

40083

GROUNDWATER DEVELOPMENT

ARBUTUS RIDGE

(HATCH POINT, B.C.)

FOR

CRC CANADIAN RETIREMENT CORPORATION

AND

APLIN & MARTIN ENGINEERING LTD.

DOMESTIC WELLS NOS. 4 AND 5

By

W.L. Brown, P. Eng.

April, 1989

GROUNDWATER DEVELOPMENT
ARBUTUS RIDGE
(HATCH POINT, B.C.)
FOR
CRC CANADIAN RETIREMENT CORPORATION
AND
APLIN & MARTIN ENGINEERING LTD.

DOMESTIC WELLS NOS. 4 AND 5

By
W.L. Brown, P. Eng.

April, 1989

1.0 INTRODUCTION

- 1.1 Location - Domestic Wells Nos. 4 and 5 are located in the western area of Arbutus Ridge Estates on what is known as the Decker property, named after the former owner. Domestic Well No. 4 lies approximately 80 metres east of Telegraph Road and 80 metres south of Hatch Point Road (unopened). Domestic Well No. 5 lies approximately 60 metres east of Telegraph Road and 170 metres north of Hutchinson Road. These two wells are approximately 140 metres apart. Please see the Well Location Map Figure 1 in pocket.
- 1.2 Drilling and Testing - These two wells were constructed in December, 1988 to March, 1989 during a period of inclement weather and of local influenza. Domestic Well No. 4 was test pumped from March 2 to 5, 1989 and Domestic Well No. 5 was test pumped from March 14 to 17, 1989. These pump tests were conducted during and after a relatively dry winter.

2.0 HYDROGEOLOGY

- 2.1 Bedrock - These two domestic wells were not drilled to bedrock so that the configuration of bedrock shown in former reports cannot be changed significantly except that Domestic Well No. 4 shows that the top of bedrock lies almost 40 metres (130 feet) below sea level. This compares with bedrock being encountered in Irrigation Well 1 and Domestic Wells 1, 2 and 3 from approximately 30 metres above sea level to approximately 10 metres below sea level (100 feet A.S.L. to 30 feet B.S.L.). A channel therefore exists beneath this part of Arbutus Ridge Estates which could become a target for future groundwater development. Please see the simplified well logs on Figures 2 and 3 and the attached written well logs.
- 2.2 Unconsolidated Sediments - Domestic Wells Nos. 4 and 5 encountered artesian sand and gravel aquifers that are capped with 36 metres (120 feet) and 20 metres (65 feet) of relatively impervious silts and clays. The static water levels in these two wells was within 2 metres of each other at 68 and 66 metres (223 and 216 feet) above sea level. This is approximately 10 metres (33 feet) above the static water levels measured in Domestic Wells 1, 2 and 3. The sand aquifer screened in these first three wells is not artesian and are in a

significantly different hydrogeologic setting from those screened in Domestic Wells Nos. 4 and 5.

3.0 WELL CONSTRUCTION

Domestic Well No. 4 was drilled by a cable tool and an air rotary rig and Domestic Well No. 5 was drilled entirely by an air rotary rig. Reference to the well logs attached will show that both wells are cased with 203 mm (8-inch) diameter steel casing and that both screen assemblies consist of a 203 mm (8-inch) nominal diameter stainless steel well screen capped by a 178 mm (7-inch) diameter steel riser with 178 mm (7-inch) diameter pump sumps below the screens. The well screen in Domestic Well No. 4 has 8/1000-inch slot openings and the well screen in Domestic Well No. 5 has 10/1000-inch slot openings.

The screen in Domestic Well No. 4 was developed by bailing and the screen in Domestic Well No. 5 was developed by air blowing.

4.0 PUMP TESTING

4.1 Domestic Well No. 4 - A constant rate pump test was conducted during March 2-5, 1989 at a discharge rate of 278 m³/day (51 U.S. gpm or 42.5 I gpm) after approximately 700 minutes into the test. Drawdown water level readings were measured and recorded during the 4,350 minute (3 day) pumping period and recovery water levels were measured and recorded for a period of 250 minutes (4 hours) after the pump was turned off. Water levels were also measured and recorded in Domestic Well No. 3 during the pumping period. Domestic Well No. 3 lies approximately 490 m (1610 feet) to the ESE of Domestic Well No. 4. Please see the pump test data and Figures 4, 5 and 6 attached.

4.2 Domestic Well No. 5 - This well was pumped for a period of 4,350 minutes (3 days) at a constant rate of 861 m³/day (158 U.S. gpm or 132 I gpm). Drawdown water levels were measured and recorded during this pumping period in Domestic Wells Nos. 3, 4 and 5. Recovery water levels were recorded and measured in Domestic Well No. 5 for a period of 250 minutes (slightly over 4 hours). Please see the pump test data and Figures 7, 8 and 10 attached.

5.0 ANALYSIS OF PUMP TEST DATA

5.1 Domestic Well No. 4 - Reference to Figures 4, 5 and 6 and the pump test data will show that the drawdown readings fluctuated in wave-like patterns from 1,100 minutes (0.76 days) into the test to the end of the test at 4,350 minutes (3 days). The maximum amplitude of these waves is shown on Figure 6 to be 0.588 m (1.929 feet). The maximum fluctuation in Domestic Well No. 3 which was used as an observation well during this pump test was 0.108 m (0.354 feet). The tide maxima and minima levels at Fulford Harbour (Salt Spring Island) the closest station to Arbutus Ridge have also been plotted on Figure 6.

The water level fluctuation during the pump test could have been caused by the following:

5.1.1 Tidal Fluctuations - If the tide graph on Figure 6 is moved approximately 700 minutes (11.5 hours) forward a reasonable match is made between the tide and water level plots. However, the water levels at a depth of 81 metres were approximately 6 metres (20 feet) above sea level and Domestic Well No. 4 lies approximately 1,500 metres (5,000 feet) west of the sea shore. The amplitude of the tide was approximately 7 feet while the amplitude of the water level fluctuation was almost 2 feet. Although a tidal influence is suggested by the plots on Figure 6 it does not seem reasonable to use this relationship to explain the water level fluctuations.

5.1.2 Barometric Fluctuation - Although it is commonly known that wells screened in artesian aquifers can act as water barometers no data is available to test this phenomenon.

5.1.3 Intermittant Pumping of Neighbouring Wells - The pumping of neighbouring wells would cause a drop in the water levels of Domestic Well No. 4. Thus the time of day of the troughs becomes significant. The times of the troughs are as follows:

0820 - March 3, 1989
0600 - March 4, 1989
2240 - March 4, 1989
0840 - March 5, 1989

Irrigation watering would not have been a factor during this pump test so that only domestic and farm animal water use needs to be considered. The troughs at 0820 and 0840 on March 3 and 5 could have been caused by domestic water use but the 0600 and 2240 troughs on March 4 would not have been caused by this means. The water levels in Domestic Well No. 3 does not fluctuate in concert with the water levels in the pumped Domestic Well No. 4 as would be the case if the fluctuation had been caused by Domestic Wells Nos. 1 and 2. Domestic Well No. 2 is only 360 m south of Domestic Well No. 3. Therefore, the pumping of neighbouring wells does not appear to be a reasonable explanation for the water level fluctuations observed during the pump test.

- 5.1.4 Pumping Rate Fluctuation - The average depth of the water levels during the last 22 hours of the test is approximately 80.5 metres. The specific capacity of Domestic Well No. 4 during the period can be calculated as follows:

Depth to Water	80.5 m
Static Water Level	19.9
	<hr/>
Drawdown	60.6 m or 199 feet

Specific Capacity - $51/199 = 0.26$ US gpm/ft. of drawdown.

The maximum fluctuation of 1.929 feet could have been caused by a change of only $1.929 (0.26) = 0.5$ US gpm.

This is less than 1% of the 51 US gpm recorded flow. The flow rate was measured by watch and container so that a half a gallon change in flow would not be observed.

Of the possible causes described above very minor changes in pump discharge appears to be the most reasonable cause of the observed fluctuations.

Figures 4 and 5 indicate that the transmissivity of the aquifer in Domestic Well No. 4 ranges from 2565 to 1400 US gpd/ft.

- 5.2 Domestic Well No. 5 - Reference to Figures 7, 8 and 10 and the pump test data will show that fluctuation also occurred in the water levels of the pumped Domestic Well No. 5 and Domestic Wells Nos. 3 and 4 which were used as observation wells during this test. The water levels in Domestic Well No. 5 had a maximum fluctuation of approximately 0.1 m (0.33 ft.).

An analysis similar to the one described above for Domestic Well No. 4 leads to the conclusion that minor fluctuations in pump discharge probably caused the observed water level fluctuations. It is noted that the water level at a depth of approximately 69.8 m is 36 metres (120 feet) above sea level so that a tidal effect is precluded. The specific capacity of Domestic Well No. 5 can be calculated as follows:

Depth to Water	69.8 m
Static Water Level	39.9
Drawdown	<hr/> 29.9 m or 98 feet

Specific Capacity - $158/98 = 1.6$ US gpm/ft. of drawdown.

The water level fluctuations of 0.33 feet would have been caused by a discharge fluctuation of:

$$0.33 (1.6) = 0.53 \text{ US gpm}$$

The flow rate was measured by a 4-inch diameter tube and 3-inch diameter orifice. Reference to orifice tables shows that a 1/2 inch change in manometer readings corresponds to a flow rate change of 3 US gpm. Thus a 0.53 US gpm change in flow would be equivalent to a $0.53/3 \times 0.5 = 0.088$ inch change in the manometer reading. Such a change would go undetected by observers in the field.

The writer concludes that these two wells reached essential stabilization during the last almost 1,000 minutes of these tests and that observed water level changes were caused by minute undetectable changes in pump discharges.

The semi-log plots on figures 7 and 8 show transmissivity values in the range of 8,000 to 10,000 US gpd/ft. and Figure 8 shows a storativity factor of

1.4×10^{-4} . This storativity value is compatible with the artesian conditions noted on the well log.

6.0 PRODUCTIVE CAPACITY

6.1 Domestic Well No. 4 - The productive capacity of this well can be calculated as follows:

Depth to Top of Screen	94.49 metres	310 feet
Static Water Level	19.86	65
Total Available Drawdown	<u>74.63</u>	<u>245</u>

Specific Capacity - 0.26 US gpm/ft. of drawdown as calculated above in section 5.1.4.

Interference from Domestic Well No. 5 - 20 feet (see Figure 9). Productive Capacity using 70% of Total Available Drawdown $0.7(245 - 20) (0.26) = 40$ US gpm or 33 I gpm.

6.2 Domestic Well No. 5 - The productive capacity of this well is calculated as follows:

Depth to Top of Screen	104.55 metres	343 feet
Static Water Level	39.87	131
Total Available Drawdown	<u>64.68</u>	<u>212</u>

Specific Capacity - 1.6 US gpm/ft. of drawdown as calculated above in section 5.2.

Interference from Domestic Well No. 4 discharging at 30 I gpm is 4 feet.

Productive Capacity using 70% of Total Available Drawdown $0.7 (212 - 4) 1.6 = 233$ US gpm.

Unfortunately, the velocity of water entering the well screen must not exceed 0.1 feet per second to prevent turbulent flow and the danger of such flow moving sand through the screen into the well with consequent pump damage and well failure.

The 20 feet of 10 slot 8-inch telescopic diameter screen has an open area of 28 square inches per foot of length. Thus the safe Productive Capacity of this screen is $28(20)(.31) = 174$ US gpm or 145 I gpm.

Thus, even though the Productive Capacity of Domestic Well No. 5 is calculated from 70% of Total Available Drawdown and the Specific Capacity to be 233 US gpm the screen characteristics will reduce this to 174 US gpm or 145 I gpm. The productivity of the Arbutus Ridge Estates well field could be increased by (283-174) 59 US gpm or 50 I gpm by replacing Domestic Well No. 5 with a larger diameter well. Twenty feet of 12-inch telescopic diameter 10 slot screen will pass 260 US gpm or 216 I gpm at 0.1 ft./sec. entrance velocity.

7.0 WATER QUALITY

Samples of water were collected prior to the end of each pump test. These were sent to a commercial laboratory for chemical analyses. These show that the groundwater from these wells is potable and meets the Canadian and British Columbia drinking water guideline for all parameters analysed. Please see the chemist's reports attached.

8.0 RECOMMENDATIONS AND CONCLUSIONS

8.1 Based upon presently available information the safe productive potential of these wells are:

Domestic Well No. 4	40 US gpm	30 I gpm	196 m ³ /day
Domestic Well No. 5	174 US gpm	145 I gpm	948 m ³ /day

8.2 The total proven capacity of the Arbutus Ridge Estates Domestic Well Field is now:

Domestic Well No. 1	66 US gpm	55 I gpm	360 m ³ /day
Domestic Well No. 2	55 US gpm	46 I gpm	300 m ³ /day
Domestic Well No. 3	35 US gpm	29 I gpm	190 m ³ /day
Domestic Well No. 4	40 US gpm	30 I gpm	196 m ³ /day
Domestic Well No. 5	174 US gpm	145 I gpm	948 m ³ /day
Total Productive Capacity	370 US gpm	305 I gpm	1995 m ³ /day

8.3 If more groundwater is needed, two more wells can be located along Hutchinson Road with an expected probable total productive potential of approximately 200 I gpm. Also the deep bedrock channel indicated by the results of the Domestic Well No. 4 drilling should be explored to determine the type and productivity of those sediments filling the channel.

- 8.4 It is important to note that the aquifer discovered in Domestic Wells Nos. 4 and 5 is hydrogeologically separated from the aquifer developed in Domestic Wells Nos. 1, 2 and 3. These two sets of wells should not affect the productive potentials of each other.
- 8.5 These wells should NOT be
overpumped
vibrated
raw-hided
- 8.6 The new concrete cribbings that will be constructed around these new domestic wells will change the datum of the measuring point from that used on the well logs and pump tests attached to this report. The relationship between the original ground surface and the new top of cribbings should be established and recorded.
- 8.7 The pumps set in the pump sumps should be "shrouded" to ensure that the motors are properly cooled.
- 8.8 Water level measurements should be made and recorded in all wells during the first five years of operation. These records should be reviewed by the writer once a year with a view to increasing the safe productive potential of the well field.
- 8.9 When all the pumps are installed in all the wells the well field should be "tuned" to produce the maximum total safe production without dewatering the well screens.

CHEMICAL ANALYSIS REPORT

ASL

Date: April 3, 1989
File No. 7332A
Report On: Water Analysis
Report To: Brown Erdman & Turner Ltd.
207 - 132 West 15th Street
North Vancouver, B. C.
V7M 1R5

DATE OF SUBMISSION:

March 7, 1989

SAMPLE IDENTIFICATION

Labelled as shown in RESULTS section.

METHODOLOGY

Analysed in accordance with "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, 1985.

RESULTS OF ANALYSIS


Results are presented in the table(s) attached.

REMARKS

The water as represented by the sample submitted can be characterized as moderate with respect to dissolved mineralization.

The water sample met Canadian and British Columbia drinking water guidelines for all parameters analysed.

ASL ANALYTICAL SERVICE LABORATORIES LTD.


Barbara Szczechor, B.Sc.
Supervisor
Water Quality Laboratory

BS/mm



analytical service laboratories ltd.

CONSULTING CHEMISTS & ANALYSTS
1650 Pandora Street
Vancouver, B.C. • V5L 1L6
Fax (604) 253-6700 • Tel. (604) 253-4188

RESULTS OF ANALYSIS

File No. 7332A
Page 2 of 2

Physical Parameters	Drinking *1 Water Guidelines	Arbutus Ridge Portable Well #4
<u>Physical Tests</u>		
pH	6.5-8.5	7.99
Conductivity (μ mhos/cm)	-	140.
Colour (CU)	15.	<5.
Turbidity (NTU)	5.	<1.0
Suspended Solids (mg/L)	-	6.0
Dissolved Solids (mg/L)	500.	106.
Total Hardness (mg/L)	-*2	60.3
<u>Dissolved Anions</u>		
Alkalinity CaCO ₃	-	70.4
Sulfate SO ₄	500.	1.0
Chloride Cl	250.	3.8
Fluoride F	1.5	0.04
Nitrate + Nitrite N	10.0	0.080
<u>Total Metals</u>		
Iron Fe	0.30	0.032
Manganese Mn	0.05	0.008
<u>Dissolved Metals</u>		
Arsenic As	0.05	0.0046
Barium Ba	1.0	<0.010
Cadmium Cd	0.005	<0.0002
Chromium Cr	0.05	<0.015
Copper Cu	1.0	<0.010
Iron Fe	-	<0.03
Lead Pb	0.05	<0.001
Manganese Mn	-	0.009
Zinc Zn	5.0	<0.005
Calcium Ca	-	15.0
Magnesium Mg	-	5.42
Potassium K	-	0.92
Sodium Na	- *3	9.94

< = Less than

Results expressed as milligrams per litre except for pH,
Conductivity (μ mhos/cm), Colour (CU), Turbidity (NTU)*1 "Maximum acceptable concentration" as published by Health &
Welfare Canada, 1985*2 Maximum level not established - water supplies with a hardness
exceeding 200 mg/L are considered poor but will be tolerated.

Not a health consideration

*3 Maximum level not established - of concern to consumers with
sodium restricted diet. Levels exceeding 20 mg/L may be of
concern in this circumstance.

CHEMICAL ANALYSIS REPORT

ASL

Date: April 12, 1989`
File No. 7427A
Report On: Water Analysis
Report To: Brown Erdman & Turner Ltd.
207 - 132 West 15th Street
North Vancouver, B. C.
V7M 1R5

Attention: Mr. Bill Brown
DATE OF SUBMISSION:

March 21, 1989

SAMPLE IDENTIFICATION

Labelled as shown in RESULTS section.

METHODOLOGY

Analysed in accordance with "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, 1985.

RESULTS OF ANALYSIS

Results are presented in the table(s) attached.



analytical service laboratories Ltd.

CONSULTING CHEMISTS & ANALYSTS
1650 Pandora Street
Vancouver, B.C. • V5L 1L6
Fax (604) 253-6700 • Tel. (604) 253-4188

REMARKS

File No. 7427A

Page 2 of 3


The water as represented by the sample submitted can be characterized as moderate with respect to dissolved mineralization.

The water sample met Canadian and British Columbia drinking water guidelines for all parameters analysed.

ASL ANALYTICAL SERVICE LABORATORIES LTD.

A. W. Maynard, M.Sc.
Senior Partner

BS/AWM/mm


Barbara Szczachor, B.Sc.
Supervisor
Water Quality Laboratory

RESULTS OF ANALYSIS

File No. 7427A
Page 3 of 3

Canadian Retirement Corp. Site F Mar 17/89
Drinking *1 Water Guidelines

Physical Tests

pH	8.00	6.5-8.5
Conductivity	146.	-
Colour	<5.	15.
Turbidity NTU	<1.0	5.
Suspended Solids	1.3	-
Dissolved Solids	127.	500.
Hardness CaCO3	61.6	-*2

Anions

Alkalinity CaCO3	75.0	-
Sulphate SO4	<1.0	500.
Chloride Cl	3.8	250.
Fluoride F	0.06	1.5
Silicate SiO2	19.9	-
NO3/NO2 N	0.15	10.0

Total Metals

Iron T Fe	<0.03	0.30
Manganese T Mn	<0.005	0.05

Dissolved Metals

Arsenic D As	0.0023	0.05
Barium D Ba	<0.010	1.0
Chromium D Cr	0.0023	0.05
Copper D Cu	<0.010	1.0
Iron D Fe	<0.03	-
Lead D Pb	<0.001	0.05
Manganese D Mn	<0.005	-
Zinc D Zn	0.064	5.0

Calcium D Ca	15.9	-
Magnesium D Mg	5.21	-
Potassium D K	0.75	-
Sodium D Na	7.32	-

Microbiological Tests

Total Coliform	ND	-
Fecal Coliform	ND	-

< = Less than ND = Not Detected
Results expressed as milligrams per litre except for pH, Conductivity (µmhos/cm), Colour (CU), Turbidity (NTU) and Coliform Bacteria (colonies/100 ml)
*1 "Maximum acceptable concentration" as published by Health & Welfare Canada, 1985
*2 Maximum level not established - water supplies with a hardness exceeding 200 mg/L are considered poor but will be tolerated. Not a health consideration
*3 Maximum level not established - of concern to consumers with sodium restricted diet. Levels exceeding 20 mg/L may be of concern in this circumstance.

ARBUTUS RIDGE DOMESTIC WELL NO.4

CONSTANT RATE PUMP TEST

DRAWDOWN

Date: March 2/5, 1989

Discharge Rate: 51 U.S. gpm, 42.5 Igpm or 278 m³/day

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
March 2 1400	0.0	19.856	Measuring Point - top of casing
	0.5	23.762	0.55 m above existing ground
	1.0	28.365	Discharge 40 m from well
	1.5	33.626	Flow rate checked by watch
	2.0	38.840	and drum
	2.5	43.284	
	3.0	50.483	90 U.S. gpm
	3.5	51.612	
	4.0	52.875	
	4.5	57.472	
	5.0	59.455	
	6.0	62.378	
	7.0	68.126	
	8.0	71.504	Reducing Discharge
	9.0	72.441	58 U.S. gpm
	10.0	73.047	
	12.0	74.290	
	14.0	75.217	
	16.0	75.918	
	18.0	76.448	56 U.S. gpm
20.0	76.850		
25.0	77.572		
30.0	78.000		
35.0	78.240		
40.0	78.404		
45.0	78.861		

ARBUTUS RIDGE DOMESTIC WELL NO.4

CONSTANT RATE PUMP TEST

DRAWDOWN

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
1500	50.0	78.754	
	60.0	78.955	
	70.0	79.105	54 U.S. gpm
	80.0	79.234	
	90.0	79.307	
	100.0	79.386	Domestic Well No. 3 used as
	125.0	79.481	observation well. Top casing
	150.0	79.636	.461 m above existing ground
	200.0	79.832	54 U.S. gpm
	250.0	80.021	Well No.3 24.474 m
	300.0	80.134	54 U.S. gpm
	350.0	80.183	
	400.0	80.274	54 U.S. gpm
	450.0	80.339	New observer
	500.0	80.457	Well No.3 24.495m
2400 March 3	550.0	80.533	
	600.0	80.583	
	650.0	80.606	
	700.0	80.623	51 U.S. gpm
	750.0	80.639	Well No.3 24.506m
	800.0	80.694	
	850.0	80.723	51 U.S. gpm
	900.0	80.729	
	950.0	80.754	Well No.3 24.520m
	1000.0	80.785	
1050.0	80.852	51 U.S. gpm	
0910	1100.0	80.830	
	1150.0	80.699	
	1200.0	80.724	51 U.S. gpm
	1250.0	80.773	Well No.3 24.514m

ARBUTUS RIDGE DOMESTIC WELL NO.4

CONSTANT RATE PUMP TEST

DRAWDOWN

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
	1300.0	80.500	51 U.S. gpm
	1350.0	80.446	
	1400.0	80.446	51 U.S. gpm
	1450.0	80.444	
	1500.0	80.490	Well No.3 24.514m
	1550.0	80.482	51 U.S. gpm
	1600.0	80.495	
	1650.0	80.463	
	1700.0	80.635	51 U.S. gpm
	1750.0	80.700	Well No.3 24.495m
	1800.0	80.617	51 U.S. gpm
	1850.0	80.665	New Observer
	1900.0	80.732	
	1950.0	80.801	
2320 3	2000.0	80.905	51 U.S. gpm
March 4	2050.0	80.976	
	2100.0	80.914	
	2150.0	80.898	51 U.S. gpm
	2200.0	80.965	
	2250.0	81.000	Well No.3 24.458m
	2300.0	80.951	51 U.S. gpm
	2350.0	80.971	
	2400.0	80.999	51 U.S. gpm
	2450.0	80.945	
	2500.0	80.971	Well No.3 24.445m
	2550.0	80.954	51 U.S. gpm
	2600.0	80.861	
	2650.0	80.791	51 U.S. gpm
1100	2700.0	80.676	51 U.S. gpm New Observer
	2750.0	80.723	Well No.3 24.430
	2800.0	80.615	
	2850.0	80.659	

ARBUTUS RIDGE DOMESTIC WELL NO.4

CONSTANT RATE PUMP TEST

DRAWDOWN

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
2330 March 5	2900.0	80.558	51 U.S. gpm
	2950.0	80.491	Well No.3 24.448m
	3000.0	80.610	
	3050.0	80.547	
	3100.0	80.474	
	3150.0	80.415	
	3200.0	80.411	
	3250.0	80.501	
	3300.0	80.529	51 U.S. gpm
	3350.0	80.554	
	3400.0	80.574	
	3450.0	80.561	51 U.S. gpm
	3500.0	80.530	Well No.3 24.412m
	3550.0	80.501	
	3600.0	80.451	
	3650.0	80.500	
	3700.0	80.492	51 U.S. gpm
	3750.0	80.477	Well No.3 24.437m
	3800.0	80.583	
	3900.0	80.544	51 U.S. gpm
	3950.0	80.532	
	4000.0	80.614	Well No.3 24.436m
	4050.0	80.645	
	4100.0	80.517	
	4150.0	80.488	
	4200.0	80.475	51 U.S. gpm
	4250.0	80.517	Well No.3 24.308m
4300.0	80.447	51 U.S. gpm	
4350.0	80.476	Took Water Sample Pump Off.	

ARBUTUS RIDGE DOMESTIC WELL NO. 4

CONSTANT RATE PUMP TEST

DRAWDOWN

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
	RECOVERY		
March 5			T/T'
	0.0	80.476	
	0.5	77.315	8701
	1.0	74.005	4351
	1.5	70.430	
	2.0	68.245	2176
	2.5	65.341	
	3.0	62.822	1451
	3.5	60.352	
	4.0	58.045	1089
	4.5	55.810	
	5.0	53.755	871
	6.0	49.849	
	7.0	46.538	
	8.0	43.501	
	9.0	40.752	
	10.0	38.258	436
	12.0	34.273	
	14.0	31.112	
	16.0	28.725	
	18.0	26.622	
	20.0	25.330	219
	25.0	23.134	
1500	30.0	22.000	146
	35.0	21.407	
	40.0	21.124	110
	45.0	20.912	
	50.0	20.862	88
1530	60.0	20.778	

ARBUTUS RIDGE DOMESTIC WELL NO.4

CONSTANT RATE PUMP TEST

DRAWDOWN

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
	70.0	20.731	
	80.0	20.663	
	90.0	20.650	
	100.0	20.644	45
	125.0	20.588	
	150.0	20.538	
	200.0	20.495	23
	250.0	20.454	

ARBUTUS RIDGE DOMESTIC WELL NO. 5

CONSTANT RATE PUMP TEST

DRAWDOWN

Date: March 14/17, 1989

Discharge Rate: 158 U.S. gpm, 132 Igpm or 861 m³/day

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
Mar 14 1530	0.0	39.867	Measuring Point - top of casing 0.8 m above existing ground
	0.5	45.619	Discharge 75 m from well
	1.0	50.614	Flow rate checked by 3-inch orifice and 4-inch tube
	1.5	51.089	
	2.0	51.321	Depth to water Well No. 3 24.497 m
	2.5	51.549	Well No. 4 19.950 m
	3.0	53.442	
	3.5	55.141	
	4.0	57.154	125 US gpm water slightly cloudy
	4.5	58.005	
	5.0	59.752	
	6.0	61.442	143 US gpm
	7.0	62.092	
	8.0	62.410	Increasing rate
	9.0	62.952	148 US gpm
	10.0	63.416	
	12.0	63.792	Increasing rate
	14.0	64.760	153 US gpm
	16.0	65.318	
	18.0	65.627	158 US gpm water clear
20.0	65.810		
25.0	66.291		
1600	30.0	66.271	
	35.0	66.372	158 US gpm
	40.0	66.491	

ARBUTUS RIDGE DOMESTIC WELL NO. 5

CONSTANT RATE PUMP TEST

DRAWDOWN

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
Mar 14	45.0	66.571	
	50.0	66.619	158 US gpm
1630	60.0	66.760	
	70.0	66.982	
	80.0	67.132	158 US gpm
	90.0	67.321	
	100.0	67.352	
	125.0	67.542	158 US gpm
	150.0	67.613	
	200.0	67.751	Well No. 3 24.451 m Well No. 4 21.363
	250.0	67.964	158 US gpm
	300.0	68.082	
	350.0	68.082	
	400.0	68.212	Well No. 3 24.458 m Well No. 4 21.774
	450.0	68.257	
2350	500.0	68.286	
Mar 15	550.0	68.459	
	600.0	68.484	Well No. 3 24.447 m Well No. 4 22.235
	650.0	68.549	
	700.0	68.601	158 US gpm
	750.0	68.643	
	800.0	68.661	Well No. 3 24.441 Well No. 4 22.121
	850.0	68.679	158 US gpm
	900.0	68.674	
	950.0	68.713	
	1000.0	68.751	Well No. 3 24.432 Well No. 4 22.311
	1050.0	68.794	
	1100.0		
	1150.0		
	1200.0		
	1250.0		

ARBUTUS RIDGE DOMESTIC WELL NO. 5

CONSTANT RATE PUMP TEST

DRAWDOWN

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
Mar 15 1400	1300.0	69.243	158 US gpm
	1350.0	69.330	
	1400.0	69.330	Well No. 3 24.421 m Well No. 4 22.490
	1450.0	69.332	158 US gpm
	1500.0	69.342	
	1550.0	69.392	158 US gpm
	1600.0	69.448	Well No. 3 24.418 m Well No. 4 22.541
	1650.0	69.408	158 US gpm
	1700.0	69.409	
	1750.0	69.409	158 US gpm
0000 Mar 16	1800.0	69.407	Well No. 3 24.397 m Well No. 4 22.601
	1850.0	69.372	158 US gpm
	1900.0	69.365	
	1950.0	69.379	158 US gpm
	2000.0	69.401	Well No. 3 24.395 m Well No. 4 22.627
	2050.0	69.388	
	2100.0	69.405	158 US gpm
	2150.0	69.396	
	2200.0	69.391	Well No. 3 24.395 m Well No. 4 22.676
	2250.0	69.391	158 US gpm
1500	2300.0	69.392	
	2350.0	69.421	
	2400.0	69.445	Well No. 3 24.401 m Well No. 4 22.701
	2450.0	69.551	
	2500.0	69.542	
	2550.0	69.561	
	2600.0	69.581	Well No. 3 24.431 m Well No. 4 22.740
	2650.0	69.598	
	2700.0	69.637	158 US gpm
	2750.0	69.561	
1500	2800.0	69.564	Well No. 3 24435 m Well No. 4 22.763
	2850.0	69.599	158 US gpm

ARBUTUS RIDGE DOMESTIC WELL NO. 5

CONSTANT RATE PUMP TEST

DRAWDOWN

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
Mar 16 1550	2900.0	69.665	
	2950.0	69.654	158 US gpm
	3000.0	69.703	Well No. 3 24.435 Well No. 4 22.795
	3050.0	69.745	158 US gpm
	3100.0	69.712	
	3150.0	69.749	
	3200.0	69.798	Well No. 3 24.435 Well No. 4 22.752
	3250.0	69.787	158 US gpm
	3300.0	69.783	
2320	3350.0	69.760	
Mar 17 0100	3400.0	69.734	Well No. 3 24.451 Well No. 4 22.794
	3450.0	69.780	
	3500.0	69.751	158 US gpm
	3550.0	69.739	
	3600.0	69.742	Well No. 3 24.462 Well No. 4 22.837
	3650.0	69.724	
	3700.0	69.740	
	3750.0	69.745	
	3800.0	69.732	158 US gpm Well No. 3 24.470 m
	3850.0	69.757	Well No. 4 22.895 m
	3900.0	69.742	
	3950.0	69.780	
	4000.0	69.771	Well No. 3 24.452 Well No 4 22.914
	4050.0	69.762	
	4100.0	69.812	158 US gpm
	4150.0	69.881	
	4200.0	69.841	Well No. 3 24.450 Well No. 4 22.864
	4250.0	69.878	
	4300.0	69.807	Collected water samples
1600	4350.0	69.811	

ARBUTUS RIDGE DOMESTIC WELL NO. 5

CONSTANT RATE PUMP TEST

RECOVERY

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
Mar 17 1600	0.0	69.811	
	0.5	59.938	
	1.0	54.483	
	1.5	51.200	
	2.0	49.000	
	2.5	47.555	
	3.0	46.670	
	3.5	46.021	
	4.0	45.564	
	4.5	45.252	
	5.0	45.021	
	6.0	44.687	
	7.0	44.457	
	8.0	44.337	
	9.0	44.221	
	10.0	44.120	
	12.0	43.935	
	14.0	43.824	
	16.0	43.699	
	18.0	43.605	
20.0	43.513		
25.0	43.320		
30.0	43.176		
35.0	43.042		
40.0	42.942		
45.0	42.860		
50.0	42.772		
1700	60.0	42.626	
	70.0	42.520	
	80.0	42.431	

ARBUTUS RIDGE DOMESTIC WELL NO. 5

CONSTANT RATE PUMP TEST

RECOVERY

Time of Day hr/min	Elapsed Time Minutes	Depth to Water Metres	Comment
Mar 17	90.0	42.320	
	100.0	42.253	
	125.0	42.083	
	150.0	41.967	
	200.0	41.761	
2010	250.0	41.753	

HATCH POINT
DOMESTIC WELL NO. 4
(TEST WELL 7)

Depth (Below Ground Surface)		Description
Metres	Feet	
0.00 - 23.77	0 - 78	Sand and gravel, silty
23.77 - 43.28	78 - 142	Sand, silty, bark pieces at bottom of unit
43.28 - 78.63	142 - 258	Silt, occasional sand bed
78.63 - 98.15	258 - 322	Sand, brown, silty, <u>water-bearing</u>
98.15 - 124.97	322 - 410	<u>Clay, silt beds,</u> stoney
124.97 - 125.58	410 - 412	Gravel, silty, <u>water-bearing</u>
125.58	412	<u>Till</u>

Construction Details - below ground surface

	Metres	Feet
203 mm (8-inch) diameter casing	+0.55 - 94.49	+1.8 - 310
178 mm (7-inch) diameter riser	92.96 - 94.49	305 - 310
203 mm (8-inch) telescopic diameter screen	94.49 - 97.54	310 - 320
178 mm (7-inch) diameter sump	97.54 - 103.63	320 - 340
Screen - stainless steel, 8 slot		

HATCH POINT
DOMESTIC WELL NO. 5
(TEST WELL "E")

Depth (Below Ground Surface)		Description
Metres	Feet	
0.00 - 42.67	0 - 140	Sand and gravel
42.67 - 51.21	140 - 168	Sand, silty
51.21 - 55.78	168 - 183	Sand and gravel
55.78 - 63.70	183 - 209	Sand, silty
63.70 - 71.63	209 - 235	Silt with clay beds
71.63 - 73.76	235 - 242	Sand and gravel, silty
73.76 - 83.82	242 - 275	Clay, well bedded
83.82 - 85.65	275 - 281	Sand and gravel, silty
85.65 - 111.25	281 - 365	Sand, some gravel <u>water-bearing</u>
111.25 - 111.56	365 - 369	Interbedded sand and clay

Construction Details - below ground surface

	Metres	Feet
203 mm (8-inch) diameter casing	+0.80 - 104.55	+2.6 - 343
178 mm (7-inch) diameter riser	103.02 - 104.55	338 - 343
203 mm (8-inch) telescopic diameter screen	104.55 - 110.64	343 - 363
178 mm (7-inch) diameter sump	110.64 - 112.17	363 - 368
Screen - stainless steel, 10 slot		