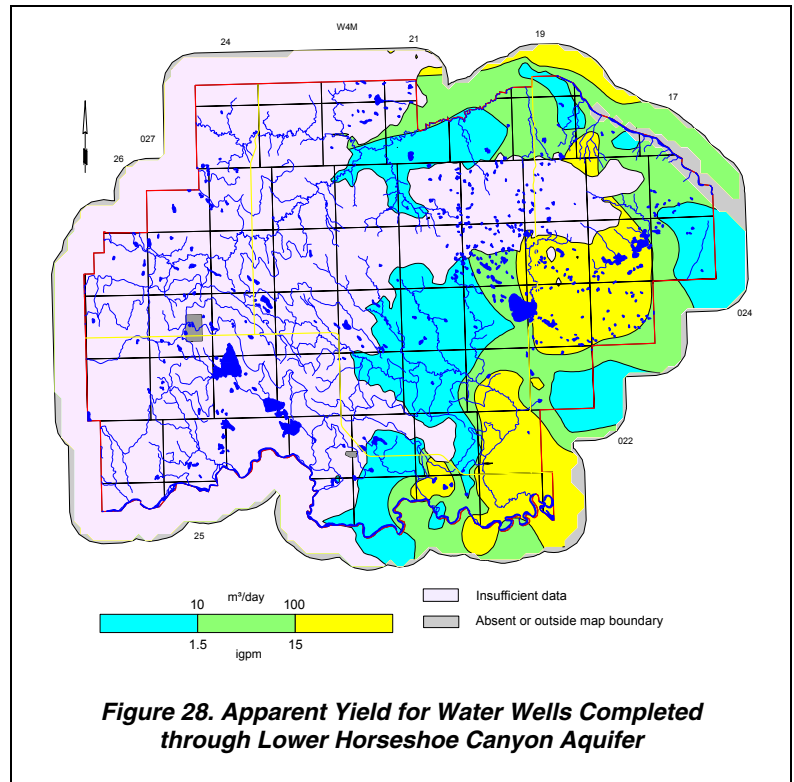
#### 5.3.10.1 Depth to Top

The depth to the top of the Lower Horseshoe Canyon Formation is variable, ranging from less than ten metres at the eastern extent, to more than 500 metres in the western part of the County (page A-52).

#### 5.3.10.2 Apparent Yield

The apparent yields for individual water wells completed through the Lower Horseshoe Canyon Aquifer range mainly from 10 to 100 m<sup>3</sup>/day, with more than 85% of the values being greater than ten m<sup>3</sup>/day.

In the County, there are eight licensed water wells completed in the Lower Horseshoe Canyon Aquifer, for a total of 176 m<sup>3</sup>/day. For one of the eight licensed groundwater users, no amount has been assigned to this water well and is possibly being used as a standby water well. The remaining seven licensed water wells are for Hutterian Brethren Colonies; five water wells are licensed to Sunshine Colony and two are licensed to the Ridgeland Colony. Of the five Sunshine Colony water supply wells, four are in section 17-024-18 W4M and are licensed to a total of 80.3 m<sup>3</sup>/day, for both agricultural and municipal purposes. The two Ridgeland Colony water supply wells are in 14-05-025-17 W4M and are licensed to divert a total of 101.3 m<sup>3</sup>/day for agricultural and municipal purposes. Six of the eight licensed water wells could be linked to a water well in the AENV groundwater database.



**Figure 28. Apparent Yield for Water Wells Completed through Lower Horseshoe Canyon Aquifer**

### 5.3.10.3 Quality

The groundwaters from the Lower Horseshoe Canyon Aquifer are mainly a sodium-bicarbonate type (see Piper diagram on CD-ROM). Total dissolved solids concentrations are mainly greater 500 mg/L, with only three TDS concentrations being less than 500 mg/L. The sulfate concentrations range mainly between 100 and 500 mg/L. Ninety percent of the chloride concentrations from the Lower Horseshoe Canyon Aquifer are less than 100 mg/L. The fluoride concentrations in the Lower Horseshoe Canyon Aquifer are expected to be more than 1.0 mg/L where the depth to top of the Lower Horseshoe Canyon Aquifer is mainly less than 50 metres below ground surface.

Constituent	No. of Analyses	Range for County in mg/L			All Bedrock Median	Recommended Maximum Concentration SGCDWQ
		Minimum	Maximum	Median		
Total Dissolved Solids	89	14	3742	1088	1069	500
Sodium	55	0	1240	328	350	200
Sulfate	88	0	1961	152	285	500
Chloride	89	0	924	14	13	250
Fluoride	79	0	1	0.3	0.7	1.5

Concentration in milligrams per litre unless otherwise stated  
 Note: indicated concentrations are for Aesthetic Objectives except for Fluoride, which is for Maximum Acceptable Concentration (MAC)  
 SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality  
 Federal-Provincial Subcommittee on Drinking Water, March 2001

**Table 14. Apparent Concentrations of Constituents in Groundwaters from Lower Horseshoe Canyon Aquifer**

The minimum, maximum and median concentrations of TDS, sodium, sulfate, chloride and fluoride in the groundwaters from water wells completed in the Lower Horseshoe Canyon Aquifer in the County have been compared to the SGCDWQ and median concentrations from all upper bedrock aquifer(s) in the adjacent table. Of the five constituents that have been compared to the SGCDWQ, the median values of **TDS** and **sodium** exceed the guidelines. The median concentrations of TDS and chloride from water wells completed in the Lower Horseshoe Canyon Aquifer are greater than the median concentrations from water wells completed in all upper bedrock aquifer(s).

## 6. Groundwater Budget

### 6.1 Hydrographs

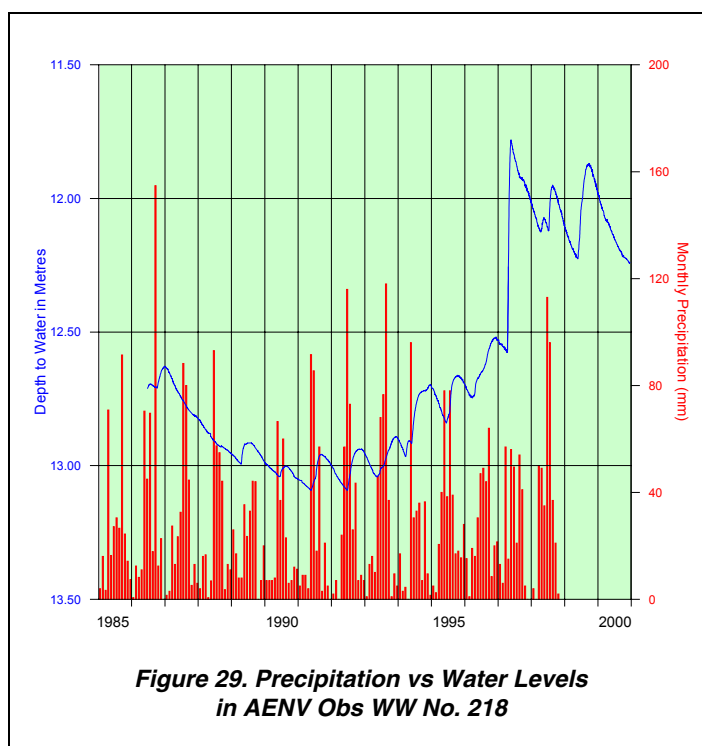
In the County, there are three observation water wells that are part of the AENV regional groundwater-monitoring network. These are locations where water levels are being measured and recorded as a function of time: AENV Obs Water Well Nos. 218 and 219 are in 05-10-022-21 W4M near Cluny, and AENV Obs WW No. 220 is in 13-06-022-25 W4M near Carseland (see Figure A-57).

AENV Obs WW No. 218 is completed open hole from 64.0 to 72.5 metres below ground surface in multiple bedrock aquifers within the Horseshoe Canyon Formation. AENV Obs WW No. 219 is completed from 12.5 to 14.3 metres below ground surface in both the Upper Sand and Gravel Aquifer and the Upper Horseshoe Canyon Aquifer. Groundwater monitoring data for AENV Obs WW No 218 are available from mid-1986 to mid-1997, and from mid-1986 to the end of 2000 for AENV Obs WW No. 219.

The adjacent hydrograph shows annual cycles of recharge and decline throughout the year. In an area where there are no expected seasonal uses of groundwater, the highest water level will usually occur in late spring/early summer and the lowest water level will be in late winter/early spring. The highest water levels in AENV Obs WW Nos. 218 and 219 generally occur in the late fall/early winter and the lowest water levels generally occur in the spring (see Figure A-58). Overall annual fluctuations in AENV Obs WW No. 218 mainly range from 0.1 to 0.3 metres. In 1997, the water level rose from a low of 12.58 metres in March to a high of 11.78 metres below ground surface in May. From 1987 to 1991, there has been a net decline in the water level of approximately 0.4 metres.

The water-level fluctuations in AENV Obs WW No. 218 in 05-10-022-21 W4M have been compared to the precipitation measured at the Gleichen weather station. In 1987 and 1988, there were no annual cycles of recharge in response to a decrease in precipitation. In 1989 and 1990, the rise in water level in late spring/early summer could be associated with recharge when the frost leaves the ground. From 1991 to 1996, the rise in water level late in the year could be associated with excess precipitation after most vegetation has been killed by frost and before the ground froze. The water-level rise in March 1997 may be a calibration adjustment of the water-level recorder.

The closest licensed groundwater users to AENV Obs WW Nos. 218 and 219 are in sections 07 and 08, township 022, range 20, W4M, six kilometres to the west. In this area, there are 11 licensed groundwater users. All 11 groundwater licences are held by the Cluny Hutterite Colony, and since 1997 have been authorized to divert up to 190 m<sup>3</sup>/day for exploration purposes. There is no completion information available in the AENV licensed database for the Cluny Hutterite Colony water wells; however, completion data are available in the AENV groundwater database for the Cluny Hutterite Colony water wells in sections 07 and 08, township 022, range 20, W4M, all of which are completed in the Lower Horseshoe Canyon Aquifer.

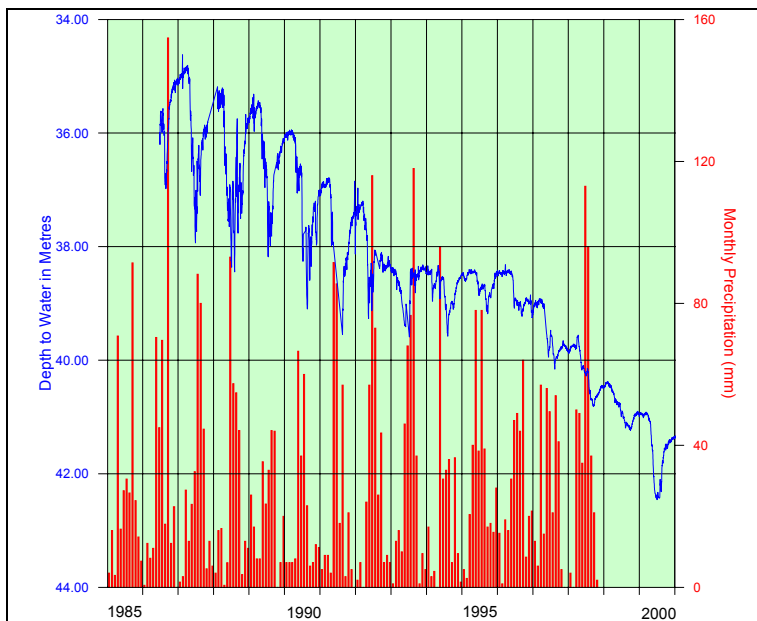


**Figure 29. Precipitation vs Water Levels  
in AENV Obs WW No. 218**

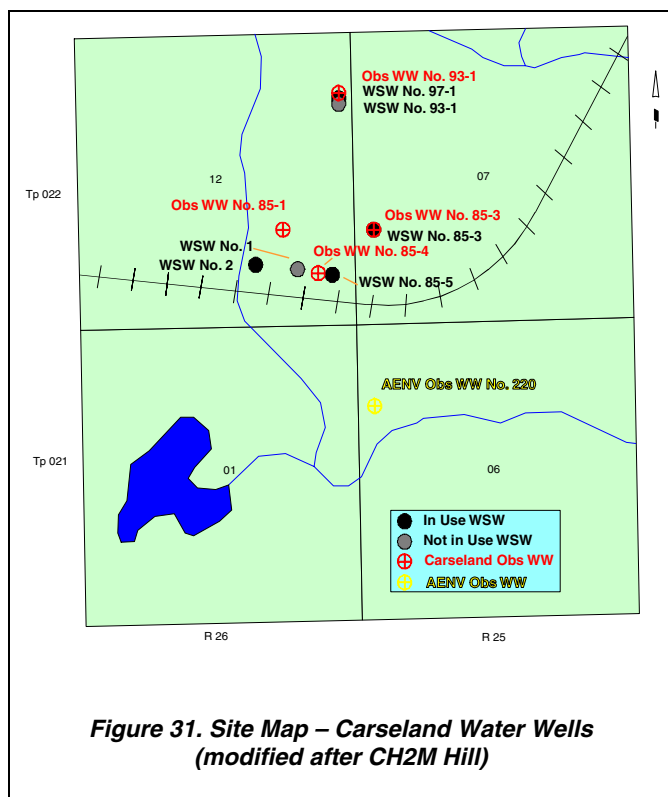
It does not appear that groundwater diversion from the Cluny Hutterite Colony water wells is having an effect on the water-level fluctuations in AENV Obs WW No. 218 because of the distance from the observation water well.

AENV Obs WW No. 220 is located in 13-06-022-25 W4M near Carseland, and is completed from 61.6 to 64.6 metres below ground surface in the Lower Surficial Aquifer. Groundwater monitoring data for AENV Obs WW No. 220 are available from mid-1986 to the end of 2000.

The water-level fluctuations in AENV Obs WW No. 220 appear to be related to seasonal groundwater uses. The adjacent hydrograph shows that the highest water levels in AENV Obs WW No. 220 occur in late winter/early spring and the lowest water levels are in late summer/early fall. This situation is a result of an increase in groundwater use by the Hamlet of Carseland during the summer months. The present data indicate that water levels in AENV Obs WW No. 220 have declined an average of 0.5 metres per year. The decline has been recorded since 1986 in AENV Obs WW No. 220, which is approximately one kilometre southeast of the Hamlet of Carseland water supply wells.



**Figure 30. Monthly Groundwater Precipitation vs Water Levels in AENV Obs WW No. 220**



**Figure 31. Site Map – Carseland Water Wells (modified after CH2M Hill)**

Of the six water supply wells shown in the adjacent figure, groundwater is currently being diverted from WSW Nos. 2, 85-3, 85-5 and 97-1.

Records of the groundwater diversion from the four producing water supply wells in the Hamlet of Carseland have been made available to HCL by Wheatland County. Water levels are currently being monitored in Obs WW No. 85-1, Obs WW No. 85-3, Obs WW No. 85-4 and Obs WW No. 93-1. The Hamlet's water supply wells and observation water wells are all completed in the Lower Sand and Gravel Aquifer.

The data include daily groundwater diversions, and weekly water levels from four observation water wells from January 1996 to December 2000. CH2M Hill provided HCL with a site diagram of the Carseland water wells (both water supply and observation), graphs showing groundwater production and water levels from 1994 to 1999, and licensing information for the four water supply wells in 1992.