Stoner Drinking Water Supply:
Source Water Characteristics

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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 per capita 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.

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 used,
- 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, 18 community water supplies in the Omineca-Peace region were selected for monitoring during 2002/03, with four or more sites being selected each subsequent year.

This brief report will summarise water quality data collected from the community of Stoner raw potable water source (ground water) (figure 1). The data are compared to current provincial drinking water quality guidelines meant to protect finished water. This comparison should identify parameters with concentrations that represent a risk to human health. It is intended that this process 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.

Figure 1. Community of Stoner overview map. Note the surrounding land use activities including urban development and a major highway. A large landfill is located to the SE of the well (not shown on map). The map scale is 1:5000.

Site Description

Watershed Overview

The community of Stoner is located approximately 30km south of Prince George, B.C.. The drinking water supply consists of one well, located less than 100m from Stone Creek. 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 ˉ40°C to 30°C (B.C. Ministry of Forests, 1998).

The land use activity immediately surrounding the well includes urban development and a major highway. In the surrounding area there is agricultural and forestry operations, as well as a regional landfill.

The Stoner well is located in aquifer #327, which is approximately 3.1km^2. Information on the aquifer suggests it to be unconfined composed of alluvial and glaciofluvial sand and gravel deposits that form terraces along the Fraser River. It has been given a IIA rating according to the British Columbia Aquifer Classification System, which suggests a highly

vulnerable aquifer of moderate demand.

No well log exists in the Provincial database for the Stoner water well, however, four well logs in close proximity to the well (170-300m) do. Three of these logs indicate a complete gravel lithology, with one of the logs having a mixed gravel/boulder lithology. Since the aquifer is unconfined and gravel is dominant throughout the well profile (the Stoner well is 60ft deep), there is no confining layer to help prevent contaminants from entering the aquifer and subsequently being taken up at the well. This suggests the well to be highly vulnerable to possible contamination.

There is a waste disposal permit in the vicinity of the Stoner well, more specifically the Stone Creek Landfill (PR1603). The operation is located approximately 1.5km southeast of Stoner and has been operating since August 1972. The landfill recently closed down in 2006.

Drinking Water Supply & Treatment

The community of Stoner draws its domestic water from a ground water supply consisting of one well. The well is located near Stone Creek, at the approximate UTM co-ordinates 10U 522273, 5942674. The water is pumped from the well and then distributed to approximately 13 connections. There is currently no holding reservoir and the water is not treated. Mr. Cook indicated the well is shock chlorinated approximately one time per month with a bleach solution.

Mr. Cook does not currently have any major quality or quantity concerns regarding the water supply; however, there have been some issues in the past. More specifically, in 2001/2002 Stoner was using a different well that was approximately 82ft deep and had an 8 inch casing. However, this well would not sustain the demand of the community and water shortages resulted. Since the new well was drilled, which is located within 50m of the old well, there have been no quantity issues.

Materials & Methods

Sample Collection & Analyses for the 2005/06 Water Monitoring Program

An experienced 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 well at the raw water tap.

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. Water samples were shipped by overnight courier in coolers with ice packs to Cantest Laboratories Inc. for bacteria and Maxxam Analytical Services 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 into the monitoring program. This included use of rigorous sampling protocols, proper training of field staff, setting of data quality objectives (DQO) 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 10% of the overall chemistry and bacterial sample numbers.

Results

Water Monitoring Program (2005/06)

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 water chemistry field blank and replicate samples were all considered to be of good quality. There were no blanks that exceeded the lab acceptance criteria of 5 times the minimum detectable level (MDL) and no replicates exceeding our set objective of 25% relative percent difference.

Since there were no DQO exceedances during this sampling program, all data are considered to be of good quality and suitable for review.

Bacteriology

The 2005/06 bacterial data are summarised in Table 1.

Drinking water quality guidelines for *E. coli, Enterococci* and fecal coliforms are 0 CFU/100mL for raw water supplies that undergo no treatment. The guideline for total coliforms is 0 CFU/100mL (10 CFU/100mL if 90th percentiles are calculated).

As seen in Table 1, no bacteria were detected during this sampling program. However, because the community currently uses no form of water treatment, ongoing bacterial sampling should occur. Given the shallow depth of the well in a vulnerable aquifer and the close proximity to Stone Creek, there is potential for possible contamination.

Table 1. Results of bacterial analysis for Stoner source water. Results are in CFU/100mL.

Date	Total Coliforms	*E.coli*	*Enterococci*	Fecal Coliforms
Provincial Guideline	0 CFU/100 mL	0 CFU/100 mL	0 CFU/100 mL	0 CFU/100 mL
11/23/05	<1	<1	<1	<1
02/01/06	<1	<1	<1	<1
03/23/06	<1	<1	<1	<1
06/01/06	<1	<1	<1	<1
08/17/06*	-	-	-	-

*****Although bacterial samples were collected on this date, due to errors with the courier, the samples did arrive at the laboratory within the required holding time. Therefore, the results were not included with the analysis.

Water Chemistry

In 2005/06, ground water samples were collected on five dates. The water samples were analysed for general parameters as well as for the ICPMS low level metals package that includes metals in the total and dissolved form (Table 2).

Of the chemical and physical parameters tested through the duration of this study, two consistently exceeded guidelines and one was of note.

Colour, True (Col. Units) - The mean colour concentration for the year was 17 TCU with a maximum of 30 TCU (the recommended water quality guideline is 15 TCU). The colour of water is a measure of its dissolved compounds (attributed to the presence of organic and inorganic materials). High colour levels are regarded as a pollution problem in terms of aesthetics, and can be produced by agricultural and industrial effluents. Colour can also originate naturally from organic soils and wetlands.

Turbidity (NTU) - The maximum detected turbidity was 4.6 NTU, with a mean of 2.9 NTU (the recommended provincial DW guideline is <0.1 NTU for a raw water supply with no treatment). Turbidity is a measure of the suspended particulate matter in the water, including silt, organic material and/or micro-organisms, that interfere with the passage of light. Turbidity can increase the available surface area of solids upon which bacteria grow, can interfere with disinfection and can be aesthetically unpleasant. Possible sources of increased turbidity in a groundwater supply include poor well construction, a damaged well casing or screen, impact from a surface source or be naturally occurring.

Total Organic Carbon (mg/L) – TOC is of note, because although concentrations exceeded recommended drinking water guidelines of 4 mg/L, the guideline is only applicable for systems that use disinfection. Stoner does not currently use any type of disinfection; however, they do shock chlorinate approximately once per month. The maximum detected TOC concentration was 8.6 mg/L with a mean of 6.2 mg/L. TOC is a measure of the dissolved and particulate organic carbon. TOC can be important in drinking water systems that use chlorination, as high levels can promote the formation of trihalomethanes which are considered carcinogens. Sources of TOC include agricultural, municipal and industrial waste discharges. Natural sources include humic substances and partly degraded plant and animal materials.

The data from 2005/06 suggest that most parameters are well below recommended drinking water guidelines. However, the parameters that do exceed guidelines, are those generally found in surface water. Although a GUDI (groundwater under the direct influence of surface water) test was not performed during this study, these exceedances suggest some influence. This is supported by the locality of this well to Stone Creek (approximately 100m) and the highly permeable, unconfined aquifer.

Table 2. Results of chemical analysis for the Stoner water supply.

	MDL	Unit	Sample Date 23-Nov-05	Sample Date 01-Feb-06	Sample Date 23-Mar-06	Sample Date 01-Jun-06	Sample Date 17-Aug-06	Drinking Water Guideline	Guideline Type
Bacteria									
Total Coliforms	1	CFU/100mL	<1	<1	<1	<1	-	<10	
Fecal Coliforms	1	CFU/100mL	<1	<1	<1	<1	-	<1	
E.Coli	1	CFU/100mL	<1	<1	<1	<1	-	<1	
Enterococci	1	CFU/100mL	<1	<1	<1	<1	-	<1	
Misc. Inorganics									
Bromide (Br)	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1		
Fluoride (F)	0.01	mg/L	0.05	0.04	0.04	0.04	0.04	1.5	Maximum
Preparation									
Filter and HNO3 Preservation		N/A	YES	YES	YES	Yes	Yes		
Calculated Parameters									
Total Hardness (CaCO3)	0.5	mg/L	53	47	54	43	48		
Nitrate (N)	0.002	mg/L	0.042	0.111	0.181	0.047			
Misc. Inorganics									
Dissolved Hardness (CaCO3)	0.5	mg/L	53	47	54	43	48	500	Unacceptable
Alkalinity (Total as CaCO3)	0.5	mg/L	44.8	39.6	44.5	34.6	45.8		
Total Organic Carbon (C)	0.5	mg/L	7.4	4.8	5.1	8.6	5.0	4	Max when chlorination
Anions									
Dissolved Sulphate (SO4)	0.5	mg/L	5.3	6.3	8.2	<0.5	7.8	500	Aesthetic
Dissolved Chloride (Cl)	0.5	mg/L	1.8	1.5	1.5	0.9	<0.5	250	
Dissolved Metals by ICPMS									
Dissolved Aluminum (Al)	0.3	ug/L	49.9	46.1	21.9	53.1	21.8	200	Maximum
Dissolved Antimony (Sb)	0.005	ug/L	0.055	0.043	0.041	0.037	0.055		
Dissolved Arsenic (As)	0.1	ug/L	0.1	<0.1	0.1	0.2	0.1		
Dissolved Barium (Ba)	0.02	ug/L	11.9	10.0	12	7.07	9.69		
Dissolved Beryllium (Be)	0.02	ug/L	0.04	<0.02	<0.02	0.04	<0.02		
Dissolved Bismuth (Bi)	0.02	ug/L	<0.02	<0.02	<0.02	<0.02	<0.02		
Dissolved Cadmium (Cd)	0.01	ug/L	0.03	0.03	0.01	0.02	<0.01		
Dissolved Chromium (Cr)	0.2	ug/L	0.7	0.6	0.4	0.7	0.3		
Dissolved Cobalt (Co)	0.005	ug/L	0.074	0.035	0.022	0.042	0.027		
Dissolved Copper (Cu)	0.05	ug/L	10.5	98.4	37.4	37.1	62.4		
Dissolved Lead (Pb)	0.01	ug/L	0.31	1.27	0.18	0.12	0.75		
Dissolved Lithium (Li)	0.05	ug/L	0.94	0.57	0.62	0.66	0.66		
Dissolved Manganese (Mn)	0.008	ug/L	17.1	3.92	2.81	5.9	6.07		
Dissolved Molybdenum (Mo)	0.05	ug/L	0.44	0.33	0.36	0.25	0.49		
Dissolved Nickel (Ni)	0.05	ug/L	3.23	2.43	1.8	1.85	2.28		
Dissolved Selenium (Se)	0.2	ug/L	0.3	0.4	0.7	0.6	<0.2		
Dissolved Silver (Ag)	0.02	ug/L	<0.02	<0.02	<0.02	<0.02	<0.02		
Dissolved Strontium (Sr)	0.005	ug/L	59.9	51.0	59.2	39	51.2		
Dissolved Thallium (Tl)	0.002	ug/L	0.008	0.009	0.005	0.011	0.005		
Dissolved Tin (Sn)	0.01	ug/L	0.02	0.10	<0.01	0.02	0.04		
Dissolved Uranium (U)	0.002	ug/L	0.425	0.362	0.262	0.474	0.256		
Dissolved Vanadium (V)	0.06	ug/L	0.35	0.13	0.23	0.2	0.12		
Dissolved Zinc (Zn)	0.1	ug/L	6	23.0	5.7	6	3.4		
Leachable Metals									
Total Aluminum (Al)	0.3	ug/L	68.2	65.6	32.6	78.3	27.5		
Total Antimony (Sb)	0.005	ug/L	0.053	0.049	0.043	0.038	0.063	6	Interim Maximum
Total Arsenic (As)	0.1	ug/L	0.2	0.1	0.1	0.3	0.1	10	Interim Maximum
Total Barium (Ba)	0.02	ug/L	12.8	10.7	12.2	7.77	10.3	1000	Maximum
Total Beryllium (Be)	0.02	ug/L	0.06	0.02	<0.02	<0.02	<0.02	4	EPA Guideline
Total Bismuth (Bi)	0.02	ug/L	<0.02	<0.02	<0.02	0.05	<0.02		
Total Cadmium (Cd)	0.01	ug/L	0.02	0.03	0.01	0.02	0.01	5	Maximum
Total Chromium (Cr)	0.2	ug/L	0.9	0.5	0.6	1	0.3	50	Maximum
Total Cobalt (Co)	0.005	ug/L	0.077	0.042	0.026	0.061	0.032		
Total Copper (Cu)	0.05	ug/L	11.9	123	40.1	50.6	60	1000	Maximum
Total Lead (Pb)	0.01	ug/L	0.74	6.11	0.63	1.05	1.63	10	Maximum
Total Lithium (Li)	0.05	ug/L	0.99	0.71	0.72	0.71	0.71		
Total Manganese (Mn)	0.008	ug/L	17.8	4.46	3.15	7.17	6.72	50	Aesthetic
Total Molybdenum (Mo)	0.05	ug/L	0.54	0.36	0.36	0.25	0.48	250	Maximum
Total Nickel (Ni)	0.05	ug/L	3.5	2.65	1.81	2.14	2.13		
Total Selenium (Se)	0.2	ug/L	0.4	0.5	0.7	0.7	<0.2	10	Maximum
Total Silver (Ag)	0.02	ug/L	<0.02	<0.02	<0.02	0.03	0.02		
Total Strontium (Sr)	0.005	ug/L	62.3	52.4	60.8	41.5	55.9		
Total Thallium (Tl)	0.002	ug/L	0.01	0.008	0.006	0.012	0.005	2	EPA Guideline
Total Tin (Sn)	0.01	ug/L	0.02	0.35	0.02	0.13	0.12		
Total Uranium (U)	0.002	ug/L	0.494	0.437	0.311	0.604	0.28	100	Maximum
Total Vanadium (V)	0.06	ug/L	0.47	0.24	0.3	0.45	0.19		
Total Zinc (Zn)	0.1	ug/L	6.3	25.0	5.8	7.2	11.3	5000	Aesthetic
MISCELLANEOUS									
True Colour	5	Col. Unit	30	15	10	15	15	15	Aesthetic
Nutrients									
Total Kjeldahl Nitrogen (Calc)	0.02	mg/L	0.23	0.15	0.11	0.15	0.09		
Total Organic Nitrogen (N)	0.02	mg/L	0.23	0.15	0.11	0.15			
Dissolved Phosphorus (P)	0.002	mg/L	0.003	0.004	0.004	0.003			
Ammonia (N)	0.005	mg/L	<0.005	<0.005	<0.005	<0.005		Refer to tables	
Nitrate plus Nitrite (N)	0.002	mg/L	0.042	0.113	0.191	0.049	0.026	10	
Nitrite (N)	0.002	mg/L	<0.002	0.002	0.01	0.002			
Total Nitrogen (N)	0.02	mg/L	0.27	0.26	0.31	0.2	0.12		
Total Phosphorus (P)	0.002	mg/L	0.004	0.004	<0.002	0.012	0.005		
Physical Properties									
Conductivity	1	uS/cm	105	98	111	80	111	700	Maximum
pH	0.1	pH Units	7.0	7.0	7.0	6.9	7.6	6.5-8.5	Aesthetic
Physical Properties									
Total Suspended Solids	4	mg/L	<4	<4	<4	<4	<4	Refer to tables	
Total Dissolved Solids		mg/L	64	54	70	64	56		
Turbidity	0.1	NTU	4.6	1.8	1.8	2.4	3.8	0.1	Maximum
Dissolved Metals by ICP									
Dissolved Boron (B)	0.008	mg/L					<0.008		
Dissolved Calcium (Ca)	0.05	mg/L	13.1	11.6	13.2	10.5	11.9		
Dissolved Iron (Fe)	0.005	mg/L	0.148	0.189	0.07	0.124	0.186	0.3	Aesthetic
Dissolved Magnesium (Mg)	0.05	mg/L	5.06	4.48	5.18	4.05	4.40	100	Taste for sensitive people
Dissolved Phosphorus (P)	0.1	mg/L					<0.1		
Dissolved Potassium (K)	1	mg/L					<1		
Dissolved Sodium (Na)	0.05	mg/L					2.07		
Dissolved Sulphur (S)	0.1	mg/L					3.0		
Dissolved Titanium (Ti)	0.003	mg/L					<0.003		
Dissolved Zirconium (Zr)	0.005	mg/L					<0.005		
Total Metals by ICP									
Total Boron (B)	0.008	mg/L							
Total Calium (Ca)	0.05	mg/L	13.1	11.7	12.6	10.2	11.0		
Total Iron (Fe)	0.005	mg/L	0.336	0.667	0.186	0.266	0.383		
Total Magnesium (Mg)	0.05	mg/L	5.03	4.51	4.89	4.08	4.90		
Total Phosphorus (P)	1	mg/L							
Total Potassium (K)	1	mg/L							
Total Sodium (Na)	0.05	mg/L	1.85	1.64	1.78	1.59	2.20	0 (20 for sensitiv	Aesthetic
Total Sulphur (S)	0.1	mg/L							
Total Titanium (Ti)	0.003	mg/L							
Total Zirconium (Zr)	0.005	mg/L							

Conclusions & Recommendations

Review of the Stoner water supply suggests an overall good water quality with most water soluble contaminants present below their recommended drinking water guideline. However, continual exceedances by colour and turbidity with an elevated TOC suggest the well may be impacted to some extent by Stone Creek. Given that the well is less than 100m to the stream, there is a possibility of surface to ground water interaction.

Without conducting a more detailed assessment on the well and aquifer in question, a 300m radius can be arbitrarily assigned as the zone where contamination is most likely to happen (Mike Wei, Senior Hydrogeologist, MOE, p.c.). Since the Stoner well is shallow in an unconfined aquifer, the well is highly vulnerable to possible contamination. Given the close proximity to Stone Creek and the various land uses in the area (e.g. landfill, Highway 97, septic systems) there is potential for an impact to the water quality.

It is recommended that the community of Stoner do an inspection on their well. More specifically, the well cap, casing and screen should be examined to ensure the elevated turbidity found during this program isn't entering the system through a fault in well construction. If the well is deemed to be in good working order, it can be assumed the elevated turbidity is from the aquifer, which suggests surface interaction. Potential treatment options to deal with this elevated turbidity, colour and TOC should then be discussed with the Northern Health Authority.

This study is one part of a broader water quality management program being carried out by the Environmental Quality Section in MOE's Omineca-Peace Region. The overall objectives of this program are to monitor water quality to identify problems, to determine causes, and to work with local governments, landowners and other interested parties to improve or otherwise protect water quality and aquatic life. Information sharing between governments, specifically MOE, the Northern Health Authority and various Regional and Municipal governments, is an ongoing practice.

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Contact Information

For more information regarding either this short report, watershed protection and/or drinking water, please contact:

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