203 - 2902 West Broadway, Vancouver, BC, Canada V6K 2G8 • Tel: (604) 733-5930 • Fax: (604) 733-5931

Enterprise Geoscience Services Ltd.

Myrtle Pond Water System
Water Source Yield Assessment

Project No. 14005

August, 2014

203 - 2902 West Broadway, Vancouver, BC, Canada V6K 2G8 • Tel: (604) 733-5930 • Fax: (604) 733-5931

Enterprise Geoscience Services Ltd.

Myrtle Pond Water System
Water Source Yield Assessment
Powell River, BC

Prepared For
Powell River Regional District
Powell River, BC

Prepared by
Enterprise Geoscience Services Ltd.
Vancouver, B.C.

Distribution:	Powell River Regional District	2 copies
	Enterprise Geoscience Services Ltd.	1 copy

Project No. 14005

August, 2014

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

1.0 Introduction

1.1 Terms of Reference

The Powell River Regional District (PRRD) applied for and received a federal grant through the Community Infrastructure Improvement Fund to upgrade the Myrtle Pond Water System (MPWS) located southeast of Powell River, BC (Figure 1). Three drilled wells serve as the water supply source. The primary objective of the grant funding is to improve the treatment for the water system and the PRRD has retained Kerr Wood Leidal (KWL) of Burnaby, BC to design the treatment system upgrades and procure new equipment. As part of the commitments for the grant funding, PRRD must document that the water source is capable of meeting the system demand. This report provides an assessment of the individual and combined safe yield of the three water system source wells.

1.2 Background

1.2.1 Water Supply Source and System Demand

The Myrtle Creek Estates (MCE) development is a rural subdivision located approximately 10 km southeast of Powell River. The property occupies District Lots 1499 and 1650 in the community of Myrtle Pond and is comprised of 58 lots. A potential build-out of the MCE includes 26 additional lots, for a total of 84 connections. An additional 50 properties outside of MCE that are currently supplied by private wells may also be connected to the MPWS, for a total of 134 connections. Average daily demand (ADD) and maximum daily demand (MDD) for current (58), build-out (84) and future connections (134) were determined by KWL based on Rural Design Guidelines (Table 1). According to the water system operator, in addition to domestic use, the water system is used periodically by the local fire department for suppression of structure fires and wildfires resulting in rapid drawdown of the storage reservoir.

Table 1. Average and maximum daily demand

Scenario	ADD[1] (m^3/d)	ADD (US GPM)	MDD[2] (m^3/d)	MDD (US GPM)
Current - 58 Lots	58	11	164	30
Build-Out - 84 Lots	79	15	232	43
Future Connections (incl. across the highway) - 134 Lots	122	22	366	67

Notes:
1. ADD = average daily demand (equals indoor use plus system leakage)
2. MDD = maximum daily demand (equals ADD + irrigation use)

Three pumping wells currently serve the water system: W-93, MCE 1-05 and MCE 2-08 (Figure 2). W-93 is an open rock well 163 m deep; 1-05 is a screened overburden well 30.5 m deep and 2-08 is a screened overburden well 73 m deep. Well 2-08 was originally screened at a similar depth to 1-05, but was deepened in 2009 due to drawdown interference when 1-05 and 2-08 were pumping simultaneously. Construction logs for all wells are provided in Appendix A. A site plan showing the locations of the wells and the as-built details is presented in Figure 2, developed by McElhanney Consulting Services. Note that well 2-08 was deepened subsequent to the date this drawing was originally produced and the construction log for the deepened well is included in Appendix A.

The yield and condition of these wells for long term water supply has been evaluated in several studies by various consultants. These studies include:

- Pacific Hydrology Consultants (PHC), 1993. Completion Report Construction and Testing of a Water Well for Myrtle Pond Waterworks, October 25, 1993 report to Powell River Regional District (Well W-93).
- Piteau Associates Engineering Ltd. (PAEL), 2005. Hydrogeologic Assessment for Groundwater Supply, Myrtle Pond Water Works, Powell River, BC, March 3, 2005 letter report to Mr. Irfan Gehlen, P.Eng, Kerr Wood Leidal Associates Ltd (Well W-93).
- PHC, 2005. Construction and Capacity Testing of Myrtle Creek Estates Well 1-05, Located in the Northwest Corner of D.L. 1499 in the Myrtle Creek Area, April 12, 2005 report to Mr. Tod English, Myrtle Creek Estates (Well 1-05).
- PHC, 2008. Well Construction and Capacity Testing of Myrtle Creek Estates Well 2-08, Report to Myrtle Creek Estates (Original Well 2-08).
- Hodge Hydrologeology Consulting (HHC), 2010. Myrtle Creek Estates – Well Construction and Capacity Testing of Deepened Well 2-08, April 29, 2010 letter

report to Mr. Tod English, Myrtle Creek Estates (testing of Well 2-08 deepened in 2009).

Well W-93

Well W-93 was drilled in 1993 to a total depth of 163 metres. The well was drilled through overburden with 150 mm diameter steel casing to 30.5 m and then open hole through shale bedrock to the total depth. Two water-bearing fracture zones were identified between 133 -140 m and 159 -161 m. PHC conducted a pumping test in 1993 and concluded that the well would have a safe yield of at least 1.82 L/s (29 USgpm). Based on the original test, the calculated transmissivity was 9.8 m^2/day. The well was put in operation in 1993 and by 2004 concerns were raised about declining water levels in a well on a neighboring property. PAEL conducted a review of the well performance in 2004 and concluded the static level in the well had dropped 46 m from the initial level measured in 1993. They followed up with a pumping test in 2004 comparable to the one performed in 1993 (same pumping rate and duration) and observed a more pronounced rate of drawdown in the 2004 pumping test and determined formation transmissivity had declined to 3.8 m^3/d. PAEL concluded that the large (46 m) decline in static level over the 11 year operating period was likely due to over-pumping of well. They concluded that the well would eventually fail if it was continued to be pumped at the average rate over the 1993-2004 period (0.82 L/s or 13 USgpm). Based on the above, the safe long-term yield of W-93 is uncertain, but is less than 13 USgpm.

Well 1-05

MCE 1-05 was drilled in 2005 to augment the MPWS. The well screens unconsolidated sediments (sand, gravel, silt) between 23.9 and 30.5 m bgs; the initial static water level prior to the pumping test in March 2005 was approximately 12.6 metres below ground surface. During the pumping test, MCE 1-05 was pumped for 24 hours at 1.04 L/s (16.5 USgpm) which resulted in 9.73 metres of drawdown. PHC determined the 100-day specific capacity of the well to be 0.09 L/s/m (0.44 USgpm/ft) with an estimated long term capacity of 0.70 L/s (11 USgpm). A second three-day pumping test was conducted on MCE 1-05 in 2006 which produced similar estimates of 100-day specific capacity (0.096 L/S/m) and long term capacity (0.71 L/s or 11.2 USgpm). This well should be currently capable of supplying 0.7 L/s (11 USgpm) unless capacity has decreased somewhat due to iron fouling or other causes since 2006. If capacity has decreased due to routine operation, well cleaning and redevelopment should bring the well back close to original capacity.

Well 2-08 (Deepened in 2009)

In 2008, a third pumping well, MCE 2-08, was established in the MCWS under the supervision of PHC. MCE 2-08 originally screened unconsolidated sediments (coarse sand with fine gravel) between 27.6 and 29.0 mbgs. After a three-day pumping test, PHC concluded that the combined yield of MCE 1-05 and MCE 2-08 could supply 1.5-1.6 L/s (23.7-25.5 USgpm). However, it was found that when MCE 1-05 and MCE 2-08 were pumped simultaneously, significant drawdown interference occurred due to both wells screening the same aquifer and being located in close proximity to one another. This ultimately limited the yield of MCE 2-08 and it was decided that it should be deepened to increase the amount of available drawdown.

In 2009, MCE 2-08 was deepened with fine (0.008 and 0.006 inch slot openings) stainless steel well screens set between 68.3 m and 73.1 m. The drilling contractor, Drillwell Enterprises, described the screened sediments as 'grey sand/cleaner'. Under the direction of Hodge Hydrogeology Consulting (HHC), Vanderkemp Sales and Service Ltd. performed a 24-hour pump test at MCE 2-08 in January 2010. The pumping rate started at 1.83 L/s (29 USgpm) and declined to 26.4 USgpm by the end of the test. The test did not influence water levels at MCE 1-05 or W-93 and the final drawdown measured in MCE 2-08 at the end of pumping was less than 1.2 m (4 ft). HHC determined from the test results that the 100-day specific capacity of the deepened well MCE 2-08 was 0.078 L/s/m (0.38 USgpm/ft) based on an available drawdown of 37.6 m (123.4 ft) and a predicted drawdown of 10 ft after 100 days of pumping at 26.4 USgpm. Available drawdown was calculated as the difference between the static water level and mean sea level (62 metres below top of casing), a distance of 37.6 m. The long term well capacity, calculated using a 50% safety factor, was determined to be 1.47 L/s (23.4 USgpm).

1.2.2 Scope of Work

In 2014, Enterprise Geoscience Services Ltd. (EGSL) was contracted to review all existing reports on yield assessment for the three source wells and make conclusions and recommendations with respect to the ability to meet the required ADD and MDD. Based on this review it was noted that the original test on the deepened well 2-08 was poorly executed and did not significantly stress the aquifer (i.e. pumping at the test rate of 26 to 29 USgpm resulted in only 1.2 m of drawdown of the available 37.6 m or about 3% of available drawdown using sea level and not the top of the screen packer assembly as maximum pumping level).

Based on the findings of our review, it was recommended that well 2-08 be retested at a higher pumping rate to stress the aquifer. This recommendation was accepted by PRRD

and McGill's Well Service and Supply (MWSS) of Courtenay, BC was retained to conduct a new pumping test. EGSL's scope of work involved design of the test, attendance at the job site during testing, and preparation of this report.

2.0 Pumping Test of Well 2-08

Long term capacity of the deepened well MCE 2-08 was determined via a 24-hour constant rate pumping test which was preceded by an 80-minute step drawdown test. Both tests were monitored by personnel from EGSL. The step drawdown test was used to determine a sustainable pumping rate for the duration of the 24-hour pumping test. Weather was sunny and dry throughout the test period.

On June 2nd, 2014, MGWS pulled the existing 2 hp single phase pump (Goulds 33GS20 submersible pump), chlorinated the well and inspected it with a camera. The camera inspection indicated the well screens appeared to be clean and in good shape. A 7.5 hp 3 phase test pump (McDonald, Model No. 24750T) was deployed to 64.3 m bgs (intake) on 2" galvanized steel pipe (Photo 1). The wellhead assembly was equipped with a vertical mounted flowmeter (Blue-White Industries Model F300); flow rates were also verified by measuring the time to fill 40 US gallons in a graduated drum (Photo 2). Drawdown was measured with a datalogger and manual measurements in well 2-08 and periodically by hand in the other two wells. Because well 2-08 screens a confined aquifer, water discharged to ground surface near the wellhead was not expected to recharge the aquifer or influence drawdown response. Accordingly, water was discharged about 15 m away from the well head down a slope leading to a forested area.

Photo 1: 7.5 hp 3 phase test pump

Photo 2: F-300 Flow meter. Discharge line and measuring drum in background.

A step drawdown test was initiated in the afternoon of June 2, 2014. The water levels at all wells were manually dipped prior to pumping and an M20 Solinst Levelogger was deployed in a stilling tube in the pumping well to record the water level (in conjunction with manual measurements). The step test consisted of four steps, 20 minutes in duration, where the well was pumped at 40, 55, 70 and 100 USgpm (2.5, 3.5, 4.4 and 6.3 L/s). Despite initial overshooting of the target pump rate in the first step, the test proceeded smoothly and water levels stabilized within minutes of adjusting the flow rates. The data are presented in Figure 3. While a 100 USgpm pumping rate would have been sustainable for a 24-hour test, 80 USgpm was utilized to allow for any adjustments of the flow rate (the pump was operating near maximum capacity at 100 USgpm). The 80 USgpm test rate is also considerably greater than the required MDD of 67 USgpm at maximum build-out.

The 24-hour constant rate discharge test was initiated the morning on June 3, 2014. MCE 2-08 had recovered completely from the step test the previous evening. Manual water level readings were recorded at the pumping well and less frequently at MCE 1-05 and W-93. The levelogger was re-deployed at the pumping well. In addition, a Solinst Barologger monitoring ambient air pressure was also deployed to later correct the (non-vented) Levelogger readings. Flow rates were initially monitored via the flow meter and barrel measurements, which were found to agree well. Most flow readings for the latter portion of the test were taken from the flow meter. After about 12 hours of pumping, it was noted that the pumping rate had perceptibly decreased, and the flow rate was adjusted upward. Otherwise, the flow rate was not manipulated during the test.

Field measurements of discharge water quality parameters (pH, specific conductance (EC), temperature, dissolved oxygen (DO) and oxidation-reduction potential (ORP)) were continuously measured using a YSI Pro multi-parameter probe. A slow stream of water was directed to a flow cell connected to the probe via a sampling port on the well head assembly (Photo 3). Immediately before the cessation of pumping, a water sample was collected and submitted to ALS Environmental of Vancouver for analysis of total metals, anions and general parameters (pH, TDS, TSS, etc.). Plots of water quality parameters over time during the constant rate test are presented in Figure 5.

Upon cessation of pumping after 24 hours, water level recovery was monitored in the pumping well until 90% recovery had occurred (approximately 2 hours). The test pump was pulled and the original pump and pump string was cleaned with a mild bleach solution and re-deployed in the well.

Photo 3: Wellhead arrangement for pumping test and flow through cell for water quality measurements.

3.0 Results

Drawdown and recovery water levels from the 24-hour constant rate tests are plotted in Figure 4. Water levels in wells MCE 1-05 and W-93 were also measured during the test; however, the data do not indicate influence from pumping of well MCE 2-08. MCE was periodically pumped during the pumping test at MCE 2-08 and responded solely to this activity; W-93 was pumped for three hours the evening prior to the start of the constant rate test and recovered throughout the duration of the pumping test at MCE 2-08. All manual water level measurements at MCE 2-08, MCE 1-05 and W-93 are tabulated in Appendix B.

As can be seen in Figure 4, there is a slight perturbation in the drawdown data from MCE 2-08 halfway through the test which corresponds to a slight adjustment in the pumping rate. The pumping rate was nearly constant in the early portion of the test at ~82 USgpm, however, it gradually declined to 78 USgpm as the test progressed and was adjusted at the 700 minute mark. A pumped rate of 80 USgpm is used for subsequent calculations of well capacity and aquifer transmissivity.

3.1 Well capacity

According to the BC Ministry of Environment publication "*Evaluating Long-term Well Capacity for a Certificate of Public Convenience and Necessity*," the document referenced by the conditions that PRRD must fulfil for the funding grant, long term well capacity is determined from the equation:

Long Term Well Capacity = (Available drawdown) * 0.7 * (100-day specific capacity)

The 100-day specific capacity is calculated by extrapolating the drawdown from the constant rate pumping test to 100 days and dividing the pumping rate by this number. From Figure 4, it can be seen that the extrapolated drawdown from the latter portion of the test is 20.8 m. This translates to a 100-day specific capacity of 0.24 L/s/m (1.16 USgpm/ft). The factor of 0.7 is a safety factor used in determining safe yield.

Available drawdown is the difference between the static (pre-pumping) water level and a lower bound, normally taken as about 3 m above the screen assembly to allow for pump submergence. In the case of MCE 2-08, an appropriate conservative lower bound is mean sea level (note top of casing elevation is 62 m above sea level) to prevent any potential for overpumping to cause salt water intrusion to the aquifer. Using mean sea level as the lower bound, the available drawdown in the well is about 35.6 m. Based on this lower bound datum, the long-term well capacity is computed at 0.7*35.6m*0.24 L/s/m, or 6 L/s (95 USgpm). However, since the well was pumped at 80 USgpm, a more conservative assessment of long term yield is 80 USgpm.

3.2 Aquifer Transmissivity

Drawdown and recovery data from the 24-hour constant rate test were analysed using the aquifer test analysis software AQTESOLV Pro v. 4.5 (Appendix C). The data were analysed using the Dougherty-Babu Method (1984), an analytical solution for pumping tests performed in homogeneous, isotropic, confined aquifers where the pumped well is partially penetrating the aquifer. This method also takes into account well storage (i.e. the resident column of water above the pump) and well skin (the disturbance area around the well screen). Overall, this method was found to match early-time drawdown (due to

wellbore storage effects) and the derivative (change in drawdown through time) better than the Theis method (1935), however, both methods provided relatively similar results. Based on this analysis, a transmissivity value of $9x10^{-4}$ m^2/s is considered reasonable. An aquifer transmissivity of $9x10^{-4}$ m^2/s corresponds to a hydraulic conductivity value of $7x10^{-5}$ m/s, assuming an aquifer thickness of 12.8 m based on the well construction log. This value lies within the representative range of hydraulic conductivity of sand ($2x10^{-7}$ to $6x10^{-3}$ m/s) (Domenico and Schwartz, 1998).

3.3 Water Quality

Water quality parameters measured during the 24-hour constant rate test are plotted in Figure 5. Overall, field parameters essentially stabilized within 300 minutes and trended slightly thereafter. Final field measurements were pH 8.5, specific conductance 222 uS/cm, dissolved oxygen 0.07 mg/L and oxidation reduction potential -200 mV. During testing, the discharge was noted to have a sulfuric ("rotten egg") odor. The analytical results (Table 2) indicate that the water is of good quality with low levels of dissolved solids. Laboratory pH (8.36) and specific conductivity (237 uS/cm) results generally agree with the field measurements. None of the parameters exceed health based maximum acceptable criteria. Dissolved manganese (0.0824 mg/L) and color (15.7 CU) slightly exceed aesthetic objectives and pH is near the upper limit of the acceptable range (6.5-8.5). A copy of the laboratory report is contained in Appendix D.

4.0 Conclusions and Recommendations

Based on review of existing reports and the recent pumping test in 2-08, the following conclusions are made:

- The average day demand (ADD) and maximum day demand (MDD) for the water system at full build out are 22 and 67 USgpm, respectively. In addition to these domestic requirements, it is understood that the local fire services periodically uses the water system for suppression of structure fires and wildfires resulting in rapid drawdown of the water system reservoir.
- The safe yield of well W-93 is uncertain, but is less than 13 USgpm.
- The safe yield of well 1-05 is 11 USgpm.
- The safe yield of well 2-08 is 80 USgpm.
- The safe yield of well 2-08 and combined yield of all three wells is greater than the MDD.

- The methods used to assess the well yields are considered acceptable to satisfy the grant funding obligations.
- The water quality in well 2-08 meets the drinking water guidelines for all health based parameters. Colour and manganese are slightly above the aesthetic objectives.

Based on the conclusions, the following recommendations are made:

- PRRD should submit this report to the grant funding agency as partial fulfilment of the grant conditions.
- The cost to install three phase power and install a larger submersible pump in well 2-08 should be determined and if feasible, the well should be outfitted with a new pump and power source.
- Well 2-08 should be operated such that the pumping water level remains above mean sea level.
- Given the use of the water system for periodic fire fighting, as much redundancy as possible is desirable for the water system. All three wells should remain in active operation.

5.0 Closure

We trust that this report satisfies the present requirements of the PRRD. Any questions or concerns should be directed to the undersigned.

Respectfully submitted,

Enterprise Geoscience Services Ltd.

Laura Findlater, P.Geo.
Hydrogeologist, Lorax Environmental Services

John Balfour, P.Eng.
Hydrogeologist

References

BC Ministry of Environment, 2014. Evaluating long-term well capacity for a certificate of public convenience and necessity: a guidance document. Accessed June 20, 2014: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/eval_well/index.html

Domenico, P.A., and F.W Schwartz. 1998. Physical and Chemical Hydrogeology, Second Edition. John Wiley & Sons, Inc, New York. 506 pp.

Dougherty, D.E and D.K. Babu, 1984. Flow to a partially penetrating well in a double-porosity reservoir, Water Resources Research, vol. 20, no. 8, pp. 1116-1122.

HHC, 2010. Myrtle Creek Estates – Well Construction and Capacity Testing of Deepened Well 2-08. Hodge Hydrogeology Consulting (HHC). April 29, 2010 letter report to Mr. Tod English, Myrtle Creek Estates.

McCammon, J.W. 1977. Surficial geology and Sand and Gravel Deposits of Sunshine Coast, Powell River, and Campbell River Areas. Ministry of Energy, Mines and Petroleum Resources Bulletin 65, 36 pp.

PEAL, 2005. Hydrogeologic Assessment for Groundwater Supply, Myrtle Pond Water Works, Powell River, B.C. Piteau Associates (PAEL). March 3, 2005 letter report to Mr. Irfan Gehlen, P.Eng, Kerr Wood Leidal Associates Ltd.

PHC, 2008. Well Construction and Capacity Testing of Myrtle Creek Estates Well 2-08. Pacific Hydrology Consultants Ltd. (PHC). 2008 Report to Myrtle Creek Estates.

PHC, 2005. Construction and Capacity Testing of Myrtle Creek Estates Well 1-05, Located in the Northwest Corner of D.L. 1499 in the Myrtle Creek Area. Pacific Hydrology Consultants Ltd. (PHC). April 12, 2005 report to Mr. Tod English, Myrtle Creek Estates.

PHC, 1993. Completion Report Construction and Testing of a Water Well for Myrtle Pond Waterworks. Pacific Hydrology Consultants Ltd. (PHC). October 25, 1993 report to Powell River Regional District.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

Figures

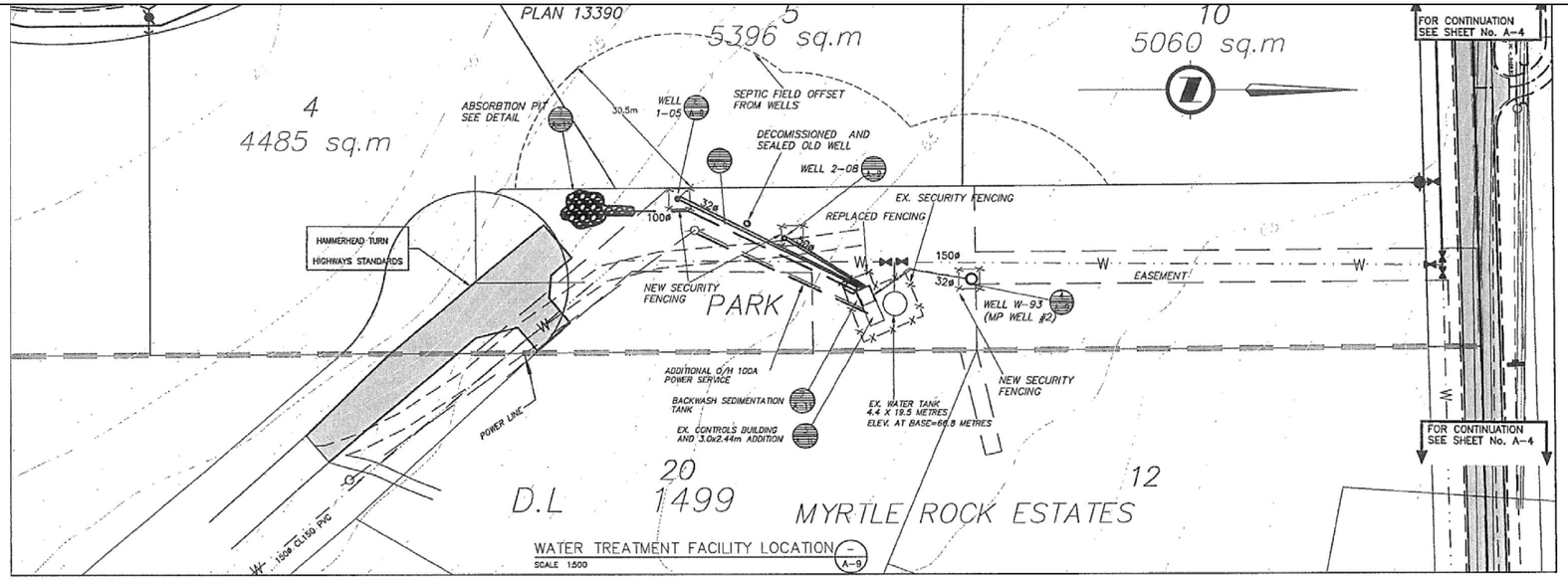
SCALE 1:50,000

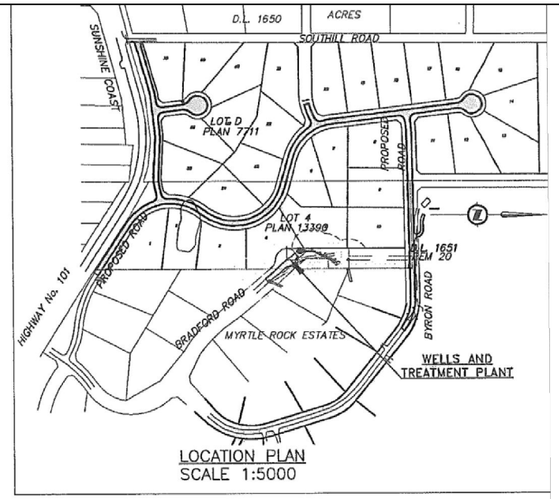
0.5 0 0.5 1.0 2.0km

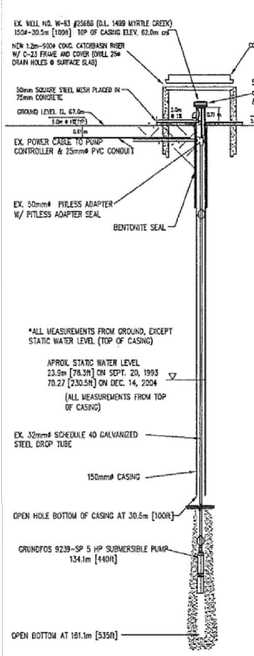
Enterprise Geoscience Services Ltd.
203 - 2902 West Broadway
Vancouver, BC, V6K 2G8

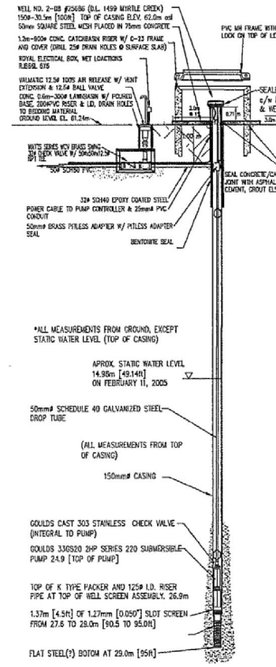
CLIENT:	**Powell River Regional District**
PROJECT:	**Pumping Test of Well 2-08 (Deepened in 2009)**
TITLE:	**Location Plan**

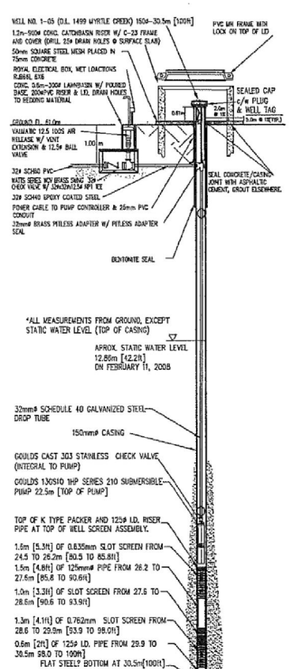
DRAWN BY:	YL	CHK. BY:	JB
DATE:	2014/06/23	REVISED:	
PROJ #:	201405		FIGURE 1

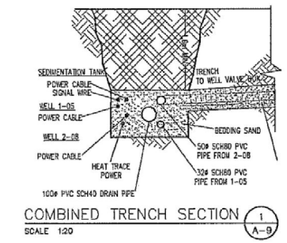












FOR ELECTRICAL AND CONTROL DETAILS, REFER TO OPERATIONS MANUAL.

THE PURPOSE OF THIS DRAWING IS TO DOCUMENT CONSTRUCTED WORKS AS REVIEWED BY MCELHANNEY CONSULTING SERVICES LTD (MCSL) ON OCTOBER 22, 2010. PLEASE NOTE:

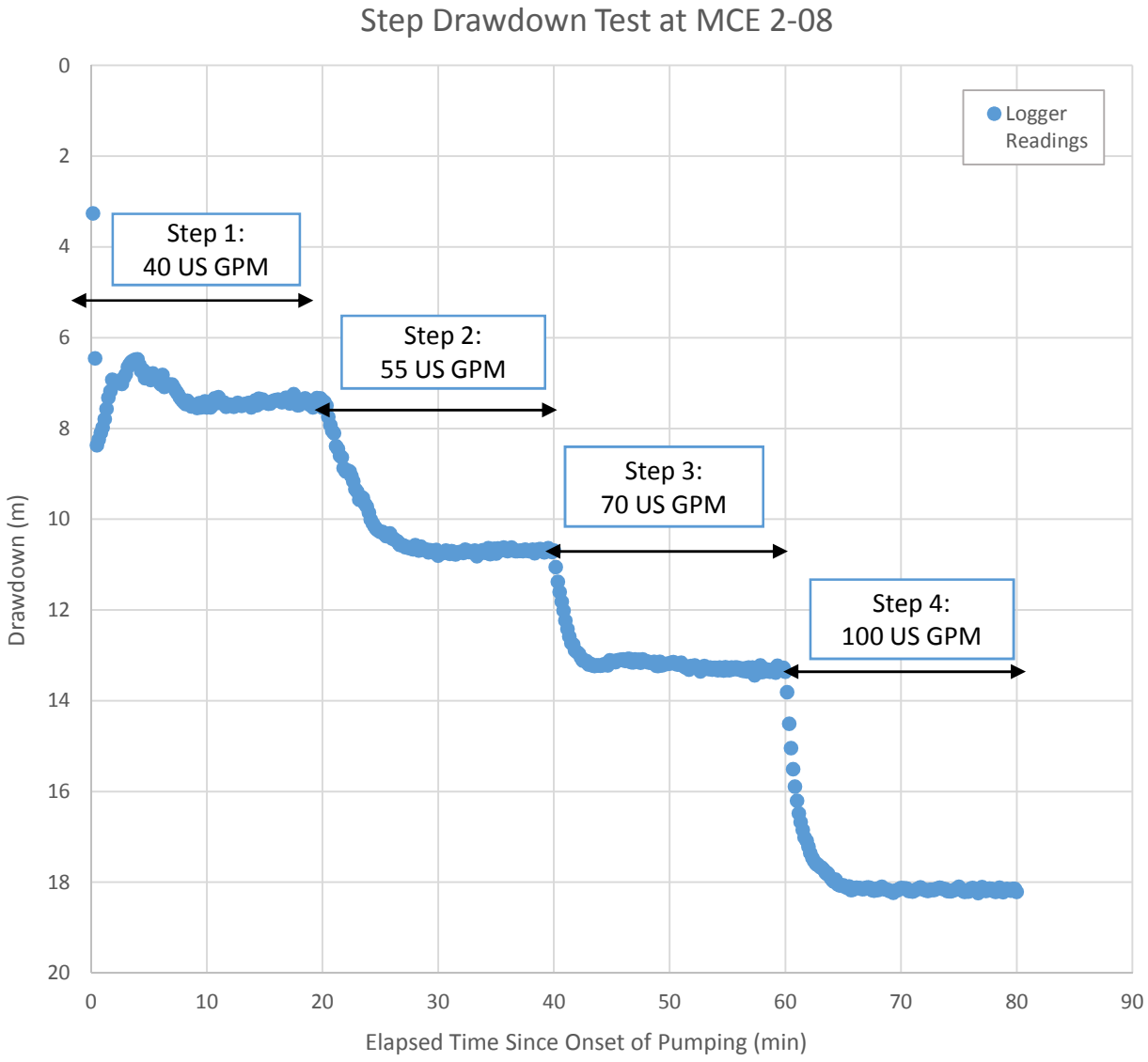
- RECORD OF CONSTRUCTION DETAILS LIMITED TO MECHANICAL ITEMS.
- DETAILS FOR ELECTRICAL DEVICES AND CONTROLS NOT RECORDED.
- RECORD DRAWINGS PROVIDED FOR DOCUMENTATION PURPOSES ONLY.
- MCSL DOES NOT WARRANT OR GUARANTEE, NOR ACCEPT ANY RESPONSIBILITY FOR THE AS-CONSTRUCTED SYSTEM.

Notes:

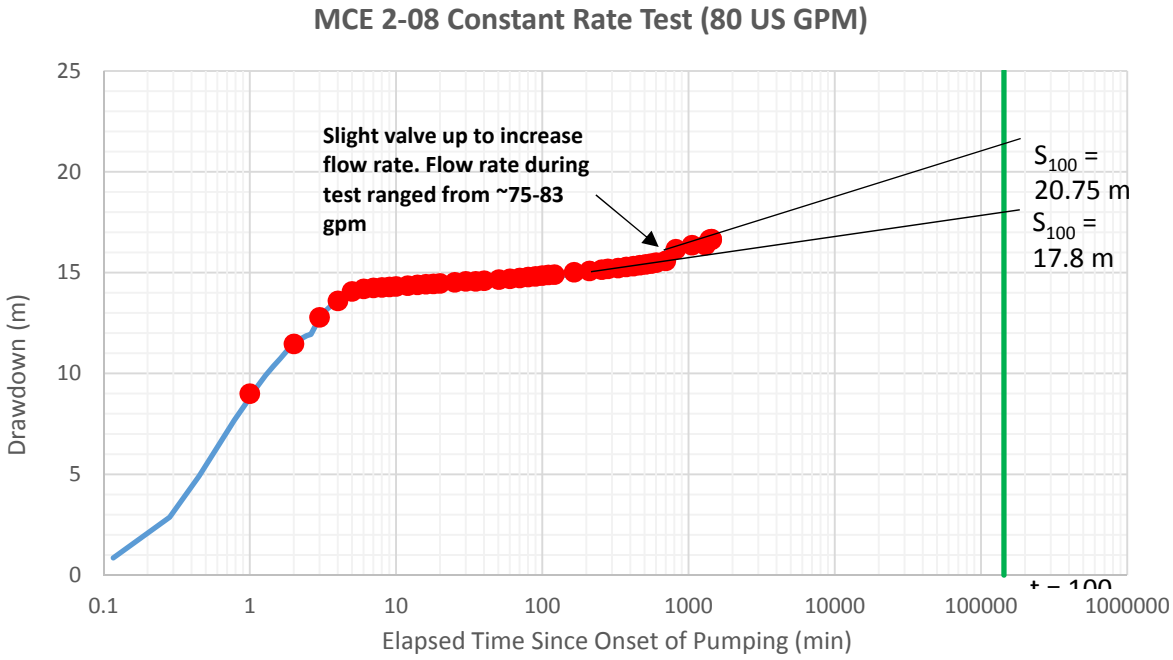
1. Source for Drawing: McElhanney Consulting Services Dwg 2211-46751-0 B-1
2. Well 2-08 was deepened in 2009. Refer to report by Hodge Hydrology Consulting Appendix A

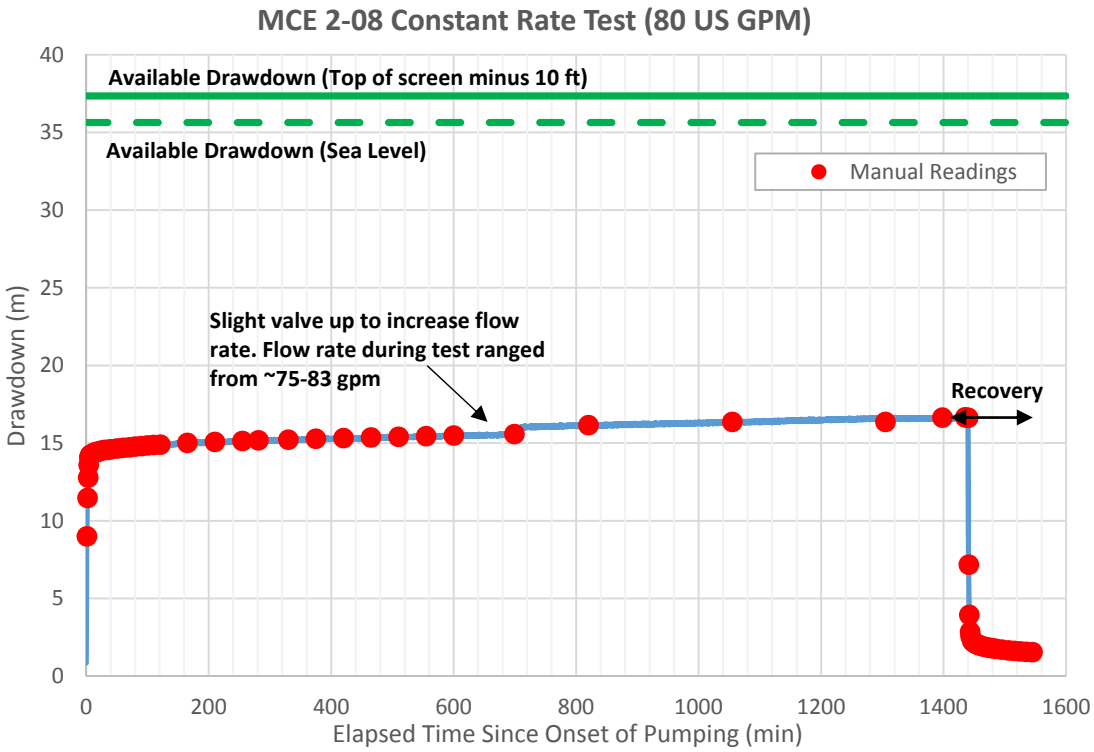
Enterprise Geoscience Services Ltd.
203 - 2902 West Broadway
Vancouver, BC, V6K 2G8

CLIENT:	**Powell River Regional District**
PROJECT:	**Pumping Test of Well 2-08 (Deepened in 2009)**
TITLE:	**As-Builts for Well Construction**
DRAWN BY: YL	CHK. BY: JB
DATE: 2014/06/23	REVISED:
PROJ #: 201405	FIGURE 2

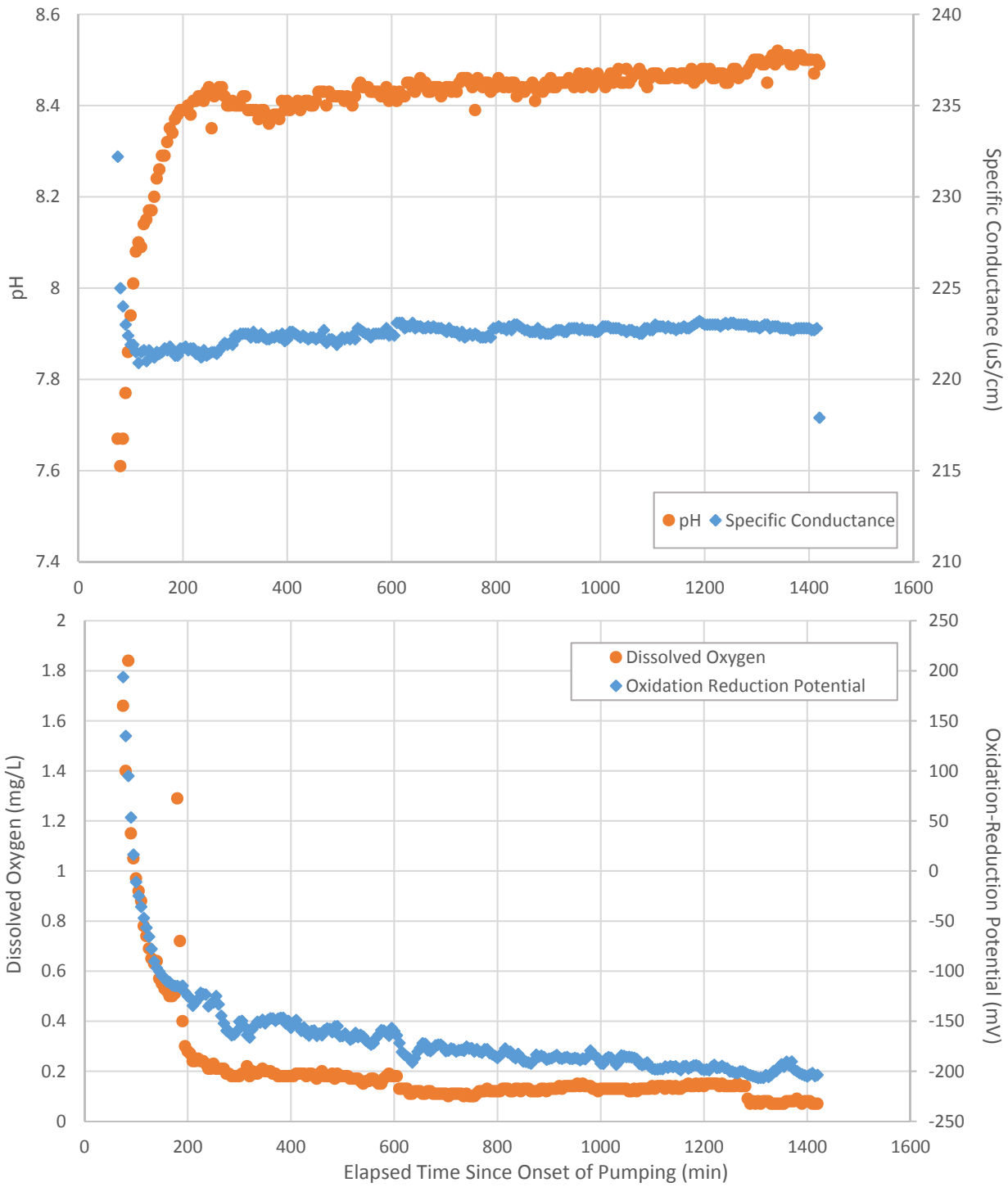


Prepared By: Enterprise Geoscience Services Ltd.	Client	Powell River Regional District	
	Project	Pumping Test of Well 2-08 (Deepened in 2009)	
	Title	Step Test	
	Date	June 23, 2014	Figure 3





Prepared By: Enterprise Geoscience Services Ltd.	Client	Powell River Regional District
	Project	Pumping Test of Well 2-08 (Deepened in 2009)
	Title	Constant Rate Test
	Date	June 23, 2014 — Figure 4



Prepared By: Enterprise Geoscience Services Ltd.	Client	Powell River Regional District
	Project	Pumping Test of Well 2-08 (Deepened in 2009)
	Title	Water Quality Field Parameters During Constant Rate Test
	Date	June 23, 2014
		Figure 5

Tables

Table 2: MCE 2-08 water quality screened against Health Canada guidelines for drinking water

Sample ID Date Sampled Time Sampled ALS Sample ID Matrix	Units	MCE 2-08 04-JUN-14 08:00 L1466295-1 Water	Guidelines MAC[1] mg/L	 AO[2] mg/L	 OG[3] mg/L	Comment
Physical Tests						
Colour, True	CU	***15.7***		15		
Conductivity	uS/cm	237				
Hardness (as $CaCO_3$)	mg/L	54.4				
pH	pH	8.36				acceptable range 6.5-8.5
Total Dissolved Solids	mg/L	176		500		
Turbidity	NTU	0.42				treated water <0.1 NTU at all times
Anions and Nutrients						
Alkalinity, Total (as $CaCO_3$)	mg/L	118				
Chloride (Cl)	mg/L	9.01		250		
Fluoride (F)	mg/L	0.112	1.5			
Nitrate (as N)	mg/L	<0.0050	10			
Nitrite (as N)	mg/L	<0.0010	1			
Sulfate (SO4)	mg/L	<0.50		500		
Total Metals						
Aluminum (Al)-Total	mg/L	<0.010			0.1, 0.2	0.1 for conventional treatment, 0.2 other treatment types
Antimony (Sb)-Total	mg/L	<0.00050	0.006			
Arsenic (As)-Total	mg/L	0.00074	0.01			As low as reasonably achievable
Barium (Ba)-Total	mg/L	<0.020	1			
Boron (B)-Total	mg/L	<0.10	5			
Cadmium (Cd)-Total	mg/L	<0.00020	0.005			
Calcium (Ca)-Total	mg/L	12.6				
Chromium (Cr)-Total	mg/L	<0.0020	0.05			
Copper (Cu)-Total	mg/L	<0.0010		1		
Iron (Fe)-Total	mg/L	0.079		0.3		
Lead (Pb)-Total	mg/L	<0.00050	0.01			
Magnesium (Mg)-Total	mg/L	5.56				
Manganese (Mn)-Total	mg/L	***0.0824***		0.05		
Mercury (Hg)-Total	mg/L	<0.00020	0.001			
Potassium (K)-Total	mg/L	3.04				
Selenium (Se)-Total	mg/L	<0.0010	0.01			
Sodium (Na)-Total	mg/L	30.4		200		
Uranium (U)-Total	mg/L	<0.00010	0.02			
Zinc (Zn)-Total	mg/L	<0.050		5		

Notes:

1. MAC: maximum acceptable concentration, health based
2. AO: aesthetic objective
3. OG: operational guideline

Formatted number exceeds aesthetic objective.

Appendix A

Well Logs

MYRTLE POND WATER SUPPLY WELL

(W-93)

Location: In Powell River Regional District, in the northwest part of D.L. 1499, approximately ten kilometres east of Powell River.

Date of construction: September 1993.

Drilling contractor: Nor-West Water Well Drilling Ltd.

Drillers litholog:

0 - 1.5 m	(0 - 5 ft)	stoney top soil
1.5 - 5.9 m	(5 - 18 ft)	stoney brown clay
5.9 - 10.4 m	(18 - 34 ft)	brown silty sand and gravel
10.4 - 17.7 m	(34 - 58 ft)	sand and gravel (loose)
17.7 - 27.1 m	(58 - 89 ft)	wet, tilly grey gravel (very silty)
27.1 - 29.3 m	(89 - 96 ft)	grey clay and silt layers
29.3 - 38.4 m	(96 -126 ft)	silty, very fine sand (wet)
38.4 - 40.2 m	(126 -132 ft)	silty, very fine sand
40.2 - 48.5 m	(132 -159 ft)	silty clay
48.5 - 66.1 m	(159 -217 ft)	wet silt with vegetation
66.1 - 67.4 m	(217 -221 ft)	fine sand; water-bearing
67.4 - 77.7 m	(221 -255 ft)	silty, very fine sand with layers of clay; water-bearing
77.7 - 94.2 m	(255 -309 ft)	clay
94.2 -100.0 m	(309 -328 ft)	till and boulders
100.0 -103.6 m	(328 -340 ft)	tight till and layers of sand
103.6 -116.1 m	(340 -381 ft)	cemented sand and gravel
116.1 -133.5 m	(381 -438 ft)	green sandy shale
133.5 -136.6 m	(438 -448 ft)	fractured green and black sandy shale
136.6 -138.7 m	(448 -455 ft)	green and black shale with sandstone stringers
138.7 -146.3 m	(455 -480 ft)	fractured green and black shale with quartz lenses
146.3 -158.5 m	(480 -520 ft)	fractured black shale and quartz lenses
158.5 -159.7 m	(520 -524 ft)	black shale (sandstone mix)
159.7 -160.9 m	(524 -528 ft)	fractured light green shale
160.9 -163.1 m	(528 -535 ft)	black shale.

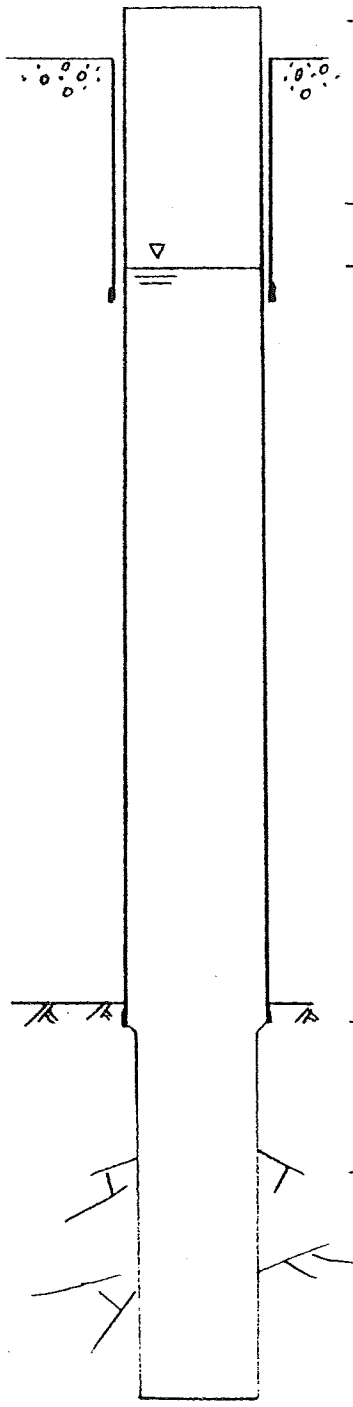
Diameter: 150 mm (6") with 200 mm (8") diameter casing to 30.5 m (100 ft).

Completed depth of well: 163.1 m (535 ft).

Static water level: 23.9 m (78.25 ft) below ground on September 20, 1993.

FIGURE 3	MYRTLE POND WELL CONSTRUCTION DETAILS

(W-93)



150 mm (6") diameter well casing stickup = 1.2 m (4 ft).

200 mm (8") diameter casing extends to 30.5 m (100 ft).

On September 20, 1993, prior to pump testing, static water level = 24.5 m (80.25 ft) below the 150 mm (6") diameter well casing.

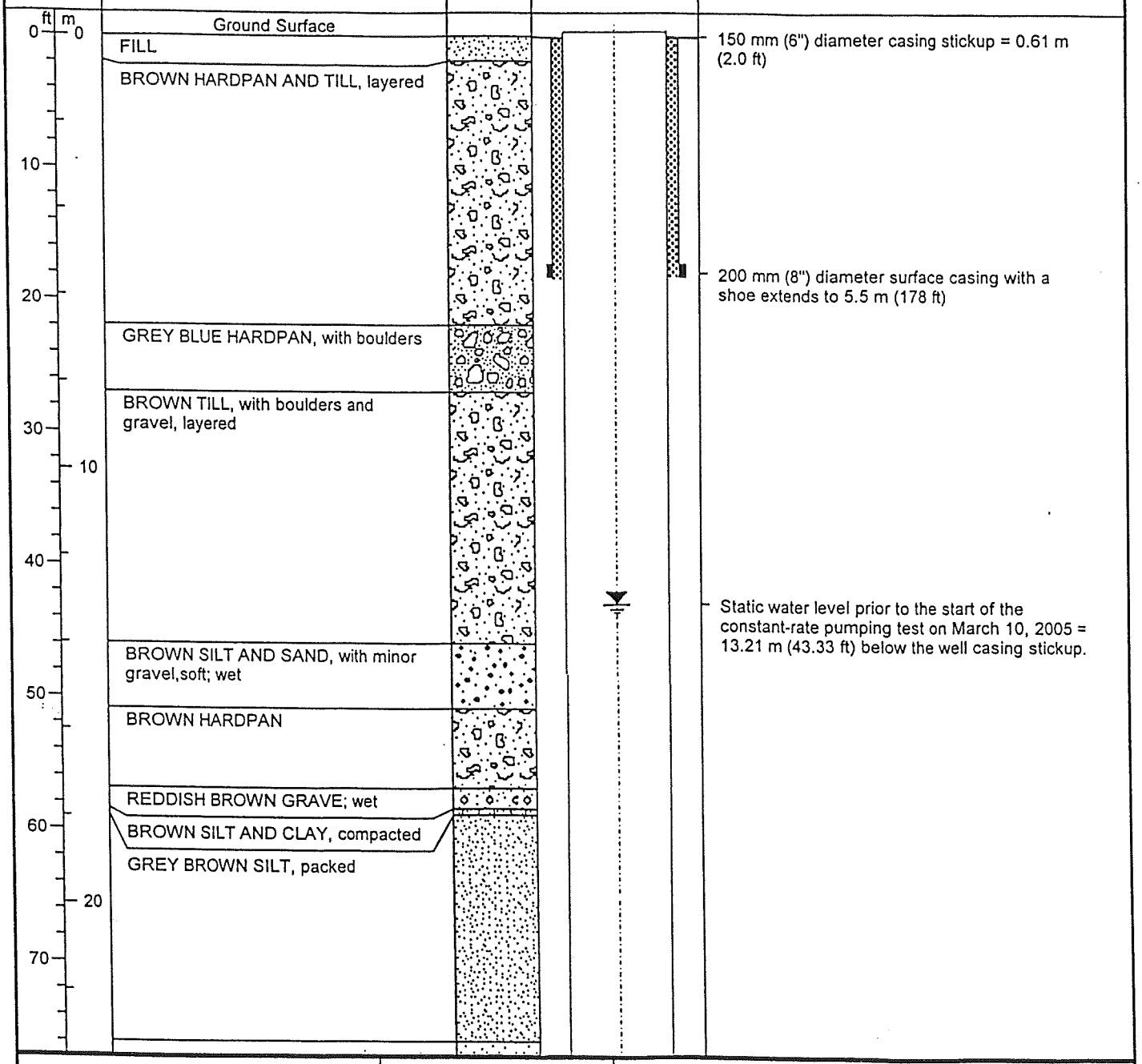
150 mm (6") diameter casing extends to 117.5 m (385.5 ft), 1.4 m (4.5 ft) beyond the top of the bedrock at 116.1 m (381 ft).

Open hole to 163.1 m (535 ft), with water-bearing fractures as follows:

133.5 to 136.6 m (438 to 448 ft) - 0.3 L/sec (4 i(?)gpm)
138.7 to 158.5 m (455 to 520 ft) - 0.6 L/sec (8 i(?)gpm)
158.5 to 161.0 m (520 to 528 ft) - 2.27+ L/sec (30+ i(?)gpm).

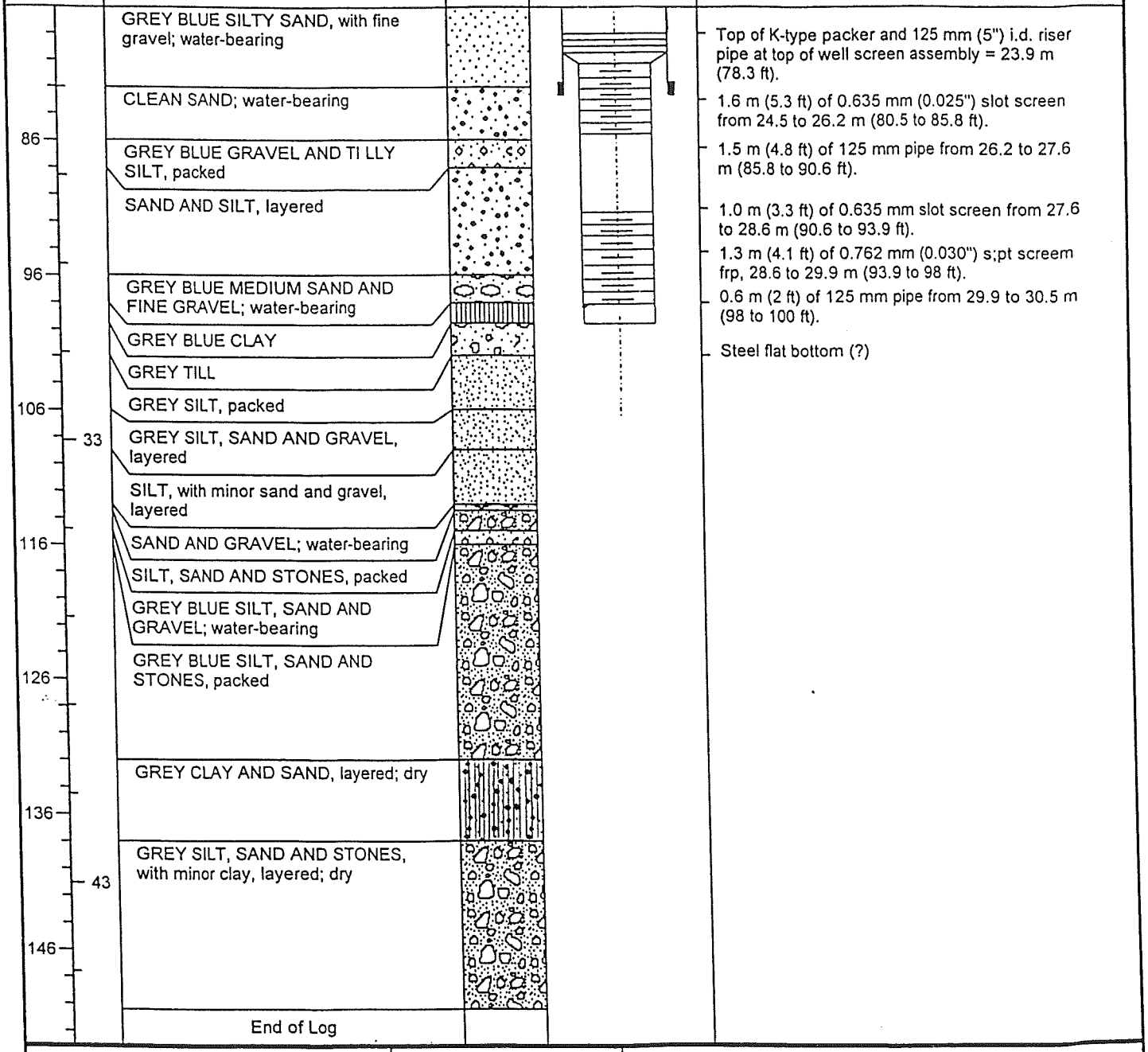
Notes:
1. The sketch is not to scale.
2. All measurements are below ground unless otherwise indicated.

PROJECT: Myrtle Creek Estates	CONTRACTOR: Canwest Drilling Ltd.	WELL NO. 1-05
PROJECT NO.: M735101	RIG: Air rotary and cable tool	CASING ELEVATION:
LOCATION: D.L. 1499, Myrtle Creek	BOREHOLE DIAMETER: 150 mm (6")	CASING STICKUP: 0.61 m (2 ft)



DATE COMPLETED: February 2005	LOGGED BY: CM	PACIFIC HYDROLOGY CONSULTANTS LTD. Consulting Hydrogeologist Suite 201 - 1537 West 8th Avenue VANCOUVER, B.C. Canada V6J 1T5 Telephone: (604) 730-6990
COMPLETION DEPTH: 30.5 m (100 ft)	REVIEWED BY:	
FIGURE NO.: 3	PAGE: 1 of 2	

PROJECT: Myrtle Creek Estates	CONTRACTOR: Canwest Drilling Ltd.	WELL NO. 1-05
PROJECT NO.: M735101	RIG: Air rotary and cable tool	CASING ELEVATION:
LOCATION: D.L. 1499, Myrtle Creek	BOREHOLE DIAMETER: 150 mm (6")	CASING STICKUP: 0.61 m (2 ft)



DATE COMPLETED: February 2005	LOGGED BY: CM	PACIFIC HYDROLOGY CONSULTANTS LTD. Consulting Hydrogeologist Suite 201 - 1537 West 8th Avenue VANCOUVER, B.C. Canada V6J 1T5 Telephone: (604) 730-6990
COMPLETION DEPTH: 30.5 m (100 ft)	REVIEWED BY:	
FIGURE NO.: 3	PAGE: 2 of 2	

Frontier Developments – Well Water Supply

(MCE 2-08)

Driller: Drillwell Enterprises Ltd.

Date Drilled: July 23, 2009

Feet From	Feet To	Geologic Formation
0	95	Previously Drilled (Note Myrtle Creek Estates Well 2-08 Report prepared by Pacific Hydrology Consultants Ltd. - Project No. M735102)
95	130	Grey sand , gravel, silty (water bearing / very silty).
130	140	Grey silt with stones
140	210	Grey sand / very fine / silty
210	252	Grey sand / cleaner
252	290	Grey silt / hard
290	309	Grey till with shells
309	314	Granite boulder
314	316	Grey till, sandy
		222 – 224 ft (Riser plus K Packer) ***224 – 236 ft (3 lengths of 0.008 slot stainless steel screens)*** ***236 – 240 ft (1 length of 0.006 slot stainless steel screen)***
		Well Tag Number - 25686
		Fractures: n/a
		Static Water Level: 79 ft. (July 23, 2009)
		Total Est. Yield: 20 + USgpm
		Surface Casing: 16 ft of 10 inch diameter.
		Casing: 224 ft of 5-inch diameter (includes overlap casing).
		Liner: No.

BRITISH COLUMBIA

Report 1 - Detailed Well Record (MCE 2-08)

Well Tag Number: 95437

Owner: FRONTIER DEVELOPMENTS

Address:

Area:

WELL LOCATION:

NEW WESTMINSTER Land District

District Lot: 1499 Plan: 1650 & 7711 Lot: D

Township: Section: Range:

Indian Reserve: Meridian: Block: 4

Quarter:

Island:

BCGS Number (NAD 83): 092F088211 Well:

Class of Well: Water supply

Subclass of Well: Domestic

Orientation of Well: Vertical

Status of Well: Alteration

Well Use: Water Supply System

Observation Well Number:

Observation Well Status:

Construction Method:

Diameter: inches

Casing drive shoe: N Y Y

Well Depth: 240 feet

Elevation: 204 feet (ASL)

Final Casing Stick Up: 24 inches

Well Cap Type: ALUMINUM CAO

Bedrock Depth: feet

Lithology Info Flag: Y

File Info Flag: N

Sieve Info Flag: N

Screen Info Flag: Y

Site Info Details:

Other Info Flag:

Other Info Details:

Construction Date: 2009-07-21 00:00:00.0

Driller: Drillwell Enterprises

Well Identification Plate Number: 25686

Plate Attached By: SCOTT BURROWS

Where Plate Attached: WELL CASING

PRODUCTION DATA AT TIME OF DRILLING:

Well Yield: 20 (Driller's Estimate) U.S. Gallons per Minute

Development Method: Bailing

Pump Test Info Flag: N

Artesian Flow:

Artesian Pressure (ft):

Static Level: 79 feet

WATER QUALITY:

Character:

Colour:

Odour:

Well Disinfected: Y

EMS ID:

Water Chemistry Info Flag: N

Field Chemistry Info Flag:

Site Info (SEAM):

Water Utility:

Water Supply System Name:

Water Supply System Well Name:

SURFACE SEAL:

Flag: Y

Material: Bentonite clay

Method: Poured

Depth (ft): 16 feet

Thickness (in): 2 inches

Liner from To: feet

WELL CLOSURE INFORMATION:

Reason For Closure:

Method of Closure:

	Closure Sealant Material: Closure Backfill Material: Details of Closure:

Screen from	to feet	Type	Slot Size
222	224		null
224	236		8
236	240		6

Casing from	to feet	Diameter	Material	Drive Shoe
0	224	5	Steel	Y
0	95	6	Steel	Y
0	16	10	null	N

GENERAL REMARKS:
WELL ORIGINALLY DRILLED IN 2008 BY DRILLWELL. PULLED SCREEN, DRILLED DEEPER & SET SCREENS.

LITHOLOGY INFORMATION:

From 0 to 21 Ft. Soft SAND WITH COBBLES brown silty

From 21 to 71 Ft. Hard GRAVEL & SAND TILL LIKE brown silty

From 71 to 79 Ft. Soft WITH FINE GRAVEL WB grey coarse sand

From 79 to 85 Ft. Hard TILL WITH COBBLES grey

From 85 to 95 Ft. Soft COARSE SAND WITH FINE GRAVEL WB. CLEAN UP OPEN BOTTOM AT 94'. grey

From 95 to 130 Ft. SAND & GRAVEL WATER BEARING VERY SILTY. grey silty

From 130 to 140 Ft. SILT WITH STONES grey

From 140 to 210 Ft. SAND VERY FINE AND SILTY grey fine

From 210 to 252 Ft. CLEANER - SAND grey

From 252 to 290 Ft. Hard SILT grey

From 290 to 309 Ft. TILL WITH SHELLS grey

From 309 to 314 Ft. GRANITE BOULDER

From 314 to 316 Ft. TILL grey sandy

- Return to Main
- Return to Search Options
- Return to Search Criteria

Appendix B

Water Level Measurements

MCE 2-08 (Pumping Well) Manual Water Level Data

03/06/2014 8:15 Pumping started at MCE 2-08

Date	Time	Manual Depth to Water[1] m	Drawdown m	Recovery %	Flow US GPM	Meter /Drum M/D	Comment
03-Jun-14	8:10	26.685	0				Static water level
03-Jun-14	8:16	35.685	9		82	D	
03-Jun-14	8:17	38.155	11.47				
03-Jun-14	8:18	39.47	12.785				
03-Jun-14	8:19	40.286	13.601				
03-Jun-14	8:20	40.75	14.065				
03-Jun-14	8:21	40.884	14.199				
03-Jun-14	8:22	40.926	14.241		82	M	
03-Jun-14	8:23	40.95	14.265				
03-Jun-14	8:24	40.972	14.287				
03-Jun-14	8:25	41	14.315		82	M	
03-Jun-14	8:27	41.038	14.353				
03-Jun-14	8:29	41.078	14.393		82	M	
03-Jun-14	8:31	41.108	14.423		82	M	
03-Jun-14	8:33	41.128	14.443		82	M	
03-Jun-14	8:35	41.149	14.464		82	M	
03-Jun-14	8:40	41.208	14.523		82	M	
03-Jun-14	8:45	41.252	14.567		82	M	
03-Jun-14	8:50	41.253	14.568		82	M	
03-Jun-14	8:55	41.287	14.602		82	M	
03-Jun-14	9:05	41.342	14.657		82	M	
03-Jun-14	9:15	41.383	14.698		82	M	
03-Jun-14	9:25	41.418	14.733		82	M	
03-Jun-14	9:35	41.47	14.785		82	M	
03-Jun-14	9:45	41.497	14.812		82	M	
03-Jun-14	9:55	41.536	14.851		82	M	
03-Jun-14	10:05	41.568	14.883		82	M	
03-Jun-14	10:16	41.587	14.902		82	M	
03-Jun-14	11:00	41.703	15.018		82	M	
03-Jun-14	11:45	41.765	15.08		82	M	
03-Jun-14	12:30	41.83	15.145		82	M	
03-Jun-14	12:56	41.87	15.185		82	M	
03-Jun-14	13:45	41.91	15.225		82	M	
03-Jun-14	13:54				77	D	
03-Jun-14	14:30	41.97	15.285		82	M	
03-Jun-14	15:15	42.007	15.322		82	M	
03-Jun-14	16:00	42.052	15.367		82	M	
03-Jun-14	16:45	42.093	15.408		82	M	

Date	Time	Manual Depth to Water[1] m	Drawdown m	Recovery %	Flow US GPM	Meter /Drum M/D	Comment
03-Jun-14	17:30	42.134	15.449		82	M	
03-Jun-14	18:15	42.178	15.493		82	M	
03-Jun-14	19:54	42.27	15.585		78	M	valve up
03-Jun-14	21:55	42.85	16.165				
04-Jun-14	1:50	43.05	16.365				
04-Jun-14	6:00	43.05	16.365				
04-Jun-14	7:33	43.326	16.641		80	M	
04-Jun-14	8:10	43.348	16.663				
04-Jun-14	8:15						pump off
04-Jun-14	8:16	33.87	7.185	57%			start of recovery
04-Jun-14	8:17	30.63	3.945	76%			
04-Jun-14	8:18	29.555	2.87	83%			
04-Jun-14	8:19	29.252	2.567	85%			
04-Jun-14	8:21	28.975	2.29	86%			
04-Jun-14	8:22	28.92	2.235	87%			
04-Jun-14	8:24	28.878	2.193	87%			
04-Jun-14	8:25	28.842	2.157	87%			
04-Jun-14	8:27	28.788	2.103	87%			
04-Jun-14	8:29	28.748	2.063	88%			
04-Jun-14	8:31	28.713	2.028	88%			
04-Jun-14	8:33	28.682	1.997	88%			
04-Jun-14	8:35	28.655	1.97	88%			
04-Jun-14	8:40	28.596	1.911	89%			
04-Jun-14	8:45	28.549	1.864	89%			
04-Jun-14	8:50	28.508	1.823	89%			
04-Jun-14	8:55	28.478	1.793	89%			
04-Jun-14	9:00	28.445	1.76	89%			
04-Jun-14	9:10	28.394	1.709	90%			
04-Jun-14	9:21	28.343	1.658	90%			
04-Jun-14	9:30	28.316	1.631	90%			
04-Jun-14	9:40	28.28	1.595	90%			
04-Jun-14	9:50	28.255	1.57	91%			
04-Jun-14	10:00	28.228	1.543	91%			

1. Depth to Water measured from top of PVC droptube, 0.316m above top of steel casing

MCE 1-05 Manual Water Level Data

03/06/2014 8:15 Pumping started at MCE 2-08

Date	Time	Manual Depth to Water[1] m	Comment
03-Jun-14	8:08	25.435	pump in MCE 1-05 running since 9:00 am, June 2, 2014
03-Jun-14	9:02	25.463	
03-Jun-14	10:12	25.538	
03-Jun-14	13:33	>25.64	
03-Jun-14	15:46	>25.64	pump in MCE 1-05 turned off
03-Jun-14	17:40	21.185	
03-Jun-14	18:20	23.305	
03-Jun-14	19:55	25.52	pump turned on between 18:20 and 19:55, then turned off
04-Jun-14	7:39	20.715	

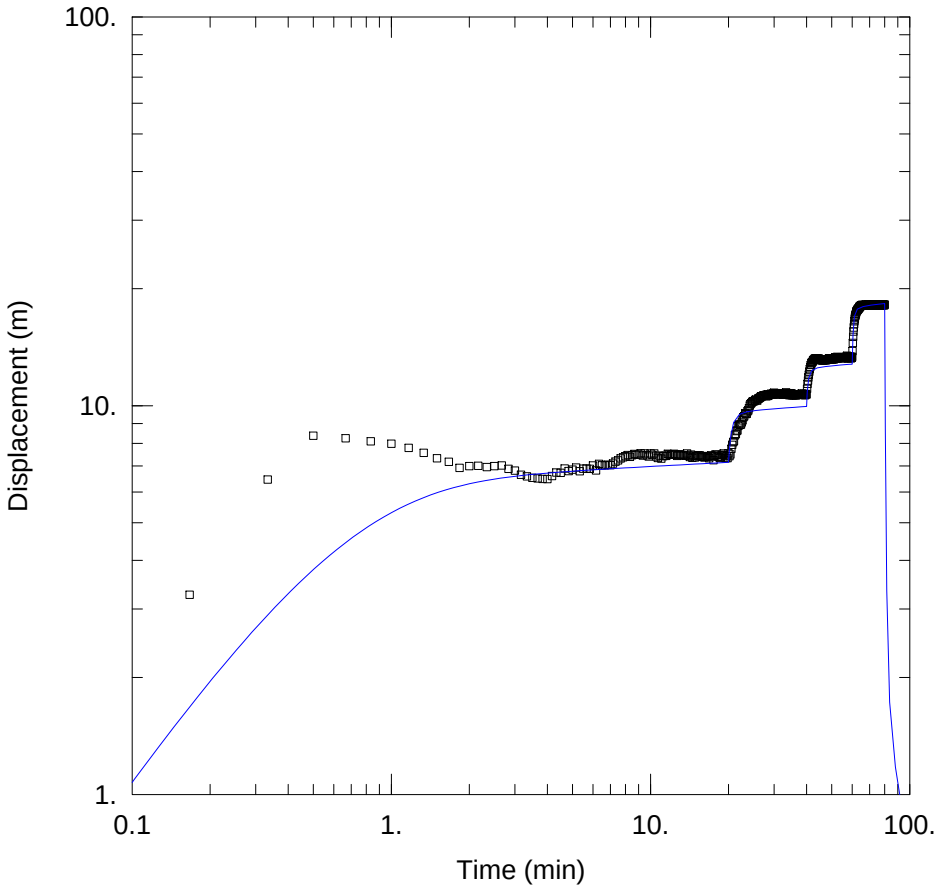
W-93 Manual Water Level Data

Date	Time	Manual Depth to Water[1] m	Comment
03-Jun-14	8:58	32.857	Well W-93 pumped for 3 hours evening of June 2, 2014
03-Jun-14	10:08	32.803	
03-Jun-14	11:11	32.782	
03-Jun-14	13:24	32.738	
03-Jun-14	15:43	32.729	
03-Jun-14	17:35	32.708	
04-Jun-14	7:36	32.593	

1. Depth to Water measured from top of steel casing

Appendix C

Pumping Test Analysis



WELL TEST ANALYSIS

Data Set: P:\...\MCE 2-08 Step.aqt
Date: 06/23/14 Time: 12:17:48

PROJECT INFORMATION

Company: Lorax Environmental
Client: Enterprise Geosciences Ltd
Project: A375-1
Location: Myrtle Creek, Powell River
Test Well: MCE 2-08
Test Date: June 3-4, 2014

AQUIFER DATA

Saturated Thickness: 12.8 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MCE 2-08	0	0

Observation Wells

Well Name	X (m)	Y (m)
▫ MCE 2-08	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Dougherty-Babu

T = 0.0008745 m^2/sec
Kz/Kr = 1.
r(w) = 0.0635 m
C = 0. min^2/m^5

S = 0.001
Sw = 1.406
r(c) = 0.0635 m
P = 2.

Step Test Model: Jacob-Rorabaugh
Time (t) = 1. min Rate (Q) in cu. m/min

$s(t) = 34.92Q + 0.Q^{2.}$
W.E. = 87.79% (Q from last step)

Appendix D

Water Analysis Report

LORAX ENVIRONMENTAL SERVICES
ATTN: Laura Findlater
2289 Burrard Street
Vancouver BC V6J 3H9

Date Received: 05-JUN-14
Report Date: 16-JUN-14 16:56 (MT)
Version: FINAL

Client Phone: 604-688-7173

Certificate of Analysis

Lab Work Order #: L1466295

Project P.O. #: A375-1
Job Reference: A375-1 MYRTLE POND
C of C Numbers: 10-376876
Legal Site Desc:

Ariel Tang
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1466295-1				
	Description	Groundwater				
	Sampled Date	04-JUN-14				
	Sampled Time	08:00				
	Client ID	MCE 2-08				
Grouping	**Analyte**					
WATER						
Physical Tests	Colour, True (CU)	15.7				
	Conductivity (uS/cm)	237				
	Hardness (as CaCO3) (mg/L)	54.4				
	pH (pH)	8.36				
	Total Dissolved Solids (mg/L)	176				
	Turbidity (NTU)	0.42				
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	118				
	Chloride (Cl) (mg/L)	9.01				
	Fluoride (F) (mg/L)	0.112				
	Nitrate (as N) (mg/L)	<0.0050				
	Nitrite (as N) (mg/L)	<0.0010				
	Sulfate (SO4) (mg/L)	<0.50				
Total Metals	Aluminum (Al)-Total (mg/L)	<0.010				
	Antimony (Sb)-Total (mg/L)	<0.00050				
	Arsenic (As)-Total (mg/L)	0.00074				
	Barium (Ba)-Total (mg/L)	<0.020				
	Boron (B)-Total (mg/L)	<0.10				
	Cadmium (Cd)-Total (mg/L)	<0.00020				
	Calcium (Ca)-Total (mg/L)	12.6				
	Chromium (Cr)-Total (mg/L)	<0.0020				
	Copper (Cu)-Total (mg/L)	<0.0010				
	Iron (Fe)-Total (mg/L)	0.079				
	Lead (Pb)-Total (mg/L)	<0.00050				
	Magnesium (Mg)-Total (mg/L)	5.56				
	Manganese (Mn)-Total (mg/L)	0.0824				
	Mercury (Hg)-Total (mg/L)	<0.00020				
	Potassium (K)-Total (mg/L)	3.04				
	Selenium (Se)-Total (mg/L)	<0.0010				
	Sodium (Na)-Total (mg/L)	30.4				
	Uranium (U)-Total (mg/L)	<0.00010				
	Zinc (Zn)-Total (mg/L)	<0.050				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Chloride (Cl)	DLM	L1466295-1
Duplicate	Fluoride (F)	DLM	L1466295-1
Duplicate	Nitrite (as N)	DLM	L1466295-1
Duplicate	Nitrate (as N)	DLM	L1466295-1
Matrix Spike	Sulfate (SO4)	MS-B	L1466295-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L1466295-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA Water Chloride by Ion Chromatography APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-F-IC-VA Water Fluoride by Ion Chromatography APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-NO2-IC-VA Water Nitrite in Water by Ion Chromatography EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA Water Nitrate in Water by Ion Chromatography EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

ANIONS-SO4-IC-VA Water Sulfate by Ion Chromatography APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

COLOUR-TRUE-VA Water Colour (True) by Spectrometer BCMOE Colour Single Wavelength

This analysis is carried out using procedures adapted from British Columbia Environmental Manual "Colour- Single Wavelength." Colour (True Colour) is determined by filtering a sample through a 0.45 micron membrane filter followed by analysis of the filtrate using the platinum-cobalt colourimetric method. Aparent Colour is determined without prior sample filtration. Colour is pH dependent. Unless otherwise indicated, reported colour results pertain to the pH of the sample as received, to within +/- 1 pH unit.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-TOT-CVAFS-VA Water Total Mercury in Water by CVAFS EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

MET-TOT-ICP-VA Water Total Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-TOT-LOW-MS-VA Water Total Metals in Water by ICPMS(Low) EPA SW-846 3005A/6020A

Reference Information

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

10-376876

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

10- 376876

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)	
Company:	Horax Environmental Services	Standard: X Other (specify):		X	Regular (Standard Turnaround Times - Business Days)
Contact:	Laura Findlater	Select: PDF X Excel X Digital X Fax			Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address:	2289 Burrard St, Vancouver V6J 3H9	Email 1:	laura.findlater@horax.ca		Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
		Email 2:	egsl@telus.net		Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	604 688-7173 Fax:				
Invoice To	Same as Report ? (circle) (Yes) or No (if No, provide details)	**Client / Project Information**		**Analysis Request**	
	Copy of Invoice with Report? (circle) (Yes) or No	Job #:	A375-1 Myrtle Pond	(Indicate Filtered or Preserved, F/P)	
Company:		PO / AFE:	A375-1		
Contact:		LSD:			
Address:					
Phone:	Fax:	Quote #:	Horax Pricing.		
Lab Work Order # (lab use only)		**ALS Contact:**	Ariel Tang	**Sampler:**	L. Findlater

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	1. General	F 2. Tot. Metals	P 3. T. Hg								Number of Containers
	MCE 2-08	04-Jun-14	08:00	Groundwater	X	X	X								3

Short Holding Time

Rush Processing

L1466295-COFC

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

* Routine potability analysis (no biological)

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Laura Findlater	June 5/14	10:30.	Doreen	June 5	1415	2 °C				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION | WHITE - LABORATORY COPY | YELLOW - CLIENT COPY | GENF 18.01 Front