Assessment of the Fort St. James Drinking Water Supply: Source Water Characteristics

James Jacklin, March 2004[1]

Introduction

In British Columbia, drinking water quality is becoming a significant public issue. We all want to have confidence in the quality of the water we consume. Its protection is also important to local purveyors, who act as our water suppliers, and to provincial government ministries responsible for water management. Within the Omineca-Peace region of B.C., our most common potable source is ground water, although many communities do make use of rivers, streams or lakes. Our basic drinking water quality is determined by a number of factors including local geology, climate and hydrology. In addition to these, human land use activities such as urbanization, agriculture and forestry, and the pollution they may cause, are becoming increasingly important influences. Environmental managers have a responsibility to control land use development so as to minimise the effects of these activities on source water quality.

The province's Drinking Water Protection Act, enacted in October, 2002, places the responsibility for drinking water quality protection with the B.C. Ministry of Health and local water purveyors. However, through the B.C. Environmental Management Act, the British Columbia Ministry of Environment (MOE) is responsible for managing and regulating activities in watersheds that have a potential to affect water quality. Accordingly, the Ministry plans to take an active role in protecting drinking water quality at its source.

Plate 1. A view of the Fort St. James pump house where the raw water samples were collected.

MOE implemented a raw water quality and stream sediment monitoring program at selected communities in the Omineca-Peace region in 2002. Community sites were selected using a risk assessment process that considered:

- whether the source supply was surface water or ground water,
- the level of water treatment,
- the population size served,
- the potential for upstream diffuse and point-source pollution,
- the availability of current, high-quality and representative data on each raw water source,
- whether past outbreaks of waterborne illness had been reported,
- the ability/willingness of local purveyors to assist with sampling.

Through this process and with available funding, a total of 18 community water supplies in the Omineca-Peace region were selected for monitoring during 2002/03.

This brief report will summarise water quality data collected from the Fort St. James raw potable water source (ground water) (Plate 1). The data are compared to current provincial drinking water quality guidelines meant to protect finished water if no treatment other than disinfection is present. This comparison should identify parameters with concentrations that represent a risk to human health. It is intended that this program will lead to the identification of human activities responsible for unacceptable source water quality, and that it will assist water managers to develop measures to improve raw water quality where needed.

[1] A template report was prepared for the author by Todd D. French of TDF Watershed Solutions, Research & Management and Bruce Carmichael, Ministry of Environment.

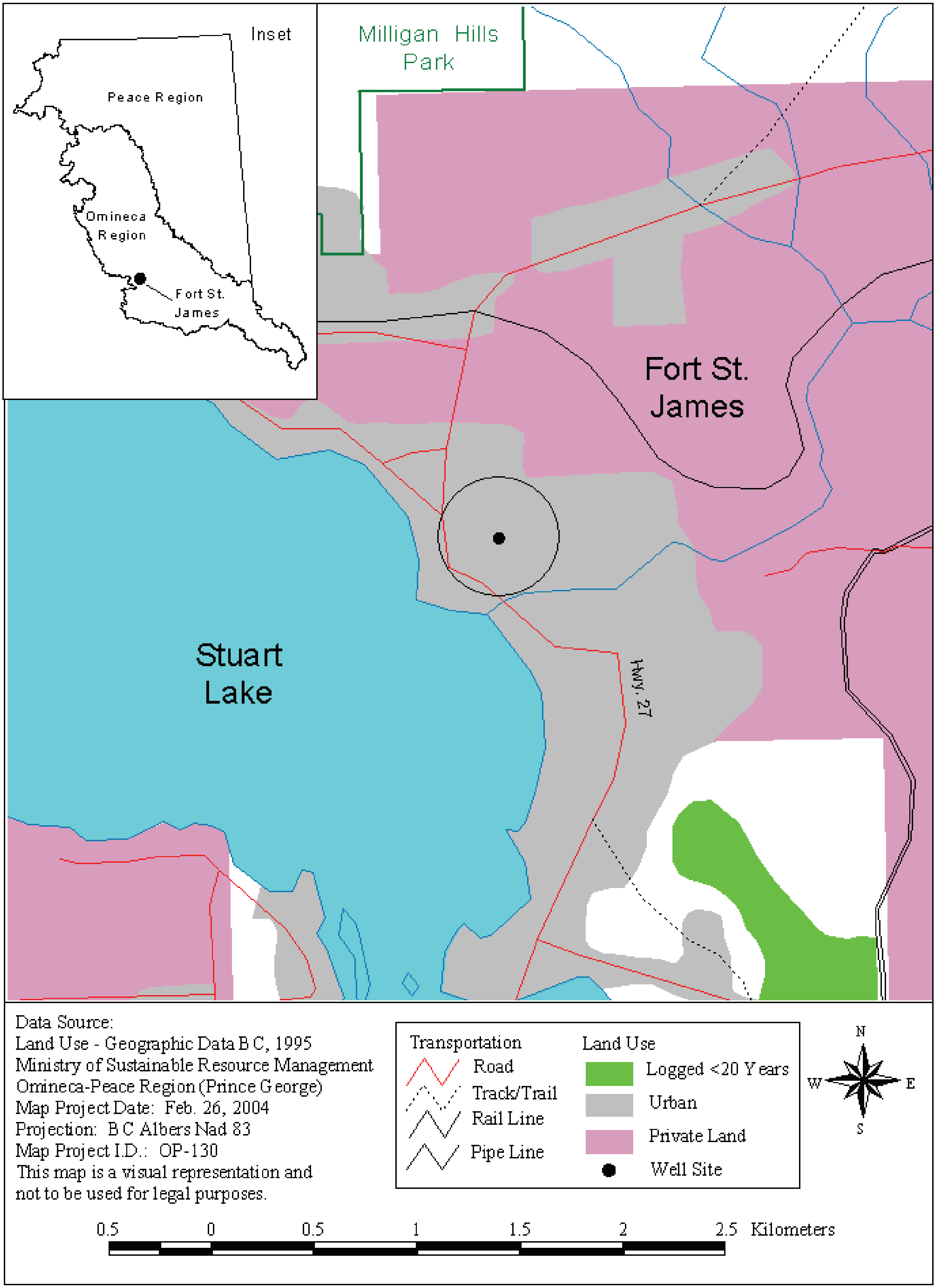

Figure 1. Fort St. James water well and nearby land-use practices. A 300 m radius surrounds the well indicating the zone where contamination is most probable to occur.

Site Description

Watershed Overview

Fort St. James has a drinking water supply that consists of one well, located in the north end of town near Stuart Lake. This area lies within the Sub-Boreal Spruce biogeoclimatic zone, which is characterized by gently rolling terrain, dense coniferous forests and extremes in the annual temperature range of -40°C to 30°C (B.C. Ministry of Forests, 1998). However, a large section of the land surrounding the Fort St. James well has been developed for urban use (Figure 1). Additionally, land use practices in the surrounding area include agriculture and forestry activities. Although Mr. Lars Sabbe (purveyor, Fort St. James) has indicated there are no current concerns regarding water quality, these land-use practices may be an issue in the future.

According to Lars Sabbe, the Fort St. James water withdrawal rate is approximately 1400 m^3/day, with a constant head pressure of 40 lbs. This water is used by Fort St. James as well as the Nak'azdl First Nations Band. The well draws water from ground deposits consisting of a variety of materials (Table 1). Based on this lithology table, it is apparent that the abundance of clay layers in the top 294 feet would limit ground permeability. This would suggest a confined aquifer, which is probably buffered to some extent from certain land use activities by the low permeability. Sands and gravels below the clay layers were followed by shale bedrock at 334 feet. At the time of well construction, the static water level was at 120 feet (36.6 m).

Table 1. Lithology profile from the Fort St. James well (well tag number 22987). Data from the aquifer database of B.C..

Depth (Ft)	Grain Size
0-4	Sand gravel
4-90	Brown clay
90-135	Pebbly clay
135-294	Blue clay
294-302	Fine to very coarse black volcanic sand
302-322	Medium to very coarse sand fine gravel
322-331	Sand gravel clean
331-334	Till
334-334	Shale bedrock

There are some waste disposal permits in the community of Fort St. James, however, most of these are not located in the same area as the well. The only permit that is located close to the well discharges directly into Stuart Lake.

Drinking Water Supply & Treatment

Fort St. James draws its domestic water from a ground water supply, consisting of one well. As measured with a GPS unit, the geographic co-ordinates of the pump house are 54°26'51.1"N/124°15'40.3"W. From the pump house, the water is transported to approximately 2000 residents in Fort St. James, as well as the associated individuals with the Nak'azdli Band. The city doesn't currently treat the water supply, however, Lars Sabbe has indicated that some private dwellings do provide their own, limited treatment such as softeners and filtration devices.

There are no concerns regarding the current water system (Sabbe, p.c.), however there are occasional high iron and manganese levels, as well as a "rotten egg smell".

Materials & Methods

Review of Previous Data

Historical data relevant to the Fort St. James source water supply assessment have been included in this report. The data were copied from Northern Health Authority (NHA) computer and paper files. The samples were collected from five different sites, including the Chamber of Commerce, the District Office, District Office #2, the Health Unit, and the Well House tap.

Sample Collection & Analyses for the 2002/03 Water Monitoring Program

Water Quality

An experienced consultant and/or MOE staff member collected water samples in laboratory certified polyethylene bottles for a variety of chemical and bacterial analyses. Representative grab samples were collected from the raw water tap (Plate 2) inside the Fort St. James pump house (site E249369 - Water Source ID Tag 1338). The chemical results, analytical detection levels and drinking water quality guidelines are provided in Table 2, Appendix A.

Bottles used for general ion analyses were rinsed three times with source water prior to sample collection. Metal and bacterial bottles were not rinsed and metal samples were lab preserved. Prior to sampling the raw water tap, the source was flushed for 5 minutes in order to minimize contamination by system piping. Water samples were shipped by overnight courier in coolers with ice packs to CanTest Ltd. (from September 2002-March 2003) and JR Laboratories Inc. (April 2003 to September 2003) for bacteria and PSC Environmental Services Ltd. for chemistry. Bacterial samples were analysed using membrane filtration. Metals analysis made use of ICPMS technology.

Quality Assessment (QA)

To ensure accuracy and precision of data, quality assurance and control (QA/QC) procedures were incorporated

Plate 2. The raw water tap within the Fort St. James pump house.

into the monitoring program. This included use of rigorous sampling protocols, proper training of field staff, setting of data quality objectives and the submission of QA samples to the lab. Field QA included duplicate and blind blank samples. Blank samples detect contamination introduced in the field and/or in the lab. A comparison of duplicate results measures the effect of combined field error, laboratory error and real between-sample variability. The blind blank and duplicate program accounted for roughly 20% of the overall chemistry and bacterial sample numbers.

Results

Review of Previous Data

Bacteriology

The NHA sampled the Fort St. James water supply from numerous locations around the community 43 times between April 2001 and July 2002. The results of this raw water bacterial program are presented in Table 3, Appendix A. There were no historical chemistry data.

All 43 samples were tested for both total and fecal coliforms. Bacterial concentrations were less than detectable during all sample collections. This suggests that bacterial problems are rare in the Fort St. James system.

Water Monitoring Program (2002/03)

Quality Assessment (QA)

The field blank and duplicate results indicate that minimal field or lab contamination of samples with bacteria occurred and that acceptable precision in bacterial sampling and analysis was observed.

The six water chemistry field blank samples that were prepared either the same day or within one day of the Fort St. James collections tested positive for some parameters. The concentration of most of these parameters was either very close to or less than 5-fold the minimum detectable concentration, an acceptable threshold as per the lab acceptance criteria. Six parameters exceeded these acceptance criteria and are listed below in Table 4.

Table 4. Blind blank samples that tested strongly positive (≥ 5-fold MDL) for chemical contamination.

Date	Parameter	Measured Concentration	MDL
Sep. 25/02	Total Dissolved Phosphorus	0.031 mg/L	0.002 mg/L
Sep. 25/02	Total Phosphorus	0.038 mg/L	0.002 mg/L
Sep. 25/02	Strontium-Dissolved	0.047 µg/L	0.005 µg/L
Sep. 25/02	Tin-Dissolved	0.23 µg/L	0.01 µg/L
Jan. 20/03	Sulfate	14.6 mg/L	0.5 mg/L
Mar. 10/03	Lead-Total	0.19 µg/L	0.01 µg/L

Although the levels of some of these blank results are equal to or greater than the actual concentrations observed in Fort St. James on some dates, the values are usually well below provincial raw drinking water guidelines by greater than two orders of magnitude. The contamination that did occur may have resulted during the deionization process in the lab or during the transfer of the deionized water between bottles in the field. Regardless, these levels of blank contamination should not limit the comparison of data to water quality guidelines.

The five water chemistry duplicate samples that were prepared either the same day or within one day of the Fort St. James collections did have some values outside the lab acceptance criteria of 25% relative percent difference (Table 5, Appendix A). The differences that are present may be due to problems with collection and/or analytical precision. Of particular concern is the imprecision of copper, which occurred well above its respective detection level. All of the parameters that did have differences greater than 25% between the duplicates were well below recommended drinking water guidelines.

Bacteriology

The 2002/03 bacterial data are summarised in Table 6. Drinking water quality guidelines for *E. coli, Enterococci* and fecal coliforms are all 0 CFU/100mL in drinking water supplies that undergo no treatment.

Table 6. Results of bacterial analyses for the Fort St. James raw water supply. Units are CFU/100mL.

Date	Total Coliform	*E. coli*	*Enterococci*	Fecal Coliform
Provincial Guideline	No Provincial Guideline	0 CFU/100 mL	0 CFU/100 mL	0 CFU/100 mL
Sep. 25/02	<1	<1	<1	<1
Jan. 20/03	<1	<1	<1	<1
Mar. 10/03	<1	<1	<1	<1
Apr. 23/03	<2; <2	<2; <2	<2; <2	<2; <2
May 22/03	<1	<1	<1	<1
Sep. 4/03	<1	<1	<2	<1

All six samples collected from this water supply contained no detectable bacteria. These data, as well as the historical data, suggest that bacterial concentrations are low and not currently being affected by land use activities.

Water Chemistry

In 2002/03, ground water samples were collected on six different dates. The water samples were analysed for 15 general parameters as well as for the ICPMS low level metals package that includes 27 metals in the total form.

Of the chemical parameters tested through the duration of this study, one exceeded recommended drinking water guidelines and two were of note. The exceeding parameter, iron, had a mean concentration of 0.59 mg/L, over the aesthetic guideline of 0.3 mg/L. Insoluble iron is often found in waters as colloidal material which can be difficult to remove. Additionally, iron has the tendency to colour water.

The two parameters of note were specific conductance and hardness. Specific conductance, which had a mean concentration of 620 µS/cm, was approaching the recommended guideline of 700 µS/cm. High specific conductivity values indicate a high ion concentration, which can be related to the dissolved solids content of the water.

Water hardness, which can often be a problem in ground water supplies, had a mean concentration of 333 mg/L $CaCO_3$. Waters that exceed 120 mg/L $CaCO_3$ are considered hard. This hardness is due to the presence of calcium and magnesium in the water. Hard water can reduce the toxicity of some metals, but can also leave scale deposits on piping. Some anthropogenic sources that contribute to water hardness are mining and industrial effluents. Hard water also occurs naturally in many ground water systems.

The data from 2002/03 indicates that chemical parameters in the Fort St. James water supply are generally low. The only parameters of concern were high hardness and iron levels, both of which naturally occur in many ground water systems.

A complete list of the results as well as their corresponding guideline is attached in Table 2, Appendix A. A list of the raw data is provided in Table 7, Appendix A.

Conclusions & Recommendations

Review of the Fort St. James ground water data indicates an overall good raw drinking water quality. Water soluble contaminants were present at concentrations well below drinking water guidelines. The only parameters that were of note were high iron, hardness and specific conductivity concentrations. All of these parameters often occur at high levels naturally in ground water supplies, due to the abundance of iron, calcium and magnesium bearing rocks. These parameters are generally associated with the aesthetics of water, rather than with health concerns. Lars Sabbe did indicate that there were some concerns in the past regarding a “rotten egg” smell in the water. This smell is usually caused by the presence of hydrogen sulphide (H_2S), which is a product of the anaerobic decay of organic matter containing sulphur or by the anaerobic reduction of sulphate by micro-organisms (Manahan, 2000). Although the presence of H_2S wasn’t tested for during this project, sulphate concentrations averaged 50.2 mg/L over the year. This is below the recommended drinking water guideline for sulphate of 500 mg/L.

Based on the lack of information regarding the well, a 300 m radius is arbitrarily assigned as the zone where contamination is most likely (Mike Wei, Senior Hydrogeologist, MOE, p.c.). Since the lithology profile of the well indicates dominantly clays between 4 and 294 feet, the aquifer is probably confined and therefore more buffered against land use activities compared to unconfined aquifers (dominantly sands and gravels). Although these clay layers would retard leachates from moving quickly into the sand and gravel layers where water withdrawal occurs, harmful land use practices in the close vicinity of the well (approximately 300 m) are discouraged. Regardless, a 300 m radius site assessment may still be useful to indicate where there is potential for contamination.

Because Fort St. James currently uses no form of water treatment, it is also recommended that periodic bacterial samples are collected to ensure that levels do not exceed recommended drinking water guidelines of 0 CFU/100 mL.

Acknowledgements

We thank Mr. Lars Sabbe, as well as the Fort St. James staff, for their insight and direction around the community water supply. Mr. Todd French is recognized for his help in designing and implementing the project (TDF Watershed Solutions, Research & Management). The NHA is thanked for their help during the planning process of this project.

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Contact Information

For more information regarding either this short report, watershed protection and/or drinking water, please contact the Ministry of Environment (Contact: Bruce Carmichael (Prince George), 250-565-6455) or the Northern Health Authority (Contact: Bruce Gaunt (Prince George), 250-565-2150 or Caroline Alexander (Fort St. John), 250-787-3355).

References

Greenberg, A.E., L.S. Clesceri, and A.D. Eaton (EDS.). 1992. Standard methods for the examination of water and wastewater (18th Edition). Published Jointly by American Public Health Association, American Water Works Association, and Water Environment Federation.

Manahan, Stanley E. 2000. Environmental Chemistry. 7th Ed. Lewis Publishers, New York.

Provincial Health Officer. 2001. Drinking water quality in British Columbia: the public health perspective. A report of the health of British Columbians. Provincial Health Officer's Annual Report 2000, B.C. Ministry of Health Planning, Victoria, B.C.. 147 pp.

PSC. 2002. 2002-2006 analysis & pricing information. Prepared by PSC Environmental Services, 8577 Commerce Court, Burnaby, B.C., V5A 4N5, for B.C. Ministry of Water, Land and Air Protection. 47pp.

Resource Inventory Committee. 1998. Guidelines for interpreting water quality data. Province of British Columbia.

The Ecology of the Sub-Boreal Spruce Zone. 1998. Ministry of Forests Research Branch, Victoria, B.C.

MOE. 2004. Aquifers and Water Wells of British Columbia

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Appendix A

Table 2. 2002/03 sample parameters, summaries of current results and associated B.C. drinking water guidelines.

Parameter	# of Values	Min.	Max.	Mean	Std. Dev.	MDL	D.W. Guideline	Guideline Type
General								
pH	6	8.1	8.3	8.2	0.10	0.1	6.5-8.5	aesthetic objective
Colour (TCU)	6	5	5	5	0.0	5	≤ 15	aesthetic objective
Specific Conductance (µS/cm)	6	609	632.5	620.5	8.90	1	≤ 700	maximum acceptable concentration
Turbidity (NTU)	4	3.775	5.41	4.39	0.891	0.1	≤ 1	maximum acceptable concentration
Hardness Total (mg/L)	6	320	343	333	8.2		≤ 500 $CaCO_3$ (Diss.)	aesthetic objective
Alkalinity (mg/L)	6	304	318	313	5.3	0.5		
Residue Non-Filterable (mg/L)	6	4	4	4	0.0	4		
Total Organic Carbon (mg/L)								
TOC	6	0.5	1	0.7	0.23	0.5	≤ 4	maximum, to control THM production
Anions (mg/L)								
Chloride Dissolved	6	0.5	1.3	1.0	0.31	0.5	≤ 250	aesthetic objective
Fluoride Dissolved	6	0.065	0.11	0.089	0.017	0.01	≤ 1.5	maximum acceptable concentration
Bromide Dissolved	6	0.1	0.1	0.1	0.00	0.1		
Nutrients (mg/L)								
Nitrate+Nitrite	6	0.002	0.006	0.004	0.002	0.002	≤ 45 (Nitrate)	maximum acceptable concentration
Phosphorus Total	2	0.027	0.027	0.027		0.002		
Phosphorus Total-Diss.	2	0.002	0.002	0.002		0.002		
Sulphate (mg/L)								
Sulphate	6	47.7	53.8	50.2	2.85	0.5	≤ 500	aesthetic objective
Metals Total (ug/L)								
Aluminum-T	6	0.03	0.4	0.27	0.139	0.3	≤ 200 (Diss.)	maximum acceptable concentration
Antimony-T	6	0.005	0.026	0.015	0.008	0.005	≤ 6	interim maximum acceptable concentration
Arsenic-T	6	6.6	8.6	7.6	0.73	0.1	≤ 25	interim maximum acceptable concentration
Barium-T	6	55.8	61.8	59.2	2.60	0.02	≤ 1000	maximum acceptable concentration
Beryllium-T	6	0.02	0.02	0.02	0.000	0.02		
Bismuth-T	6	0.02	0.02	0.02	0.000	0.02		
Cadmium-T	6	0.01	0.04	0.02	0.013	0.01	≤ 5	maximum acceptable concentration
Calcium-T (mg/L)	6	51.3	53.5	52.3	0.899	0.05		
Chromium-T	6	0.2	0.2	0.2	0.00	0.2	≤ 50	maximum acceptable concentration
Cobalt-T	6	0.005	0.005	0.005	0.000	0.005		
Copper-T	6	0.07	0.74	0.36	0.296	0.05	≤ 1000	aesthetic objective
Iron-T (mg/L)	5	0.444	0.652	0.596	0.102	0.005	≤ 0.3	aesthetic objective
Lead-T	6	0.01	0.05	0.03	0.015	0.01	≤ 10	maximum acceptable concentration
Lithium-T	6	8.09	8.84	8.45	0.295	0.05		
Magnesium-T (mg/L)	6	46.6	50.8	49.0	1.57	0.05	≤ 100 (Diss.)	aesthetic objective
Manganese-T	6	11	30.8	26.2	8.52	0.008	≤ 50	aesthetic objective
Molybdenum-T	6	5.66	6.58	6.18	0.346	0.05	≤ 250	maximum acceptable concentration
Nickel-T	6	0.05	0.05	0.05	0.000	0.05		
Selenium-T	6	0.2	0.2	0.2	0.00	0.2	≤ 10	maximum acceptable concentration
Silver-T	5	0.02	0.02	0.02	0.00	0.02		
Sodium-T (mg/L)	6	13.7	14.7	14.2	0.44	0.05	≤ 200	aesthetic objective
Strontium-T	6	413	447	438	14.1	0.005		
Thallium-T	6	0.002	0.002	0.002	0.000	0.002	≤ 2	maximum acceptable concentration
Tin-T	6	0.01	0.57	0.13	0.247	0.01		
Uranium-T	6	0.149	0.168	0.154	0.008	0.002	≤ 100	maximum acceptable concentration
Vanadium-T	6	0.06	5.74	1.91	2.222	0.06	≤ 100	maximum acceptable concentration
Zinc-T	6	0.1	5.4	1.6	2.15	0.1	≤ 5000	aesthetic objective

Table 3. Historical bacteriological data collected from the Fort St. James water supply. Units are CFU/100mL.

Date	Sample Location	Total Coliform	Fecal Coliform	Date	Sample Location	Total Coliform	Fecal Coliform
04-Apr-01	District Office #2	<1	<1	05-Dec-01	Wellhouse tap, Lot 82, West Birch Street	<1	<1
25-Apr-01	Wellhouse tap, Lot 82, West Birch Street	<1	<1	13-Dec-01	Chamber of Commerce	<1	<1
02-May-01	Health Unit	<1	<1	02-Jan-02	Health Unit	<1	<1
09-May-01	Chamber of Commerce	<1	<1	09-Jan-02	Chamber of Commerce	<1	<1
16-May-01	Wellhouse tap, Lot 82, West Birch Street	<1	<1	23-Jan-02	Wellhouse tap, Lot 82, West Birch Street	<1	<1
23-May-01	Wellhouse tap, Lot 82, West Birch Street	<1	<1	30-Jan-02	Health Unit	<1	<1
30-May-01	Chamber of Commerce	<1	<1	06-Feb-02	Health Unit	<1	<1
13-Jun-01	Health Unit	<1	<1	20-Feb-02	Wellhouse tap, Lot 82, West Birch Street	<1	<1
20-Jun-01	Chamber of Commerce	<1	<1	27-Feb-02	District Office #2	<1	<1
27-Jun-01	Wellhouse tap, Lot 82, West Birch Street	<1	<1	13-Mar-02	Chamber of Commerce	<1	<1
11-Jul-01	Health Unit	<1	<1	20-Mar-02	Wellhouse tap, Lot 82, West Birch Street	<1	<1
18-Jul-01	Chamber of Commerce	<1	<1	03-Apr-02	Chamber of Commerce	<1	<1
25-Jul-01	Wellhouse tap, Lot 82, West Birch Street	<1	<1	10-Apr-02	Health Unit	<1	<1
08-Aug-01	Chamber of Commerce	<1	<1	01-May-02	Chamber of Commerce	<1	<1
22-Aug-01	Wellhouse tap, Lot 82, West Birch Street	<1	<1	08-May-02	Health Unit	<1	<1
03-Oct-01	Wellhouse tap, Lot 82, West Birch Street	<1	<1	15-May-02	Wellhouse tap, Lot 82, West Birch Street	<1	<1
10-Oct-01	Chamber of Commerce	<1	<1	22-May-02	District Office Stuart Drive	<1	<1
12-Sep-01	Health Unit	<1	<1	29-May-02	Wellhouse tap, Lot 82, West Birch Street	<1	<1
17-Oct-01	Health Unit	<1	<1	26-Jun-02	Wellhouse tap, Lot 82, West Birch Street	<1	<1
31-Oct-01	Health Unit	<1	<1	31-Jul-02	Wellhouse tap, Lot 82, West Birch Street	<1	<1
07-Nov-01	Chamber of Commerce	<1	<1	29-Jul-02	Health Unit	<1	<1
28-Nov-01	Health Unit	<1	<1				

Table 5. Duplicate samples that exceeded precision acceptability criteria (≤25% difference when >5-fold MDL). All concentrations in µg/L.

Parameter	MDL (µg/L)	September/02			January/03			April/03			May/03		
		Conc. 1	Conc. 2	RPD %	Conc. 1	Conc. 2	RPD %	Conc. 1	Conc. 2	RPD %	Conc. 1	Conc. 2	RPD %
Antimony-T	0.005	0.034	0.057	**50.5**	0.03	0.042	**33.3**						
Copper-T	0.05	4.85	8.97	**59.6**				0.36	0.78	**73.7**			
Copper-D	0.05	6.19	3.49	**55.8**									
Lead-T	0.01	0.38	0.69	**57.9**				0.01	0.09	**160**			
Lithium-T	0.05	0.28	0.05	**139**							0.22	0.29	**27.4**
Tin-T	0.01	0.04	0.09	**76.9**									
Zinc-T	0.1							0.9	1.4	**43.5**			

RPD %=Relative Percent Difference
**Data are presented for the purpose of batch specific QA assessment. Most QA samples were not collected at Fort St. James.*

Table 7. 2002/03 raw drinking water data collected from the Fort St. James community well.

Date	Total Coliform (CFU/100mL)	Fecal Coliform (CFU/100mL)	Enterococci (CFU/100mL)	E. Coli (CFU/100mL)	pH (pH Units)
25-Sep-02	<1	<1	<1	<1	8.1
20-Jan-03	<1	<1	<1	<1	8.2
10-Mar-03	<1	<1	<1	<1	8.3
23-Apr-03	<2	<2	<2	<2	8.1
23-Apr-03	<2	<2	<2	<2	8.1
22-May-03	<1	<1	<1	<1	8.3
13-Aug-03					8.2
04-Sep-03	<1	<1	<2	<1	

True Colour (Col. Unit)	Specific Conductance (µS/cm)	Residues - NonFilt. (mg/L)	Turbidity (NTU)	Hardness - Total (mg/L)	Alkalinity - T as $CaCO_3$ (mg/L)
5	616	<4		320	304
5	609	<4		334	314
5	625	<4	3.98	334	318
5	631	<4	3.85	332	314
5	634	<4	3.7	332	316
5	620	<4	5.41	343	312
5	618	<4	5.99	338	309

Bromide - Diss. (mg/L)	Chloride - Diss. (mg/L)	Fluoride - Diss. (mg/L)	Carbon - Tot. Org. (mg/L)	$NO_2 + NO_3$ (mg/L)	Phosphorus - Tot. Diss. (mg/L)
<0.1	<0.5	0.1	0.8	<0.002	
<0.1	1.3	0.09	1	0.006	
<0.1	1	0.08	<0.5	0.003	
<0.1	1.1	0.06	<0.5	0.004	
<0.1	1.3	0.07	<0.5	0.005	
<0.1	1	0.11	<0.5	<0.002	0.002
<0.1	1	0.1	<0.5	1.11	0.006

Phosphorus - Tot. (mg/L)	Sulfate (mg/L)	Aluminum - Tot. (µg/L)	Antimony - Tot. (µg/L)	Arsenic - Tot. (µg/L)	Barium - Tot. (µg/L)
	47.9	<0.3	0.026	7.8	55.8
	52.8	0.4	0.005	7.4	61.8
	47.7	<0.3	0.015	7.4	58
	49.7	<0.3	0.015	6.5	61.6
	48.4	<0.3	0.023	6.7	62
0.027	53.8	<0.03	0.012	8.6	58.5
0.024	50.2	<0.3	<0.005	7.1	57

Beryllium - Tot. (µg/L)	Bismuth - Tot. (µg/L)	Cadmium - Tot. (µg/L)	Calcium - Tot. (mg/L)	Chromium - Tot. (µg/L)	Cobalt - Tot. (µg/L)
<0.02	<0.02	<0.01	51.3	<0.2	<0.005
<0.02	<0.02	0.04	51.5	<0.2	<0.005
<0.02	<0.02	0.01	52.6	<0.2	<0.005
<0.02	<0.02	0.01	52.6	<0.2	<0.005
<0.02	<0.02	0.01	52.5	<0.2	<0.005
<0.02	<0.02	0.01	53.5	<0.2	<0.005
<0.02	<0.02	0.01	53.1	3.2	0.012

Copper - Tot. (µg/L)	Iron - Tot. (mg/L)	Lead - Tot. (µg/L)	Lithium - Tot. (µg/L)	Magnesium - Tot. (mg/L)	Manganese - Tot. (µg/L)
0.74		0.04	8.27	46.6	11
0.08	0.652	<0.01	8.63	49.9	30.8
0.07	0.639	0.03	8.41	49.1	30
0.36	0.646	<0.01	8.06	48.8	30.4
0.78	0.655	0.09	8.12	48.7	30.3
0.36	0.444	0.03	8.84	50.8	28.8
<0.05	0.601	<0.01	7.8	49.9	29.1

Molybdenum - Tot. (µg/L)	Nickel - Tot. (µg/L)	Selenium - Tot. (µg/L)	Silver - Tot. (µg/L)	Sodium - Tot. (mg/L)	Strontium - Tot. (µg/L)
5.66	<0.05	<0.2	<0.02		443
6.05	<0.05	<0.2	<0.02	14.3	413
6.29	<0.05	<0.2	<0.02	13.9	447
6.29	<0.05	<0.2	<0.02	13.7	438
6.35	<0.05	<0.2	<0.02	13.7	439
6.58	<0.05	<0.2	<0.02	14.7	446
6.3	<0.05	<0.2	<0.02	14.2	458

Thallium - Tot. (µg/L)	Tin - Tot. (µg/L)	Uranium - Tot. (µg/L)	Vanadium - Tot. (µg/L)	Zinc - Tot. (µg/L)
<0.002	0.01	0.149	0.77	5.4
<0.002	0.57	0.168	1.5	0.8
<0.002	<0.01	0.149	1.48	<0.1
<0.002	<0.01	0.149	<0.06	0.9
<0.002	0.02	0.154	<0.06	1.4
<0.002	0.04	0.153	5.74	0.6
<0.002	<0.01	0.143	0.96	0.3