



Date: May 4, 2016

File: 76600-20 Armstrong

To: Christa Zacharias-Homer, Deputy Director, Regional Operations, Victoria

Cc: Robyn Roome, Director, Monitoring, Assessment and Stewardship, Nelson

Re: Ministry of Environment Nitrate-Nitrogen Water Data for the Hullcar Aquifer and Deep Creek Update.

Introduction

This document is to serve as an update to an earlier report 2016-02-15 Review of MOE data Hullcar aquifer, authored by Carrie Morita, RPBio. This update was required to add data received after the original document was written and also includes additional historical data not available during the first review. The original document is included within this update with permission of the author.

The Hullcar aquifer, or aquifer #103, is an unconfined aquifer located in the North Okanagan near Armstrong, within the Township of Spallumcheen, B.C. Aquifer #102 is a confined aquifer located below #103. It is believed that there may be some connection between the two aquifers. The Steele Springs Water District (SSWD), which services about 150 people, extracts its domestic water from Hullcar aquifer (#103). SSWD has been under a water quality advisory issued by the Interior Health Authority (IHA) since March 2014, due to high nitrate levels in the aquifer. Recently the nitrate levels have exceeded the Canadian Drinking Water Guideline of 10 mg/L nitrate-nitrogen¹. Prolonged exposure to high levels of nitrate can lead to a reduction in the amount of oxygen that can be carried by the blood in a condition called methemoglobinemia. This condition is a particularly high risk for bottle-fed babies under 6 months, women who are pregnant, elderly persons with heart conditions and

¹ Concentrations of nitrate in water are reported by the laboratories in units of nitrate-nitrogen where 1 mg nitrate-nitrogen/L = 4.43 mg nitrate/L.

others with compromised immune systems. (personal communication Dr. K Golmohammadi IHA, 2016).

This memo summarizes nitrate-nitrogen data collected from Steele Springs Water District (raw water), 6 surface water sites and 2 ground water sites above the SSWD source by the Ministry of Environment (MOE), IHA, SSWD and contractors between March 1987 and April 2016. Only results from CAEL certified laboratories were included in the analyses. For some of the sites a number of parameters were analyzed, such as other forms of nitrogen and dissolved ions, but this memo focusses on nitrate-nitrogen only. This memo also does not report on data collected by the SSWD, or other groundwater data collected in the Hullcar Aquifer by the Ministry of Forests, Lands and Natural Resource Operations. Land use over the aquifer is not summarized although it is known that there is intensive agriculture in the area.

Lab results were reviewed and are summarized in the tables 1, 2 and 3 of Appendix I. Samples were collected by Ministry of Environment staff, IHA or contractor and shipped to either Maxxam Analytics (prior to June, 2015), ALS (after June, 2015) or CARO Environmental. No differences in nitrate results can be attributed to the change in laboratories. All laboratory QA/QC reports for the samples collected were acceptable.

Results

Samples were collected that represent the Steele Springs Water District drinking water at the SSWD Overflow (site E30110, previously E206927). This is the same location where the SSWD and the IHA collect their samples. Results for these water samples are summarized in **Table 1 and Figure 1**. The SSWD Overflow water shows higher nitrate-nitrogen levels than ambient surface water samples. During the period of March 18, 1987 to April 12, 1989 levels ranged from a minimum of 3.65 mg/L to a maximum of 4.75 mg/L. Between April 10, 2012 and November 5, 2013 these levels double from 2.55 mg/L to 6.0 mg/L while from November 5, 2013 to February 17, 2015 the values doubled again to 13.0 mg/L. During the summer months these values dropped to 9.76 mg/L before increasing to 13.3 mg/L on February 22, 2016. Current value is 13.0 mg/L. Of the samples taken from January 2014 to May 2016, nitrate levels in 14 of 17 samples exceeded the Canadian drinking water guideline of 10 mg/L. Viewing the graphical data (Figure 1) we see the steep upward trend from February 2011 to the present with depressions in the curve during the summer periods. Further study will be required to explain these trends.

MOE also collected water samples from several surface water locations in the area including immediately downstream of the Steele Springs outlet (site E301111; n=12) as well as Deep Creek (site E260908, n=47; site E301551, n= 6; site E301112, n=7) and Parkinson Lake (site E301550, n=3). These data is presented in Table 2.

Twelve water samples were collected below the Steele Springs outlet (E301111). Results ranged from 3.12 to 9.47 mg/L (Figure 2), marginally below the drinking water guideline of 10mg/L, but elevated above the aquatic life guideline of 3.0 mg/L (chronic) and significantly below the acute guideline level of 32.8 mg/L.

Water quality at Deep Creek at Gulch Road (E301112), located 2.5 km downstream of the SSWD overflow site, represents cumulative inputs from the larger drainage area. This site had nitrate-nitrogen values ranging from 1.33 mg/L to 6.82 mg/L which is elevated above levels generally found naturally (**Table 2 and Figure 3**). Three results were above the aquatic life guideline of 3.0 mg/L. The two sites upstream of the SSWD overflow site on Deep Creek (E260908 and E301551) had relatively low levels of nitrates ranging from 0.475 mg/L to 3.32 mg/L and 0.117 mg/L to 1.8 mg/L respectively during this period (**Table 2**). However, samples between March 1987 and April 1989, at Deep Creek at Hullcar Road, were significantly higher, with spring freshet values above 10.0 mg/L and low flow fall samples between .014 and 0.775 mg/L (as shown in Figure 4). These values met the Water Quality Objectives set in 1994. Further sampling will be required to determine if the current Aquatic Life guideline of 3.0 mg/L (32.8 max) would still be met.

Parkinson Lake is a small kettle lake above the Hullcar aquifer to the west of SSWD overflow site. Nitrate-nitrogen values in Parkinson Lake water samples were all <1 mg/L and similar to levels generally found naturally (**Table 2**).

MOE also collected limited groundwater samples from the Regher Barn Tap (E301113; n=6) and the Reimer Tap (no EMS #; n=1). Water from these sites is sourced from private wells and although drill records are not available, it is assumed that this water is extracted from the Hullcar aquifer (#103). Nitrate-nitrogen levels in the water samples ranged from 7.18 mg/L to 11.4 mg/L which are elevated above levels generally found naturally (**Table 3**). The two most recent water samples from the Regher Barn Tap were above the Canadian drinking water guideline.

Assessment

The Health Canada guideline for nitrate is 45 mg/L nitrate which is equivalent to 10 mg/L nitrate-nitrogen. This value is derived using the no-observed-adverse-effect level (NOAEL) for infantile methemoglobinemia of 45 mg/L observed in the North American

population. Most infants do not show signs of toxicity until the lowest-observed-adverse-effect level (LOAEL) or approximately twice the NOAEL (Health Canada 1992). The maximum nitrate-nitrogen value detected was 13.3 mg/L which above the NOAEL but below the LOAEL.

In British Columbia, nitrate levels in ambient groundwater are generally less than 1 mg/L. Nitrate levels greater than 3 mg/L in groundwater usually indicate nitrate addition from human activities (Ministry of Environment 2007). Nitrate is very mobile in soil and easily migrates to the water table when present in amounts in excess of plant needs (Health Canada 1992).

The data collected confirms high levels of nitrate in the Hullcar aquifer, with concentrations above the Canadian drinking water guideline. Insufficient information was available to identify all potential sources of nitrate to the aquifer.

Given that Hullcar aquifer is unconfined, and thus vulnerable to contamination, any uncontained source of nitrogen – manure or chemical fertilizer application, septic fields, manure storage, feedlots, etc. – has the potential to introduce nitrate to the aquifer.

Recommendations

Based on the limited data reviewed, our recommendations are:

1. MOE data collected on nitrate levels in the Hullcar aquifer should continue to be shared with IHA to support its assessments of risks to human health.
2. Well owners using the Hullcar aquifer should test their drinking water regularly. If nitrate concentrations are higher than the drinking water guideline, owners should consult the IHA.
3. There are numerous and complex factors that influence the potential for nitrate contamination of the Hullcar aquifer. A more definitive study would likely require the expertise of a hydrogeologist with experience in agricultural areas.
4. Qualified Professionals providing future assessment of the application of nutrients to lands above the Hullcar aquifer should take into account the current nitrate levels recorded at SSWD Overflow and the potential cumulative contributions of other land use activities to nitrate levels.
5. Further monitoring be undertaken to increase our understanding of water chemistry of the aquifer and interaction with surface conditions as well as assess potential sources of the contamination.

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References

Health Canada. 1992. Nitrate/Nitrite. Guidelines for Canadian Drinking Water Quality – Supporting Documents. Ottawa, ON.

Ministry of Environment. 2007. Nitrate in Groundwater. Well Stewardship Information Series Factsheet.

[http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/ground_fact_sheets/pdfs/no3\(020715\)_fin2.pdf](http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/ground_fact_sheets/pdfs/no3(020715)_fin2.pdf)

APPENDIX 1 – TABLES

Table 1. Summary of Nitrate-Nitrogen data collected by MOE at SSWD Overflow (E30110)

Date	Laboratory	MDL (mg/L)	Nitrate (mg/L)
18-Mar-87	Maxxam	0.02	4.2
26-Mar-87	Maxxam	0.02	4.3
15-Apr-87	Maxxam	0.02	4.15
29-Apr-87	Maxxam	0.02	3.85
2-Jun-87	Maxxam	0.02	3.65
2-Jul-87	Maxxam	0.02	3.75
14-Sep-87	Maxxam	0.02	3.65
16-Nov-87	Maxxam	0.02	3.65
10-Mar-88	Maxxam	0.02	4.05
7-Jul-88	Maxxam	0.02	3.65
3-Nov-88	Maxxam	0.02	3.95
12-Apr-89	Maxxam	0.02	4.75
10-Feb-11	CARO	0.01	1.67
10-Apr-12	CARO	0.01	5.23
12-May-12	CARO	0.01	5.51
14-May-12	CARO	0.01	5.33
10-Apr-12	CARO	0.01	5.23
3-Jun-12	CARO	0.01	5.73
28-Jun-12	CARO	0.01	3.48
12-Sep-12	CARO	0.01	6.00
4-Nov-12	CARO	0.01	5.42
26-Nov-12	CARO	0.01	5.05
8-Jan-13	CARO	0.01	2.55
4-Feb-13	CARO	0.01	2.75
5-Mar-13	CARO	0.01	3.08
2-Apr-13	CARO	0.01	4.60
23-Apr-13	CARO	0.01	3.98
29-May-13	CARO	0.01	3.64
2-Jul-13	CARO	0.01	3.42
30-Jul-13	CARO	0.01	3.44
24-Sep-13	CARO	0.01	4.54
5-Nov-13	CARO	0.01	5.73
7-Jan-14	CARO	0.01	7.03
21-Jan-14	Maxxam	0.02	8.80
25-Jan-14	CARO	0.01	7.82
1-Mar-14	CARO	0.01	10.10

13-Mar-14	Maxxam	0.02	10.60
19-Mar-14	CARO	0.01	9.75
10-Dec-14	CARO	0.01	10.40
8-Jan-15	CARO	0.01	10.80
1-Feb-15	CARO	0.01	12.60
17-Feb-15	Maxxam	0.02	13.00
26-Mar-15	Maxxam	0.02	12.30
21-Apr-15	Maxxam	0.02	11.10
20-May-15	Maxxam	0.02	10.10
22-Jun-15	ALS	0.015	9.78
20-Jul-15	ALS	0.015	9.87
26-Aug-15	ALS	0.015	9.76
23-Sep-15	ALS	0.015	10.20
21-Oct-15	ALS	0.015	11.10
25-Nov-15	ALS	0.015	12.50
18-Dec-15	ALS	0.015	13.20
25-Jan-16	ALS	0.015	13.30
22-Feb-16	ALS	0.015	13.30
23-Mar-16	ALS	0.015	12.40
23-Apr-16	ALS	0.015	13.00

Values in bold exceed the Canadian Drinking Water Guideline of 10 mg/L nitrate-nitrogen.

Table 2. Summary of Nitrate-Nitrogen data collected by MOE at Surface Water Stations.

Date	Laboratory	MDL (mg/L)	E301111	E301551	E260908	E301112	E301550
			Steele Springs below outlet	Deep Creek at 4114 Hulcar Rd	Deep Creek above Hulcar Rd	Deep Creek at Gulch Rd	Parkinson Lake
			Nitrate (mg/L)	Nitrate (mg/L)	Nitrate (mg/L)	Nitrate (mg/L)	Nitrate (mg/L)
25-Feb-87	Maxxam	0.02			1.29		
5-Mar-87	Maxxam	0.02			1.51		
11-Mar-87	Maxxam	0.02			6.25		
18-Mar-87	Maxxam	0.02			10.1		
26-Mar-87	Maxxam	0.02			9.8		
2-Apr-87	Maxxam	0.02			6.5		
8-Apr-87	Maxxam	0.02			1.69		

15-Apr-87	Maxxam	0.02		1.35
22-Apr-87	Maxxam	0.02		0.99
29-Apr-87	Maxxam	0.02		0.45
7-May-87	Maxxam	0.02		0.61
14-May-87	Maxxam	0.02		0.59
21-May-87	Maxxam	0.02		0.34
2-Jun-87	Maxxam	0.02		0.34
2-Jul-87	Maxxam	0.02		0.17
16-Nov-87	Maxxam	0.02		0.19
10-Mar-88	Maxxam	0.02		7.35
24-Mar-88	Maxxam	0.02		9.1
31-Mar-88	Maxxam	0.02		9.1
6-Apr-88	Maxxam	0.02		4.25
14-Apr-88	Maxxam	0.02		1.21
21-Apr-88	Maxxam	0.02		0.7
29-Apr-88	Maxxam	0.02		0.4
4-May-88	Maxxam	0.02		0.43
11-May-88	Maxxam	0.02		0.28
18-May-88	Maxxam	0.02		0.36
1-Jun-88	Maxxam	0.02		0.07
29-Sep-88	Maxxam	0.02		0.12
3-Nov-88	Maxxam	0.02		0.14
12-Apr-89	Maxxam	0.02		5.55
15-Mar-11	Maxxam	0.02		0.916
30-Mar-11	Maxxam	0.02		7.22
6-Apr-11	Maxxam	0.02		3.45
13-Apr-11	Maxxam	0.02		1.35
6-Oct-11	Maxxam	0.02		0.224
13-Oct-11	Maxxam	0.02		0.282
19-Oct-11	Maxxam	0.02		0.3
26-Oct-11	Maxxam	0.02		0.287
2-Nov-11	Maxxam	0.02		0.334
26-Nov-12	CARO	0.01		1.12
2-Apr-13	CARO	0.01	3.67	
23-Apr-13	CARO	0.01	3.12	
29-May-13	CARO	0.01	3.58	
2-Jul-13	CARO	0.01	3.69	
30-Jul-13	CARO	0.01	3.73	
24-Sep-13	CARO	0.01	4	
5-Nov-13	CARO	0.01	5.02	
26-Nov-13	CARO	0.01	5.01	
7-Jan-14	CARO	0.01	5.1	
17-Feb-15	Maxxam	0.02	9.47	1.8
				1.92

26-Mar-15	Maxxam	0.02	9.3	3.32	1.79	2.2	0.0028
21-Apr-15	Maxxam	0.02	9.13	0.796	0.775	1.33	0.0211
20-May-15	Maxxam	0.02		0.678	0.685	2.07	0.0642
22-Jun-15	ALS	0.015		0.0475	0.457	3.31	
20-Jul-15	ALS	0.015					
26-Aug-15	ALS	0.015	8.7	0.281	0.22	6.28	
23-Sep-15	ALS	0.015		0.186	0.117	6.82	

Table 3. Summary of Nitrate-Nitrogen data collected by MOE from Private Wells.

Sampling Date	Analyzing Laboratory	Detection Limit (mg/L)	Private Wells	
			E301113	TBD
			Regher Barn Tap	Reimer Tap
17-Feb-15	Maxxam	0.02	8.64	-
26-Mar-15	Maxxam	0.02	9.03	-
21-Apr-15	Maxxam	0.02	6.89	7.18
20-May-15	Maxxam	0.02	7.97	-
22-Jun-15	ALS	0.015	10.2	-
20-Jul-15	ALS	0.015	-	-
26-Aug-15	ALS	0.015	11.4	-
23-Sep-15	ALS	0.015	-	-

Values in bold exceed the Canadian Drinking Water Guideline of 10 mg/L nitrate-nitrogen.

Figure 1: Nitrate levels at SSWD Overflow March 18,, 1987 to April 23, 2016

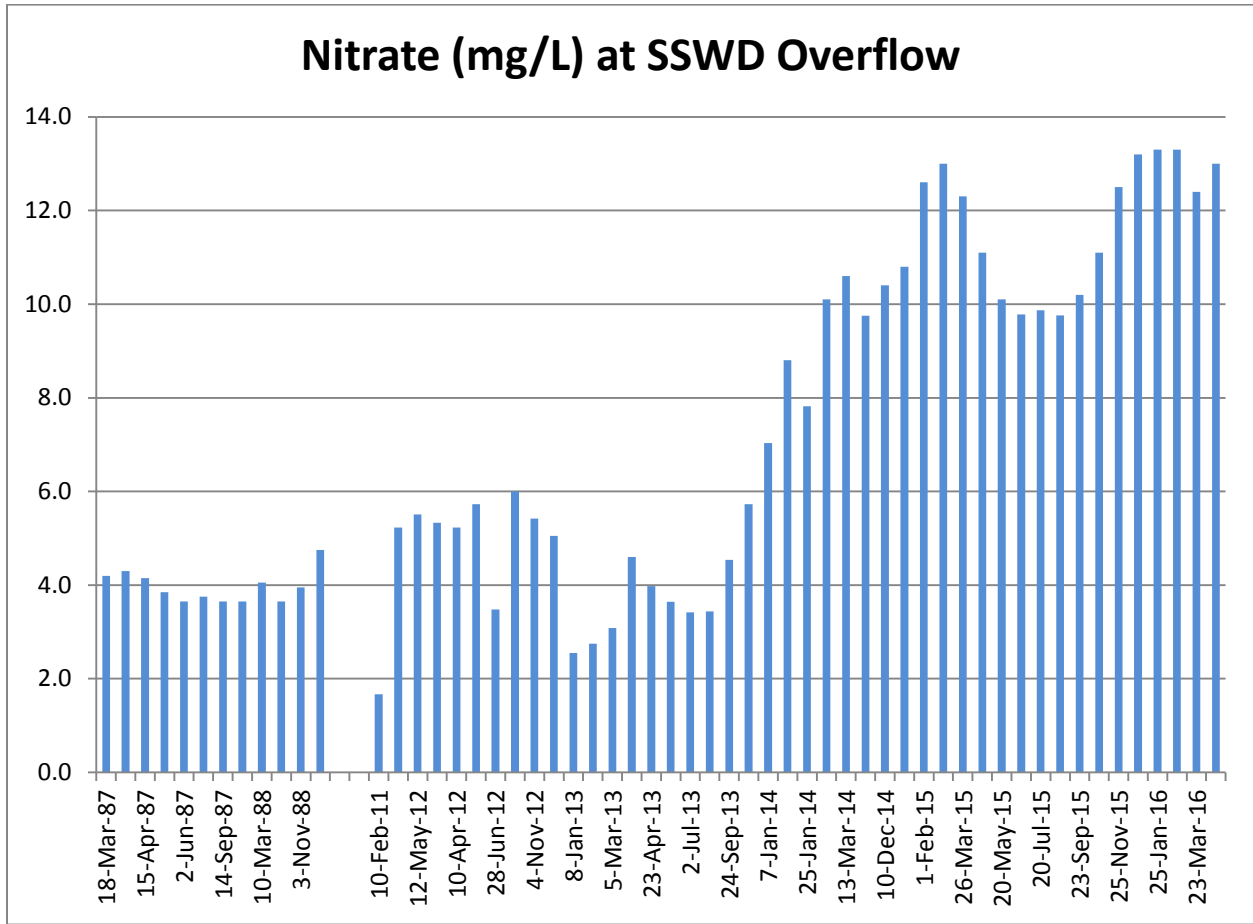


Figure 2: Nitrate levels below SSWD Overflow April 2, 2013 to September 23, 2015

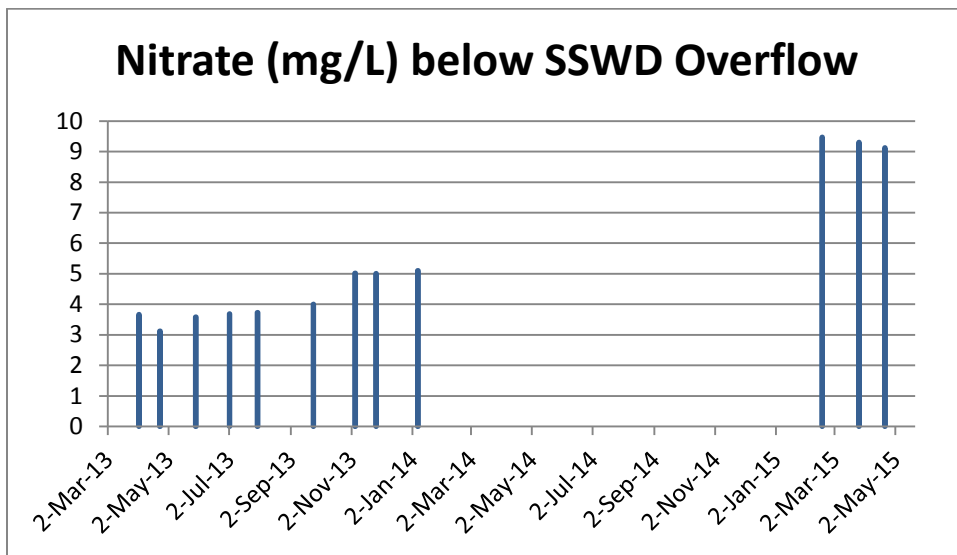


Figure 3: Nitrate levels Deep Creek at Gulch Road, February 17, 2015 to September 23, 2015

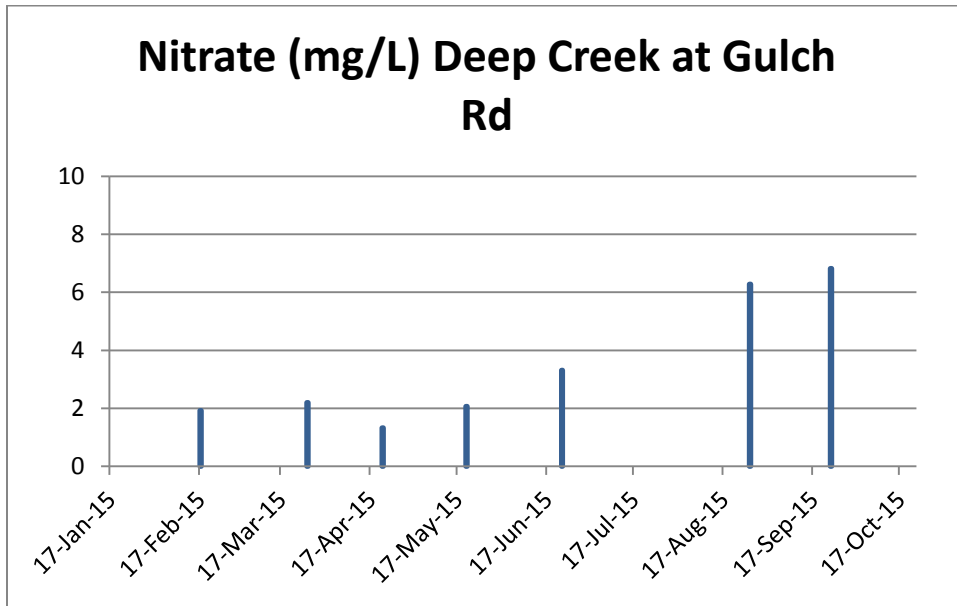


Figure 4: Nitrate levels Deep Creek at Hullcar Road, February 25, 1987 to August 26, 2015.

