



THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

**REGIONAL DISTRICT OF NANAIMO
SAN PAREIL WELLS GWUDI INVESTIGATION**

Report

to

REGIONAL DISTRICT OF NANAIMO

May 31, 2010
File: 17-336-1

Thurber Engineering Ltd.
Victoria, B.C.



May 31, 2010

File: 17-336-1

Regional District of Nanaimo
6300 Hammond Bay Road
Nanaimo, B.C. V9T 6N1

Attention: Mr. Wayne Moorman, P.Eng.

**REGIONAL DISTRICT OF NANAIMO
SAN PAREIL WELLS GWUDI INVESTIGATION**

Dear Mr. Moorman:

Thurber Engineering Ltd. (Thurber) is pleased to present this report summarizing the results of a 'ground water under direct influence of surface water' (GWUDI) investigation for the Regional District of Nanaimo (RDN) San Pareil Wells #1 and #4.

Use of this letter report is subject to the attached *Statement of General Conditions*.

1. INTRODUCTION AND BACKGROUND

Thurber was retained by RDN to undertake a GWUDI investigation for two production wells at the San Pareil well field, located near the Englishman River at the south end of Parksville, B.C. The subject wells are Well #1 (Ministry of Environment (MOE) well identification number (WIN) 13713) and Well #4 (WIN 13993). Our initial proposal for this work was provided on May 26, 2009 and a revised scope of work, pertaining to the then recently developed BC GWUDI process, was provided on August 10, 2009. Authorization to proceed with the revised scope of work was given by RDN on January 27, 2010 via personal correspondence.

The MOE WELLS database (MOE, 2010) indicates that Well #1 was constructed in 1976. The well is known to be comprised of a dug well connected to a single, 30 m long, horizontal, infiltration gallery that is at a depth of approximately 4.6 m. The database does not indicate who constructed Well #1. Well #4 was constructed in 2004 by Fyfe's Well Drilling and Pump Co. Ltd. under the direction of Levelton Consultants Ltd. (Levelton) (2005). Well #1 and #4 are respectively located approximately 60 m and 90 m from the Englishman River and there is a wetland located within the well field. The wells are separated by a distance of approximately 105 m. Both wells are currently in use by the RDN. Copies of the

well logs for Well #1, Well #4 and monitoring well MW1 are located in Appendix A and a site plan is shown in Figure 1 attached.

The purpose of the GWUDI investigation was to assess the risk of potentially harmful pathogenic contamination of Wells #1 and #4 from nearby surface water (including the Englishman River and nearby wetlands).

2. METHODOLOGY

This investigation was conducted according to the BC Draft Guidance Document. The BC MOE released “Draft 5 Guidance Document for Determining Ground Water at Risk of Containing Pathogens Including Ground Water Under Direct Influence of Surface Water” in June 2009 (Kohut, 2009). This guidance document, although not a Regulation or Guideline, is now being used by some provincial Health Authorities.

The BC GWUDI process is designed to determine if a well source can be classified as ‘at risk’ of containing pathogens (thereby requiring treatment or remedial works) based on an investigation which potentially involves four stages:

- Stage 1: Screening Tool;
- Stage 2: Preliminary Hydrogeological Investigation;
- Stage 3: Advanced Hydrogeological Investigation; and,
- Stage 4: Long-Term Water Quality Monitoring.

According to the Draft Guidance Document, at the end of Stage 1 it is established whether the well is ‘at risk’, ‘low risk’, or if the risk status is indeterminate. If the results indicate the former or the latter, there is an alternative to either gather more information through Stage 2 and 3 or undertake remedial steps, including treatment, well rehabilitation or relocation, etc. to lower the risk status. Stage 4 involves long-term water quality monitoring and is required for all water supply system sources, regardless of their risk status.

3. RESULTS

The results of completing Stage 1 for Wells #1 and #4 indicated that the wells may be at risk of containing pathogens due to their intake depth combined with their location, their construction, the type of aquifer in which they are completed and their historical raw water quality. The depth to the top of the screen of both wells is less than 15 m below the ground (approximately 4.6 m for Well #1 and 4.0 m for Well #4, based on logs). According to floodplain mapping, Wells #1 and #4 are situated within the 1 in 200 year high water level of the Englishman River. The wells are completed in MOE Aquifer #221 which is an unconfined, unconsolidated aquifer that is classified by the MOE as ‘highly vulnerable’ to surface

contamination (Kreye and Wei, 1994). Finally, total coliform has been historically detected in the raw water from both wells. There has been no detection of any potentially harmful pathogens at the point of consumption, following disinfection of the source water.

In order to assess the risk posed by the depth and location of the wells and the nature of the aquifer in which they are completed, further investigation (Stage 2) was warranted. This was undertaken using readily available, relevant geological and hydrogeological information and focused on the two potential sources of pathogens to the subject wells: via the Englishman River and via the wetland adjacent to the wellheads. The risk of pathogenic contamination from surface water was assessed by investigating the connection between the water sources. Due to the close proximity of the wells, this part of the Stage 2 investigation is considered applicable to both Wells #1 and #4. However, since Well #1 is a dug well that primarily sources groundwater from a trenched, horizontal infiltration gallery, it is more vulnerable to surface contamination in the vicinity of the wellhead than Well #4. Figure 2 shows a theoretical cross-section running approximately north-south through the well field and the subject wells. This figure illustrates the intake gallery at Well #1 as well as the geology and water levels (MW1 and wet land), which is discussed in more detail below.

The geologic unit that comprises the aquifer consists of fluvial sand and gravel deposits (BCGS, 1972; Fyles, 1962). From the logs for the two wells, the depth to bedrock at this location is approximately 4 to 6 m. It is likely that these deposits are laterally continuous to the base of the River.

The hydraulic connection between the aquifer, the Englishman River and the wetlands located adjacent to the well field was assessed by comparing their relative water levels. Monitoring data obtained from RDN monitoring well MW1 were used to represent the water levels in the aquifer. Although MW1 is located within the well field, its water levels do not appear to be impacted considerably from pumping of the production wells. Water levels in the River and wetlands are presently not monitored continuously; however, they were surveyed on April 8, 2010. Figure 3 shows recent water elevations from MW1, compared to these survey elevations. MW1 water levels were measured with a logging pressure transducer and the readings were not corrected for barometric pressure changes (subtraction of barometric pressure), but were adjusted to actual water table elevations using manual measurements. The water level trend shown in Figure 3 therefore may not represent that of the aquifer; however, based on observed barometric fluctuations, water elevations are considered accurate to within approximately 30 cm. From Figure 3 it is apparent that the water levels in MW1 and the wetlands are essentially the same on the date the survey was conducted. The River water level is approximately 0.6 m higher at a location approximately

50 m upstream from MW1. It is therefore likely that the groundwater in the subject aquifer has a direct hydraulic connection to the two surface water bodies.

Due to the aquifer type (unconfined) and the relatively shallow depth to the tops of the well screens (<15 m), it was also identified in the Stage 1 investigation that there may be a risk of pathogenic contamination to the wells due to overland flow of surface water. The well field is located near the mouth of the Englishman River, where the regional topography is relatively flat; however, local drainage appears to flow to the wetlands located adjacent to the wells. From the west, this is facilitated by a culvert that drains the ditch adjacent to Plummer Rd. into the wetland. There are no known potential sources of pathogenic contamination within at least 30 m of the wells. The setbacks that are required by the Sanitary Regulations¹, and referenced in the GWUDI document, appear to be met based on field observations.

Stage 1 of the Draft Guidance Document identifies wells that do not meet the construction requirements of the Ground Water Protection Regulations² (GWPR) as being at a high risk of contamination. Review of the well logs for Well #1 and Well #4 indicates that these wells meet the requirements of the GWPR with the exception of the absence of a surface seal at Well #1. Well #4 was constructed with a 25 mm thick bentonite surface seal to a depth of 3 m as opposed to the 4.6 m required by the GWPR, however, the top of the screen section of the well starts at 4 m and therefore the depth of surface seal is reasonable.

Annual raw water quality data for Well #1 (from 2004 to 2009) and Well #4 (2008 and 2009) show the presence of total coliform (3 to >200 colony forming units (CFU)/100 mL and 1 CFU/100 mL, respectively) and no detection of *E. coli* and faecal coliform. The source of total coliform bacteria in the wells is unknown. There has been no detection of total coliform, *E. coli* or faecal coliform in any weekly, point of consumption (i.e. following chlorination of the raw water) bacteriological analyses for records dating to 2005³.

Samples for microscopic particulate analysis (MPA) were obtained from Well #1 and Well #4 on February 23 and 24, 2010. Two samples were collected from each well while they were pumped simultaneously at their utilization rates of 190 USgpm for Well #1 and 225 USgpm for Well #4. During pumping, Well #1 discharged to the reservoir while Well #4 discharged to the wetlands located approximately 40 m southeast of the wellhead. Sampling was conducted in accordance with the US Environmental Protection Agency (USEPA)'s Consensus Method for Determining Groundwaters Under the Direct Influence of Surface

¹ http://www.bclaws.ca/Recon/document/freeside/--p--/publichealthactsbc2008c.28/05_regulations/18_51_2009.xml#section2

² http://www.gp.gov.bc.ca/statreg/reg/W/Water/Water299_2004/299_2004.htm#section12

³ <http://www.rdn.bc.ca/cms.asp?wpID=900>

Water (Vasconcelos and Harris, 1992). With regard to the rating system of the USEPA Consensus Method, the MPA results for Well #4 indicate that it is low risk for microbiological contamination from surface water (risk factor of 5 for consecutive samples taken on Feb. 23 and 24) and MPA results from Well #1 indicate it is low (Feb. 23) to moderate (Feb. 24) risk (risk factors of 1 and 13, respectively). The cause of the large discrepancy between consecutive samples at Well #1 is unknown, however, it may have resulted from induced recharge from the nearby wetlands due to discharged water from Well #4. Due to elevated risk determined for the sample at Well #1, a third sample was obtained and analyzed using the USEPA's Method 1623 (USEPA, 2005). The results of the third sample taken Mar. 30 were similar to the second (moderate risk determined with a factor of 10). No *Cryptosporidium* oocysts or *Giardia* cysts were present in any of the samples tested. The laboratory data sheets for MPA analysis are located in Appendix B.

It is important to note that the USEPA Consensus Method rating system relates to the results of MPA specifically, which is only a component of the BC GWUDI process. The risk factor determined by MPA (i.e. low, moderate, and high), therefore, will not necessarily be the same as the risk status determined for the well.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the current investigations, we conclude that the risk status for Well #1 and Well #4 is indeterminate.

It is our opinion that wells completed in settings similar to that of the San Pareil well field (i.e. shallow, unconfined aquifer in a floodplain), may be considered low risk of pathogenic contamination from the surface if the wells are constructed properly, setbacks to contaminant sources are adequate, the natural filtration ability of the aquifer is effective and a sufficient amount of monitoring data exists to make a determination.

Correction of some of the construction deficiencies of Well #1, through retrofitting or replacement, would reduce the risk of contamination to the well. In addition, there is presently a limited amount of monitoring data available for the San Pareil well field to assess the filtration effectiveness of the aquifer media. Raw water quality monitoring should be enhanced to determine long-term trends in water quality for both wells.

To address these issues, we recommend the following:

- Retrofitting Well #1 by placing a 1 to 2 m wide circular blanket of clay rich soil surrounding the dug well casing overlying a hydrated bentonite seal 25



to 50 mm thick. This blanked should be sloped away from the well casing to prevent ponding of rain water. In addition, capping the existing roadway overtop of Well #1 intake gallery with a compacted clay rich soil and thin gravel running surface may be useful. As an alternative to retrofitting, replacement of Well #1 with a drilled well (constructed in accordance with the GWPR) could also be considered. We expect a vertical screened well (like Well #4) to be at less risk of contamination from surface water than a dug well.

- Curbing of the east side of Plummer Road should be considered to protect against contamination from roadway runoff and to improve drainage. This would prevent road runoff from directly entering the wetland and reduce the possibility of contaminants entering the aquifer.
- Long-term monitoring of wetland water levels using a stilling well equipped with a datalogger as there is likely a hydraulic connection between the wetland and the aquifer.
- Higher frequency, long-term raw water quality monitoring for bacteriological parameters in Well #1 and Well #4 (we suggest monthly sampling of raw water for total coliform and *E. coli* at a minimum).
- MPA sampling be undertaken this summer (August) on Well #1 and Well #4. At this time a raw water sample should be taken for particle size analysis which can also be used to assess aquifer filtration.
- Reassessment of the wells after 1 year of water quality results have been collected.

Water level monitoring is currently ongoing at the San Pareil well field with logging pressure transducers installed in Well #4, MW1 and MW2 (formerly Well #3). In addition to the continuous monitoring of these wells, it is also recommended that manual measurements be made monthly at all existing wells, including Well #1, Well #4, MW1, MW2, as well as former production Well #2 and any other monitoring location where it is practical to do so. During every download of the pressure transducers, a manual water level measurement should also be taken.

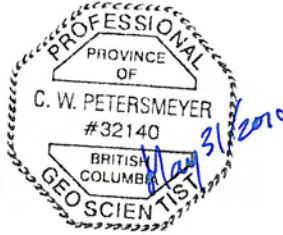


5. CLOSURE

We trust this meets your requirements at this time. Please feel free to contact us if you have any questions.

Yours truly,
Thurber Engineering Ltd.
Kevin Sterne, P.Eng
Review Principal

Chad W. Petersmeyer, P.Geo.
Hydrogeologist



REFERENCES

BCGS, Terrain, Parksville Map Sheet 92F/8, BC Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division, 1972.

Fyles, J.G., Surficial geology of Horne Lake and Parksville map-areas, Vancouver Island, British Columbia: memoir 318, Geological Survey of Canada, 1963.

Kohut A., Draft 5 Guidance Document for Determining Ground Water at Risk of Containing Pathogens Including Ground Water Under Direct Influence of Surface Water, Province of British Columbia, 2009.

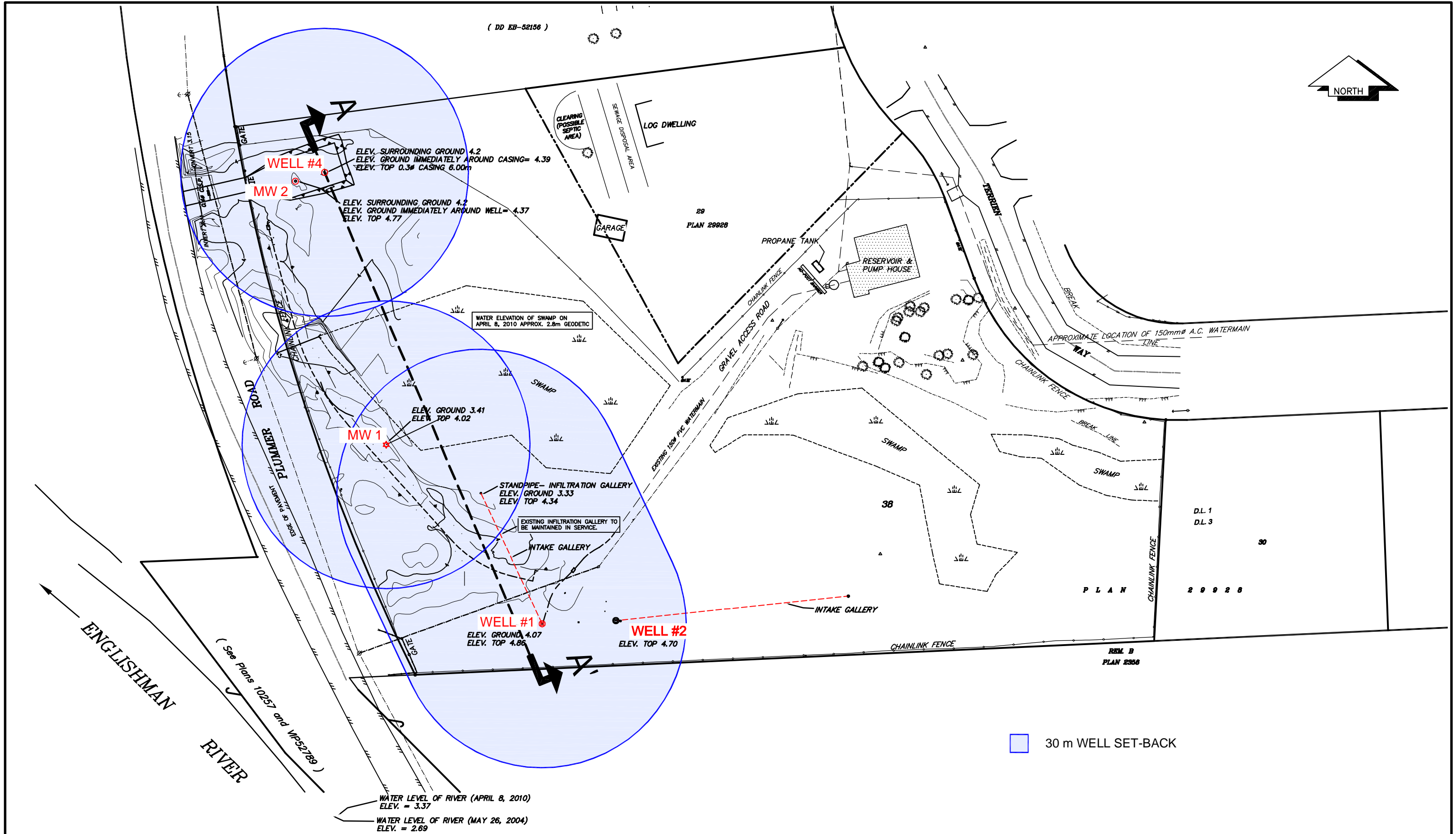
Kreye, R., and M. Wei, An Aquifer Classification System for Ground Water Management in British Columbia, Province of British Columbia, Ministry of Environment, Lands and Parks, Water Management Division, Hydrology Branch, 1994.

Levelton Consultants Ltd., Hydrogeological Assessment of San Pareil Well #2, San Pareil Well field, Parksville, BC, submitted to Regional District of Nanaimo, 2005.

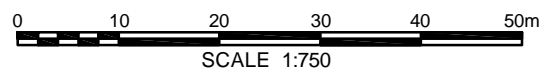
MOE, Water Stewardship Division, WELLS – Ground Water Wells Database, http://www.env.gov.bc.ca/wsd/data_searches/wells/index.html, 2010.

United States Environmental Protection Agency, Method 1623: *Cryptosporidium* and *Giardia* in water by filtration/IMS/FA, US EPA 815-R-05-002, 2005.

Vasconcelos J. and S. Harris, Consensus Method for Determining Groundwater under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA), US EPA 910/9-92-029, 1992.



NOTES:
 1. Digital base plan provided by client.



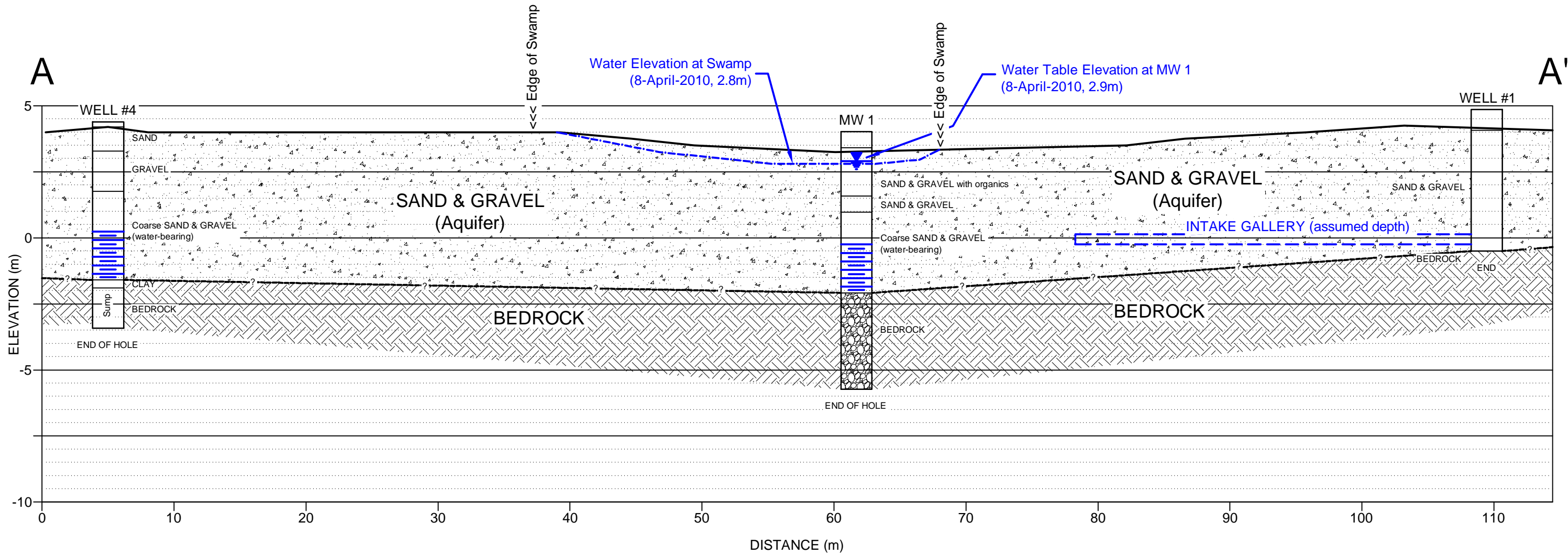
REGIONAL DISTRICT OF NANAIMO - SAN PAREIL WELL EVALUATION

SITE PLAN

SCALE: 1:750

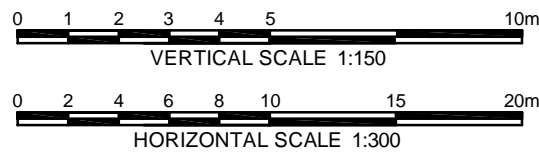
FIGURE 1





NOTES:

- 1. Digital base plan provided by client.

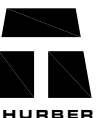


REGIONAL DISTRICT OF NANAIMO - SAN PAREIL WELL EVALUATION

SECTION A - A'

SCALE: AS SHOWN

FIGURE 2



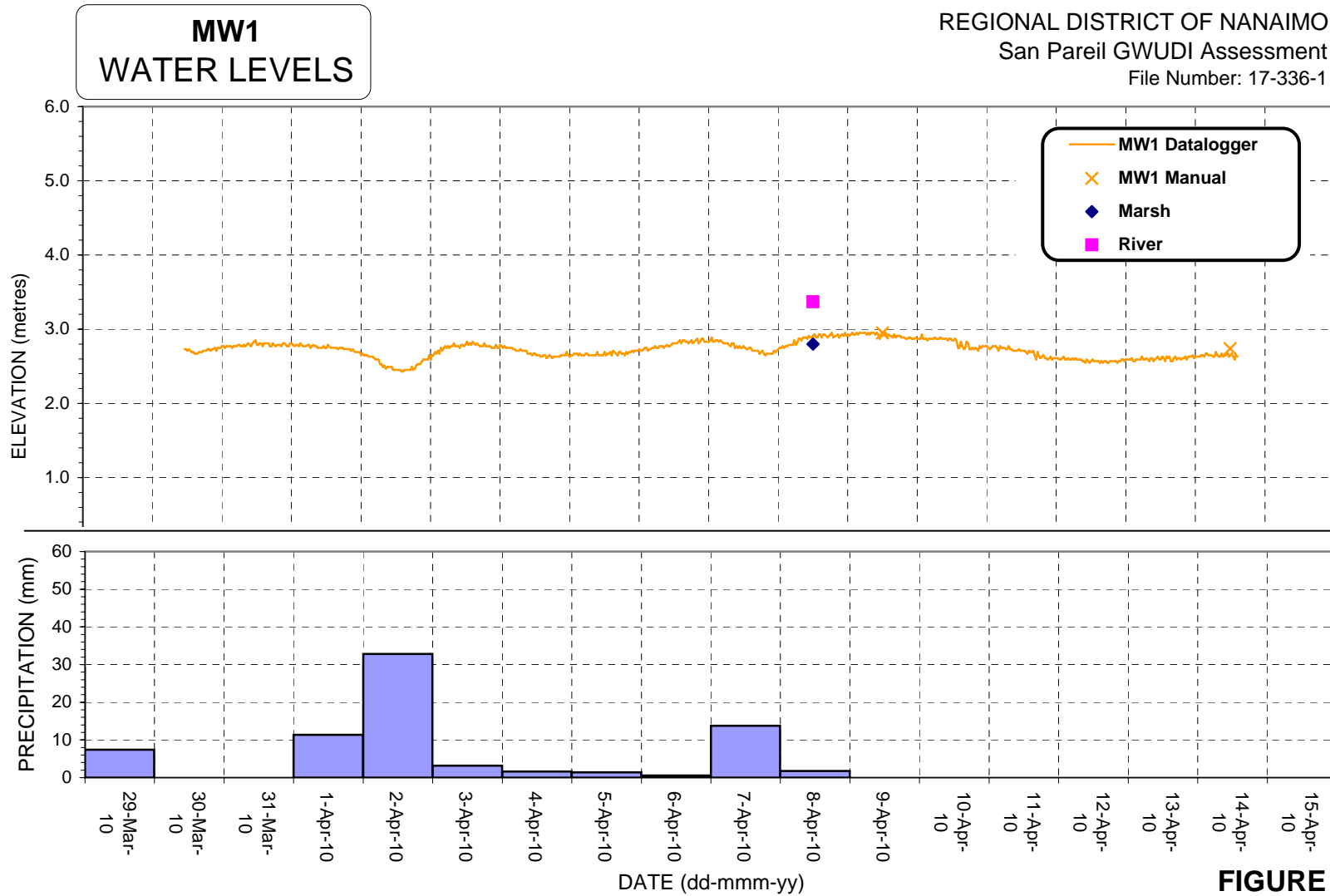


FIGURE 3

STATEMENT OF GENERAL CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document, subject to the limitations provided herein, are only valid to the extent that this Report expressly addresses proposed development, design objectives and purposes, and then only to the extent there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation or to consider such representations, information and instructions.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS WE MAY EXPRESSLY APPROVE. The contents of the Report remain our copyright property. The Client may not give, lend or, sell the Report, or otherwise make the Report, or any portion thereof, available to any person without our prior written permission. Any use which a third party makes of the Report, are the sole responsibility of such third parties. Unless expressly permitted by us, no person other than the Client is entitled to rely on this Report. We accept no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without our express written permission.

5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and this report is delivered on the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by us. We are entitled to rely on such representations, information and instructions and are not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

INTERPRETATION OF THE REPORT *(continued)*

- c) Design Services: The Report may form part of the design and construction documents for information purposes even though it may have been issued prior to the final design being completed. We should be retained to review the final design, project plans and documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the report recommendations and the final design detailed in the contract documents should be reported to us immediately so that we can address potential conflicts.
- d) Construction Services: During construction we must be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RISK LIMITATION

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause an accidental release of those substances. In consideration of the provision of the services by us, which are for the Client's benefit, the Client agrees to hold harmless and to indemnify and defend us and our directors, officers, servants, agents, employees, workmen and contractors (hereinafter referred to as the "Company") from and against any and all claims, losses, damages, demands, disputes, liability and legal investigative costs of defence, whether for personal injury including death, or any other loss whatsoever, regardless of any action or omission on the part of the Company, that result from an accidental release of pollutants or hazardous substances occurring as a result of carrying out this Project. This indemnification shall extend to all Claims brought or threatened against the Company under any federal or provincial statute as a result of conducting work on this Project. In addition to the above indemnification, the Client further agrees not to bring any claims against the Company in connection with any of the aforementioned causes.

7. SERVICES OF SUBCONSULTANTS AND CONTRACTORS

The conduct of engineering and environmental studies frequently requires hiring the services of individuals and companies with special expertise and/or services which we do not provide. We may arrange the hiring of these services as a convenience to our Clients. As these services are for the Client's benefit, the Client agrees to hold the Company harmless and to indemnify and defend us from and against all claims arising through such hirings to the extent that the Client would incur had he hired those services directly. This includes responsibility for payment for services rendered and pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. In particular, these conditions apply to the use of drilling, excavation and laboratory testing services.

8. CONTROL OF WORK AND JOBSITE SAFETY

We are responsible only for the activities of our employees on the jobsite. The presence of our personnel on the site shall not be construed in any way to relieve the Client or any contractors on site from their responsibilities for site safety. The Client acknowledges that he, his representatives, contractors or others retain control of the site and that we never occupy a position of control of the site. The Client undertakes to inform us of all hazardous conditions, or other relevant conditions of which the Client is aware. The Client also recognizes that our activities may uncover previously unknown hazardous conditions or materials and that such a discovery may result in the necessity to undertake emergency procedures to protect our employees as well as the public at large and the environment in general. These procedures may well involve additional costs outside of any budgets previously agreed to. The Client agrees to pay us for any expenses incurred as the result of such discoveries and to compensate us through payment of additional fees and expenses for time spent by us to deal with the consequences of such discoveries. The Client also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the Client agrees that notification to such bodies by us will not be a cause of action or dispute.

9. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on our interpretation of conditions revealed through limited investigation conducted within a defined scope of services. We cannot accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

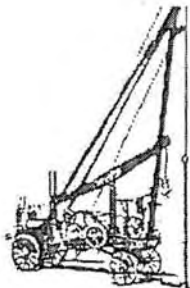


THURBER ENGINEERING LTD.



Report 1 - Detailed Well Record

<p>Well Tag Number: 34156</p> <p>Owner: NANAIMO REG DISTRICT</p> <p>Address: 1090 PLUMMER ROAD</p> <p>Area:</p> <p>WELL LOCATION: NANOOSE Land District District Lot: 1 Plan: 29928 Lot: 38 Township: Section: Range: Indian Reserve: Meridian: Block: Quarter: Island: VANCOUVER ISLAND BCGS Number (NAD 27): 092F039213 Well: 9</p> <p>Class of Well: Subclass of Well: Orientation of Well: Status of Well: New Well Use: Unknown Well Use Observation Well Number: Observation Well Status: Construction Method: Dug Diameter: 0.0 inches Casing drive shoe: Well Depth: 15 feet Elevation: 0 feet (ASL) Final Casing Stick Up: inches Well Cap Type: CAPPED Bedrock Depth: 15 feet Lithology Info Flag: N File Info Flag: N Sieve Info Flag: N Screen Info Flag: N</p> <p>Site Info Details: Other Info Flag: Other Info Details:</p>	<p>Construction Date: 1976-01-01 00:00:00.0</p> <p>Driller: Unknown Well Identification Plate Number: Plate Attached By: Where Plate Attached:</p> <p>PRODUCTION DATA AT TIME OF DRILLING: Well Yield: 300 (Driller's Estimate) Imperial Gallons per Minute Development Method: Pump Test Info Flag: Y Artesian Flow: Artesian Pressure (ft): Static Level:</p> <p>WATER QUALITY: Character: Colour: Odour: Well Disinfected: N EMS ID: Water Chemistry Info Flag: Field Chemistry Info Flag: Site Info (SEAM):</p> <p>Water Utility: Y Water Supply System Name: Water Supply System Well Name:</p> <p>SURFACE SEAL: Flag: N Material: Method: Depth (ft): Thickness (in):</p> <p>WELL CLOSURE INFORMATION: Reason For Closure: Method of Closure: Closure Sealant Material: Closure Backfill Material: Details of Closure:</p>			
Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
<p>GENERAL REMARKS: SOME INFO PROVIDED BY NANAIMO REG STAFF. CURRENT PUMPING RATE 92GPM. AVE CURRENT WATER LEVEL 7-7.5FT. FLOOD PROOFING NOT ADEQUATE. WELLHEAD PROTECTION ADEQUATE.</p> <p>LITHOLOGY INFORMATION: From 0 to 15 Ft. Sand and gravel From 15 to 0 Ft. Bedrock</p>				



Fyfe's Well Drilling & Pump Co. Ltd.
 3331 Alberni Highway, Qualicum, B.C. V9K 1Y5
 Phone: 1 800 780-FYFE Fax: (250) 752-1274
 Email: fyfedrilling@shaw.ca Website: www.fyfeswelldrilling.com
 "Clean Water For Canadians"

WELL #4

Client Name: Wayne Moorman	Mailing Address: 6300, Hammond Bay Rd., Nanaimo, BC, CANADA C9T 6N2
Company/Agency: Regional District of Nanaimo	Well Site Address: San Panel, Parksville, BC, CANADA
Telephone No.: (877) 607-4111	Fax No.: (250) 390-1542
Email Address:	

WELL LOCATION			
BCGS:	NTS:	Accur:	
Lon:	Lat:	Elev:	
UTM X:	UTM Y:	Zone:	
Lot:	District Lot:	Plan:	Part:
Section:	Township:	Range:	Land District:
Block:	PID:	West of Meridian:	
Legal Misc.:			

CONSTRUCTION INFORMATION	
Client Well ID: PW-01-05	Proposed Use: MUN
Type Of Work: NEW	Method: AIR
Rlg No.: 1	

WELL DIMENSIONS		
Well Dia: 14.0 in	Depth Drilled: 25.0 ft	Bedrock Depth: 5.0 ft
Liner Type:	Liner Dia:	
Liner Installed From:	To:	

SURFACE SEAL		
Material 1: BEN	Method: POR	
Seal From: 0.0 ft	To: 10.0 ft	Depth: 10.0 ft
Material 2:	Method:	
Seal From:	To:	Depth:
Material 3:	Method:	
Seal From:	To:	Depth:
Reason(s):		

WELL CASING			
Material 1: STL	Joined By: WEL	Dia: 16.0 in	Wall: 0.25 in
Shoe: YES	Length From: 0.0 ft	To: 10.0 ft	
Material 2: STL	Joined By: WEL	Dia: 14.0 in	Wall: 0.25 in
Shoe: YES	Length From: 0.0 in	To: 14.0 in	
Material 3:	Joined By:	Dia:	Wall:
Shoe:	Length From:	To:	

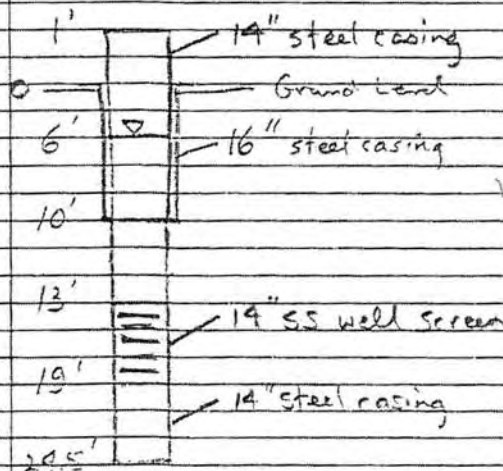
GRAVEL PACK INFORMATION		
Material Size:	Length From:	To:

SCREEN INFORMATION			
Material: SST	Type: TEL	Joined By: THR	
Dia 1: 14.0 in	Slot Size: 150	Placed From: 13.0 ft	To: 19.0 ft
Dia 2:	Slot Size:	Placed From:	To:
Blank Dia: 14.0 in	Material: STL	Placed From: 19.0 ft	To: 24.5 ft
Riser From: 11.0 ft	To: 14.0 ft	Bottom: PLG	Total: 13.6 ft

PERFORATIONS		
Type:	Length From:	To:

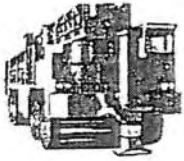
WELL DEVELOPMENT	
Method 1: JET	Time: 12.0 hrs
Method 2: PMP	Time: 24.0 hrs
Method 3:	Time:
Notes:	

LITHOLOGY		
Stratum (ft)	Material Description	
0.0 - 3.0	coarse light-brown medium hard coarse sand	
3.0 - 5.0	light-brown medium hard medium gravel	
5.0 - 8.0	coarse soft fine gravel	
8.0 - 10.0	water bearing coarse sand & gravel	
10.0 - 12.0	water bearing coarse sand & gravel 5-10 gpm	
12.0 - 15.0	water bearing coarse sand & gravel 10-15 gpm	
15.0 - 17.0	very coarse soft gravel 1 to 2 inch stones	
17.0 - 19.0	very coarse soft & 1-2 inch gravel stones with small cobbles 80+ gpm	
19.0 - 20.0	blue clay	
20.0 - 25.0	hard conglomerate / shale	



WELL COMPLETION SUMMARY		
Final Depth: 24.6 ft	Completed In: OVB	Est. Yield: 250.0 USgpm
Method: PMP	Static Level: 8.0 ft	Artesian Yield:
Sample Collected: YES	Disinfected: YES	
Notes:		

CONSTRUCTION PERSONNEL	
Contractor: Fyfe's Well Drilling Ltd.	
Driller: Glen Fyfe	License: WWW-94-32
Consultant: Levelton Consultants Ltd. c/o Brad Loffler	
Date Started: Friday, December 17, 2004	Date Completed: Friday, April 01, 2005



Fyfe's

Well Drilling & Pump Co. Ltd.

MW 1

3331 Alberni Hwy., Qualicum Beach, B.C. V9K 1Y5

Toll free: (800) 7803933 / Local: (250) 752-9358 / Fax: (250) 752-1274

Email: jfyfe@bcsupernet.com

Your Professional Well & Water Services Company

IDENTIFICATION

Well Record I.D.:	BCAA11 - 060	MoE Well Tag No.:	
Client Name:	Regional District of Nanaimo		
Company/Agency:	San Pareil Water Utility		
Mailing Address:	6300, Hammond Bay , Nanaimo , V9T 6N2		
Well Site Address:	Plummer Rd., , Parksville		
Telephone No.:	(250) 390-6560	Fax No.:	(250) 390-1542
Email Address:	wfmoor@rdn.bc.ca		

WELL LOCATION

BCGS:	GPS Lat:	GPS Lon:
Lot:	District Lot:	Plan:
Part:	Section:	Township:
Range:	Land District: 34	Block:
PID:	West of:	Elevation:
Legal Misc.:		

LITHOLOGY

Stratum (ft.)	Material Description
0.0 3.0	Road fill
3.0 6.0	Loose, brown sand & gravel w/ some organics
6.0 8.0	Loose, brown sand & gravel
8.0 18.0	Water bearing coarse sand & gravel
18.0 30.0	Bedrock - grey, medium conglomerate

CONSTRUCTION INFORMATION

Client Well I.D.:	TW 1-2002	Proposed Use:	T/P
Type Of Work:	NEW	Method:	AIR
Rig No.:	1		

WELL DIMENSIONS

Well Dia.:	6.0 in.	Depth Drilled:	30.0 ft.	Completed Depth:	18.0 ft.
Liner Type:		Liner Dia.:			
Liner Installed From:		To:			

SURFACE SEAL

No Surface Seal

WELL CASING

Material 1:	STL	Joined By:	WEL	Dia.:	6.0 in.	Wall:	0.25 in.
Shoe:	YES	Length From:	0.0 ft.	To:	14.0 ft.		

GRAVEL PACK INFORMATION

No Gravel Pack

SCREEN INFORMATION

Material:	SST	Type:	TEL	Joined By:	THR		
Dia. 1:	6.0 in.	Slot Size:	50	Placed From:	12.0 ft.	To:	18.0 ft.
No Screen Blank							
Riser From:	12.0 ft.	To:	13.0 ft.	Bottom:	PLG	Total:	6.5 ft.

PERFORATIONS

No Perforations

WELL DEVELOPMENT

Method 1:	AIR	Time:	7.0 hrs.
Notes:			

WELL COMPLETION SUMMARY

Final Depth:	18.0 ft.	Completed In:	OVB	Est. Yield:	50.0 USgpm
Method:	AIR	Static Level:	5.0 ft.	Artesian Yield:	
Sample Collected:	NO	Disinfected:	YES		
Notes:					

CONSTRUCTION PERSONNEL

Contractor:	Fyfe's Well Drilling Ltd.				
Driller:	Glen Fyfe	License No.:	0039-WW-94		
Consultant:	J. Fyfe				
Date Started:	02/04/2002	Date Completed:	03/04/2002		



THURBER ENGINEERING LTD.



THURBER ENGINEERING LTD.



MICROSCOPIC PARTICULATE ANALYSIS REPORT SHEET (GUDI)

CLIENT: Chad Petersmeyer
Thurber Engineering
100, 4396 West Saanich Rd.
Victoria, BC
V8Z 3E9
TELEPHONE: (250) 727-2201
FAX: (250) 727-3710

Date of Sample: 23-Feb-10
Sample Location: Well #1Sanpareil
Type: Raw
Volume Filtered (L): 4066
Temperature (°C): 8.4
pH: 6.07
Conductivity: 56

The methodology used to generate this report conforms to the USEPA Consensus Method for the Microscopic Particulate Analysis. Based on the validation data, the method is fit for its intended use. Hyperion Research Ltd. is accredited for this analysis by CALA under the ISO/IEC 17025:2005 standard.

Sample Processing Information					Final Pellet Vol. (µL): 30.0	
Date Received	Time Received	Customer #	Temp. on Arrival (°C)	Lab ID	Density Medium	Sediment (mL)
25-Feb-10	1007	123	5.7	50034	none	0.10
Total Wash (mL)	Concentrated (mL)	G/C Volume (µL)	MPA Volume (µL)	Suspension Vol. (µL)	Equiv. Vol. (L)	
1000	1000	27	82	109	4,066	

GIARDIA and CRYPTOSPORIDIUM RESULTS

Giardia cysts/100 L: 0.00 *Cryptosporidium* oocysts/100 L: 0.00

PARTICULATE ANALYSIS RESULTS

Primary Particulates	Total Count	#/380 L (100 US gal.)	Relative Risk Factor
Diatoms:	0	0.00	NS
Other Algae:	6	0.75	NS
Insect/larvae:	0	0.00	NS
Rotifers:	13	1.62	R
Plant Debris:	68	8.47	R
Relative Risk Factors: EH - extremely heavy M - moderate H - heavy R - Rare NS - not significant			

Secondary Particulates	Total Count	#/380 L (100 US gal.)
Pollen	19	2
Nematodes	6	1
Crustacea	0	0
Amoebae	0	0
Ciliates/flagellates	0	0
Other	1	0
Large Debris	low	
Fine Debris	iron, clay	
Minerals	silica	

CONCLUSION: Based on this sample, the risk of surface water contamination is judged to be low and the risk factor is 1

Additional Data: Algae present in surface water

Analyst:

Peter M. Wallis, Ph.D.

From the EPA Consensus Method:	
<u>Risk of Surface Water Contamination</u>	
20+	- high risk
10 to 19	- moderate risk
0 to 9	- low risk

Recovery efficiencies for particles are known to be low by this method but are compensated for by filtering a large volume of water. Minimum recovery was measured to be 6.5 +/-1.2% for *Giardia* cysts, 0.5 +/-0.2% for *Cryptosporidium* oocysts and 4.2 +/-2.3% for *Euglena* (algae). Despite the low recovery, the method reliably detected as few as 1 cell/L of groundwater in validation trials with no false positives.



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Victoria, BC
V8Z 3E9
TELEPHONE: (250) 727-2201
FAX: (250) 727-3710

Date of Sample: 24-Feb-10
Sample Location: Well #1Sanpareil
Type: Raw
Volume Filtered (L): 3936
Temperature (°C):
pH:
Conductivity:

The methodology used to generate this report conforms to the USEPA Consensus Method for the Microscopic Particulate Analysis. Based on the validation data, the method is fit for its intended use. Hyperion Research Ltd. is accredited for this analysis by CALA under the ISO/IEC 17025:2005 standard.

Sample Processing Information						Final Pellet Vol. (µL): 40.0	
Date Received	Time Received	Customer #	Temp. on Arrival (°C)	Lab ID	Density Medium	Sediment (mL)	
26-Feb-10	1025	123	6.4	50041	none	0.20	
Total Wash (mL)	Concentrated (mL)	G/C Volume (µL)	MPA Volume (µL)	Suspension Vol. (µL)	Equiv. Vol. (L)		
1000	1000	43	130	173	3,936		

GIARDIA and CRYPTOSPORIDIUM RESULTS	
Giardia cysts/100 L: 0.00	Cryptosporidium oocysts/100 L: 0.00

PARTICULATE ANALYSIS RESULTS

Primary Particulates	Total Count	#/380 L (100 US gal.)	Relative Risk Factor
Diatoms:	0	0.00	NS
Other Algae:	762	97.90	H
Insect/larvae:	0	0.00	NS
Rotifers:	18	2.31	R
Plant Debris:	59	7.58	R
Relative Risk Factors: EH - extremely heavy M - moderate H - heavy R - Rare NS - not significant			

Secondary Particulates	Total Count	#/380 L (100 US gal.)
Pollen	51	7
Nematodes	12	2
Crustacea	0	0
Amoebae	0	0
Ciliates/flagellates	0	0
Other	1	0
Large Debris	low	
Fine Debris	iron	
Minerals	silica	

CONCLUSION: Based on this sample, the risk of surface water contamination is judged to be moderate and the risk factor is 13

Additional Data:

Analyst:

Peter M. Wallis, Ph.D.

From the EPA Consensus Method:	
<u>Risk of Surface Water Contamination</u>	
20+	- high risk
10 to 19	- moderate risk
0 to 9	- low risk

Recovery efficiencies for particles are known to be low by this method but are compensated for by filtering a large volume of water. Minimum recovery was measured to be 6.5 +/-1.2% for *Giardia* cysts, 0.5 +/-0.2% for *Cryptosporidium* oocysts and 4.2 +/-2.3% for *Euglena* (algae). Despite the low recovery, the method reliably detected as few as 1 cell/L of groundwater in validation trials with no false positives.



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100, 4396 West Saanich Rd.
Victoria, BC
V8Z 3E9
TELEPHONE: (250) 727-2201
FAX: (250) 727-3710

Date of Sample: 30-Mar-10
Sample Location: Well #1 Sanpareil
Type: Raw
Volume Filtered (L): 101
Temperature (°C): 8.4
pH: 6.1
Conductivity: 56

The methodology used to generate this report conforms to the USEPA Consensus Method for the Microscopic Particulate Analysis. Based on the validation data, the method is fit for its intended use. Hyperion Research Ltd. is accredited for this analysis by CALA under the ISO/IEC 17025:2005 standard.

Sample Processing Information					Final Pellet Vol. (µL): 10.0	
Date Received	Time Received	Customer #	Temp. on Arrival (°C)	Lab ID	Density Medium	Sediment (mL)
31-Mar-10	1110	123	1.4	50060	none	0.10
Total Wash (mL)	Concentrated (mL)	G/C Volume (µL)	MPA Volume (µL)	Suspension Vol. (µL)	Equiv. Vol. (L)	
1200	1200	100	100	100	202	

GIARDIA and CRYPTOSPORIDIUM RESULTS	
Giardia cysts/100 L: 0.00	Cryptosporidium oocysts/100 L: 0.00

PARTICULATE ANALYSIS RESULTS

Primary Particulates	Total Count	#/380 L (100 US gal.)	Relative Risk Factor
Diatoms:	0	0.00	NS
Other Algae:	8	30.10	M
Insect/larvae:	0	0.00	NS
Rotifers:	0	0.00	NS
Plant Debris:	15	56.44	M
Relative Risk Factors: EH - extremely heavy M - moderate H - heavy R - Rare NS - not significant			

Secondary Particulates	Total Count	#/380 L (100 US gal.)
Pollen	0	0
Nematodes	7	26
Crustacea	0	0
Amoebae	1	4
Ciliates/flagellates	0	0
Other	0	0
Large Debris	low	
Fine Debris	low silica	
Minerals	low iron	

CONCLUSION: Based on this sample, the risk of surface water contamination is judged to be moderate and the risk factor is **10**

Additional Data: Algae present in surface water. Method 1623 modification. Algae in poor condition.

Analyst:

Peter M. Wallis, Ph.D.

From the EPA Consensus Method:	Recovery efficiencies for particles using the Consensus Method for MPA was measured to be 6.5 +/-1.2% for <i>Giardia</i> cysts, 0.5 +/-0.2% for <i>Cryptosporidium</i> oocysts and 4.2 +/-2.3% for <i>Euglena</i> (algae). The estimated recoveries based on lab trials for the Method 1623 modification were 37.2 +/-7.0% for <i>Giardia</i> cysts, 81.2 +/-10.9% for <i>Cryptosporidium</i> oocysts and 36.2 +/-6.9% for <i>Euglena</i> (algae).
<u>Risk of Surface Water Contamination</u>	
20+ - high risk 10 to 19 - moderate risk 0 to 9 - low risk	



THURBER ENGINEERING LTD.



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V8Z 3E9
TELEPHONE: (250) 727-2201
FAX: (250) 727-3710

Date of Sample: 23-Feb-10
Sample Location: Well #4 Sanpareil
Type: Raw
Volume Filtered (L): 4046
Temperature (°C): 8.1
pH: 6.1
Conductivity: 53

The methodology used to generate this report conforms to the USEPA Consensus Method for the Microscopic Particulate Analysis. Based on the validation data, the method is fit for its intended use. Hyperion Research Ltd. is accredited for this analysis by CALA under the ISO/IEC 17025:2005 standard.

Sample Processing Information						Final Pellet Vol. (µL): 10.0	
Date Received	Time Received	Customer #	Temp. on Arrival (°C)	Lab ID	Density Medium	Sediment (mL)	
25-Feb-10	1007	123	5.7	50035	P/S 1.23	0.40	
Total Wash (mL)	Concentrated (mL)	G/C Volume (µL)	MPA Volume (µL)	Suspension Vol. (µL)	Equiv. Vol. (L)		
1000	1000	22	65	87	4,046		

GIARDIA and CRYPTOSPORIDIUM RESULTS	
Giardia cysts/100 L: 0.00	Cryptosporidium oocysts/100 L: 0.00

PARTICULATE ANALYSIS RESULTS

Primary Particulates	Total Count	#/380 L (100 US gal.)	Relative Risk Factor
Diatoms:	0	0.00	NS
Other Algae:	87	10.89	R
Insect/larvae:	0	0.00	NS
Rotifers:	24	3.01	R
Plant Debris:	6	0.75	R
Relative Risk Factors: EH - extremely heavy M - moderate H - heavy R - Rare NS - not significant			

Secondary Particulates	Total Count	#/380 L (100 US gal.)
Pollen	9	1
Nematodes	15	2
Crustacea	0	0
Amoebae	0	0
Ciliates/flagellates	0	0
Other	0	0
Large Debris	low	
Fine Debris	clay	
Minerals		

CONCLUSION: Based on this sample, the risk of surface water contamination is judged to be low and the risk factor is 5

Additional Data: Algae present in surface water

Analyst:

Peter M. Wallis, Ph.D.

From the EPA Consensus Method:	
<u>Risk of Surface Water Contamination</u>	
20+	- high risk
10 to 19	- moderate risk
0 to 9	- low risk

Recovery efficiencies for particles are known to be low by this method but are compensated for by filtering a large volume of water. Minimum recovery was measured to be 6.5 +/-1.2% for *Giardia* cysts, 0.5 +/-0.2% for *Cryptosporidium* oocysts and 4.2 +/-2.3% for *Euglena* (algae). Despite the low recovery, the method reliably detected as few as 1 cell/L of groundwater in validation trials with no false positives.



MICROSCOPIC PARTICULATE ANALYSIS REPORT SHEET (GUDI)

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Thurber Engineering
100, 4396 West Saanich Rd.
Victoria, BC
V8Z 3E9
TELEPHONE: (250) 727-2201
FAX: (250) 727-3710

Date of Sample: 24-Feb-10
Sample Location: Well #4 Sanpareil
Type: Raw
Volume Filtered (L): 3817
Temperature (°C):
pH:
Conductivity:

The methodology used to generate this report conforms to the USEPA Consensus Method for the Microscopic Particulate Analysis. Based on the validation data, the method is fit for its intended use. Hyperion Research Ltd. is accredited for this analysis by CALA under the ISO/IEC 17025:2005 standard.

Table with 7 columns: Date Received, Time Received, Customer #, Temp. on Arrival (°C), Lab ID, Density Medium, Sediment (mL). Includes rows for Total Wash (mL), Concentrated (mL), G/C Volume (µL), MPA Volume (µL), Suspension Vol. (µL), and Equiv. Vol. (L).

GIARDIA and CRYPTOSPORIDIUM RESULTS
Giardia cysts/100 L: 0.00
Cryptosporidium oocysts/100 L: 0.00

PARTICULATE ANALYSIS RESULTS

Table with 4 columns: Primary Particulates, Total Count, #/380 L (100 US gal.), Relative Risk Factor. Lists Diatoms, Other Algae, Insect/larvae, Rotifers, Plant Debris.

Table with 3 columns: Secondary Particulates, Total Count, #/380 L (100 US gal.). Lists Pollen, Nematodes, Crustacea, Amoebae, Ciliates/flagellates, Other, Large Debris, Fine Debris, Minerals.

CONCLUSION: Based on this sample, the risk of surface water contamination is judged to be low and the risk factor is 5

Additional Data:

Analyst:

Handwritten signature of Peter M. Wallis

Peter M. Wallis, Ph.D.

From the EPA Consensus Method:
Risk of Surface Water Contamination
20+ - high risk
10 to 19 - moderate risk
0 to 9 - low risk

Recovery efficiencies for particles are known to be low by this method but are compensated for by filtering a large volume of water. Minimum recovery was measured to be 6.5 +/-1.2% for Giardia cysts, 0.5 +/-0.2% for Cryptosporidium oocysts and 4.2 +/-2.3% for Euglena (algae). Despite the low recovery, the method reliably detected as few as 1 cell/L of groundwater in validation trials with no false positives.