6. Groundwater Budget

6.1 Hydrographs

In the M.D., there is one observation water well that is part of the AENV regional groundwater-monitoring network where water levels are being measured and recorded with time. This observation water well, AENV Obs WW No. 223, is located in 04-28-027-26 W4M near Irricana, and is completed from 45.7 to 46.9 metres below ground level in the Haynes Aquifer.

In 1996, the Wildrose Country Ground Water Monitoring Association undertook a pilot project in the Beiseker/Irricana area that involved monitoring the groundwater levels in 26 water wells. The Beiseker/Irricana area was selected as the site for the pilot project because of the high level of interest in groundwater issues during the summer of 1996 (HCL, March 1998). The interest was in part a response to proposed industrial development and in part a response to water-level declines that had been observed by some water well owners in the area.

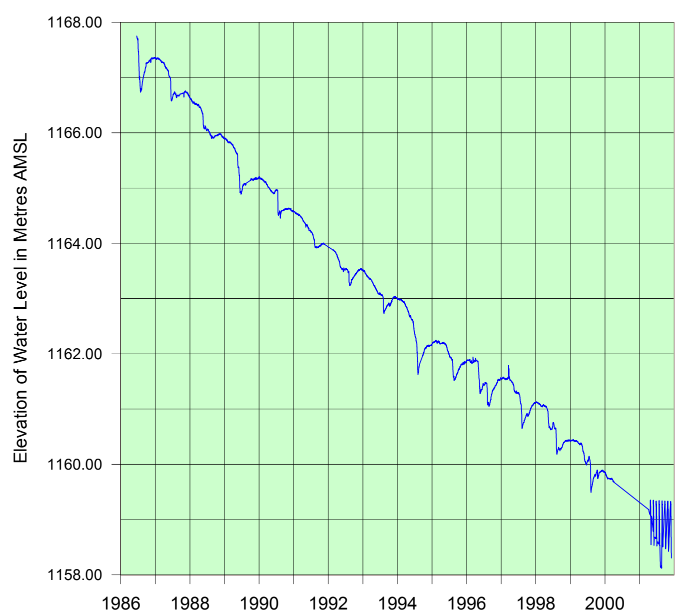

Figure 26. Hydrograph - AENV Obs WW No. 223

In an area where there are no pronounced 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. In the Wildrose Country Ground Water Monitoring Association pilot study, it was noted that the highest water levels occur in late winter/early spring and the lowest water levels are in late summer/early fall (HCL, March 1998), as shown in the hydrograph for the AENV Obs WW No. 223 (Figure 26). This situation is a result of the significant increase in groundwater use by the villages of Irricana and Beiseker during the summer months. The villages of Irricana and Beiseker have a combined total of ten licensed water supply wells that are completed in the Haynes Aquifer. The present data indicate that water levels in the Beiseker/Irricana Area are continuing to decline at an average of 0.8 metres per year. The decline has been recorded for 15 years in the AENV Obs WW No. 223, which is two kilometres northwest of the Village of Irricana. None of the existing hydrographs of the water wells associated with the WIldrose study show water-level rises that can be related to recharge events. This does not mean there is no recharge, only that there are no data that can be used to quantify the recharge (HCL, March 2001).

The Andrews Water Well is one of the sites that is being monitored as part of the Wildrose Country pilot project. The Andrews WW in NW 27-027-26 W4M is completed from 64.0 to 73.2 metres below ground surface in the Haynes Aquifer. The hydrograph (Figure 27) shows that in 1996 and 1997, water levels have tended to decline during the summer followed by a rise in water level throughout the winter. However, in 1998, 1999 and 2001, the annual pattern of water-level fluctuation changed and the water levels declined in the summer and continued to decline during the winter. The net result is that the water level declined nearly three metres. In 1998, a water-level decline of up to 1.9 metres was also recorded in five other water wells, including four domestic water wells and the Village of Beisker WSW No. 7.

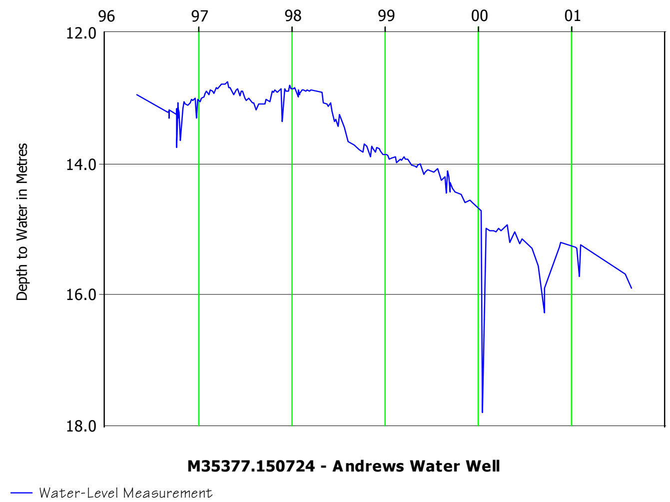

Figure 27. Hydrograph – Andrews Water Well

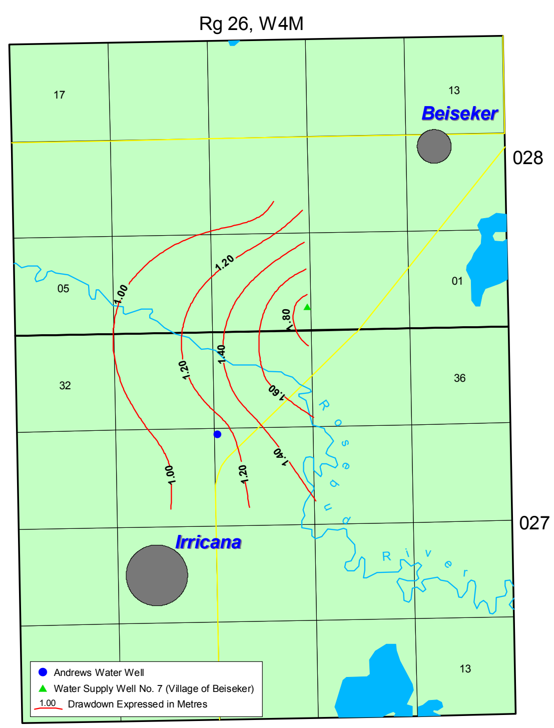

Figure 28. Map of 1998 Drawdown

When the 1998 water-level decline is plotted on a map, the maximum decline can be seen to occur in the SE corner of 03-028-26 W4M. The contour map shown in Figure 28 does not provide the location where the maximum decline has occurred because water-level data are not available from the eastern part of the area. However, Beiseker Water Supply Well No. 7 is located close to the area where the maximum decline is occurring.

Records of the groundwater diversion from the Village of Beiseker WSW No. 7 are available from November 1996 to March 1999. In an attempt to determine if the pumping from WSW No. 7 was the cause of the water-level decline, a mathematical simulation using a model aquifer was completed. The model aquifer was used to calculate the water levels at the Andrews Water Well, based on the production from WSW No. 7. Despite the limited data available, a reasonable match was obtained between measured and calculated water levels between November 1996 and June 1998. However, from June 1998 to March 1999, the calculated water level is up to one metre above the measured water level. The difference between measured and calculated water levels indicates that, from the present understanding of the local hydrogeology, the increase in water-level decline that has occurred since June 1998 is not a result of increased diversion from Beiseker WSW No. 7. This assumes that the production data from Beiseker WSW No. 7 are accurate.

The aquifer model used in the simulation does not take groundwater recharge into account. Therefore, if there were a decrease in recharge to the groundwater, a water-level decline could occur and the simulation would not account for the change. However, if a second water supply well is added to the groundwater simulation, diverting 180 m³/day starting 08 June 1998 and increasing to 225 m³/day on 01 Jan 1999, the calculated water level is very similar to the measured water level, as shown in Figure 29.

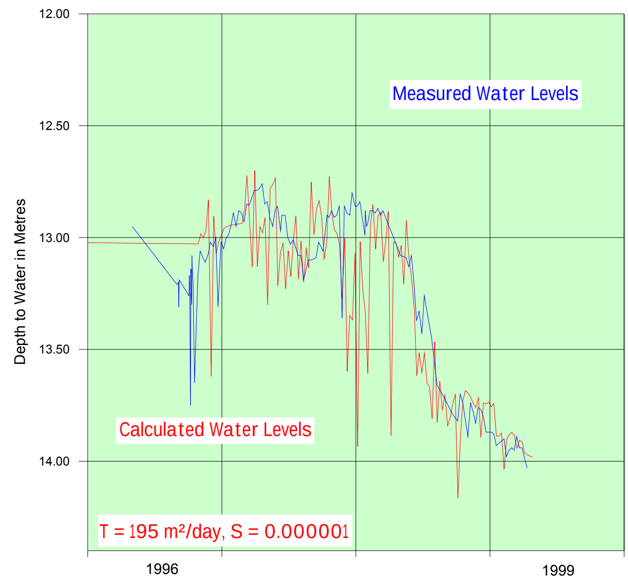

Figure 29. Water-Level Comparison – Andrews Water Well

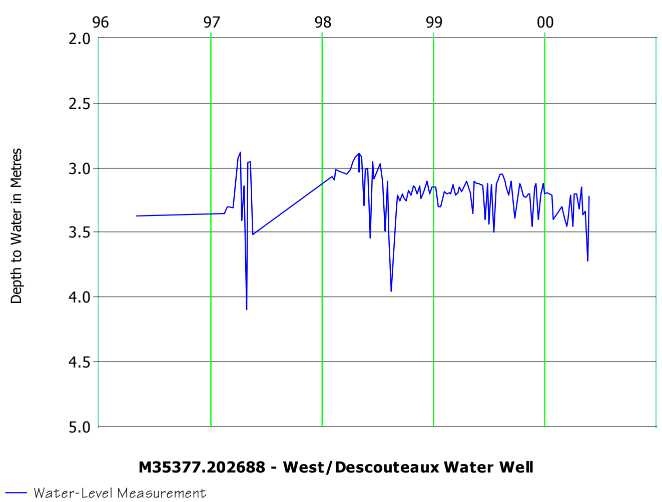

Figure 30. Hydrograph – West/Descouteaux Water Well

The West/Descouteaux Water Well in 04-34-027-26 W4M is completed from 12.2 to 18.3 metres below ground surface in the Lower Sand and Gravel Aquifer. The hydrograph for the West/Descouteaux Water Well (Figure 30) shows that there has been an overall decline in the water level of less than 0.5 metres since on-going groundwater monitoring was initiated in 1998.

The results of the Wildrose Country pilot project have shown the importance of water-level data in the management of the groundwater resource. The groundwater diversion by the Village of Beiseker has had an impact on the water levels in some area water wells; groundwater monitoring is the only method of quantifying that effect.

6.2 Estimated Water Use from Unlicensed Groundwater Users

An estimate of the quantity of groundwater removed from each geologic unit in the M.D. of Rocky View must include both the licensed diversions and the unlicensed use. As stated previously on page 6 of this report, the daily water requirement for livestock for the M.D. based on the 1996 census is estimated to be 14,855 cubic metres. Of the 14,855 m³/day required for livestock, 9,390 m³/day has been licensed by Alberta Environment, which includes both surface water and groundwater. To obtain an estimate of the quantity of groundwater being diverted from the individual geologic units, it has been assumed that the remaining 5,465 m³/day of water required for livestock watering is obtained from unlicensed groundwater use. In the groundwater database for the M.D., there are records for 10,856 water wells that are used for domestic/stock purposes. These 10,856 water wells include both licensed and unlicensed water wells. Of the 10,856 water wells, 947 water wells are used for stock, 997 are used for domestic/stock purposes, and 8,912 are for domestic purposes only.

There are 1,944 water wells that are used for stock or domestic/stock purposes (Table 6). There are 236 licensed groundwater users for agricultural (stock) purposes, giving 1,708 unlicensed stock water wells. (Please refer to Table 1 on page 6 for the breakdown by aquifer of the 236 licensed stock groundwater users). By dividing the number of unlicensed stock and domestic/stock water wells (1,708) into the quantity of groundwater required for stock purposes that is not licensed (5,465 m³/day), the average unlicensed water well diverts 3.2 m³/day for stock purposes. Because of the limitations of the data, no attempt has been made to compensate for dugouts, springs or inactive water wells, and the average stock use is considered to be 3.2 m³/day per stock water well.

Groundwater for household use does not require licensing. Under the Water Act, a residence is protected for up to 3.4 m³/day. However, the standard groundwater use for household purposes is 1.1 m³/day. Since there are 9,909 water wells serving a population of 23,326, the domestic use per water well is 0.6 m³/day.

To obtain an estimate of the groundwater from each geologic unit, there are three possibilities for a water well. A summary of the possibilities and the quantity of water for each use is as follows:

Domestic 0.6 m³/day
Stock 3.2 m³/day
Domestic/stock 3.8 m³/day

Based on using all available domestic, domestic/stock, and stock water wells and corresponding calculations, the following table was prepared. The table shows a breakdown of the 10,856 unlicensed and licensed water wells used for domestic, stock, or domestic/stock purposes by the geologic unit in which each water well is completed. The final column in the table equals the total amount of unlicensed groundwater that is being used for both domestic and stock purposes. The data provided in the table below indicate that most of the 9,583 m³/day, estimated to be diverted from unlicensed domestic, stock, or domestic/stock water wells, is from the Dalehurst and Lacombe aquifers. In the case of the Lower Sand and Gravel Aquifer, there is slightly more licensed than is projected to be used.

	Unlicensed and Licensed Groundwater Diversions							*Licensed Groundwater Diversions*	*Unlicensed Groundwater Diversions*
Aquifer Designation	Number of Domestic	Daily Use (0.6 m³/day)	Number of Stock	Daily Use (3.2 m³/day)	Number of Domestic and Stock	Daily Use (3.8 m³/day)	Totals m³/day	Totals (m³/day)	Totals m³/day
Upper Sand/Gravel	94	56	11	35	7	27	118	3	115
Lower Sand/Gravel	123	74	16	51	16	61	186	224	-38 (0)
Bedrock	174	104	18	58	38	144	306	83	223
Disturbed Belt	1,070	642	158	506	115	437	1,585	319	1,266
Dalehurst	2,975	1,785	502	1,606	450	1,710	5,101	1,095	4,006
Lacombe	2,364	1,418	199	637	303	1,151	3,206	651	2,555
Haynes	112	67	25	80	34	129	276	147	129
Upper Scollard	14	8	5	16	11	42	66	47	19
Lower Scollard	1	1	0	0	0	0	1	0	1
Unknown	1,985	1,191	13	42	23	87	1,320	13	1,307
Totals	8,912	5,346	947	3,031	997	3,788	12,165	2,582	9,583 (9,621)

Table 6. Unlicensed and Licensed Groundwater Diversions

By assigning 0.6 m³/day for domestic use, 3.2 m³/day for stock use and 3.8 m³/day for domestic/stock use, and using the total maximum authorized diversion associated with any licensed water well that can be linked to a record in the database, a map has been prepared that shows the estimated groundwater use in terms of volume (licensed plus unlicensed) per section per day for the M.D. (not including springs).

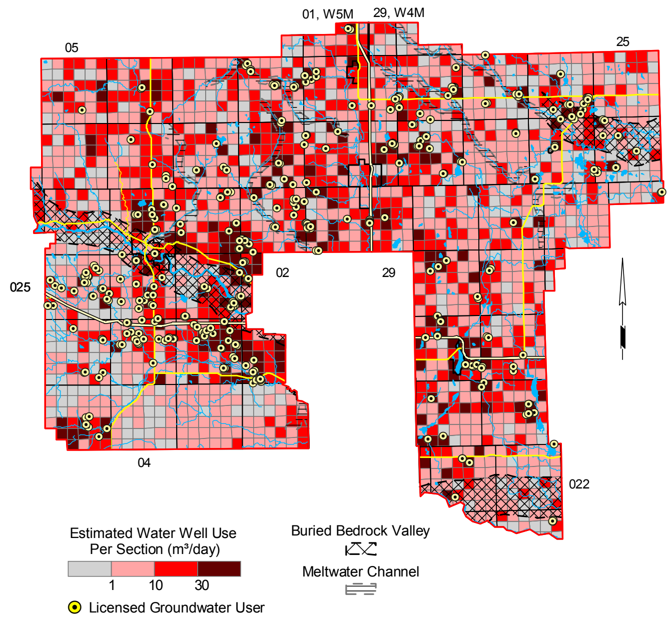

Figure 31. Estimated Water Well Use Per Section

There are 1,891 sections in the M.D. In 23% (437) of the sections in the M.D., there is no domestic or stock or licensed groundwater user. The range in groundwater use for the remaining 1,454 sections with groundwater use is from 0.6 m³/day to more than 19,000 (dewatering) m³/day, with an average use per section of 34 m³/day (5.2 igpm). Without the inclusion of the dewatering well, the average use per section is 20.5 m³/day. The estimated water well use per section can be more than 30 m³/day in 195 of the 1,454 sections. There is at least one licensed groundwater user in 93 of the 195 sections. The most notable areas where water well use of more than 30 m³/day is expected occur mainly in the vicinity of linear bedrock lows and near Calgary, as shown on Figure 31.

Groundwater Use within the M.D. of Rocky View (m³/day)		%
Domestic/Stock (licensed and unlicensed)	12,165	31
Municipal (licensed)	3,881	10
Commercial/Dewatering/Exploration et al (licensed)	22,576	58
Total	38,622	100

Table 7. Total Groundwater Diversions

In summary, the estimated total groundwater use within the M.D. of Rocky View is 38,622 m³/day, with the breakdown as shown in the adjacent table. An estimated 2,754 m³/day is being withdrawn from unknown aquifer units. The remaining 35,868 m³/day has been assigned to specific aquifer units. Approximately 75% of the total estimated groundwater use is from licensed water wells.

6.3 Groundwater Flow

A direct measurement of groundwater recharge or discharge is not possible from the data that are available for the M.D. One indirect method of measuring recharge is to determine the quantity of groundwater flowing laterally through each individual aquifer. This method assumes that there is sufficient recharge to the aquifer to maintain the flow through the aquifer and the discharge is equal to the recharge. However, even the data that can be used to calculate the quantity of flow through an aquifer must be averaged and estimated. To determine the flow requires a value for the average transmissivity of the aquifer, an average hydraulic gradient and an estimate for the width of the aquifer. For the present program, the flow has been estimated for those parts of the various aquifers within the M.D.

The flow through each aquifer assumes that by taking a large enough area, an aquifer can be considered as homogeneous, the average gradient can be estimated from the non-pumping water-level surface, and flow takes place through the entire width of the aquifer; flow through the aquifers takes into consideration hydrogeological conditions outside the M.D. border. Based on these assumptions, the estimated lateral groundwater flow through the individual aquifers has been summarized in Table 8:

Aquifer/Area	Trans (m²/day)	Gradient (m/m)	Width (m)	Flow (m³/day)	Aquifer Flow (m³/day)	Licensed Diversion (m³/day)	Unlicensed Diversion (m³/day)	Total (m³/day)
Lower Sand and Gravel					14,600	20,709	0	20,709
Calgary Valley								
east	1200	0.0048	2,500	14383				
Unnamed (northeast)								
southeast	30	0.0023	2,500	174				
Disturbed Belt					22,500	467	1,266	1,733
North								
east	37	0.016	8,000	4625				
Central								
south	27	0.020	15,000	8100				
northeast	12	0.020	15,000	3600				
South								
northeast	22	0.009	30,000	6188				
Dalehurst					109,200	3,356	4,006	7,362
Northcentral								
east	15	0.020	20,000	6000				
west	15	0.010	20,000	3000				
Northwest Central								
east	16	0.007	20,000	2286				
west	16	0.007	10,000	1143				
Northwest								
west	29	0.021	30,000	18125				
northwest	29	0.021	15,000	9063				
southeast	29	0.021	15,000	9063				
north	29	0.021	25,000	15104				
south	29	0.007	25,000	5179				
east	29	0.006	29,000	5256				
West Central								
northeast	22	0.015	15,000	4950				
southwest	22	0.020	15,000	6600				
Southwest 1								
northeast	52	0.010	15,000	8125				
southwest	52	0.010	15,000	8125				
Southwest 2								
northeast	23	0.010	15,000	3594				
southwest	23	0.010	15,000	3594				
Lacombe					12,000	1,825	2,555	4,380
Northeast								
north-northeast	16	0.008	35,000	4667				
Southeast								
East-southeast	49	0.005	30,000	7350				
Haynes					12,030	1,020	129	1,149
Northeast								
Northeast	30.6	0.004	25,000	2732				
Southeast								
northeast	31	0.004	6,000	775				
west	31	0.008	15,000	3875				
south	31	0.010	15,000	4650				
Upper Scollard					210	132	19	151
Northeast								
Northeast	2.5	0.003	20,000	125				
Southeast								
south	2	0.003	12,000	80				

Table 8. Groundwater Budget

Table 8 indicates that there is more groundwater flowing through the aquifers than has been authorized to be diverted from the individual aquifers, except for the Lower Sand and Gravel Aquifer. However, even where use is less than the calculated aquifer flow, there can still be local impacts on water levels as shown by the groundwater monitoring in the Beiseker/Irricana area. The calculations of flow through individual aquifers as presented in the above table are very approximate and are intended only as a guide for future investigations.