Town of Faro Water Wells Investigation
Preliminary Results
Project #20a

prepared for:

Anvil Range Mining Corporation
(Interim Receivership)

prepared by:

Gartner Lee Limited

reference: **GLL 40-419**

date: **January 2005**

distribution:

1 Deloitte & Touche Inc.
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January 12, 2005

Mr. Doug Sedgwick
Environmental Services
Deloitte & Touche Inc.
79 Wellington Street West, Suite 1900
Toronto, Ontario
M5K 1B9

Dear Mr. Sedgwick:

Re: 40-419 – Town of Faro Water Wells Investigation (Project #20a)
Preliminary Results – FINAL REPORT

Please find attached our final report of preliminary results associated with the Town of Faro Water Wells Investigation. This report summarizes all related field activities and data collected during 2004. The significance of these results is discussed within the context of previous studies and historical data available.

Don't hesitate to contact me if you have any questions regarding the contents of this final report.

Yours very truly,
GARTNER LEE LIMITED

Don McCallum, MASc., P.Eng.
Senior environmental Engineer / Principal

DM

(40419 FINAL RPT on LH 12-Jan-2005 Faro Water Wells.doc)

Sperling Plaza, 6400 Roberts Street, Suite 490, Burnaby, BC, V5G 4C9 tel 604.299.4144 fax 604.299.1455
Toronto | Vancouver | Calgary | Montreal | St. Catharines | Whitehorse | Yellowknife | Bracebridge
www.gartnerlee.com

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1. Introduction

1.1 Study Objectives

The Town of Faro, Yukon, obtains its municipal water supply from three groundwater wells located south of the community, near Vangorda Creek and the Pelly River. Concerns have been raised regarding the potential for mine-related activities to impact Vangorda Creek and that Vangorda Creek could influence the quality of groundwater drawn for municipal uses (see Figure 1 for a general illustration of the area). This potential issue was recently raised at the October 2003 Yukon Water Board public hearing in Faro, held to review a water license renewal application for the Anvil Range mine site. As a result of the concerns raised at the hearing, the renewed water license (QZ03-059) includes a requirement to conduct a study examining the relationship between water flowing in Vangorda Creek and water obtained from the Town of Faro water supply wells. The final results of this study are to be submitted to the Water Board in 2006, as part of the annual report for the year 2005. It was noted by the Water Board, in their "reasons for decision", that no substantive information had yet been presented to suggest that there is an impact to the municipal supply wells resulting from the Anvil Range mine site.

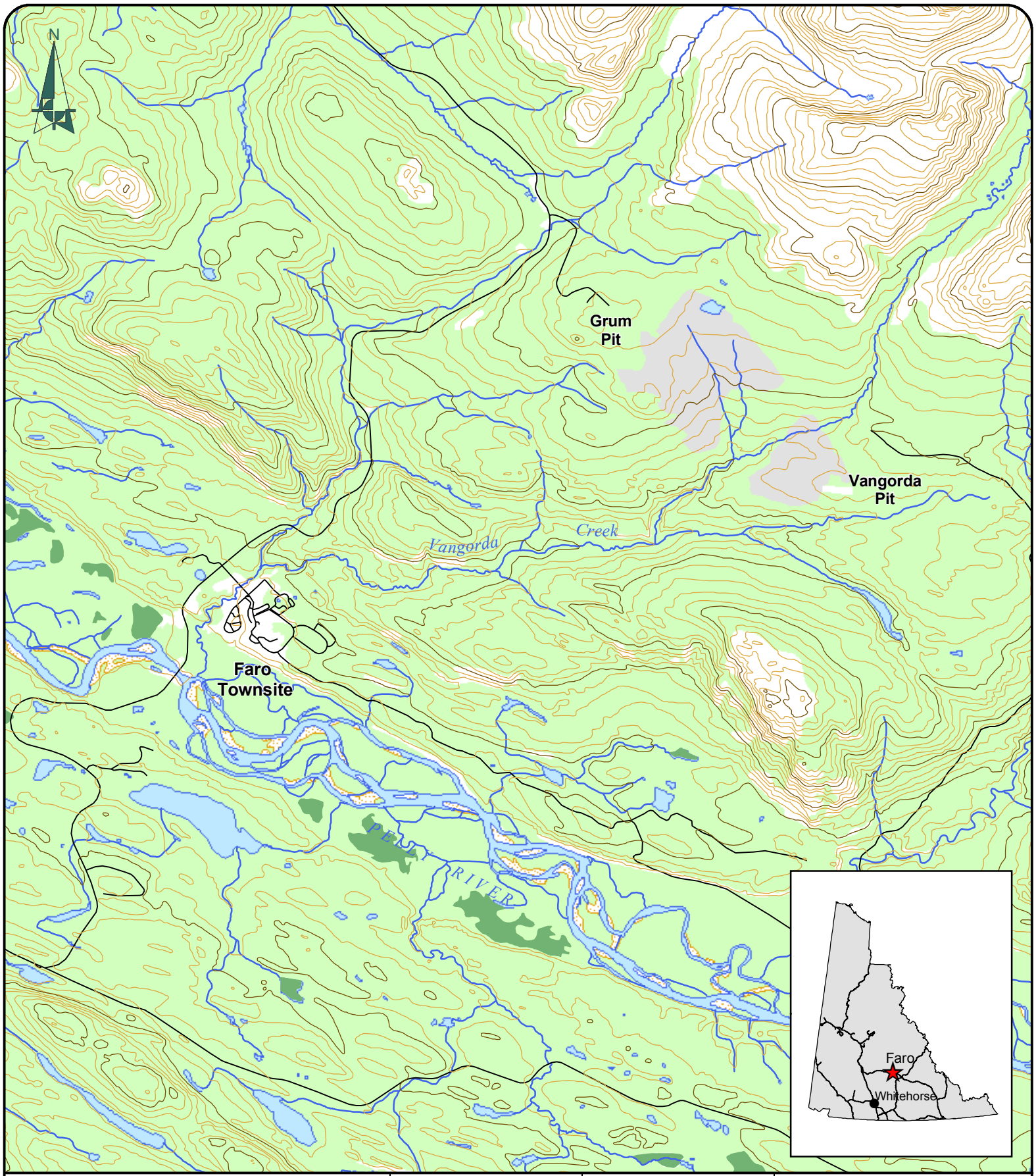
The specific objective of this study is to examine the potential relationship between Vangorda Creek and Town of Faro water supply wells. As a first step in meeting the requirements set forth in the recently issued mine site water license, this study synthesizes and summarizes historical studies and information, assesses data collected during 2004 and determines the need for further study.

1.2 Site History

The Town of Faro water supply wells #1 and #2 were drilled and completed as part of a 1968 test drilling program. An additional well was drilled and tested in 1980, and was put into production the following year, as water supply well #3 (see Figure 2). The following key water supply reports have been reviewed for this study:

- Hydrogeological Consultants (1980);
- Hydrogeological Consultants (1988);
- Jacobsen (2003).

The 1980 Hydrogeological Consultant report includes the driller's log, pumping test results, expected yield, and estimated aquifer properties associated with water supply well #3. Additionally, the report provides a background summary of the 1968 test drilling program. A total of eleven test wells were drilled in 1968 in the Vangorda Creek valley. Two of these test wells became water supply wells #1 and #2. According to this report, four of the test wells were completed as observation wells (well



LEGEND:

- Index Contours
- Intermediate Contours
- Roads
- Watercourses
- Pits
- Sand
- Waterbodies
- Wetlands
- Vegetation

0 0.5 1 2 kms

Scale 1: 75 000
Contour Interval: 100 feet

DATA SOURCES AND DISCLAIMERS:

National Topographic Data Base (NTDB) data compiled by Government of Canada, Natural Resources Canada (NRCan), at 1:50 000 scale.

Updated Road Network compiled by Government of Canada, Natural Resources Canada (NRCan) at 5m accuracy.

Deloitte.

Projection: UTM Zone 8 NAD83
Created By: AS
Reviewed By: JK
Date Issued: October 29, 2004
Project Number: 40419
File Name: 40419_figure_1_01Nov04.mxd
Revision: 1

Project: Town of Faro Water Wells Investigation
Preliminary Results Project Number 20a
Location: Faro, Yukon
Client: Deloitte & Touche Inc.

Site Location Map

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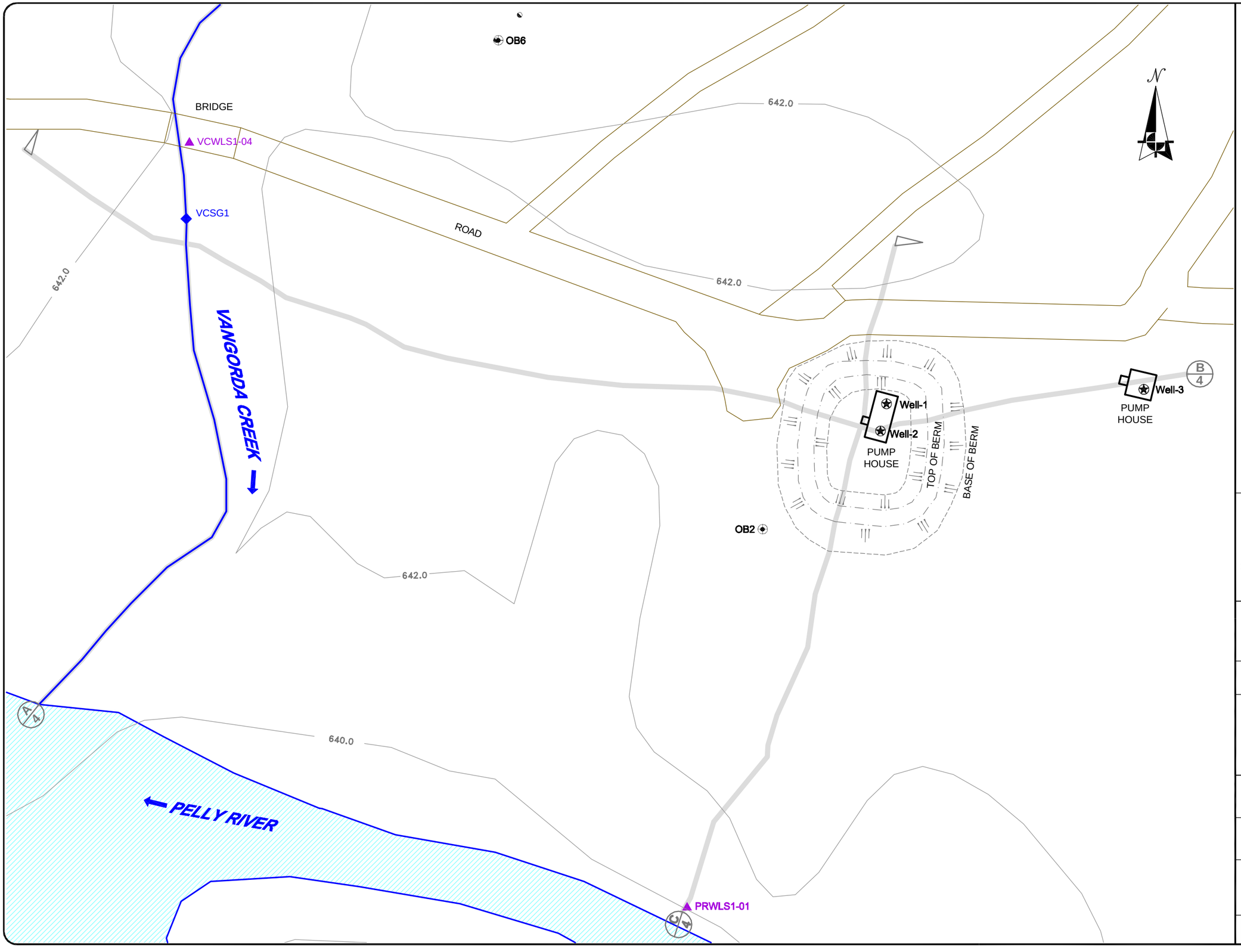
Figure No.
1



Legend:

- Building
- Stream, River
- Road
- VCSG1 — Location of Stream Gauge
- PRWLS1-04 — Water Level Sensor
- OB6 — Observation Well 2" or 6" diameter
- Well-2 — Town of Faro Water Supply Well
- Abandoned Well
- B 4 — Approximate Location of Transect (Tansect ID, Figure Number)

Data Sources:

1. Digital copy of 1:50,000 topographic map and orthophoto supplied by SRK Consulting.
2. Survey conducted in summer 2004 by Yukon Engineering Services

0 5 10 20 Metres

SCALE 1:500

Projection : UTM NAD 27 Zone 8
Contour Interval : 2 m (ASL)

Reviewed By : DMcC/JK
Prepared By : PW
Date Issued : November 1, 2004
Project No. : 40-419
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Revision : 0

Deloitte & Touche

Project: Faro Townsite Water Supply
Location: Faro, Yukon Territory
Client: Deloitte & Touche

SITE PLAN

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Figure No. 2

identifications: 8/68, 9/68, 10/68 and 11/68). A range of aquifer property (transmissivity, storativity) observations from the 1968 testing program is reported. No driller's logs from the 1968 program are included in the 1980 report. A report specific to the 1968 drilling program was not located during the research conducted for this study.

Curragh Resources, a previous owner of the Anvil Range mine, commissioned a 1988 study to assess the possibility of a direct hydraulic connection between Vangorda Creek and the aquifer in which the Town of Faro water supply wells are completed. The assessment was completed by Hydrogeological Consultants (1988) using data from the 1968 and 1980 groundwater programs. No additional field programs were conducted as part of the investigation. The findings of the study were qualitative in nature and concluded that under normal conditions, a direct hydraulic connection between Vangorda Creek and the aquifer in which the Town of Faro water wells are completed is unlikely. The study report did note the possibility of Vangorda Creek water entering the aquifer during a high-water stage. The report recommended that the following additional information be collected if more definitive conclusions were required:

- seasonal water quality data for Vangorda Creek and the town wells; and
- continuous water level readings from one observation well for a minimum of one year.

A review of the Faro water system was recently completed by the Health and Social Services Department of the Government of Yukon (Jacobsen, 2003). This review indicated that each of the three wellheads are well protected within pumphouses and elevated above the surrounding ground. It was also noted that the two buildings housing the wellheads appears to be adequately protected from flooding as a result of berms surrounding the facilities. No source water issues were identified in this report.

1.3 Study Approach

A phased approach to completing this study has been taken to ensure the program is completed in an efficient and cost-effective manner. Reporting and review are associated with the completion of each phase to determine the need for initiating subsequent work. The specific project phases and associated rationale are described below.

- **Review of previous studies and historical water quality data**
  Previous hydrogeological studies completed in the area have been reviewed for the purpose of determining known aquifer characteristics and groundwater flow information. Water quality data collected in lower Vangorda Creek since 1992 has been compared to Town of Faro municipal water supply quality data collected over a similar time period.

- **Water quality and flow data collection (2004), site survey, and instrumentation**

  Water quality samples of the town water supply, Vangorda Creek, and Pelly River have been collected (concurrently) on three occasions during 2004, corresponding to freshet conditions in Vangorda Creek, and lower stream flow conditions in the summer and fall seasons. A site survey was completed for the purpose of obtaining ground and water elevations in the vicinity of the following features: town pumping wells, two observation wells (discovered during an earlier site visit), lower Vangorda Creek, and the Pelly River (directly south of town wells). Stream flow measurements were obtained in two locations in Vangorda Creek during the fall site visit. Level Loggers, recording temperature and water depth, were also installed during October 2004 in two observation wells, Vangorda Creek and the Pelly River.

  The data collected in this phase of the study allows for a conceptual description of the local hydrogeological setting and a preliminary assessment of water quality results. These results are incorporated in this report.

- **Water quality data collection (winter/spring 2005) and assessment of site water level and temperature data**

  It is anticipated that up to one–year's continuous temperature and water level data will be captured with the Level Loggers installed in October 2004. This data will be recovered and used to refine the conceptual hydrogeological description provided herein. Additional water quality sampling may be recommended for the winter and spring periods of 2005. A report will be prepared in 2005 providing an assessment of results and recommendations.

- **Installation of additional groundwater monitors (if necessary)**

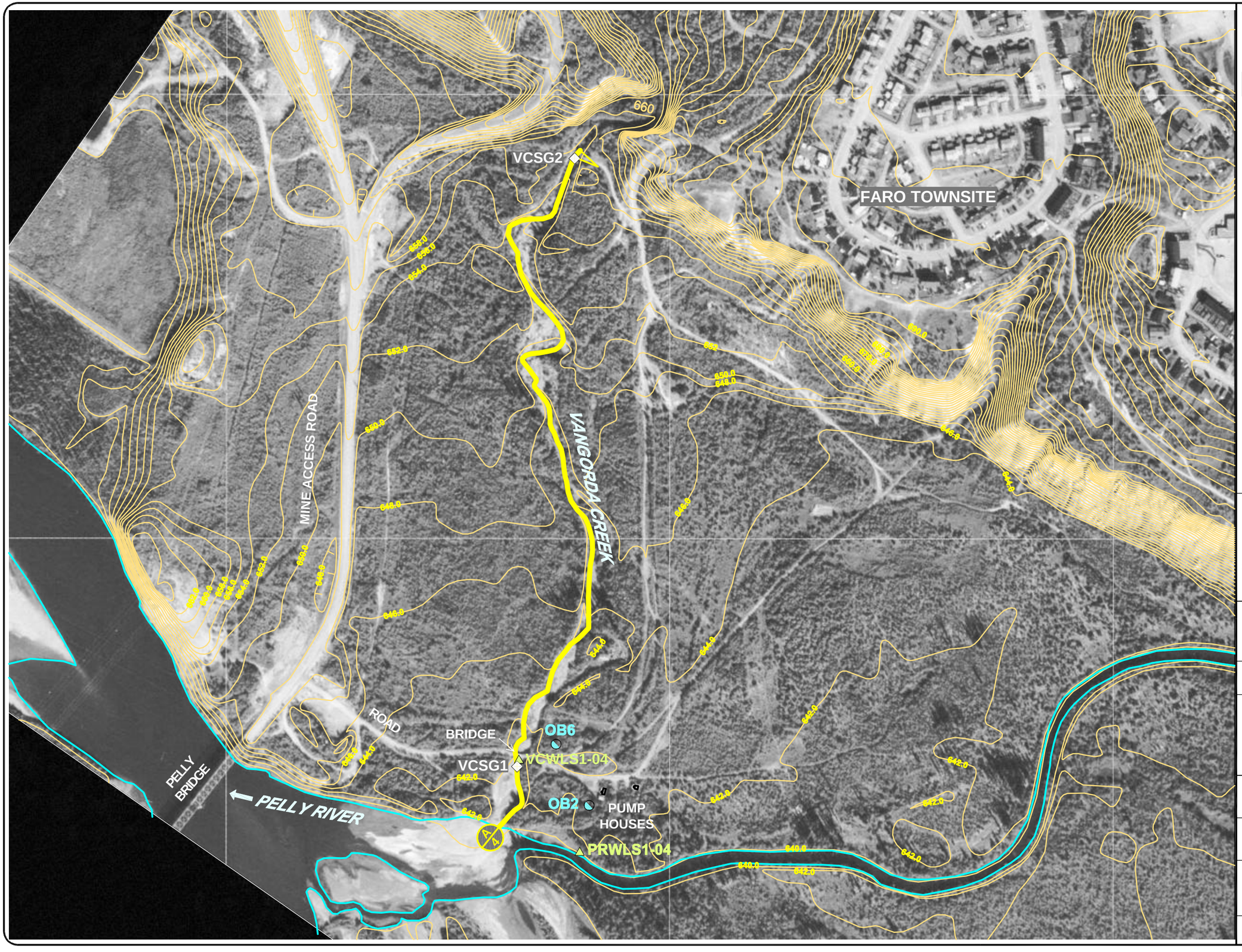
  The installation of additional groundwater monitors in the vicinity of the Town of Faro water supply wells may be recommended depending on the results of the water chemistry, temperature, and level information obtained in the earlier study phases.

2. Project Setting

The location of the three Town of Faro water supply wells are illustrated in Figure 2 in relation to other prominent site features. Water supply wells #1 and #2 are located approximately 100 m from Vangorda Creek and 70 m from the Pelly River. Four abandoned wells, which were discovered during one of the site visits, are indicated on the figure. Two of these abandoned wells (OB2 and OB6) have been used as observation wells for the purpose of this study. Water level and temperature sensors have been installed in both Vangorda Creek and the Pelly River at relevant locations and are identified on Figure 2 as VCWLS01-04 and PRWLS01-04, respectively.

Vangorda Creek is a relatively small stream, two to three metres in width during normal conditions. Approximately 800 m from its confluence with the Pelly River, it exits a relatively narrow, high gradient canyon (Figure 3) and spills onto a moderate gradient (3%) alluvial fan for a distance of approximately 250 m. Downstream of this location, the creek gradient is reduced somewhat to approximately 1%. It is apparent from aerial photography (Figure 3) and previously published reports that the lower one-third of this 800 m reach has likely occupied different channels in the recent past. As reported in the Hydrogeological Consultants (1988) report, prior to 1968 Vangorda Creek flowed in a channel east of water supply wells #1 and #2 (approximately mid-way between these wells and the current location of water well #3). In later 1968 or early 1969, the lower Vangorda Creek watercourse changed to its current location approximately 100 m west of water wells #1 and #2.

Upon review of a site air photo, available drilling logs, site elevation data, and a preliminary terrain analysis which included brief ground-truthing exercises (i.e. hand dug test pits), a conceptual geological setting of the study area was completed. As would be expected, coarse grain, alluvial fan deposits were identified across the upper portion of the study area where Vangorda Creek exits the canyon. The presence of these deposits is reflected in the fan-like topography (Figure 3). These coarse-grained, high-energy-type deposits are believed to extend down to approximately 100 to 200 meters north of the Pump Houses. Beyond this location, a transitional zone is believed to exist which incorporates the low energy, finer-grained deposits of the Pelly River flood plain. These deposits are often silty and fine-sand rich, and have been identified in the upper portion of the drilling logs associated with wells 1, 2 and 3. The interaction of groundwaters between the Vangorda Creek alluvial fan and the Pelly River flood plain deposits is the focus of this study.



Legend:

- VCSG1 — Location of Stream Gauge
- VWLS1-04 — Water Level Sensor
- OB2 — Observation Well 2" or 6" diameter
- B 4 — Approximate Location of Transect (Tansect ID, Figure Number)

N

Data Sources:

1. Digital copy of 1:50,000 topographic map and orthophoto supplied by SRK Consulting.
2. Survey conducted in summer 2004 by Yukon Engineering Services

0 100 200 Metres

SCALE 1:4000

Projection : UTM NAD 27 Zone 8
Contour Interval : 2 m (ASL)

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Deloitte & Touche

Project: Faro Townsite Water Supply
Location: Faro, Yukon Territory
Client: Deloitte & Touche

2004 SITE INSTRUMENTATION AND SURVEY

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Figure No. 3

3. Water Quality Analysis

3.1 Historical Water Quality Analysis

Historical water quality records exist for both the Town of Faro water supply wells and lower Vangorda Creek. Monitoring of the Town water supply wells has been conducted by the Town in compliance with water license conditions (current license#: MN00-030). Lower Vangorda Creek (site #V8, located near pedestrian footbridge below town) has been monitored by the Anvil Range Mining Corporation and the previous mine owner, Curragh Resources. No water quality or flow information for the Pelly River at Vangorda Creek has been located at this time.

The Town of Faro water supply monitoring results reported in annual reports for the years 1990 through 2003 have been reviewed for this study. This timeframe approximately matches the monitoring record for Vangorda Creek. Samples for trace metal analyses have generally been collected twice per year, while bacteriological samples are collected more frequently. A summary of this data is provided in Table 1. The data generally indicate a good quality water supply. There has never been a detection of fecal coliforms in the raw water supply, as reported in annual water use reports. All chemical parameters analyzed have been within Canadian Drinking Water Quality guidelines (Health Canada, 1996) with a few rare exceptions. One sample slightly exceeded the guideline for cadmium. However, 14 of 16 samples collected during the review period recorded undetectable cadmium concentrations (detection limit was consistently below the guideline). Iron levels in the raw water supply have generally been lower then the associated guideline with only a few exceptions. The iron guideline is defined for aesthetic purposes and is not related to human health.

A graphical illustration of historical well water quality is provided in Figure 4 for the purpose of exploring potential seasonal trends. Based on 13 years of monitoring data it appears that a seasonal water quality trend may exist for some parameters including conductivity. As illustrated in Figure 4, conductivity values tended to be higher in the early spring period and lower in summer and fall. It is difficult to determine cause and effect relationships from this observation as no more than two data points have been reported in any one year. The same seasonal trend is not apparent for all water quality parameters, including zinc (Figure 4).

A number of seasonal trends in Vangorda Creek quality are also apparent as illustrated in Figure 5. This figure incorporates 12 years of monitoring data collected at the Anvil Range monitoring location site V8. An inverse relationship between stream flow rate and conductivity is apparent. This relationship is expected to be the result of the relatively higher contribution of (high conductivity) groundwater to total stream flows during low-flow conditions. Another seasonal trend is also apparent for trace metals such as lead and zinc. As illustrated in Figure 5, lead concentrations and to a lesser degree zinc, tends to peak sharply in the late April and May period. This is very likely directly related to the higher suspended solids loading induced during the Vangorda Creek freshet period.

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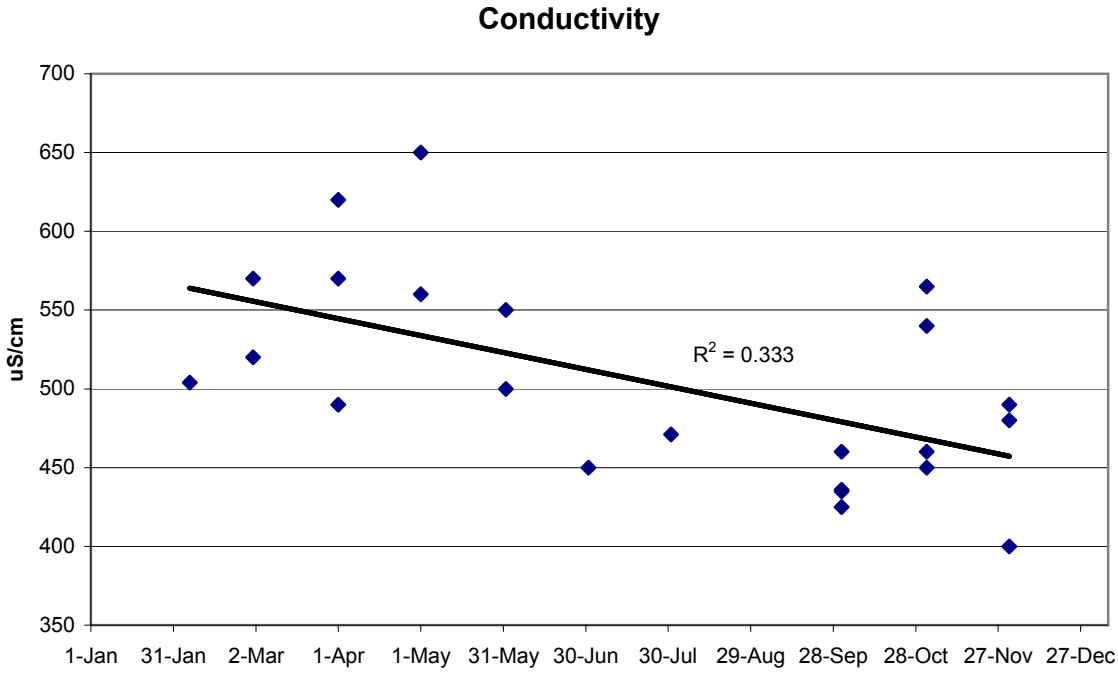
Table 1: Town of Faro Water Quality Summary (1990 - 2003)[a]

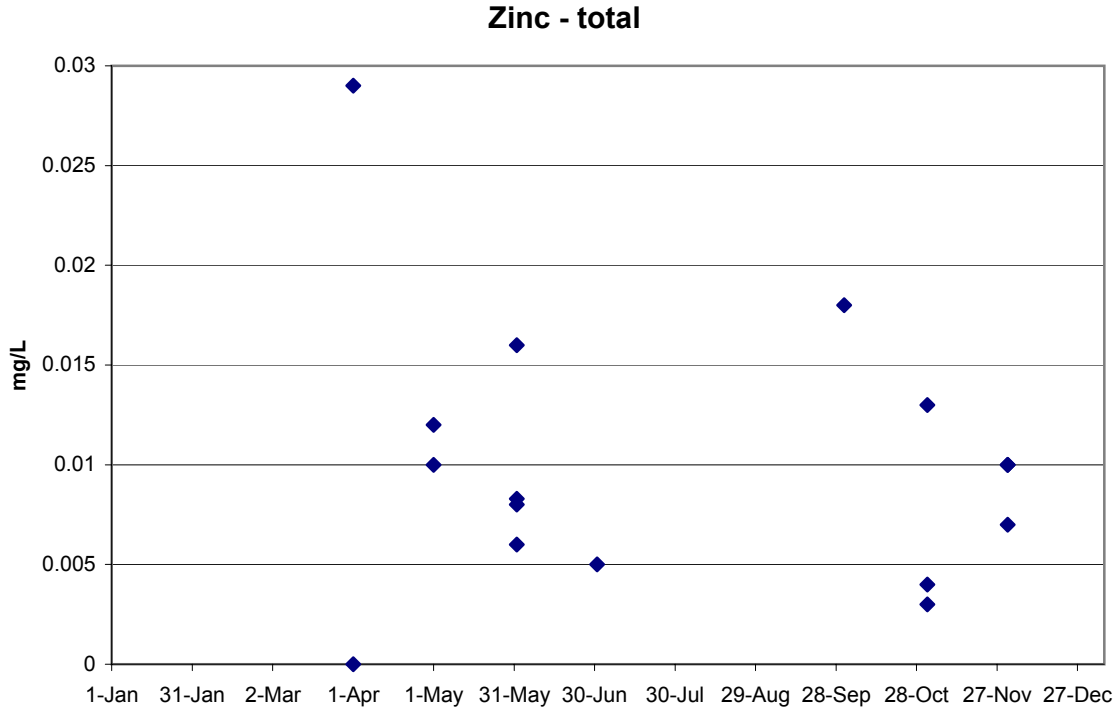
Parameter	Canadian Drinking Water Quality Guidelines[b] (mg/L)	Number of Samples (#)	Detection Limit (mg/L)	Number of samples > Detection Limit (#)	Median (mg/L)	Maximum (mg/L)
Bacteriological						
Fecal coliforms (org/100 mL)	0	86	1	0	<1	<1
Total Metals						
Arsenic	0.025	16	0.0004 - 0.04	0	<0.02	<0.04
Cadmium	0.005	16	0.0001 - 0.001	2	<0.0005	**0.0078**
Calcium	-	25		25	63	84
Iron	0.3	25	? - 0.2	24	0.045	**0.660**
Lead	0.01	16	0.0001 - 0.01	2	<0.005	0.007
Manganese	0.05	25	0.001 - 0.01	20	0.003	0.030
Zinc	5	16	0.005	15	0.010	0.029

Notes:

a	Data source: Annual Water Use Reports for Town of Faro, 1990 - 2003; data for raw untreated water supply, sampling location FA-1
b	Health Canada. Guidelines for Canadian Drinking Water quality. Sixth Ed., 1996
<	indicates less than the detection limit.
-	indicates no guideline or analysis for this parameter
bold	indicates parameter exceeded guideline

Figure 4: Town of Faro Water Supply Monitoring Results (1990 - 2003)

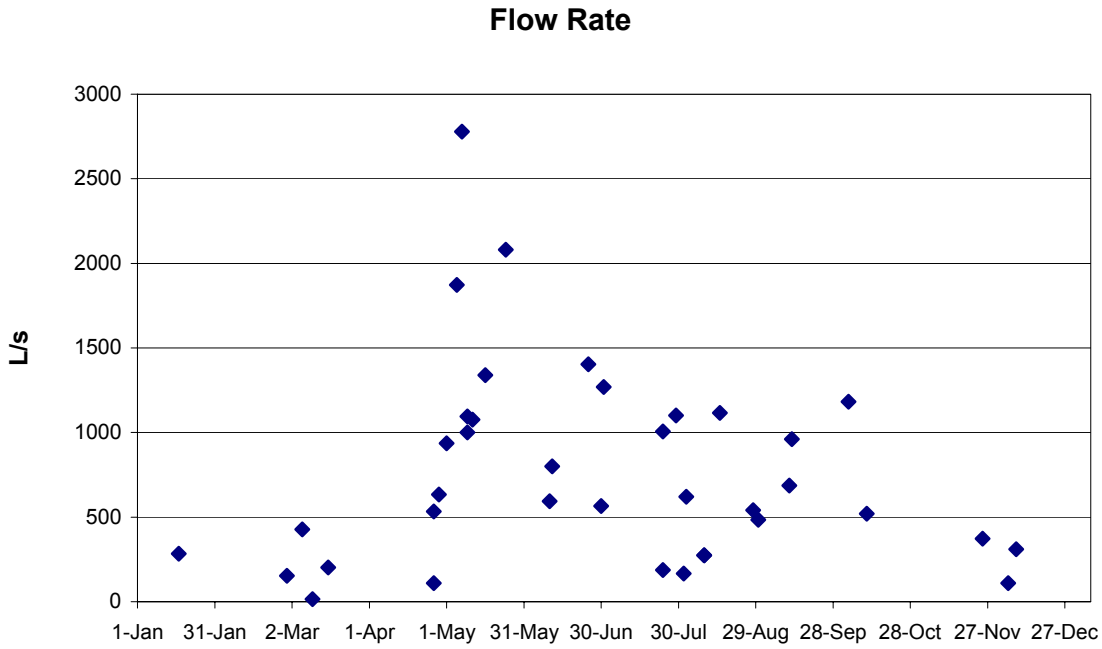


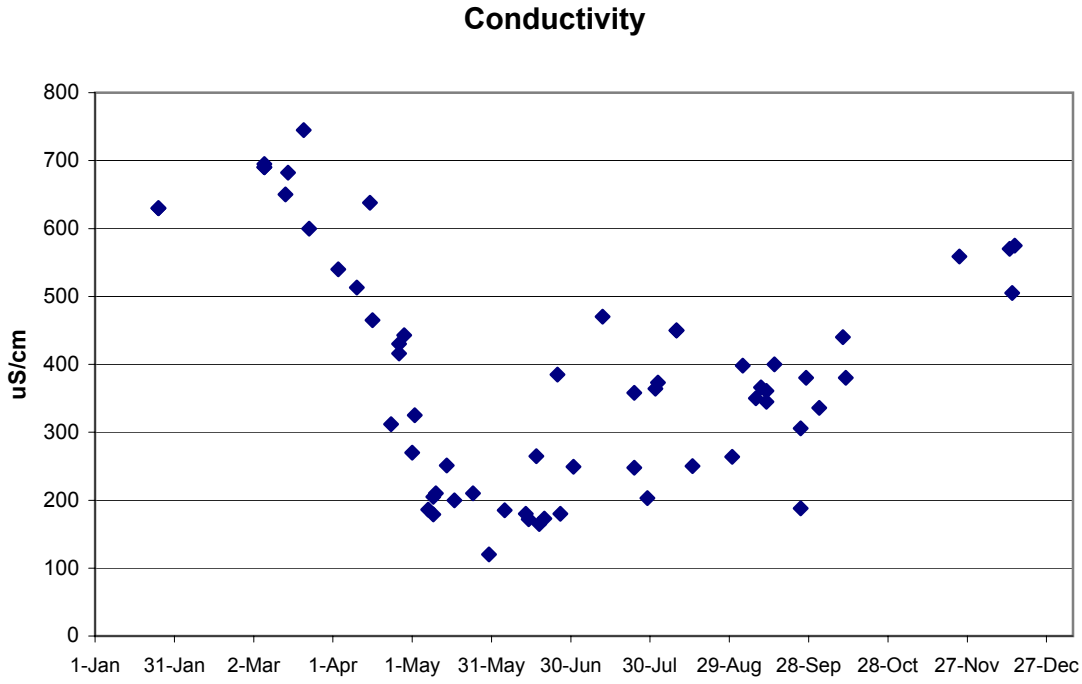


Notes

1. Data source: Annual Water Use Reports for Town of Faro, 1990 - 2003; data for raw untreated water supply, sampling location FA-1

Figure 5: Vangorda Creek Selected Monitoring Results (1992 - 2004)





3.2 2004 Water Quality Data Collection and Analysis

Samples for water quality analysis were obtained from the Town of Faro wells, Pelly River and Vangorda Creek on three occasions in 2004 (May 20, September 10, and October 7, 2004). Samples from two of the discovered abandoned wells (OB2 and OB6) were also collected for water quality analysis on October 7. Field data collected during each of the sampling events are included in Table 2.

The May 20th, 2004 sampling event was chosen to coincide with the Vangorda Creek freshet period (flow data not yet available for this period). Samples were analyzed for a range of physical parameters, dissolved anions, nutrients, total and dissolved metals (results summarized in Table 3). Three field replicates were obtained from both the Town of Faro water supply and Vangorda Creek for the purpose of variability analysis. The same set of parameters was also analyzed for samples collected during the October 7th, 2004 sampling event (results summarized in Table 4).

Grab samples obtained on September 10th, 2004 from the Town of Faro water wells, Vangorda Creek and Pelly River were submitted for environmental isotope analysis. Results of the analyses to determine the relative concentrations of heavy stable isotopes of oxygen (O-18) and hydrogen (H-2) are summarized in Table 5.

3.2.1 Discussion of Results

The Town of Faro water supply samples from each of the sampling periods met all Canadian Drinking Water Quality guidelines (Health Canada, 1996) with the exception of total lead, in the May 20th, 2004 samples (Table 3). The average (total) lead concentration from the three samples collected on that day slightly exceeded the guideline (0.015 mg/L compared to the guideline of 0.01 mg/L). A relatively high degree of uncertainty is associated with the result as indicated by the standard deviation of the three samples (0.01 mg/L). The dissolved lead concentrations in the same samples were lower than the laboratory detection limit of 0.002 mg/L. Subsequent sampling of the Town of Faro water supply on October 7th, 2004 indicated total lead concentrations significantly lower than the guideline value (0.002 mg/L; Table 4). The Town of Faro has been notified of the sampling results.

Figure 6 provides an illustrative comparison of water quality results for the Town of Faro water wells, Vangorda Creek, and the Pelly River. Based on the spring 2004 sample results, the town water well quality can be easily distinguished from Vangorda Creek and Pelly River based on the conductivity analysis (and related parameters such as hardness, alkalinity, sulphate, calcium, and magnesium). The fall 2004 results indicate less pronounced differences between water sources based on the same conductivity-related parameters. While zinc concentrations do not follow the same spatial or temporal pattern as the conductivity-related parameters, a relatively high degree of seasonal variability in zinc levels is apparent for each of the three sources.

The relatively high total trace metal concentrations observed in the "2-inch" abandoned well (OB2) can be attributed to the high suspended sediment content of the sample (808 mg/L).

Analysis of the heavy isotopes of oxygen and hydrogen is often used as a tool to understand the origin of, and distinguish between, different water sources. This analysis was conducted on a set of grab samples from Vangorda Creek, Pelly River and the town water wells to determine its potential application to address the current study objectives. The results of the analysis (Table 5) indicate (in parts per thousand) the abundance of the stable heavy isotopes in each of the samples relative to standard mean ocean water. The similarity in source characteristics for all three samples, measured by the isotope analysis, appear to preclude this technique from further use in this study.

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Table 2: Field Data Collection - 2004

Parameter	Sample Locations									
	Town of Faro Water Supply FA-1		Pelly River PRWLS 1-04		Vangorda Creek VCWLS 1-04		Observation Well "6-inch" OB6		Observation Well "2-inch" OB2	
Date Sampled	10-Sep	7-Oct	10-Sep	7-Oct	10-Sep	7-Oct	10-Sep	7-Oct	10-Sep	7-Oct
Temperature (^{o}C)	6	5.66	5.54	4.66	3.73	2.86	-	6.07	-	6.85
Conductivity (uS/cm)	-	519	321	316	459	462	-	475	-	555
pH	-	7.92	8.16	8.08	8.40	8.34	-	7.57	-	7.57
Dissolved Oxygen (mg/L)	-	12.80	12.62	12.48	16.15	14.81	-	11.50	-	-

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Table 3: Surface water and groundwater quality - Spring 2004

Parameter	Canadian Drinking Water Quality Guidelines[a]	Sample Locations				
		Town of Faro Water Supply FA-1 n=3		Pelly River PRWLS 1-04 n=1	Vangorda Creek VCWLS 1-04 n=3	
		Average[b]	Std Dev.[c]		Average[b]	Std Dev.[c]
Date Sampled		20-May-04		20-May-04	20-May-04	
Physical Tests						
Colour (CU)	15	<5		10	8	2
Conductivity (uS/cm)	-	460	15	167	166	2
Total Dissolved Solids (mg/L)	500	300	9	200	163	30
Hardness (mg/L as CaCO3)	-	261	4	92	92	1
Total Suspended Solids (mg/L)	-	2	0.6	3	1	
Turbidity (NTU)	5	<5		<5	<5	
Dissolved Anions (mg/L)						
Alkalinity-Total (as CaCO3)	-	162	1	65	67	2
Chloride Cl	250	<1		<1	<1	
Sulphate SO4	500	91	1	26	25	1
Nutrients						
Nitrate Nitrogen (as N)	10	1.11		0.66	0.74	0.3
Nitrite Nitrogen (as N)	1	0.01		<0.01	0.04	0.02
Organic Parameters (mg/L)						
Total Organic Carbon	-	<1		1	<1	
Total Metals (mg/L)						
Aluminum	-	0.022	0.004	1.553	2.393	0.03
Antimony	-	0.004		0.003	0.003	0.001
Arsenic	0.025	<0.003		0.003	<0.003	
Barium	1	0.071	0.001	0.193	0.094	0.002
Beryllium	-	<0.0002		0.0002	0.0003	0.00001
Boron	5	0.07	0.002	0.09	0.09	0.009
Cadmium	0.005	<0.0002		0.0006	0.0002	
Calcium	-	65.9	0.9	30.0	28.7	0.3
Chromium	0.05	0.005	0.0008	0.003	0.007	0.001
Cobalt	-	<0.001		0.003	0.003	0.0004
Copper	1	0.048	0.005	0.019	0.019	0.002
Iron	0.3	0.051	0.01	**4.350**	**3.916**	0.08
Lead	0.01	**0.0150**	0.01	<0.002	0.007	0.006
Magnesium	-	24.4	0.1	9.2	10.2	0.1
Manganese	0.05	0.011	0.0002	**0.253**	**0.122**	0.006
Molybdenum	-	0.002		0.002	<0.001	
Nickel	-	<0.001		0.001	0.010	0.001
Phosphorus	-	<0.01		0.25	0.15	0.01
Potassium	-	1.2	0.008	1.4	1.9	0.03
Selenium	0.01	<0.005		<0.005	<0.005	
Silver	-	<0.0002		0.0005	<0.0002	
Sodium	200	2.6	0.1	1.2	1.1	0.08
Strontium	-	0.213	0.003	0.098	0.088	0.001
Titanium	-	<0.001		0.034	0.073	0.002
Vanadium	-	<0.001		0.008	0.007	0.004
Zinc	5	0.040	0.008	0.081	0.047	0.003

Table 3: Surface water and groundwater quality - Spring 2004

(continued)

Parameter	Canadian Drinking Water Quality Guidelines[a]	Sample Locations				
		Town of Faro Water Supply FA-1 n=3		Pelly River PRWLS 1-04 n=1	Vangorda Creek VCWLS 1-04 n=3	
		Average[b]	Std Dev.[c]		Average[b]	Std Dev.[c]
Date Sampled		20-May-04		20-May-04	20-May-04	
Dissolved Metals (mg/L)						
Aluminum	-	0.025	0.007	0.153	0.300	0.06
Antimony	-	0.005		<0.002	0.002	
Arsenic	-	0.003		<0.003	<0.003	
Barium	-	0.082	0.001	0.091	0.074	0.003
Beryllium	-	0.0003	0.00004	0.0002	0.0003	0.00002
Boron	-	0.09	0.005	0.08	0.05	
Cadmium	-	<0.0002		<0.0002	0.0002	
Calcium	-	68.9	1.2	26.4	25.7	0.4
Chromium	-	0.006	0.002	0.001	0.001	
Cobalt	-	0.001		<0.001	0.001	
Copper	-	0.026	0.003	0.021	0.019	0.007
Iron	-	0.040	0.004	0.328	0.444	0.1
Lead	-	<0.002		<0.002	0.002	
Magnesium	-	25.8	0.2	7.9	8.7	0.2
Manganese	-	0.012	0.001	0.029	0.024	0.001
Molybdenum	-	0.002		0.003	0.003	
Nickel	-	<0.001		0.002	0.004	0.002
Phosphorus	-	<0.01		<0.01	<0.01	
Potassium	-	1.3	0.04	1.1	1.5	0.04
Selenium	-	<0.005		<0.005	<0.005	
Silver	-	<0.0002		0.0004	0.0002	
Sodium	-	3.2	0.1	0.7	0.9	0.3
Strontium	-	0.225	0.002	0.087	0.080	0.003
Titanium	-	<0.001		0.007	0.015	0.004
Vanadium	-	<0.001		0.001	0.002	0.0002
Zinc	-	0.019	0.003	0.034	0.036	0.001

Notes:

[a] Health Canada. Guidelines for Canadian Drinking Water quality. Sixth Ed., 1996

[b] Where detectable and non-detectable measurements recorded, the average includes the detection limit value (for the non-detects)

[c] Standard deviation calculated only where all results exceed the detecetion limit.

< indicates less than the detection limit.

- indicates no guideline or analysis for this parameter

bold indicates parameter exceeds guideline

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Table 4: Surface water and groundwater quality - Fall 2004

Parameter	Canadian Drinking Water Quality Guidelines[a]	Sample Locations				
		Town of Faro Water Supply	Pelly River	Vangorda Creek	Obs. Well "6-inch"	Obs. Well "2-inch"
		FA-1	PRWLS 1-04	VCWLS 1-04	OB6	OB2
Date Sampled		07-Oct-04	07-Oct-04	07-Oct-04	07-Oct-04	07-Oct-04
Physical Tests						
Colour (CU)	15	<5.0	<5.0	<5.0	<5.0	36.6
Conductivity (uS/cm)	-	516	318	459	483	584
Total Dissolved Solids (mg/L)	500	327	187	283	304	392
Hardness (mg/L as CaCO3)	-	277	164	247	255	298
Total Suspended Solids (mg/L)	-	<3.0	<3.0	5.5	7.0	808
Turbidity (NTU)	5	0.19	-	1.95	10.9	1450
Dissolved Anions (mg/L)						
Alkalinity-Total (as CaCO3)	-	168	111	156	152	170
Chloride Cl	250	1.05	<0.50	1.41	1.20	1.15
Sulphate SO4	500	112	55.2	89.0	107	142
Nutrients						
Nitrate Nitrogen (as N)	10	0.223	<0.0050	0.235	0.124	0.0650
Nitrite Nitrogen (as N)	1	<0.0010	<0.0010	<0.0010	<0.0010	0.0316
Total Metals (mg/L)						
Aluminum	-	<0.010	0.031	0.030	0.010	0.350
Antimony	-	<0.00050	<0.00050	<0.00050	<0.00050	0.0086
Arsenic	0.025	<0.0010	<0.0010	<0.0010	<0.0010	0.0054
Barium	1	0.096	0.076	0.066	0.090	0.124
Beryllium	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Boron	5	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	0.005	<0.000050	0.000096	<0.000050	<0.000050	0.00297
Calcium	-	67.9	41.8	59.7	62.9	76.8
Chromium	0.05	<0.00060	<0.00050	<0.00050	<0.00050	0.0145
Cobalt	-	<0.00050	<0.00050	<0.00050	<0.00050	0.0054
Copper	1	0.0043	0.0011	0.0013	0.0010	0.0357
Iron	0.3	<0.030	0.133	0.102	**0.900**	**174**
Lead	0.01	0.0020	<0.0010	<0.0010	<0.0010	**0.0324**
Lithium	-	<0.050	<0.050	<0.050	<0.050	<0.050
Magnesium	-	26.1	14.5	23.7	23.8	25.9
Manganese	0.05	<0.010	0.011	0.019	<0.010	**0.580**
Mercury	0.001	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Molybdenum	-	<0.0010	0.0012	<0.0010	<0.0010	0.0024
Nickel	-	<0.0050	<0.0050	<0.0050	<0.0050	0.028
Selenium	0.01	0.0011	<0.0010	<0.0010	<0.0010	<0.0020
Silver	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.00010
Sodium	200	3.4	<2.0	3.3	3.2	3.3
Thallium	-	<0.00020	<0.00020	<0.00020	<0.00020	<0.00040
Titanium	-	<0.050	<0.050	<0.050	<0.050	<0.050
Uranium	0.1	0.00373	0.00151	0.00394	0.00373	0.00568
Vanadium	-	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	5	0.0096	0.0096	0.0118	<0.0050	0.0972
Organic Parameters (mg/L)						
Total Organic Carbon		1.03	2.46	3.27	1.46	19.2

Notes:

a Health Canada. Guidelines for Canadian Drinking Water quality. Sixth Ed., 1996

< indicates less than the detection limit.

- indicates no guideline or analysis for this parameter

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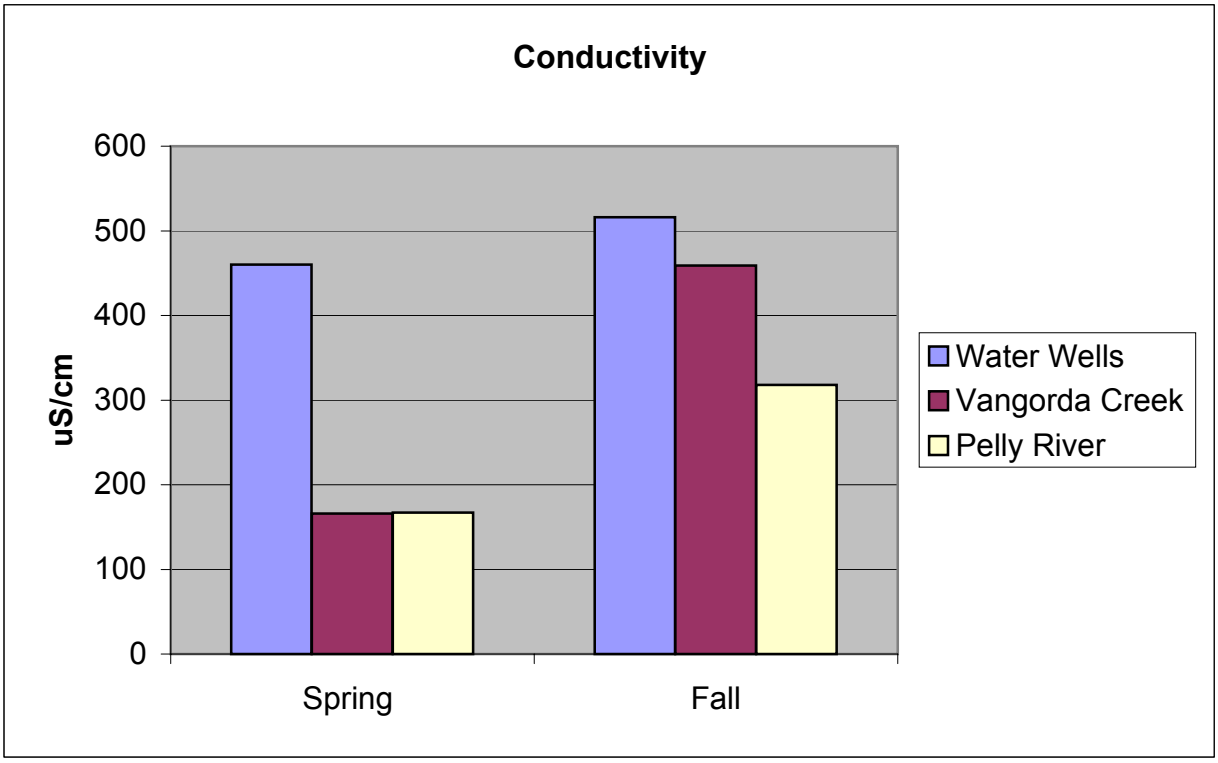
Table 5: Environmental Isotope Results

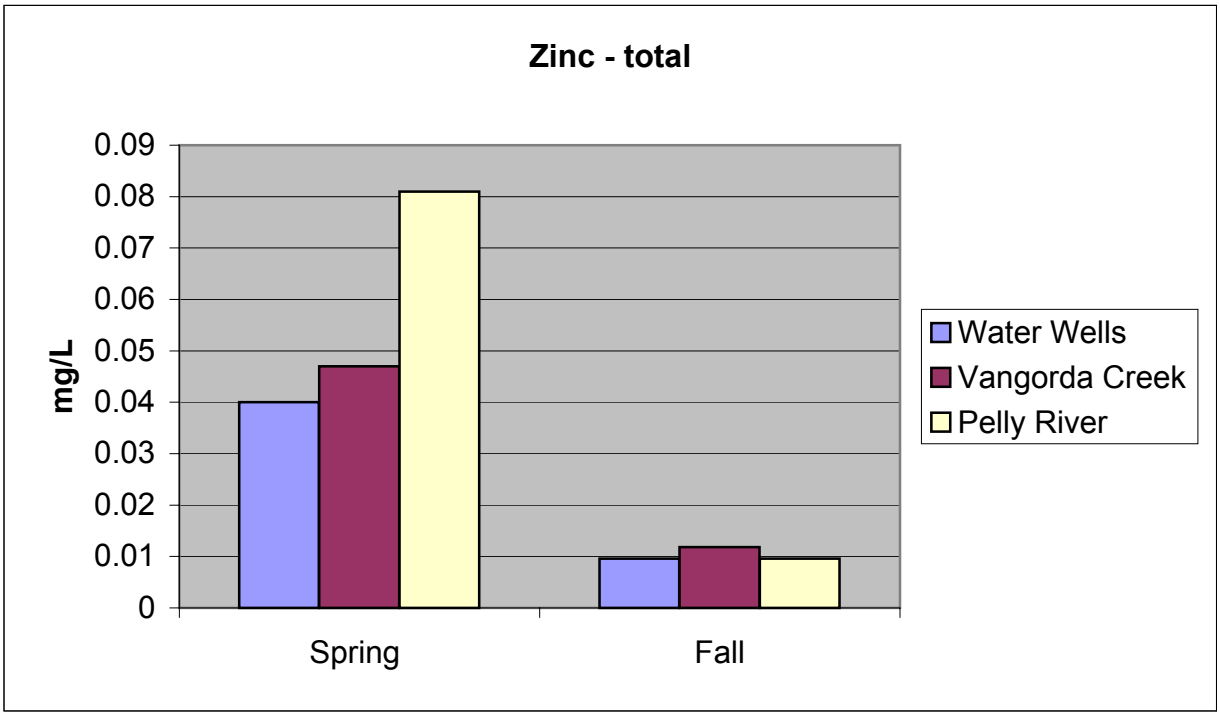
Isotope Analyzed[1]	Sample Locations					
	Town of Faro Water Supply FA-1		Pelly River @ PRWLS 1-04		Vangorda Creek @ VCWLS 1-04	
	Result	Repeat	Result	Repeat	Result	Repeat
Date Sampled	10-Sep-04		10-Sep-04		10-Sep-04	
Oxygen-18 (^{18}O *o/oo* relative to SMOW[2])	-21.41		-20.52	-20.74	-21.04	
Hydrogen-2 (^{2}H *o/oo* relative to SMOW)	-168.16	-167.90	-164.02	-163.42	-167.00	-166.51

Notes:

1. Samples analyzed at Environmental Isotope Lab, Department of Earth Sciences, University of Waterloo, Ontario
2. SMOW refers to Standard Mean Ocean Water

Figure 6: Comparison of Selected 2004 Water Quality Data





Notes:
1. Data summarized in Tables 3 and 4
2. Results below detection limit are shown on plot at the detection limit

4. Conceptual Hydrogeological Setting

4.1 Existing Monitoring / Production Wells

The locations of the three Town of Faro water supply wells are illustrated in Figure 2 in relation to other prominent site features. Water supply wells #1 and #2 are located approximately 100 metres from Vangorda Creek and 70 metres from the Pelly River. A summary of pertinent well construction details is provided in Table 6.

Given the historical groundwater drilling and testing activities that have been documented in and around the Faro Well field, a site visit was conducted in an attempt to locate abandoned wells that potentially could be used as monitoring wells. In total, four abandoned wells were discovered (Figure 3). Attempts were made to inspect and identify the well screen interval of all the abandoned wells using a down-hole camera. However, due to limitations in well diameter size, only one (OB6) of the four abandoned wells could be inspected. Additionally, only three of the four abandoned wells could accommodate the water level probe and or a water level / temperature sensor (i.e., a Level Logger). Based on these limitations, and the relative proximity of three of the located abandoned wells, only two of the four abandoned wells (OB2 and OB6) have been instrumented as part of this study. A discussion regarding the instrumentation details is provided in section 4.2. A summary of pertinent well construction details is provided in Table 6.

Details regarding operation of the production wells were obtained during the September 2004 site visit through conversations with Pat McCracken (Town of Faro - Water Operator). It was noted that the pumping levels in the productions wells are relatively shallow (< 5 to 7 m), and that the wells have never run dry. Additionally, the wells have never required cleaning or well rehabilitation, which suggests that typical bio-fouling and associated decreases in well efficiency have yet to be an issue. Groundwater temperature and flow data from the production wells are recorded daily. Groundwater temperatures are typically approximately 6°C during summer months and can drop to less than 1°C by late January or early February. Pumping rates increase during the cold winter months to supply extra water for household water bleeders. Boilers are available to heat the water source if necessary but have not been required in the last eight years (approximately).

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Table 6: Summary of Well Construction Details

Location	Elevation of Top of Casing (masl)	Depth to Bottom of Well (mbgs)	Well Bottom Elevation (masl)	Depth to Top of Screen (mbgs)	Elevation of Top of Screen (masl)
Well No. 1	642.44	12.8	629.64	8.2	634.24
Well No. 2	642.41	12.5	629.91	9.4	633.01
Well No. 3	643.33	11.6	631.73	7.9	635.43
OB2	641.55	5.81	635.74	n/a	n/a
OB6	641.73	8.5	633.23	5.8	635.93
PRWLS1-04	639.43	2.457	636.973	0	639.43

Notes:

Source of Well Completion Info (Wells 1, 2 and 3): Curragh Resourse Inc. Water Well Record

Source of Well Completion Info (Wells OB2 and OB6): GLL filed visit activities Sept and Oct. 2004.

n/a = no information avalaible

4.2 2004 Site Characterization/Instrumentation

4.2.1 Groundwater and Surface Water Elevation Survey

Yukon Engineering Services completed a site survey on October 7th, 2004 for the purpose of accurately determining groundwater and surface water elevations. Pertinent land features and water elevation monitoring locations were identified and surveyed in order to create hydrogeological cross sections through the study area. Additionally, permanent reference points such as the top of monitoring wells and gauging stations were surveyed for future reference.

As discussed earlier, two of the four abandoned wells (OB2 and OB6) have been used as observation points for the purpose of this study. In addition to static water level measurements, Solinst Level Loggers have been installed at these locations and will collect groundwater elevation data every 2 to 6 hrs. The Level Logger installed at OB6 will also collect groundwater temperature data.

Although access has been provided to production wells #1, #2, #3, in order to collect groundwater quality samples, it was not possible to collect static groundwater elevations or to install water level / temperature monitoring devices at these locations. The production wells are equipped with a line shaft pump, which is mounted to a concrete wellhead within the well house. Consequently, access into the well bore was not possible.

In addition to collecting groundwater levels at OB2 and OB6, surface water elevations were also obtained during the October 7, 2004 survey. Solinst Level Loggers were also installed in Vangorda Creek and the Pelly River; the locations are identified on Figure 2 as VCWLS01-04 and PRWLS01-04, respectively. These Level Loggers will collect water elevation and water temperature data at a frequency of once every 8 to 12 hours.

4.2.2 Stream Gauging

Stream gauging was conducted at two locations (VCSG1 and VCSG2; Figure 3) along the 800 m reach of Vangorda Creek, between the canyon and just upstream of the confluence with the Pelly River. This information was collected to assess potential surface water recharge of Vangorda Creek to the underlying alluvial sediments and aquifer. The stream gauging results are provided in Table 7.

Although there is some variability between individual stream gauge trials (~ 5 %), the data suggests that approximately 10 % of the surface water flow within Vangorda Creek between VCSG2 and VCSG1 is lost as recharge to the underlying sediments.

Table 7. Vangorda Steam Gauging Results – October 7th, 2004

Station Location	Flow (L/s)		
	Trial #1	Trial #2	Average
VCSG2 (upstream)	513	491	502
VCSG1 (downstream)	445	466	456

4.3 Discussion of Results

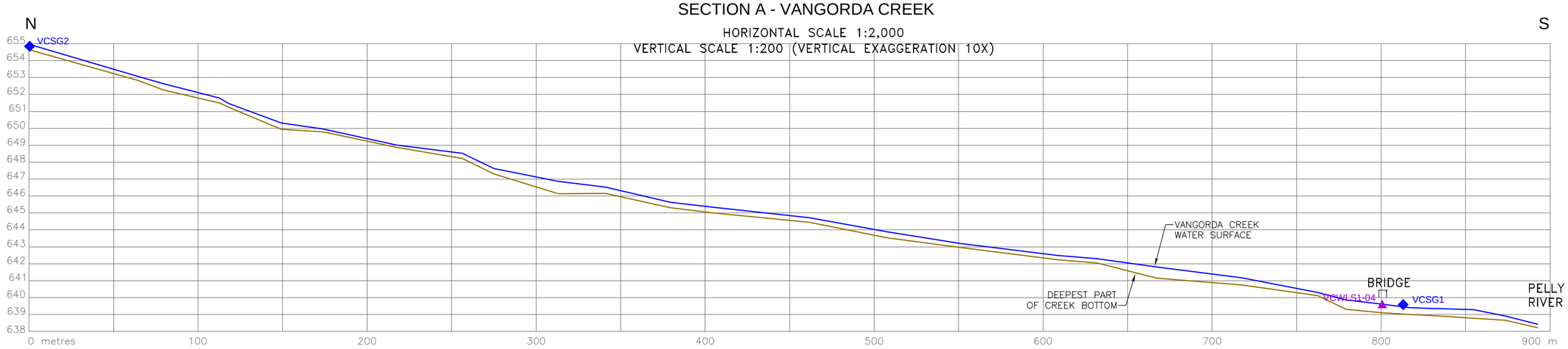
As part of this preliminary hydrogeological assessment, a "snapshot" of water elevations collected on October 7th, 2004 has been compiled and incorporated with the results of the site elevation survey. For visual comparison, the information is presented in cross section form on Figure 7. (Please refer to Figures 2 and 3 for the locations and names of the cross sections).

The elevation data indicates that the water levels in observation wells OB2 and OB6 are lower than the nearest surface waterbodies to the wells (Pelly River and Vangorda Creek, respectively). This observation suggests that water from both of these surface sources may be providing recharge boundaries for the town production wells. At this time however, this single water elevation "snapshot" does not allow an assessment of what the relative contribution of each surface water source may be to the groundwater that is being pumped from the production wells. Additionally, because transient data has yet to be collected and analyzed, it is not possible at this time to determine if the gradients observed are related directly to the pumping activities or if pumping influences in the aquifer are even detected at the monitoring locations. The transient data collection process initiated during this phase of the project (i.e., the installation of water level and temperature sensors) will help establish this relationship and will help to assess possible correlations between the groundwater and surface flow systems.

Although there is some variability between individual stream gauge trials (~5%), the data suggests that approximately 10% of the surface water flow within Vangorda Creek between VCSG2 (upstream) and VCG1 (downstream) is lost as recharge to the underlying sediments. Given the alluvial, coarse-grained nature of the surrounding sediments, as well as the moderately high-sloped and perched nature of the stream, a losing condition is not uncommon in this type of geological environment. Additional stream gauging trials throughout the year would help to further establish the extent to which Vangorda Creek provides recharge to the underlying aquifer. This data would be used to assess potential correlations between seasonal recharge from this reach of Vangorda Creek and transient groundwater levels.

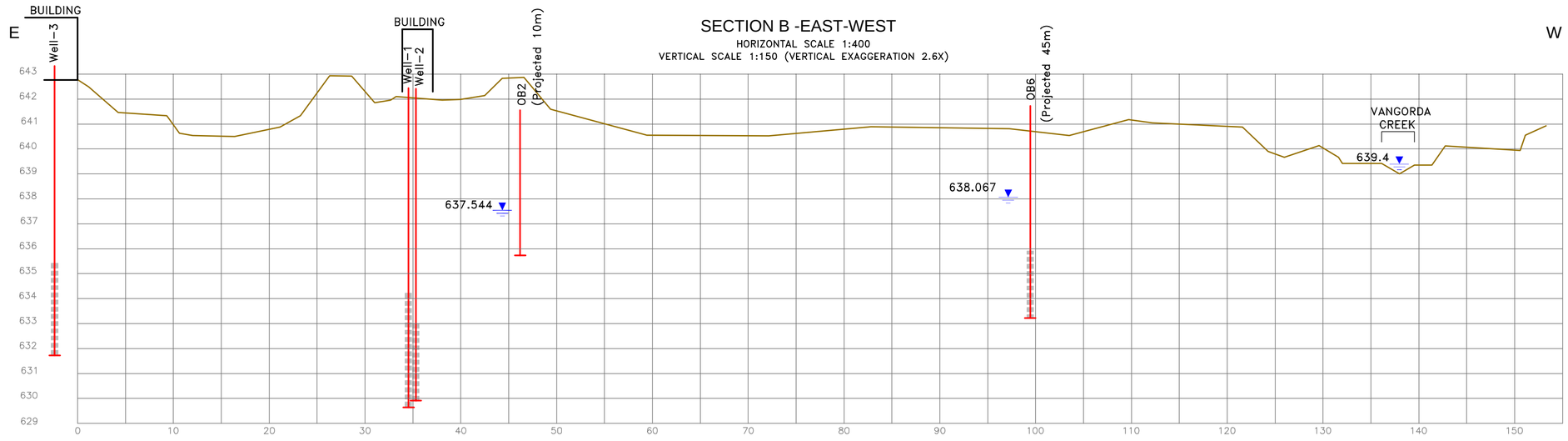
SECTION A - VANGORDA CREEK

HORIZONTAL SCALE 1:2,000
VERTICAL SCALE 1:200 (VERTICAL EXAGGERATION 10X)



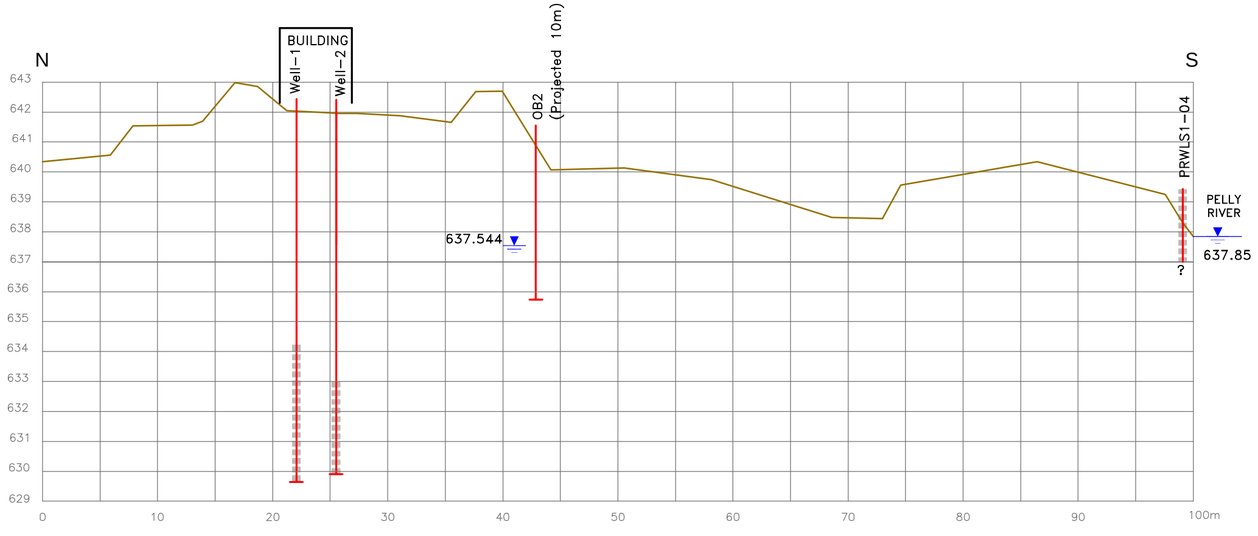
SECTION B -EAST-WEST

HORIZONTAL SCALE 1:400
VERTICAL SCALE 1:150 (VERTICAL EXAGGERATION 2.6X)



SECTION C - NORTH-SOUTH

HORIZONTAL SCALE 1:400
VERTICAL SCALE 1:150 (VERTICAL EXAGGERATION 2.6X)



LEGEND:

- Ground Surface
- Surface Water
- VCWLS1-04 — Water Level Sensor
- VCSG1 — Stream Gauging Location
- Water Level measured on October 2, 2004
- Well-2 — Well
- Screened Interval

Data Sources:

1. Digital copy of 1:50,000 topographic map and orthophoto supplied by SRK Consulting.
2. Survey conducted in summer 2004 by Yukon Engineering Services

   Source data in UTM NAD27 zone 8 projection.

DRAWING INFORMATION:	
REVIEWED BY:	DMcC/JK
DRAWN BY:	PW
DATE ISSUED:	November 1, 2004
PROJECT NUMBER:	40-419
FILE NAME:	40419-1D-03.DWG
REVISION:	0

Deloitte & Touche

Project: Faro Townsite Water Supply
Location: Faro, Yukon Territory
Client: Deloitte & Touche

HYDROGEOLOGICAL CROSS SECTIONS THROUGH STUDY AREA

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Figure No. 7

5. Summary of Preliminary Results

The following results were obtained from reviewing historical data and previous reports, and assessing site data collected in 2004:

1. An extensive water quality record of lower Vangorda Creek has been collected over the last 12 years. Water quality data have also been collected for the Town of Faro water wells over the same period, but less intensively. No historical quality information was obtained for the Pelly River in the vicinity of the study area. A review of the historical record indicates seasonal variability in Vangorda Creek quality related to flow rate. Less variability is indicated in Town of Faro water well quality data. However, a possible seasonal trend in water well quality is apparent.
2. The analysis of historical water well quality indicates the groundwater source is of high quality, consistently meeting Canadian Drinking Water Quality guidelines.
3. Water quality data collected in 2004 are consistent with historical results obtained for Vangorda Creek and the Town of Faro water wells. Seasonal variability in Pelly River water quality was observed. Additional water quality samples taken at the same locations are required to conduct a correlation analysis between the three water sources.
4. The results of environmental isotope analyses of grab samples from Vangorda Creek, Pelly River, and the town wells were too similar to isotopically differentiate the source origin of each water type.
5. Vangorda Creek flow measurements taken in October 2004 near the Pelly River were approximately 10% lower than flow measurements taken 800 m upstream. This data provides an indication that Vangorda Creek (within the study area) may be providing some degree of recharge to the underlying aquifer.
6. Site survey data collected on October 7th, 2004 indicated that the water levels in observation wells OB2 and OB6 were lower than the nearest surface waterbodies to the wells (Pelly River and Vangorda Creek, respectively). This observation suggests that water from both of these surface sources may be providing recharge boundaries for the town production wells.

6. References

Health Canada, 1996

Guidelines for Canadian Drinking Water Quality, Sixth Edition, Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial Committee on Environmental and Occupational Health.

Hydrogeological Consultants Inc. 1980

Town of Faro 1980 Groundwater Program, prepared for Associated Engineering Services Ltd. July 1980.

Hydrogeological Consultants. 1988

Assessment of the Potential for Hydraulic Link Between Vangorda Creek and the Faro Town Wells, Prepared for Curragh Resources Inc., February 26, 1988.

Jacobsen, N.A. 2003

Community Water systems in the Yukon, Prepared for Environmental Health Services, Health and Social Services Department, Government of Yukon, February 2003

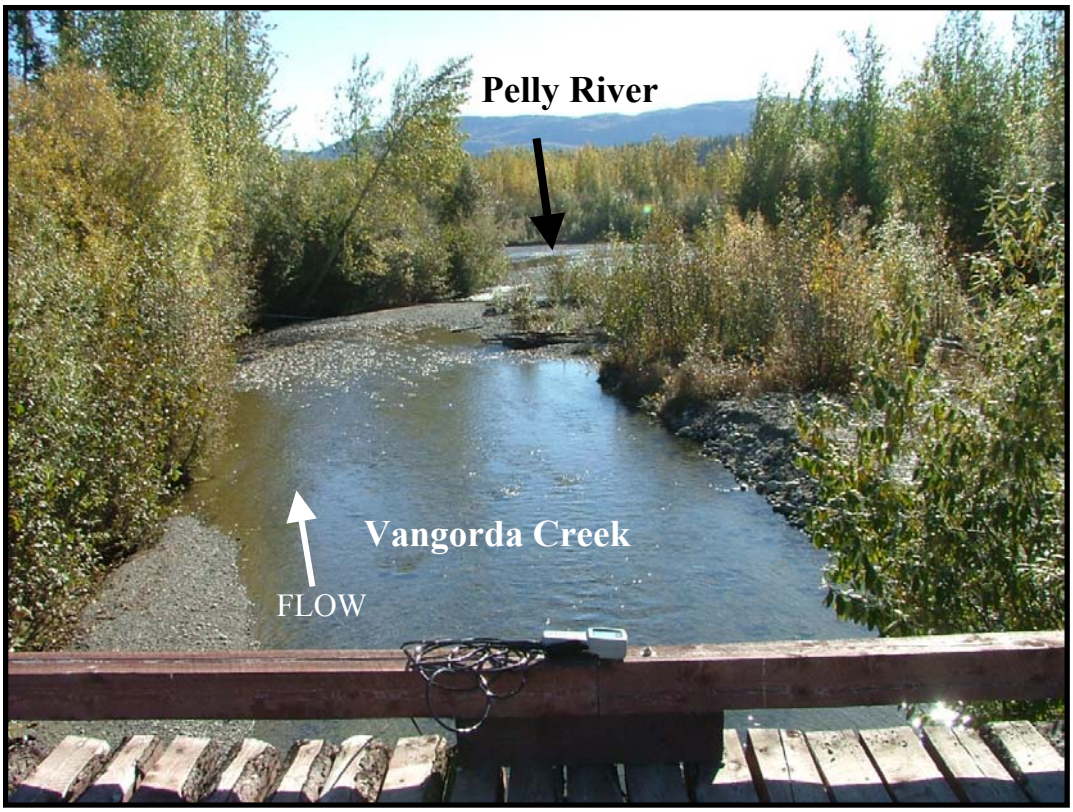
Appendices

Appendix A

Photo Log of Site Visits

Photo of Staff Gauge constructed in permeable sediments adjacent to the Pelly River. A Level Logger sensor is hanging within the Staff Gauge collecting water elevations

OB2 located just south west of Pump House #1. Note that a protective cap has been installed. A Level Logger sensor has been hung from inside the cap to collect groundwater elevation data.



View looking south down Vangorda Creek from bridge. Pelly River flowing left to right in background.

View looking north up Vangorda Creek from bridge. Note the silt terrace in the background upon which the Town of Faro is located.

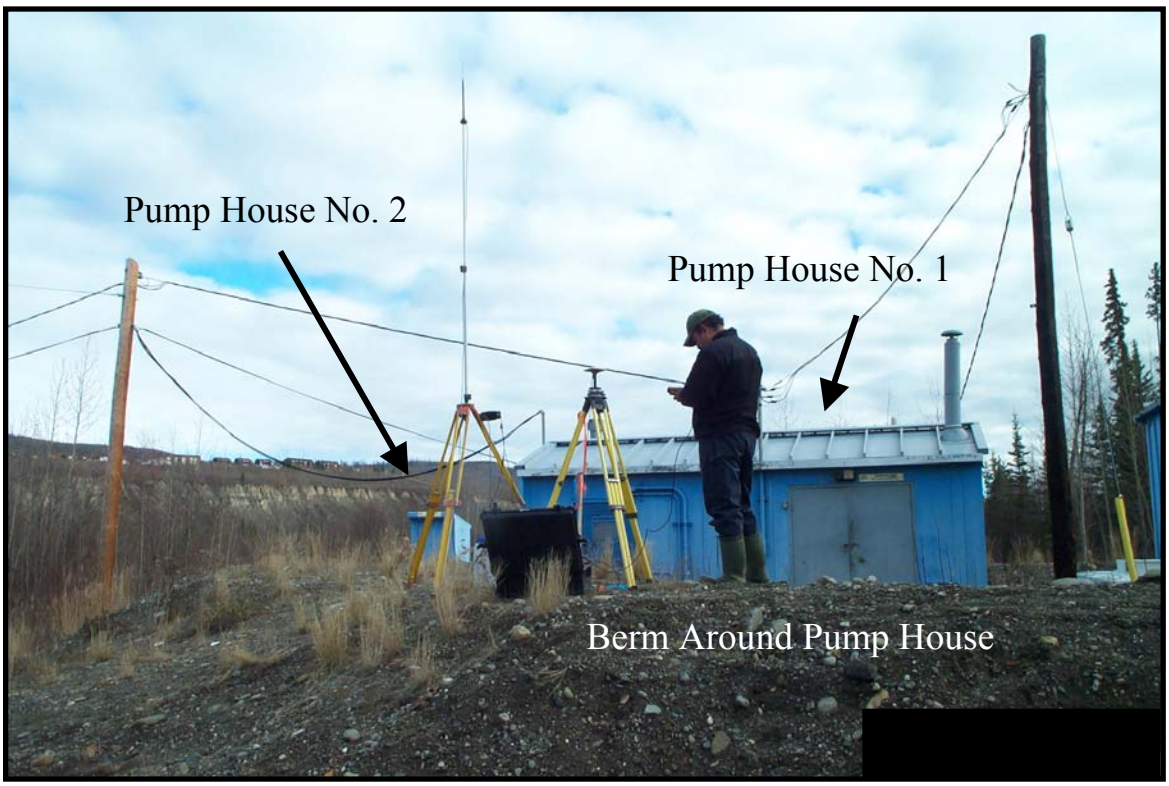
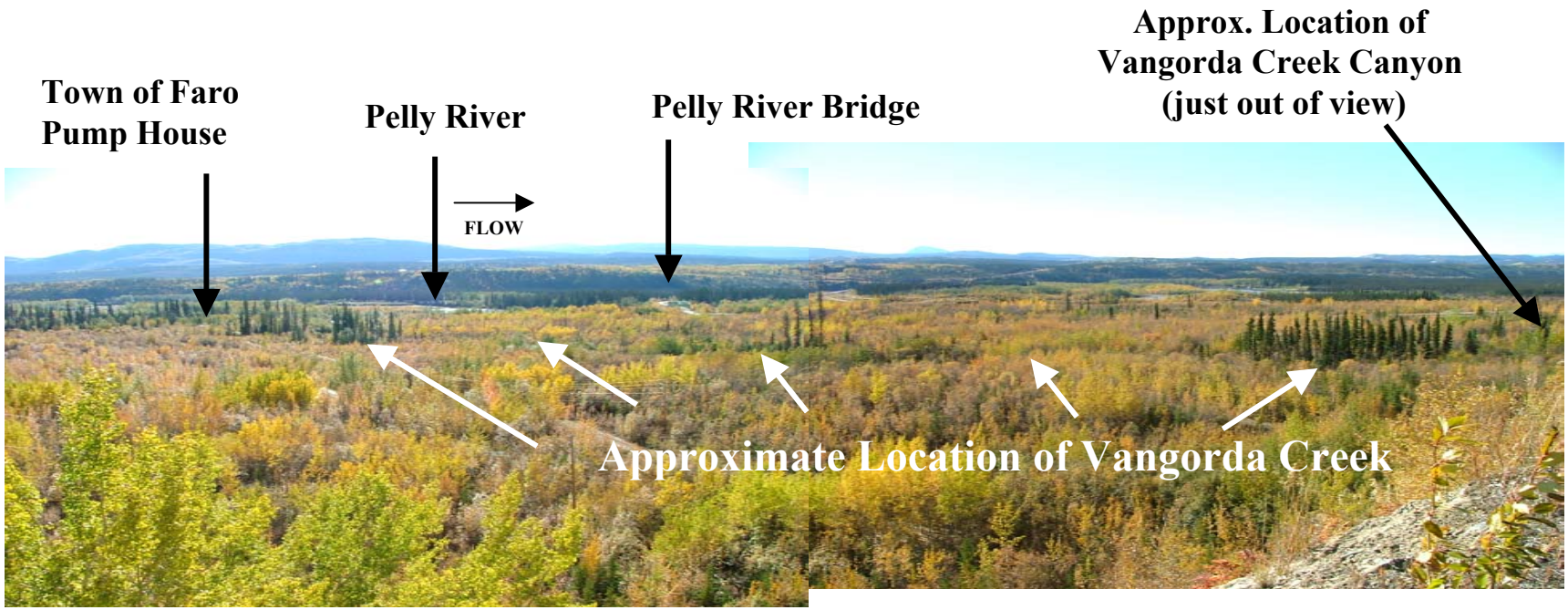


Photo of survey crew on top of berm – Town of Faro Pumphouses in background.

Photo of Forest Pearson (GLL) measuring the depth to groundwater water atOB6. Brush around wells has since been cleared and a PVC cap and Level Logger installed to collected groundwater elevation data at this location.

View of Vangorda Creek as it comes out of the Canyon onto the Vangorda Alluvial fan type deposits.

View of Vangorda Creek, just down stream (approx 20 m) of the photo location shown above. GS2 and a small foot bridge is just out of photo view to the right.



View looking out over Vangorda Alluvial deposits onto the Pelly River water coarse and flood plan. Note the moderate slope change following the exit of Vangorda Creek from the Canyon down onto the flood plan. The slope of the creek is reduced slightly as the creek comes off alluvial fan type deposits and onto the lower lying Pelly River flood plane type deposits.