Interior Health

Jaffray Ground Water Quality Assessment

BC Ministry of Water, Land and Air Protection
Kootenay Health Protection – Interior Health

Introduction

Ground water is an essential and vital resource for many residents of British Columbia and provides numerous households with water for drinking and washing. However, as ground water is not readily visible, it remains a hidden resource whose value is not well understood or appreciated. In recent years, events affecting ground water quality have heightened public awareness and concern about the importance and vulnerability of the resource.

Ground water exists almost everywhere within the ground, but some areas contain more water than others. The water table is the level below which all spaces in the soil are filled with water. The region below the water table is called the saturated zone. An aquifer is ground water that produces useful quantities of water when tapped by a well *(Figure 1)*.

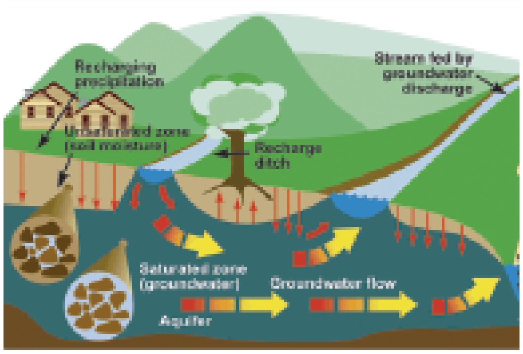

Figure 1. Example of typical ground water flow[1].

Ground water quality is influenced by natural factors such as local geology, climate, and hydrology. Ground water quality can also be affected by human activities. Any addition of undesirable substances to ground water caused by human activities is considered to be contamination. Some sources of potential contamination are:

- Fertilizers and pesticides on agricultural land
- Livestock wastes
- Leaking septic systems
- Runoff of salt and chemicals from roads and highways

Soil particles slow and reduce transport of most of these contaminants, which is why ground water is generally considered a safer drinking water source than surface water.

What is being done in BC to protect ground water quality?

In 1994, the BC government established an aquifer classification system to inventory and prioritize aquifers for planning, management and protection of the Province's ground water resource. This system classifies aquifers based on development, vulnerability to contamination, and importance of the aquifer. The highest designation of IA means the aquifer is vulnerable to contamination from surface sources and has a high water demand relative to availability. Within the Kootenay Region, two aquifers received the IA designation **(Jaffray and Wasa)**.

The provincial ambient ground water monitoring network was expanded in 2003 to monitor more IA aquifers in BC. As a result, a comprehensive ground water quality monitoring program of both the Jaffray and Wasa aquifer was undertaken between February 2003 and March 2004.

The Jaffray IA Aquifer

Jaffray is a small rural community located in the East Kootenay on Highway 3/93 between the cities of Fernie and Cranbrook. The community relies on ground water from the Jaffray aquifer to supply domestic water.

The Jaffray aquifer is both shallow and made up of unconsolidated porous soils, which allow the ground water to move freely through the openings between the individual soil particles. This may make the aquifer vulnerable to contaminants from septic systems or introduced through surface infiltration of rainfall and snowmelt, as water percolating into the ground to recharge the ground water can dissolve and transport different substances *(Figure 2)*.

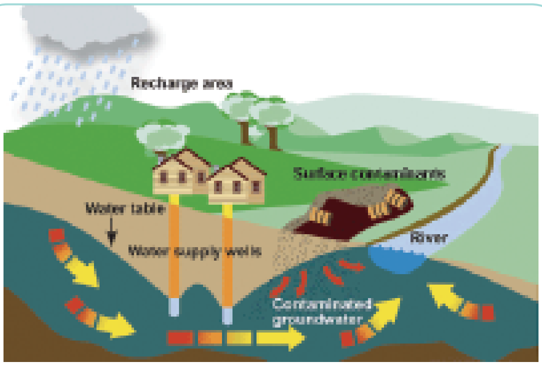

Figure 2. Example of contaminants infiltrating surface soils to ground water[1].

Jaffray Aquifer Fast Facts:[2]

- Soils are mostly coarse sandy gravels with a small amount of clay
- Water table is high *(approx. 9 feet)*
- Ground water flow is in a southwest direction
- Well depth is generally shallow *(typically between 30 and 50 ft)*

Study Overview

The Jaffray ground water quality study was developed by the Environmental Quality Section of the Ministry of Water, Land and Air Protection (WLAP) in consultation with Interior Health, Kootenay Health Protection. During the study design, specific risks to water quality within the community of Jaffray were evaluated to determine which variables should be analyzed in each ground water sample and which wells should be included in the study.

How were sites selected?

Eleven residences were selected within the area bounded by the Larsen Ranch to the west, Highway 3/93 to the north, Jaffray Loop Road to the east, and just beyond the CPR tracks to the south. The study area is shown in *Figure 3*. Wells were selected based on:

- availability of "raw" untreated water
- proximity to likely contamination sources
- spacing to provide reasonable coverage of the study area
- ability to access the well when no one is home (e.g., outdoor taps)

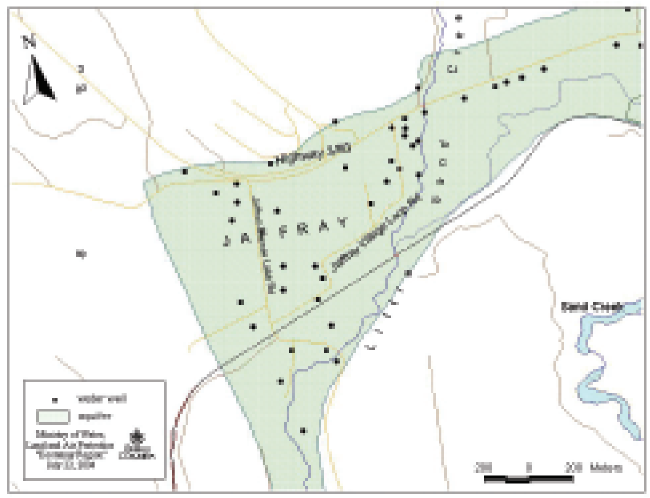

Figure 3. Jaffray aquifer and study area.

How were water samples collected?

Water samples were collected in plastic bottles at outside faucets and/or indoor taps that had no water treatment. Taps were flushed for several minutes prior to collecting samples to ensure the samples did not contain substances that may leach from plumbing systems. Samples were then placed in coolers with ice and were shipped the same day to specialized water testing laboratories (PSC Analytical Laboratories, Cantest Ltd., and JR Laboratories).

1 Adapted from Environment Canada. 2004. Freshwater Website. Updated June 8, 2004. http://www.ec.gc.ca/water/en/nature/grdwtr/e_gdwtr.htm
2 Armstrong Engineering. 1997. Jaffray Hydrogeological Study for Regional District of East Kootenay, Cranbrook, BC. File No. 4070. November 1997.

When were water samples collected?

Water sampling was done over a one year period, with an effort to collect samples during "high-risk" events such as periods of snow melt and heavy rains. In 2003, samples were collected on:

- February 3
- February 26
- March 19
- June 11
- July 30
- September 3
- October 29
- December 10

In 2004, samples were collected:

- January 13
- February 11
- March 24

What are safe levels?

WLAP[3] and Health Canada[4] publish drinking water quality guidelines, which identify substances that have been found in drinking water and are known or suspected to be harmful. The guidelines help to protect the health of Canadians by establishing maximum acceptable concentrations that can be permitted in water used for drinking. The guidelines also provide several aesthetic objectives for drinking water, which may give an unpleasant appearance, taste and odour if the substance is found at concentrations above the guideline.

What were the samples tested for and what were the results?

The Jaffray ground water study found most variables were within the normal range for ground water and were below available drinking water quality guidelines. The results for the entire study are summarized in *Table 1*.

General Parameters: Water samples were tested for parameters that are useful to characterize general properties, including alkalinity, pH, turbidity, conductivity, chloride and fluoride. All general parameters were within available drinking water quality guidelines.

Nitrogen: Samples were tested for different chemical forms of nitrogen, including ammonia, nitrate, and nitrite, which can be introduced into ground water from septic disposal or agriculture (chemical fertilizers, animal wastes). Nitrate is the most common form of nitrogen found in ground water. All levels of nitrogen were below available drinking water quality guidelines.

Total metals: Samples were tested for total metals. Metals occur naturally in ground water at different concentrations based on the geologic properties of the surrounding rocks and soils. Higher concentrations of metals in ground water may occur due to human activities such as mining or industry. Elevated levels of lead and copper are sometimes found in drinking water. However, these metals are not usually elevated within the ground water, but get into the water by leaching out of pipes and soldered joints.

Most water samples contained very low concentrations of metals. Two samples had levels of total lead above the drinking water guideline. Other samples also had slightly higher concentrations of copper or zinc, but were well below the drinking water guidelines. Due to the low levels of these metals in most samples, it appears that higher concentrations are related to leaching from pipes and/or soldered joints. Levels can be minimized by running the water for a minute before use to clear standing water from the plumbing system.

Hydrocarbons: Samples were also tested for hydrocarbon contamination on February 11, 2004 only. The analyses included benzene, toluene, ethylbenzene and xylenes (known as BTEX), methyl tertiary-butyl ether (known as MTBE), and aromatic and volatile petroleum hydrocarbons. Common sources of these compounds include leaking underground storage tanks, spills from gasoline storage sites, and stormwater runoff from roads. All samples had undetectable levels of hydrocarbons and were below available drinking water quality guidelines.

Bacteria: Samples were tested for indicators of fecal contamination and the presence of enteric pathogens, including total and fecal coliforms, *Escherichia coli (E. coli)*, and *Enterococcus*. These micro-organisms exist in the intestines of warm blooded animals and are found in wastes. They are used as indicators to verify the

3 BC WLAP. 2001. British Columbia Approved Water Quality Guidelines (Criteria) 1998 Edition. Updated: August 24, 2001. *http://wlapwww.gov.bc.ca/wat/wq/BCguidelines/approved.html#1*

4 Health Canada. 2003. Summary of Guidelines for Canadian Drinking Water Quality. April 2003. *http://www.hc-sc.gc.ca/hecs-sesc/water/pdf/summary.pdf*

safety of drinking water as their presence suggests that other enteric pathogenic microorganisms could also be present. Note that total coliform bacteria may occur naturally in soil, vegetation and water, in addition to feces. This means total coliforms are less reliable indicators of fecal pollution than specific fecal coliform bacteria, such as *E. coli* or *Enterococcus*.[5]

Of the fecal coliform bacteria, *E. coli* often receive the most attention, particularly in light of the Walkerton tragedy. *E. coli* is the predominant species within the thermotolerant or fecal coliform group of bacteria. It is generally the most sensitive to environmental stresses and only occurs in the digestive tract of humans and warm-blooded animals.[5] Therefore, *E. coli* is a definitive indicator of recent fecal contamination of water. There are hundreds of strains of *E. coli*. Most are non-pathogenic, although some can cause serious diarrhoeal infections in humans. The typical non-pathogenic *E. coli* are always found in greater concentration in feces than the disease causing strains, even during outbreaks.

The drinking water quality guidelines state that no sample should contain *E. coli* or other coliform bacteria. **However, some of the Jaffray ground water samples contained low numbers of these indicator bacteria, which suggests that these wells have been subject to fecal contamination. Contamination may have arisen from poorly constructed wells that permit surface water to seep into the aquifer, surface infiltration through the porous soils, or from poorly functioning septic systems. *Consequently, the water may not be safe to drink.***

It should be noted that contamination is often intermittent and may not be revealed by the examination of a single sample. A bacteriological water analysis shows only that at the time of examination, bacteria indicating fecal pollution did or did not grow under laboratory conditions from the sample of water tested.

How do we know the data is valid?

As part of the Jaffray ground water study, quality control (QC) samples were collected to check for external contamination of water samples and confirm the accuracy of the data. Two samples containing only deionized water *(field blanks)* were submitted to the laboratory to ensure that samples were not contaminated in the field or at the laboratory. In addition, two samples were collected from some residences and submitted to the laboratory as separate samples to examine the variability of water quality and the accuracy of the lab *(field replicates)*. The QC results found sample contamination and variability among the field replicates did not affect study conclusions.

Are there any risks to health?

This study has confirmed that the aquifer is vulnerable to contamination. The risk of contamination is probably greatest during spring thaw, heavy rainfall events, or drought. It is difficult to quantify the health risk associated with drinking water from the Jaffray aquifer due to the many variables involved. Some of those factors are:

- intermittent nature of contamination
- many possible sources of contamination, such as wild and domestic animals, septic systems, agriculture, and road run-off
- speed of contaminant infiltration into the aquifer
- proximity of wells to sources of contamination
- extent of wellhead protection by well owners
- survival rates of disease causing organisms in the ground water environment

What can be done to ensure drinking water is safe?

Just because you are not getting sick does not mean that your well water is safe. Residents using the aquifer as a drinking water source can contact the local Health Protection Office of Interior Health for advice on disinfecting their drinking water. In general, water from wells that are vulnerable to contamination should be disinfected for drinking purposes. Some options are:

- boil water for drinking
- use bottled water
- install disinfection equipment such as ultra violet filter units

5 Health Canada. 1988. Bacteriological Quality. Updated January 2002. *http://www.hc-sc.gc.ca/hecs-sesc/water/publications/bacteriological_quality/toc.htm*

Table 1. Summary of water quality from 10 wells supplied by the Jaffray aquifer sampled February 2003 - March 2004

PARAMETER	UNITS	DWG	TOTAL # SAMPLES	MINIMUM	MAXIMUM	AVERAGE	90th PERCENTILE
Bacteriology							
Fecal coliform	CFU/100mL	0	56	< 1	**9**	**1**	< 1
Total coliform	CFU/100mL	0*	105	< 1	**1100**	**22**	**14**
E. coli	CFU/100mL	0	105	< 1	**6**	< 1	< 1
Enterococci	CFU/100mL	0	46	< 1	**2**	< 2	< 2
General							
pH	pH units	6.5 to 8.5§	75	7.9	8.3	8.1	8.2
Specific Conductance	µS/cm	700	75	267	549	385	454
Turbidity	NTU	1	75	< 0.10	**3.30**	0.32	0.59
Alkalinity **(total)**	mg/L	–	71	161	251	201	222
Dissolved Anions							
Chloride	mg/L	250§	75	1.6	28.5	5.8	7.5
Fluoride	mg/L	1.5	75	0.05	0.14	0.09	0.11
Dissolved Nitrogen							
Ammonia	mg/L	–	74	< 0.005	0.039	0.006	0.007
Nitrate nitrogen	mg/L	10	75	0.11	0.70	0.28	0.37
Nitrate + Nitrite	mg/L	–	75	0.110	0.702	0.285	0.373
Nitrite nitrogen	mg/L	3.2*	75	< 0.002	0.009	0.003	0.006
Total Metals							
Aluminum **(Al)**	µg/L	200	75	< 0.3	9.3	1.3	2.26
Antimony **(Sb)**	µg/L	6	75	0.012	0.101	0.048	0.076
Arsenic **(As)**	µg/L	25	75	< 0.1	0.2	0.1	< 0.1
Barium **(Ba)**	µg/L	1000	75	37.7	60.8	49.2	53.2
Beryllium **(Be)**	µg/L	–	75	< 0.02	0.05	0.02	< 0.02
Bismuth **(Bi)**	µg/L	–	75	< 0.02	< 0.02	< 0.02	< 0.02
Cadmium **(Cd)**	µg/L	5	75	< 0.01	0.37	0.03	0.11
Chromium **(Cr)**	µg/L	50	75	< 0.2	9.3	2.2	6.7
Cobalt **(Co)**	µg/L	–	75	< 0.005	0.09	0.017	0.054
Copper **(Cu)**	µg/L	1000§	75	< 0.05	90	9.2	19.4
Lead **(Pb)**	µg/L	10	75	0.02	**79.3**	1.90	0.56
Lithium **(Li)**	µg/L	–	75	1.15	2.47	1.80	2.07
Manganese **(Mn)**	µg/L	50§	75	< 0.008	4.45	0.59	1.01
Molybdenum **(Mo)**	µg/L	250	75	< 0.05	0.28	0.21	0.26
Nickel **(Ni)**	µg/L	–	75	< 0.05	0.54	0.09	0.15
Selenium **(Se)**	µg/L	10	75	< 0.2	0.8	0.3	0.5
Silver **(Ag)**	µg/L	–	75	< 0.02	< 0.02	< 0.02	< 0.02
Strontium **(Sr)**	µg/L	–	75	0.1	115	82.6	93.76
Thallium **(Tl)**	µg/L	2	75	< 0.002	0.027	0.004	0.0118
Tin **(Sn)**	µg/L	–	75	< 0.01	87	1.44	0.11
Uranium **(U)**	µg/L	100	75	0.263	0.538	0.373	0.435
Vanadium **(V)**	µg/L	–	75	0.06	2.65	0.79	1.93
Zinc **(Zn)**	µg/L	5000§	75	0.9	385	24.3	43.2

NOTES
1. Drinking Water Guidelines (DWG) maximum acceptable concentration from BC WLAP (2001)[3] for raw untreated water, unless otherwise noted. (*) = Health Canada DWG[4], (§) = aesthetic objective.
2. Bold values exceeded DWG.
3. 90th Percentile = 90% of all samples less than this value.
4. Wells supplied by surface water (e.g., springs) excluded from this summary.

Are there laws to protect drinking water?

The *Drinking Water Protection Act* came into force in May 2003. This legislation provides a detailed and comprehensive framework for drinking water protection. Most of the legislation will be administered by the BC Ministry of Health Services and the Regional Health Authorities (Interior Health). However, WLAP shares some responsibility for protecting water quality through the management and regulation of some activities in watersheds that have the potential to affect water quality.

Ground Water Protection Regulations were passed under the provincial *Water Act* in July 2004. The regulations are an integral part of the Province's Action Plan for Safe Drinking Water, which attempts to protect water from the source to the tap. The new regulations address the risk of ground water contamination by establishing standards to ensure wells are properly drilled, sealed, maintained and closed. The regulations also require larger drinking water supply wells to be flood-proofed so run-off contamination cannot occur during flooding or heavy rains.

Study Conclusions

This study found water quality in the Jaffray aquifer is generally within the normal and accepted range of ground water and available drinking water quality guidelines. However, the presence of bacteria in some samples confirms the vulnerability of the aquifer to contamination. Residents using the aquifer as a drinking water source should seek advice from the Kootenay Health Protection office of Interior Health to treat water and ensure it is safe to consume.

Contacts

For further information on this study, please contact:

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If you would like specific information regarding health issues and/or options for treating drinking water, please contact:

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Kootenay Health Protection, Interior Health
Phone: (250) 420-2220

Further Information

General information on ground water in BC
http://wlapwww.gov.bc.ca/wat/gws/gwis.html
http://www.healthservices.gov.bc.ca/protect/water.html

Health Canada's drinking water guidelines
http://www.hc-sc.gc.ca/hecs-sesc/water/pdf/summary.pdf

Well Protection Toolkit
http://wlapwww.gov.bc.ca/wat/gws/well_protection/acrobat.html
or contact the Water Protection Section at (250) 387-9932

Canadian Ground Water Association
www.bcgwa.org

BC Ground Water Protection Regulation
http://wlapwww.gov.bc.ca/wat/gws/gws_reg_back/back.html

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