



Regional Characterization of the Beverly Channel Aquifer in the Industrial Heartland Area, Fort Saskatchewan, Alberta

Presented at "Groundwater – Our Hidden Water Resource

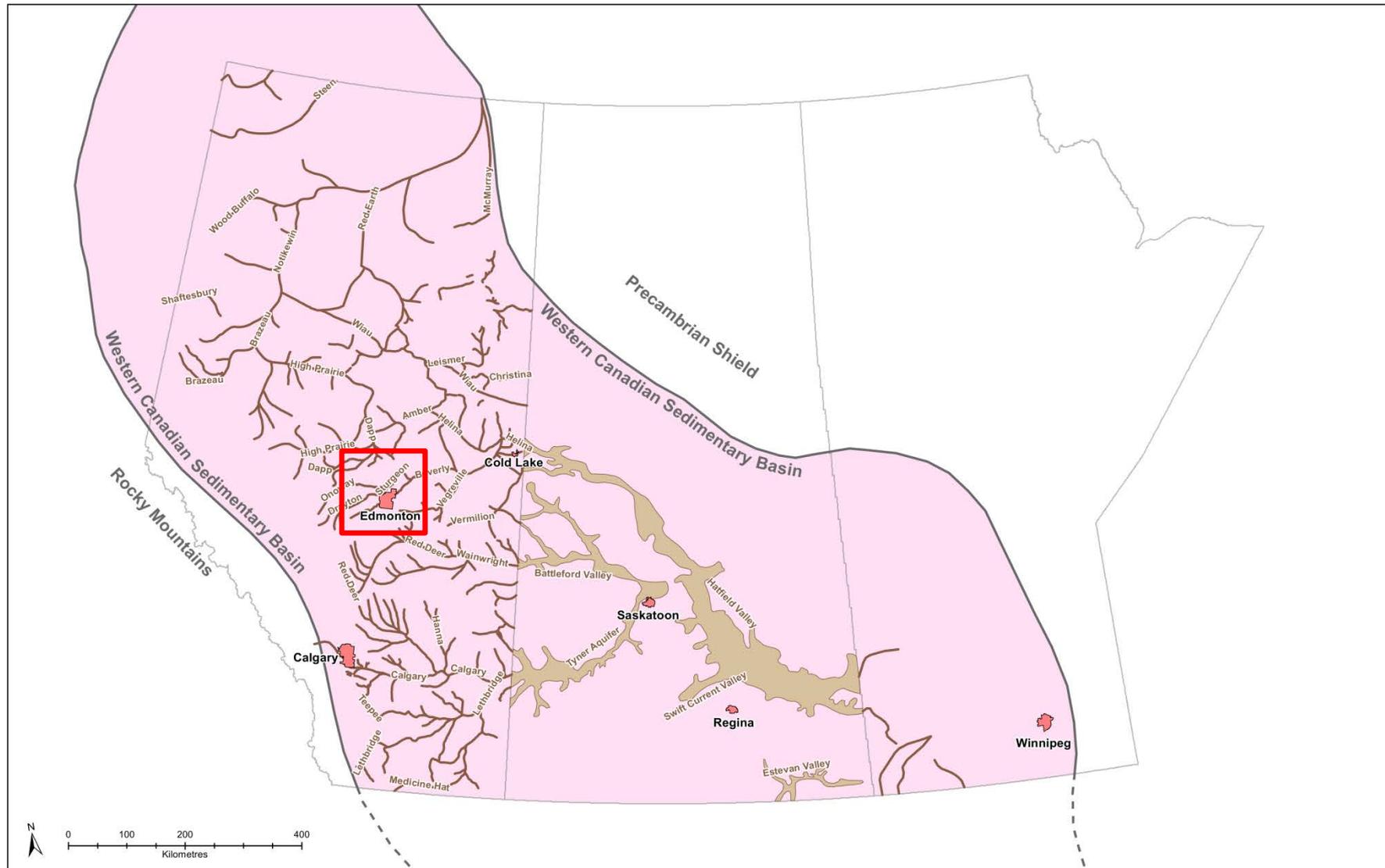
NSWA Educational Forum

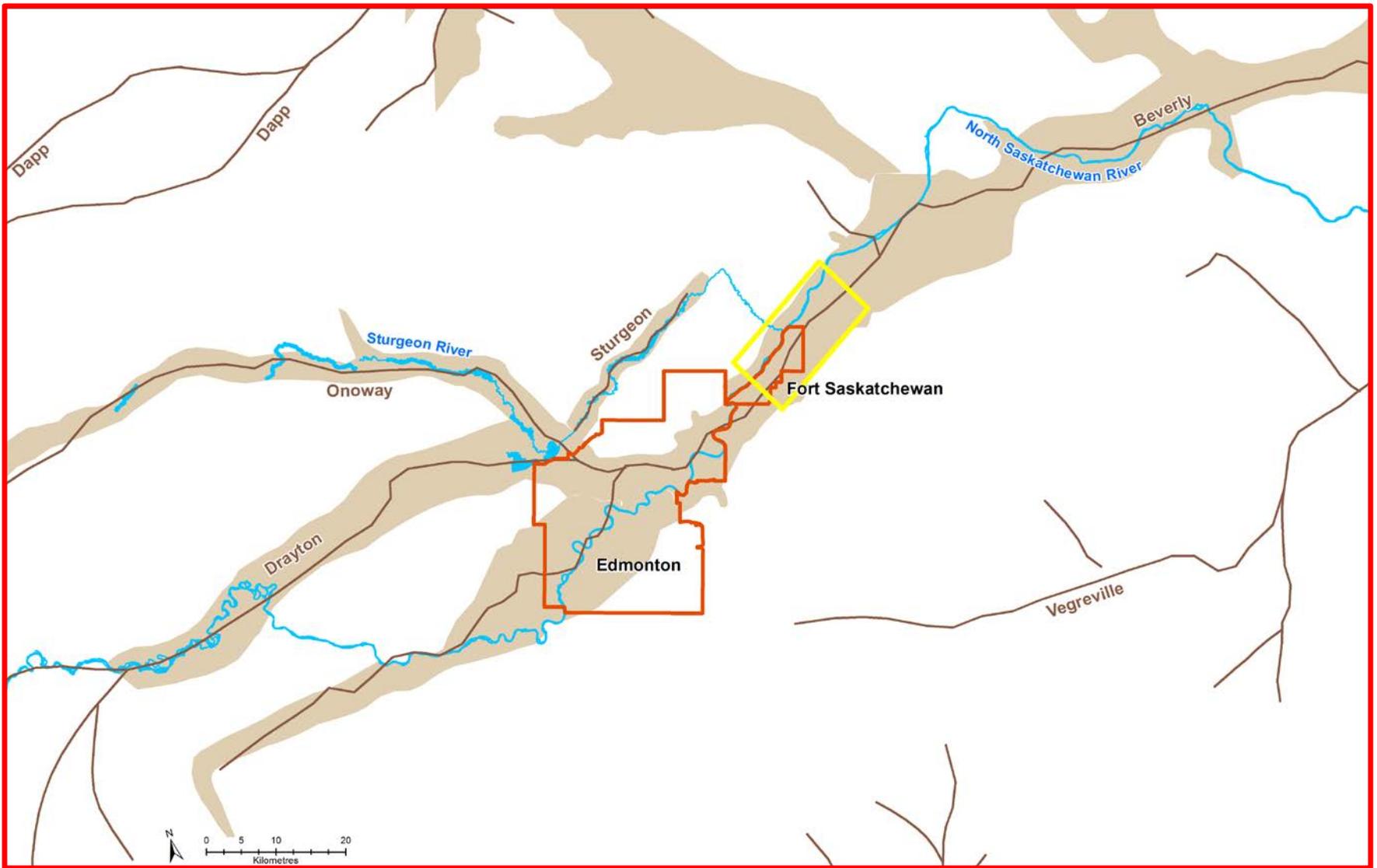
February 27, 2019

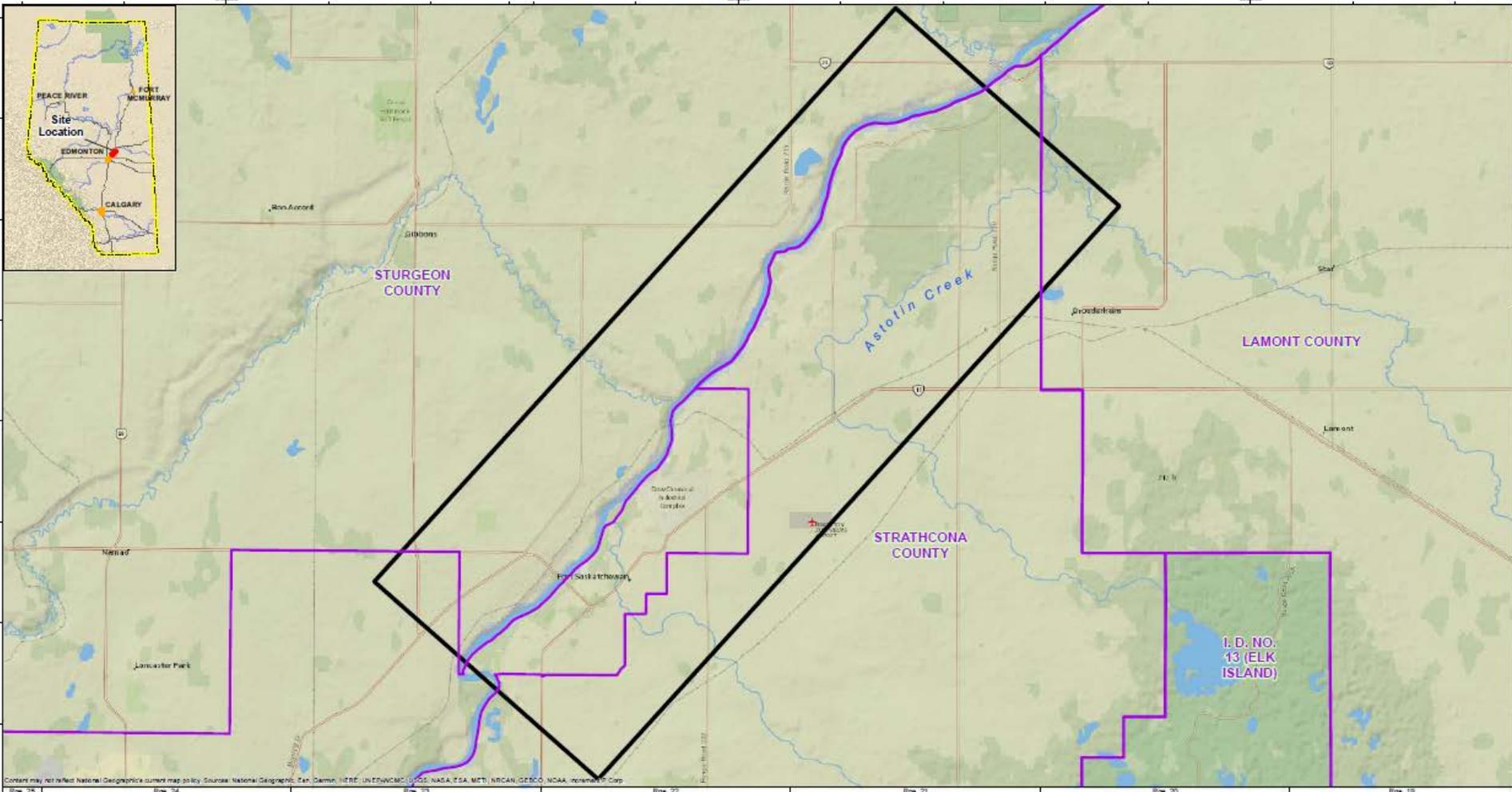
Buried Valley Channels



Buried Valleys – Regional Setting

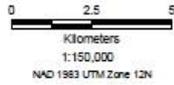






Content may not reflect National Geographic's current map policy. Sources: National Geographic, Can. Geom. Inf. Ctr., UNED/UMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iNaturalist Corp.

- Study Area
- County Boundaries



**NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
2018 GROUNDWATER QUALITY MONITORING
BEVERLY CHANNEL MONITORING WELLS**

SITE LOCATION

	Date: 26-OCT-18	Drawn by: T.S.	Edited by: L.F.	Appr'd by: T.B.
	Water/Waste Project No. 307075-01608-400			
	File No. 1			REV. A

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The NCIA Regional Groundwater Quality Project



The Northeast Capital Industrial Association (NCIA) Regional Groundwater Quality Project

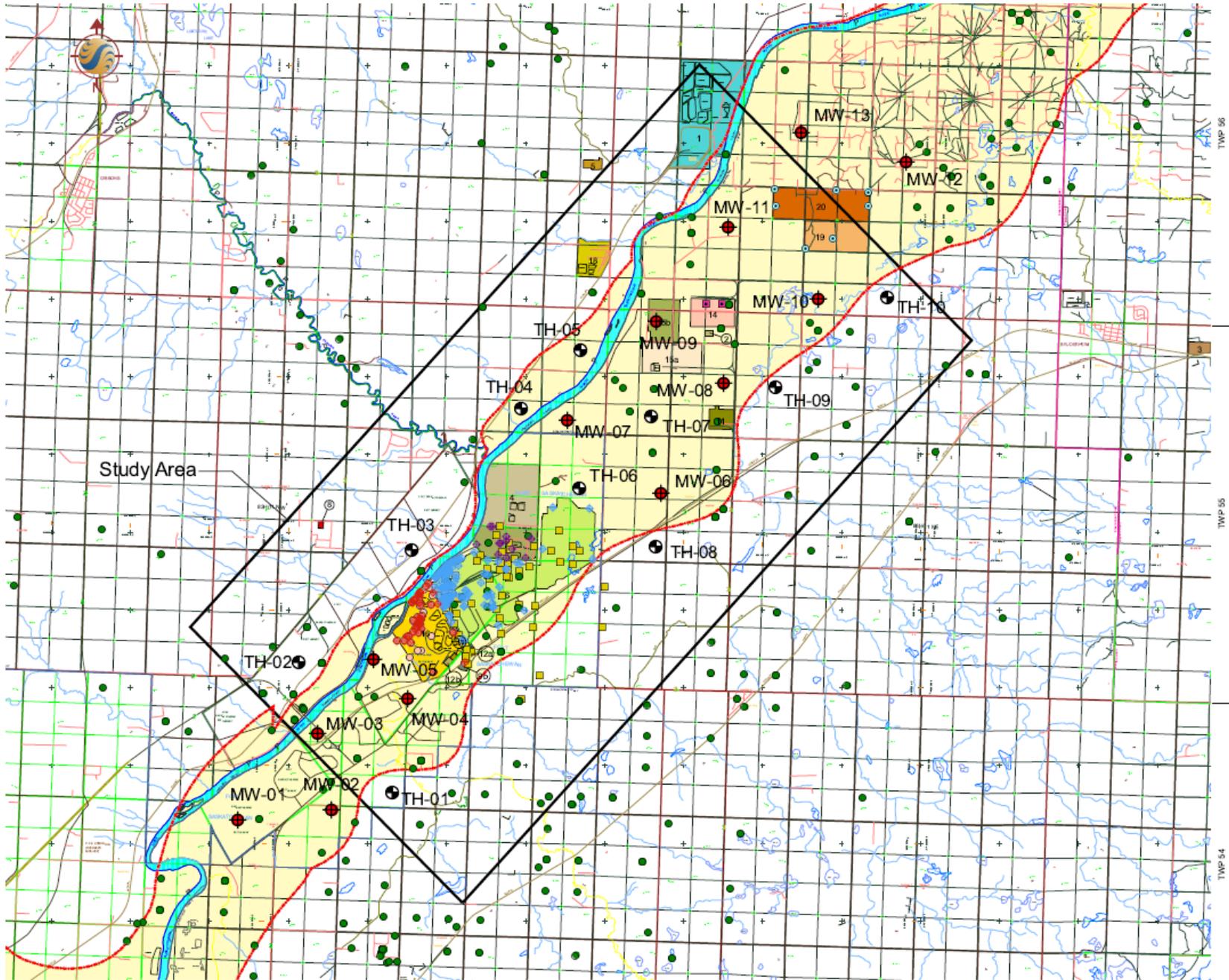
Objectives:

- Provide a framework for regional scale management of groundwater quality issues
- Develop scientific knowledge of the groundwater quality
- Gain understanding of emerging groundwater issues
- **Define groundwater quality baseline conditions**

Project Chronology:

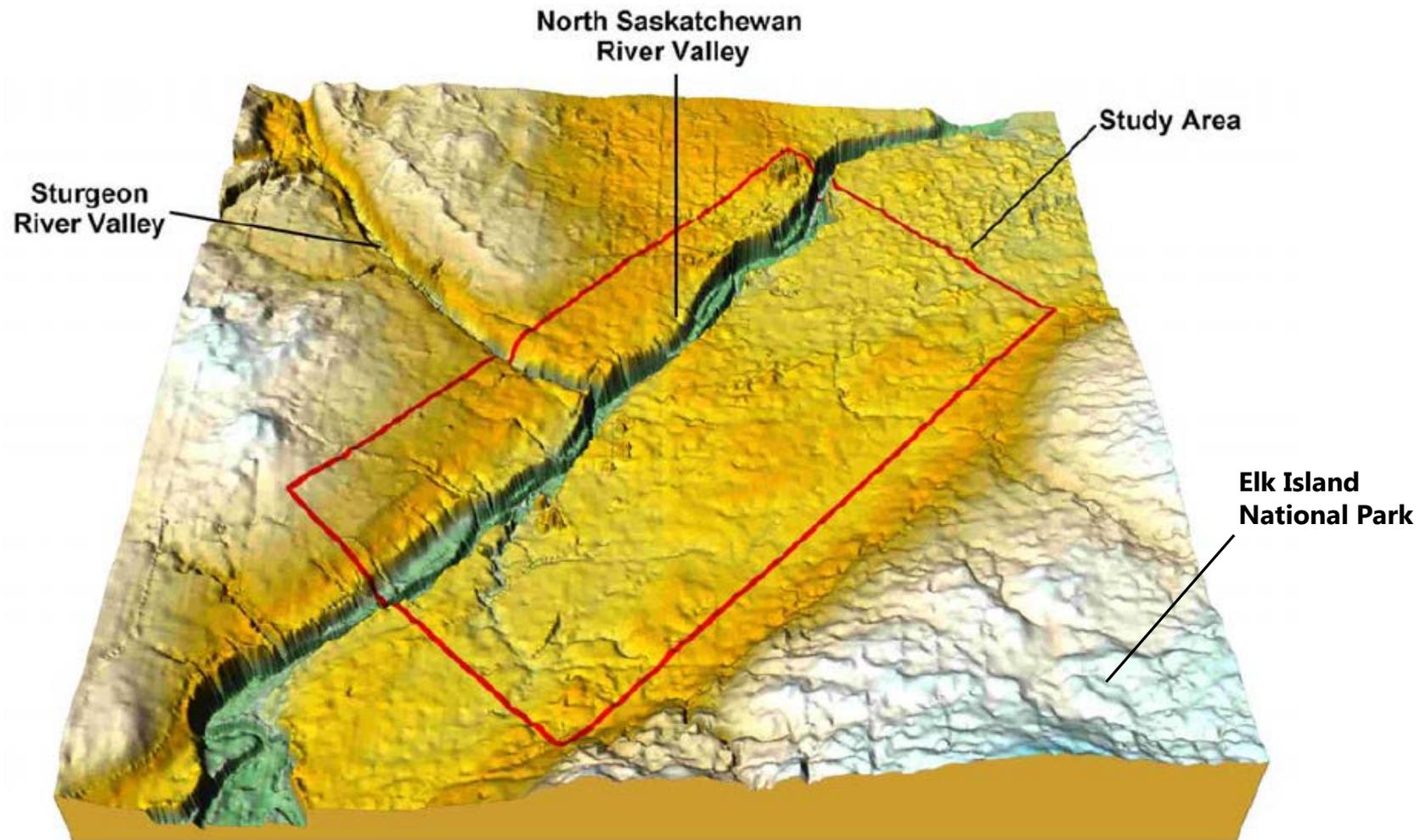
- 2003: development and population of a database and data gap assessment (\$300k spent with \$100k grant from AEP)
 - geology, groundwater levels, hydraulic parameters, chemistry
- 2005: field investigation and installation of regional monitoring wells (\$325k)
- 2005 – 2018: annual groundwater monitoring (\$300k so far)





The Study Area

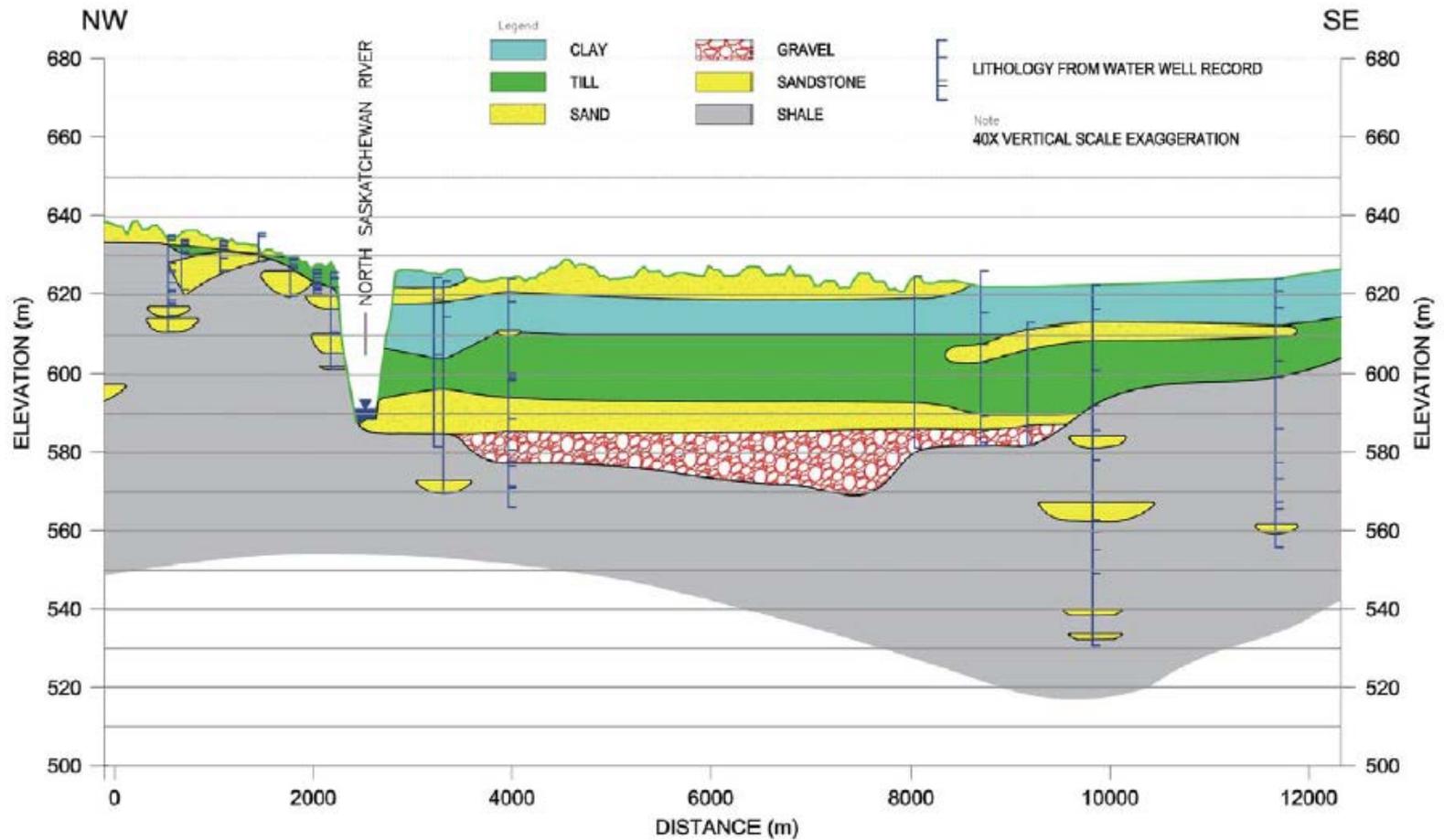
Surface Topography



Geology



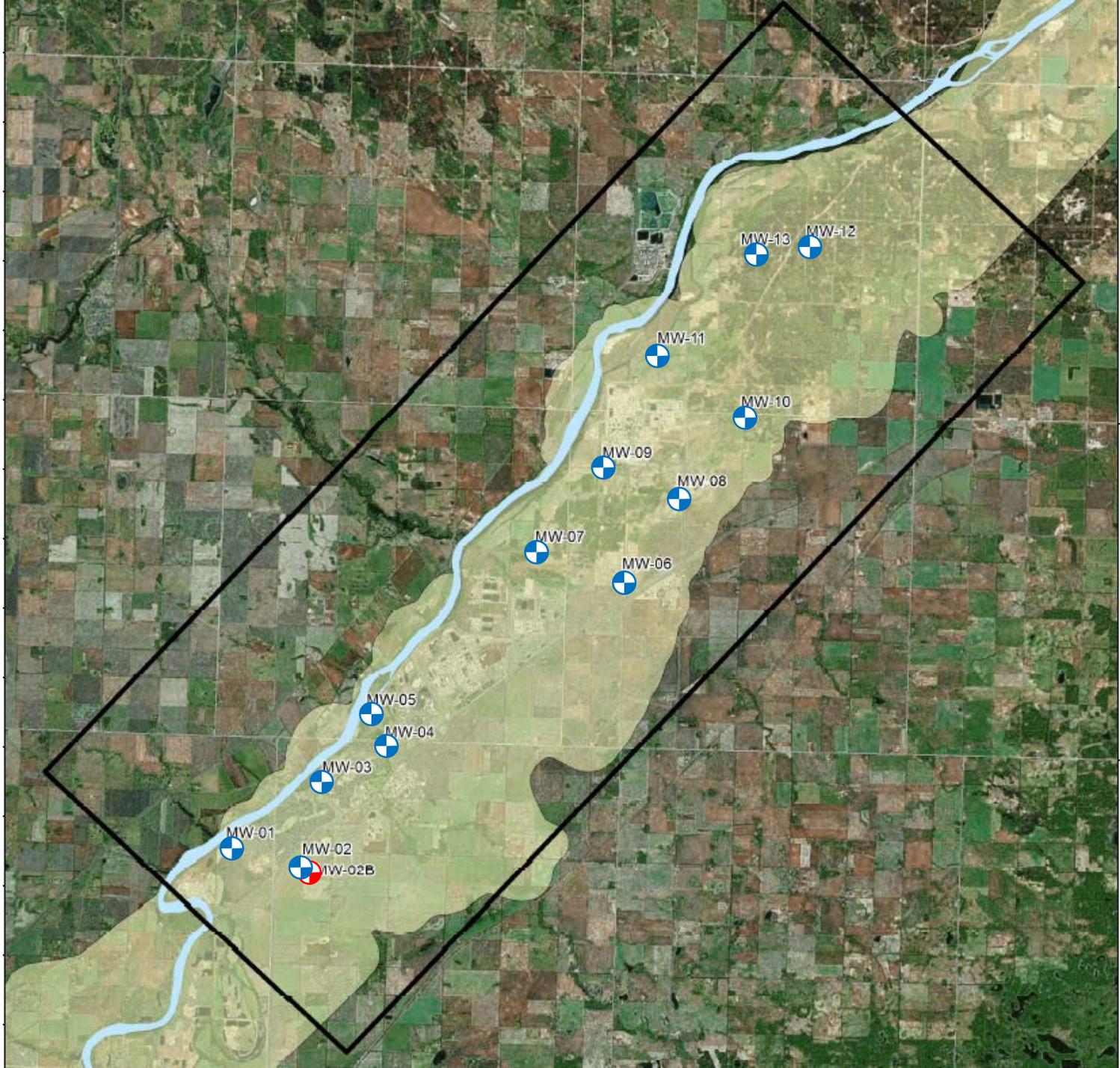
Geology



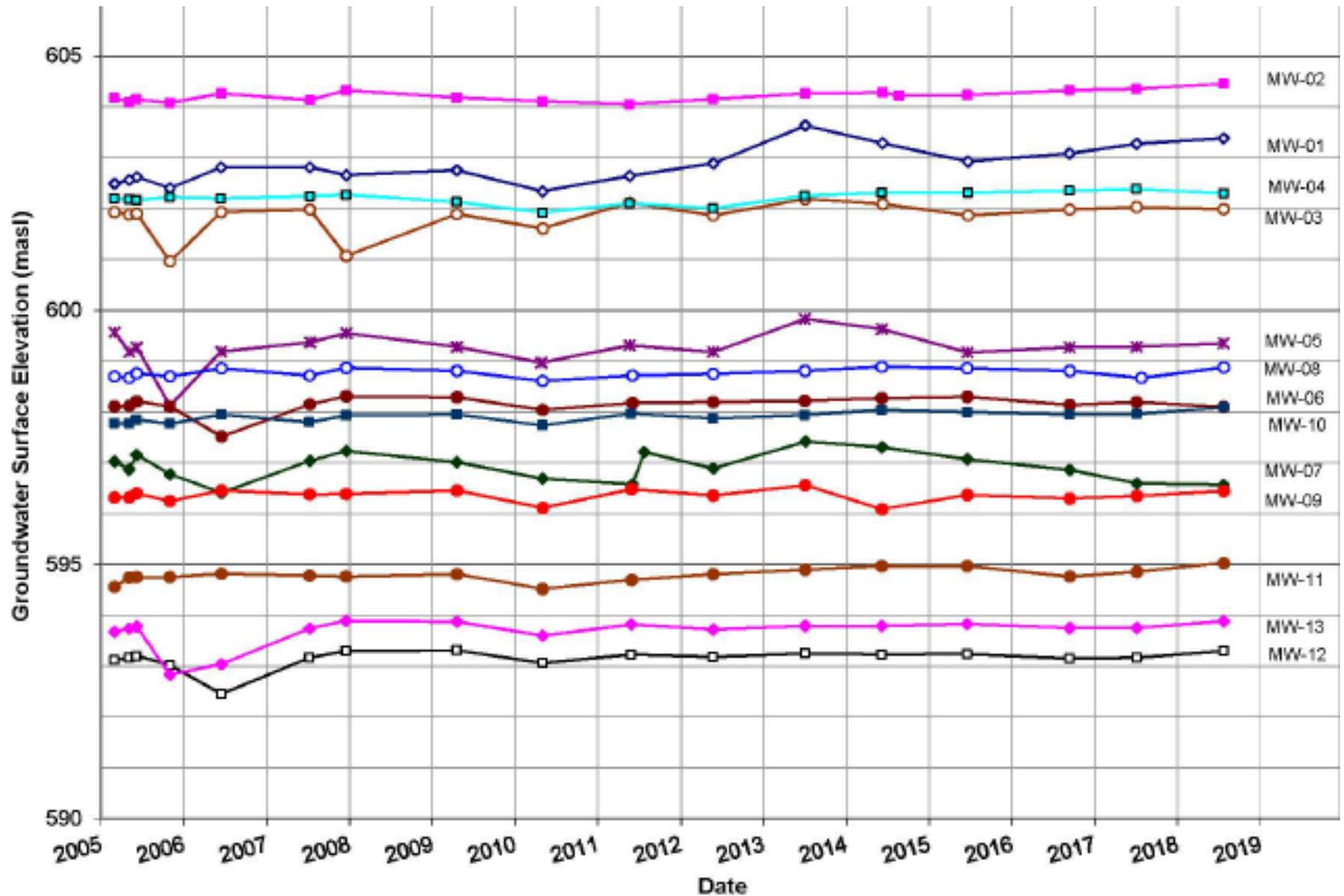
Groundwater Levels, Flow Directions and Velocity



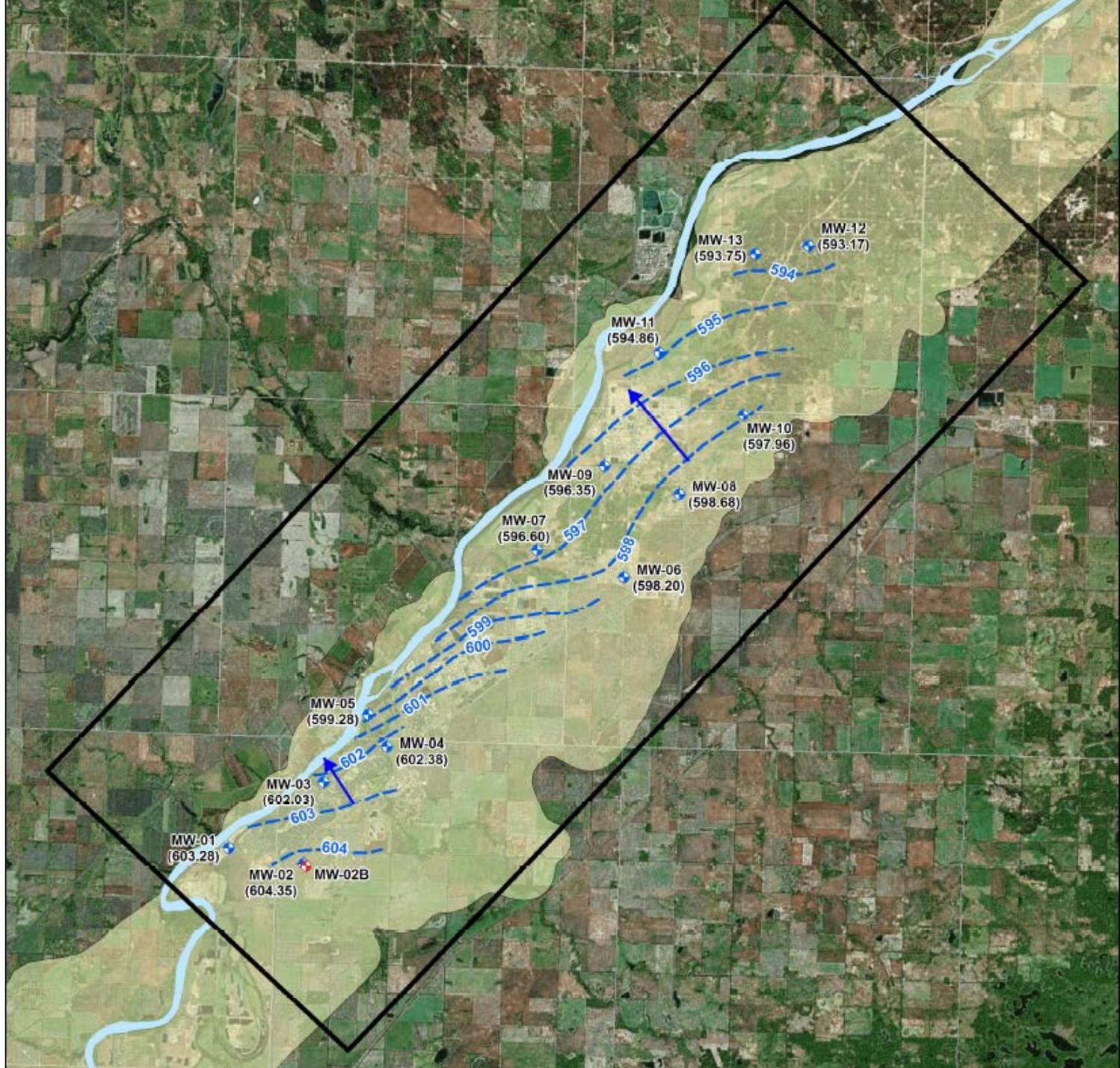
Monitoring
Well
Locations



Groundwater Levels



Groundwater
Flow
Directions



Groundwater Quality



Groundwater Quality

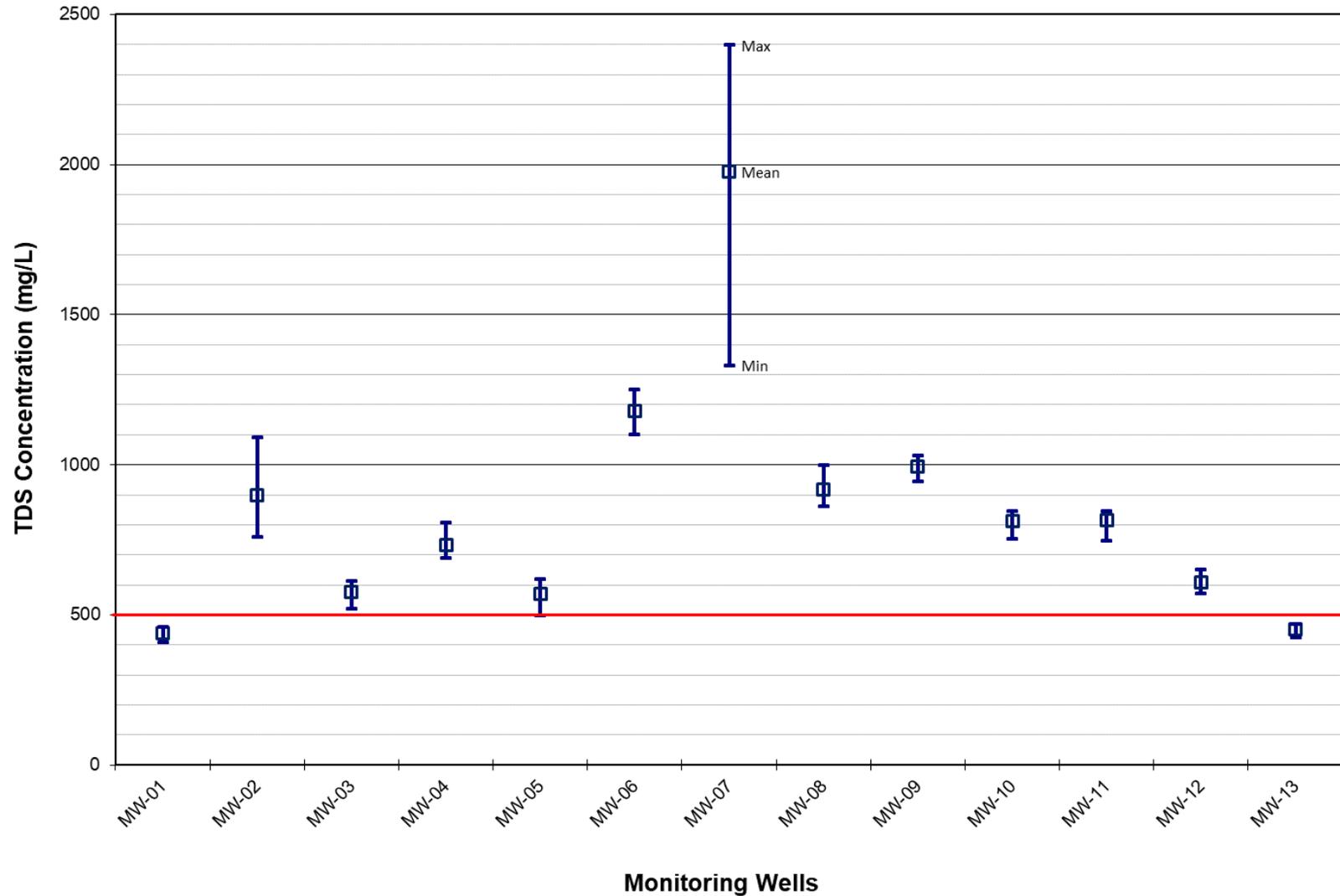
Analytical Schedule:

- Major Ions (routine potability)
- Dissolved metals and trace elements
- Petroleum Hydrocarbons (BTEX, F1, F2)
- Volatile organic compounds
- Isotopes – ^2H and ^{18}O

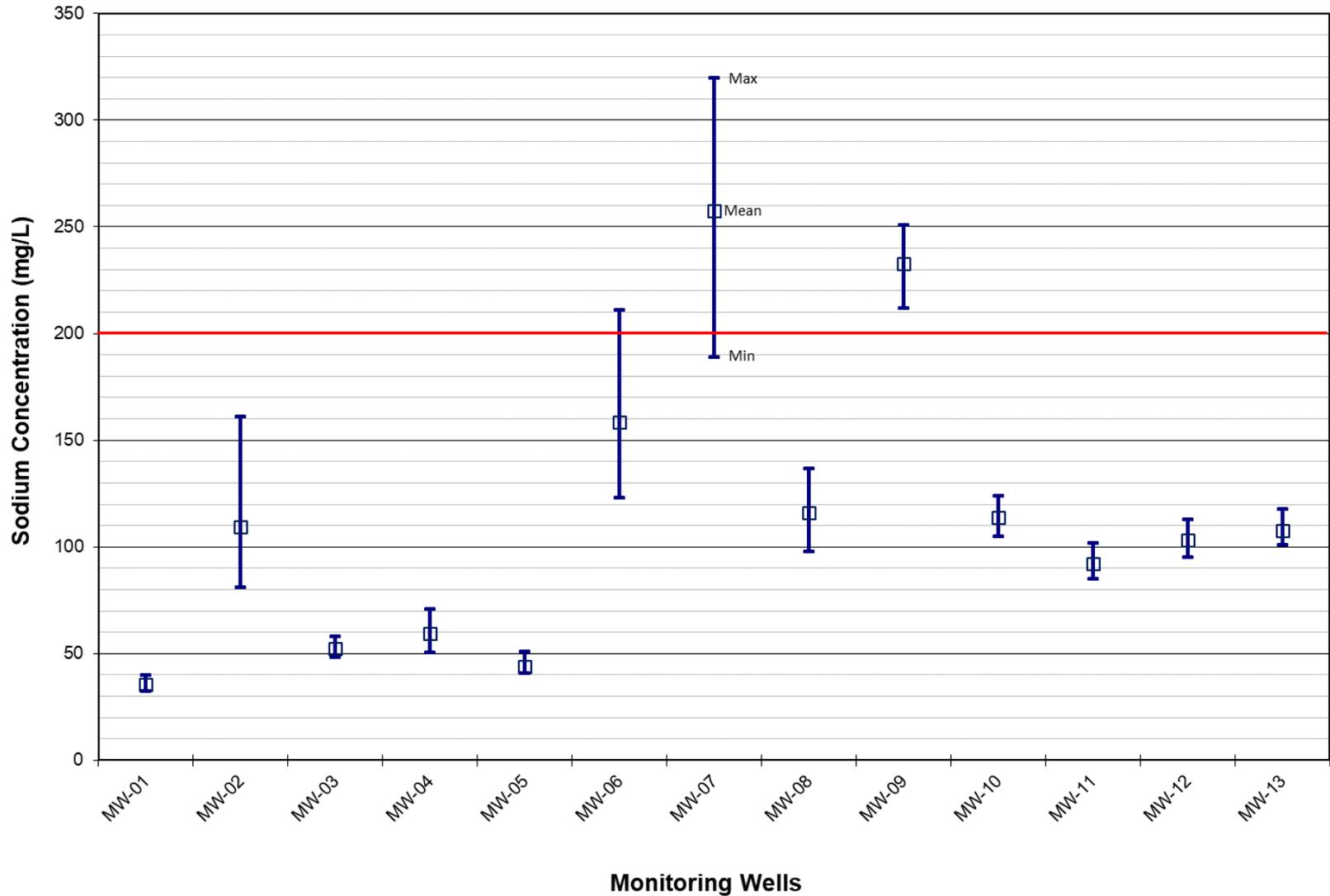
Key Indicator Parameters:

- pH, total dissolved solids (TDS),
- sodium, sulphate, chloride,
- iron, manganese

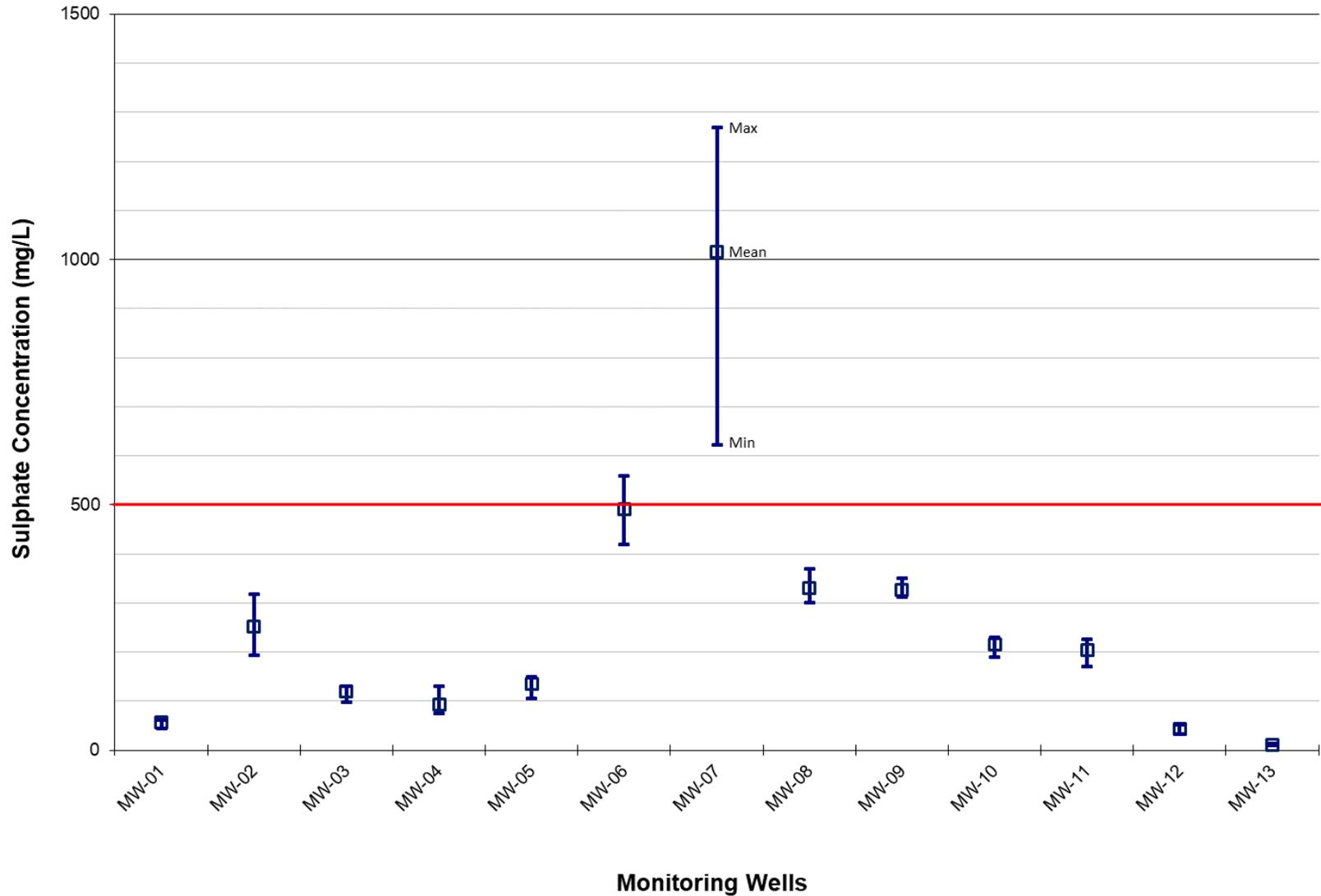
Groundwater Quality - TDS



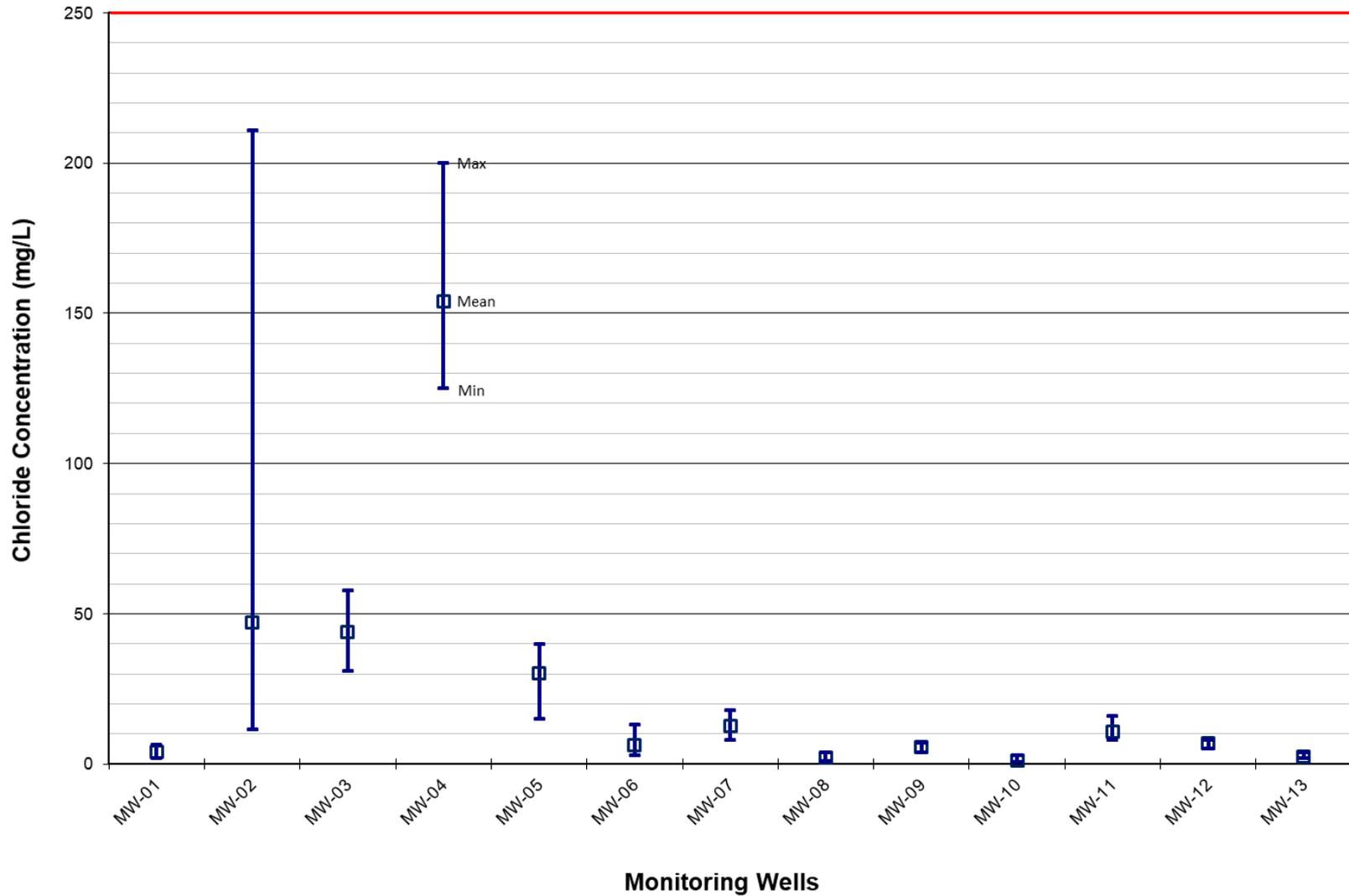
Groundwater Quality - Sodium



Groundwater Quality - Sulphate

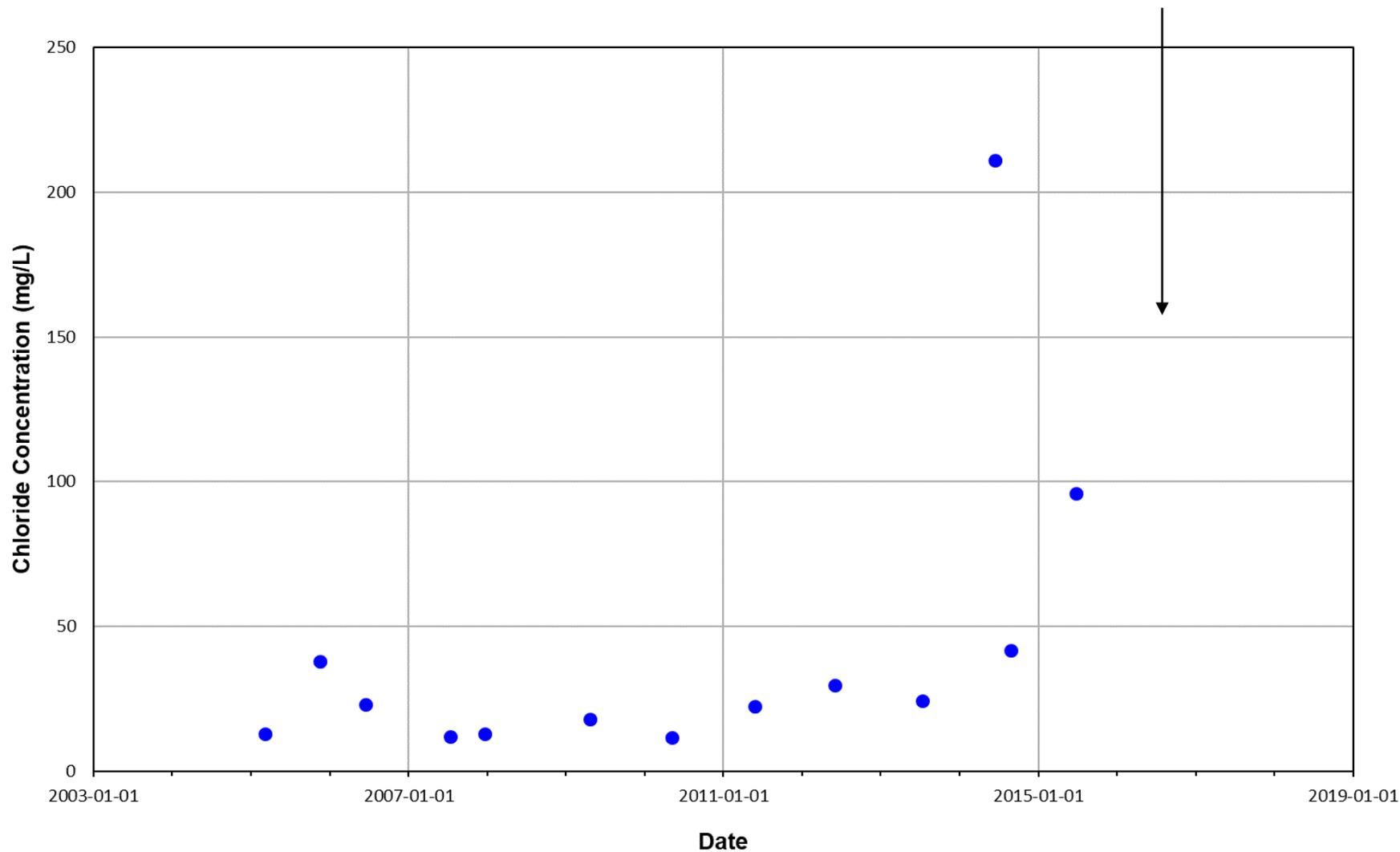


Groundwater Quality - Chloride



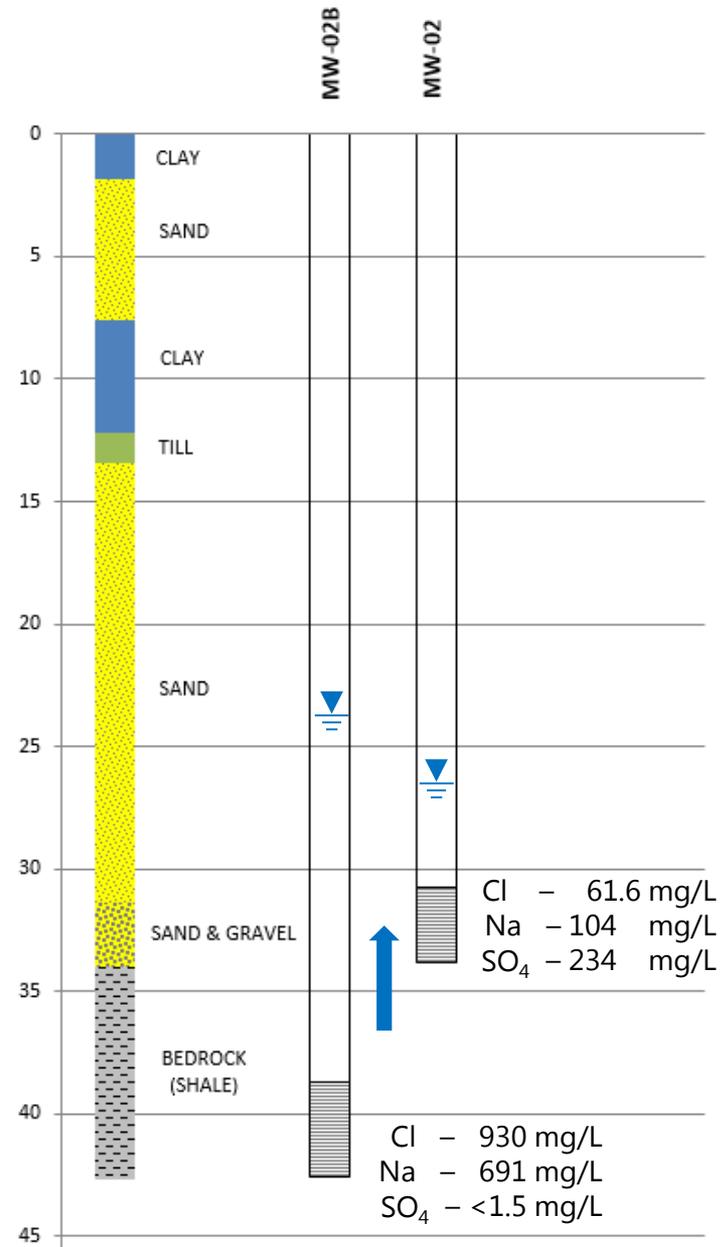
MW-02 - Chloride

Bedrock Monitoring
Well Installation

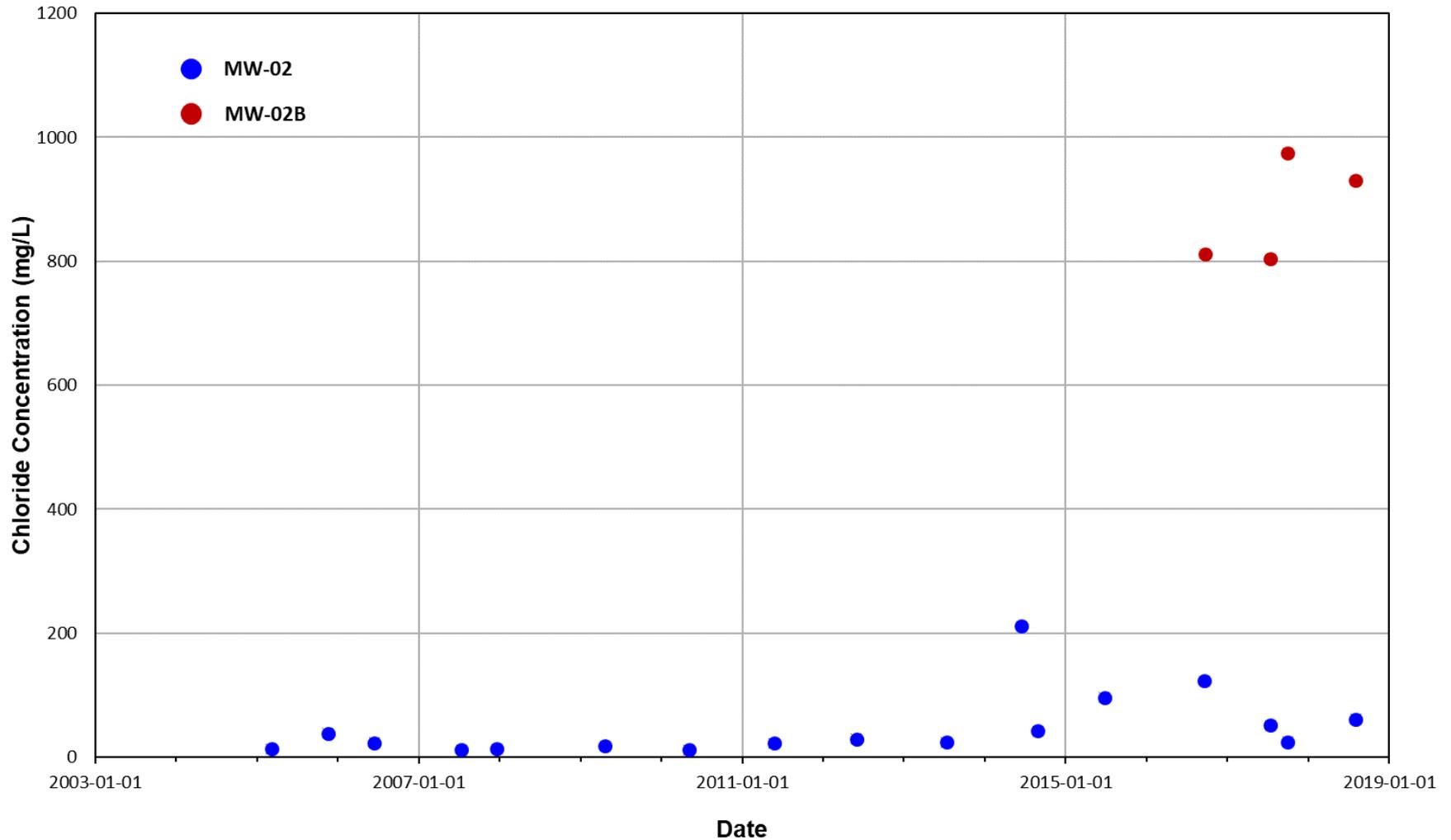


MW-02B – Bedrock Well

- Bedrock monitoring well installed in September, 2016
- Groundwater flow is upward, from bedrock to Beverly Channel
- Four sampling events to date
- Significant difference in groundwater quality



MW-02 and MW-02B - Chloride



Summary



SUMMARY

- The NCIA has implemented and managed a Groundwater Monitoring Well Network in Alberta's Industrial Heartland for over 14 years.
- Primary objective has been to define baseline groundwater conditions in the Beverly Channel Aquifer
- Monitoring results to date show:
 - spatial variations in groundwater quality
 - influence of bedrock groundwater quality
 - No impact from industrial operations in the region
- Remnants of the Bearpaw Formation, of marine origin, are present in the area and locally affect the Beverly Channel groundwater quality.
- As the data over the past 14 years of monitoring shows little change, monitoring frequency will be reduced to biennial starting in 2020.
- I have included all of the hydrochemical control charts, for each measured parameter, for each monitoring well, at the end of this presentation if you are interested...I will not be showing those today.

Reports are Publicly Available



All reports available at <http://www.ncia.ab.ca/>

— Merci

Thank You

Gracias

Danke Salammat

Contact



Dr. Laurie J. Danielson, P.Chem.

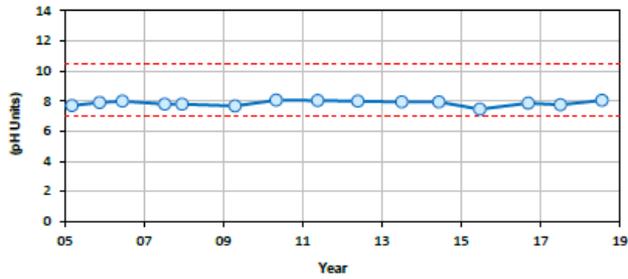
Executive Director

Northeast Capital Industrial Association

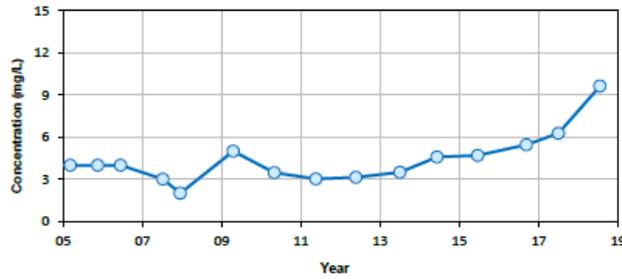
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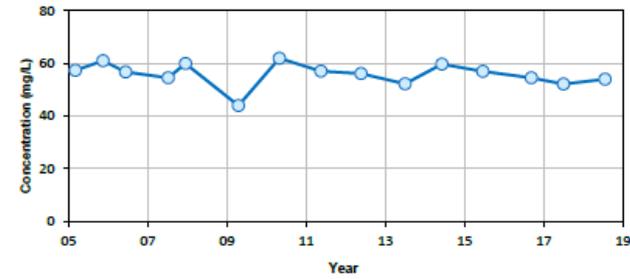
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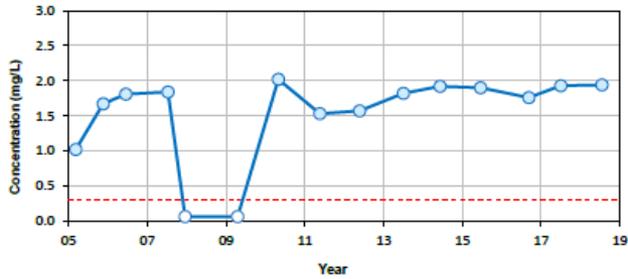
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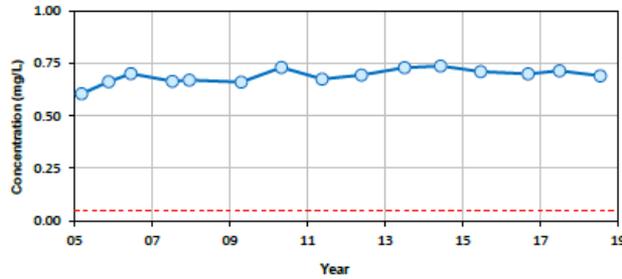
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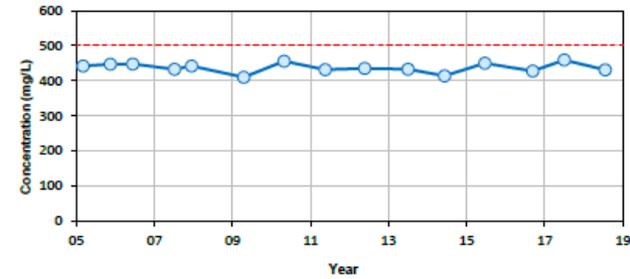
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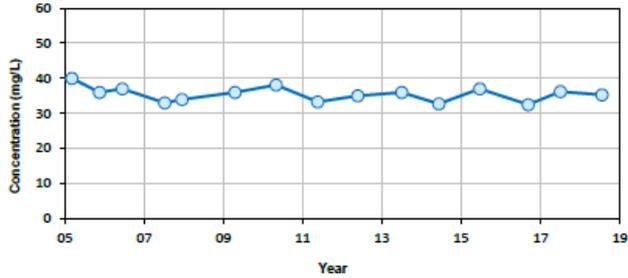
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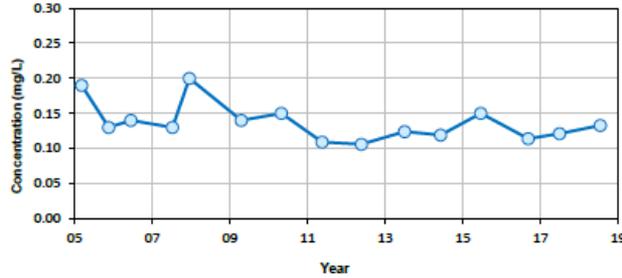
TOTAL DISSOLVED SOLIDS (CALCULATED)



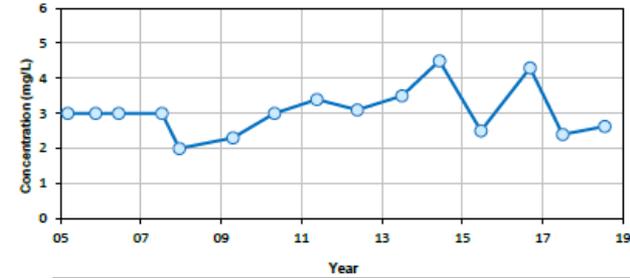
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



Notes:
 - Filled symbols denote sample values; unfilled symbols denote values less than detection limit(s)
 - Dashed line between data points indicates data gap of more than two years
 - Canadian Drinking Water AO Guidelines 2017:
 - pH: 7-10.5 pH Units
 - Iron: 0.3 mg/L
 - Sodium: 200 mg/L
 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Sulphate: 500 mg/L
 - Total Dissolved Solids (Calculated): 500 mg/L
 - Dissolved Organic Carbon: N/A

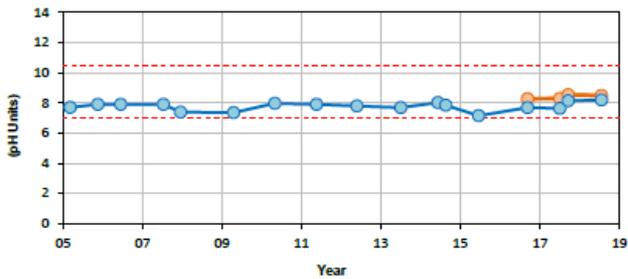
**NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
 2018 GROUNDWATER QUALITY MONITORING
 BEVERLY CHANNEL MONITORING WELLS**

HYDROCHEMICAL CONTROL CHARTS
MW-01

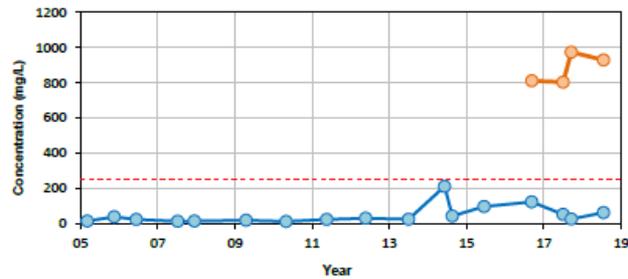
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		PID No. AS-1	REV B

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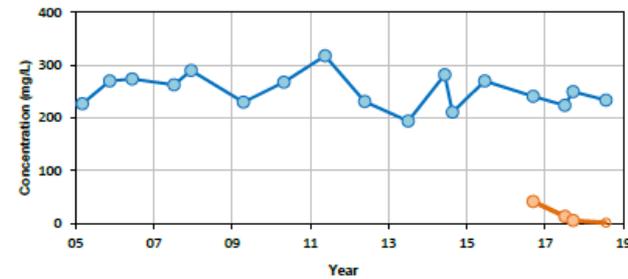
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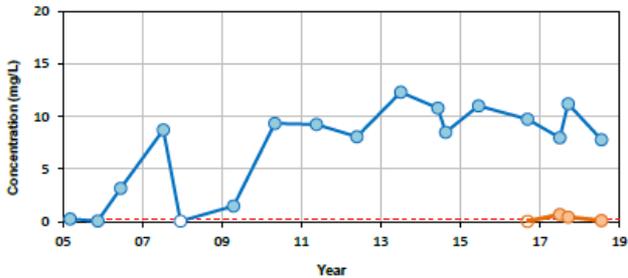
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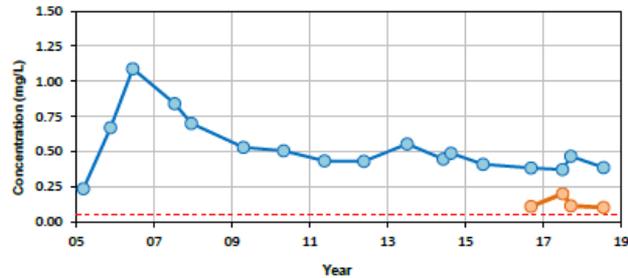
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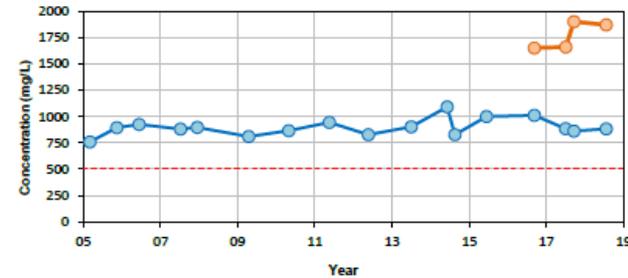
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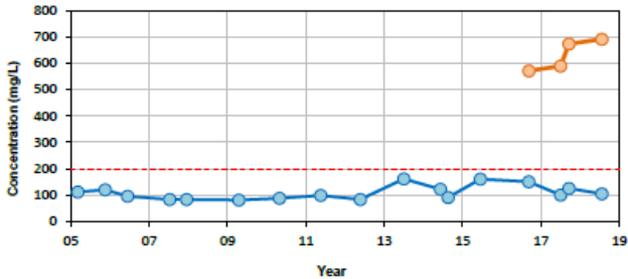
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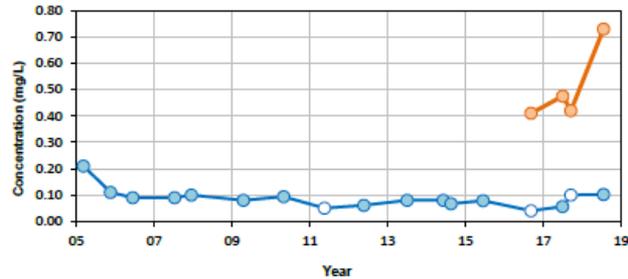
TOTAL DISSOLVED SOLIDS (CALCULATED)



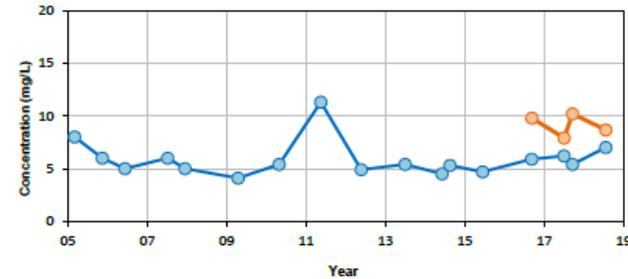
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FLUORIDE



DISSOLVED ORGANIC CARBON



Notes:

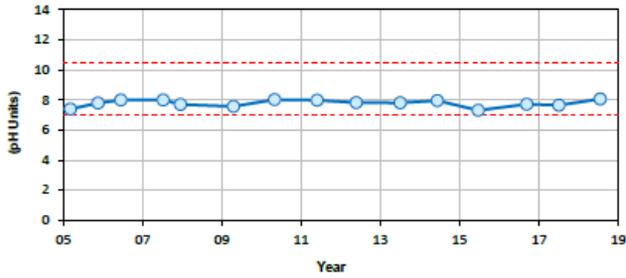
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○ Bedrock Monitoring Well (MW-02B) data point.

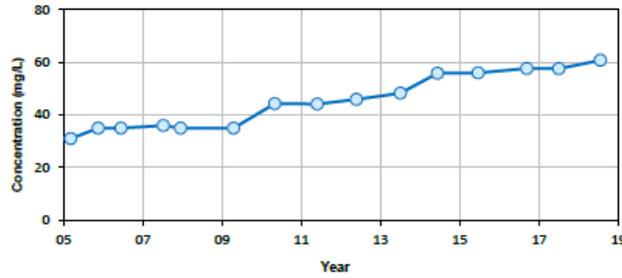
- Sulphate: 500 mg/L
- Total Dissolved Solids (Calculated): 500 mg/L
- Dissolved Organic Carbon: N/A

NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION 2018 GROUNDWATER QUALITY MONITORING BEVERLY CHANNEL MONITORING WELLS			
HYDROCHEMICAL CONTROL CHARTS MW-02 MW-02B			
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Edited by		Approval	
		307075-01608-400 File No.	
WorleyParsons Group		AS-2	B

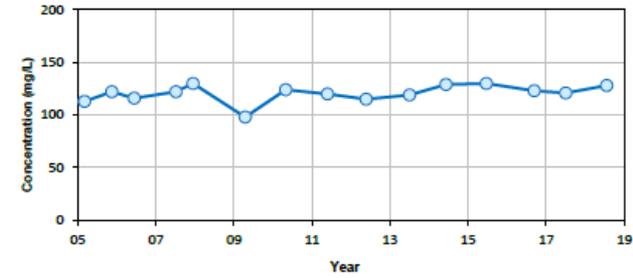
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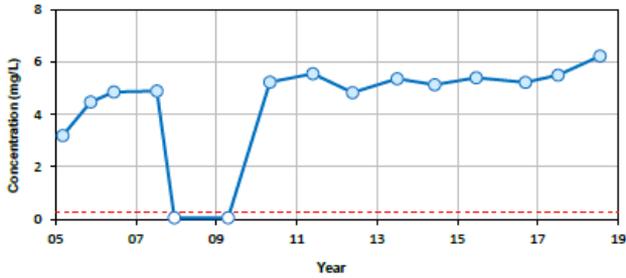
CHLORIDE



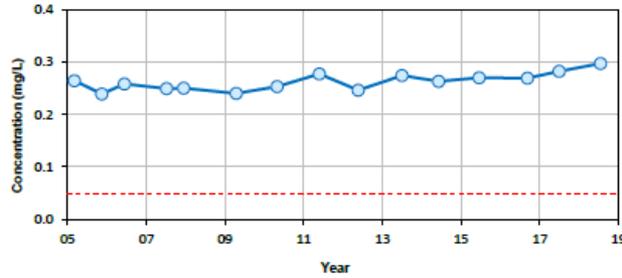
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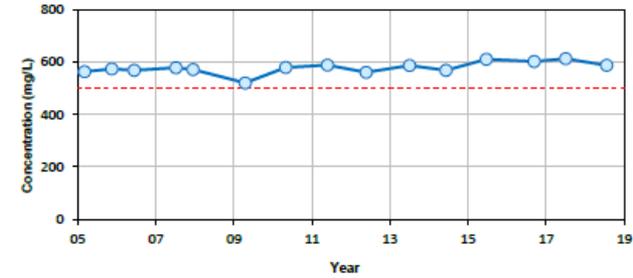
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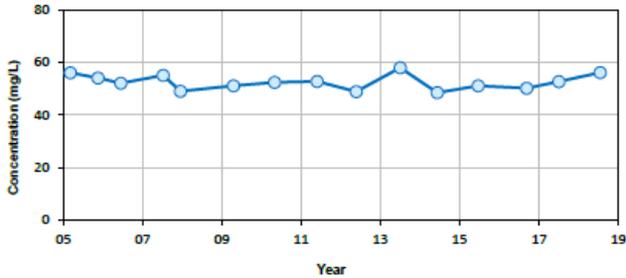
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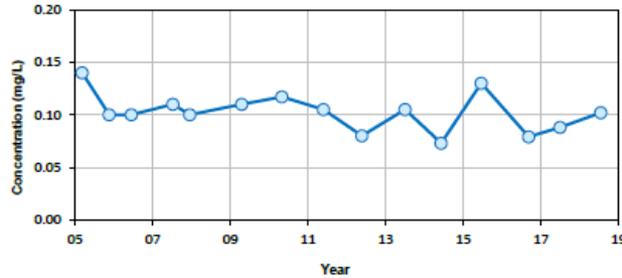
TOTAL DISSOLVED SOLIDS (CALCULATED)



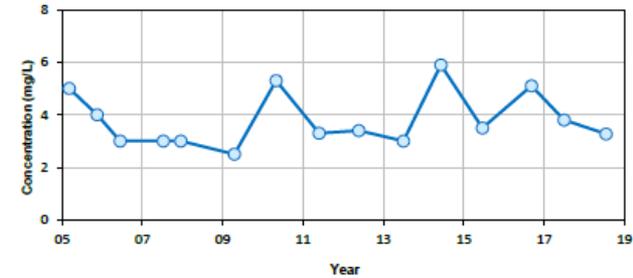
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



- Notes:**
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 - Sodium: 200 mg/L
 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Fluoride: 1.5 mg/L
 - Sulphate: 500 mg/L
 - Total Dissolved Solids (Calculated): 500 mg/L
 - Dissolved Organic Carbon: N/A

**NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
2018 GROUNDWATER QUALITY MONITORING
BEVERLY CHANNEL MONITORING WELLS**

**HYDROCHEMICAL CONTROL CHARTS
MW-03**

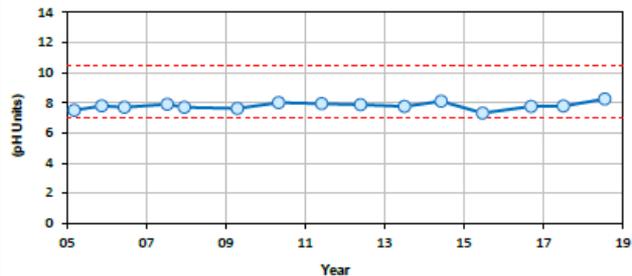
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Edited by		WorleyParsons Project No.	307075-01608-400
WorleyParsons Group		REV	B
		AS-3	

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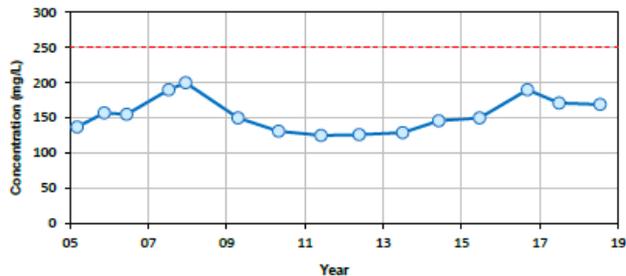


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WorleyParsons Group

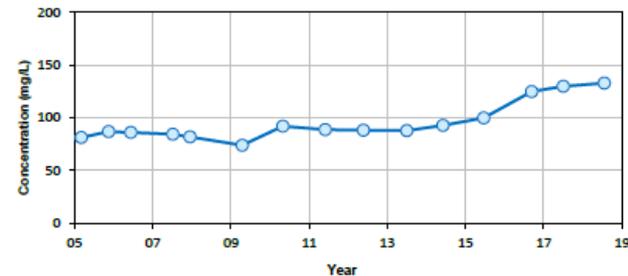
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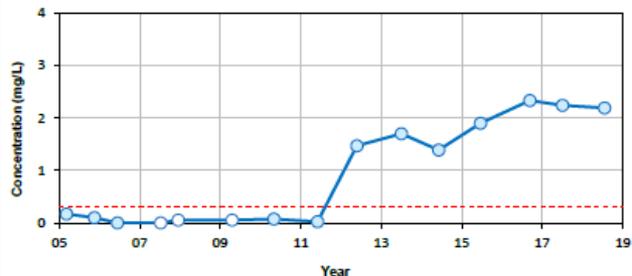
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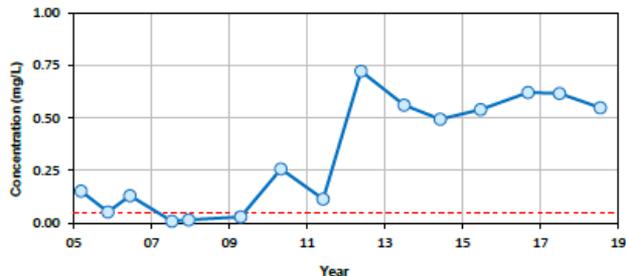
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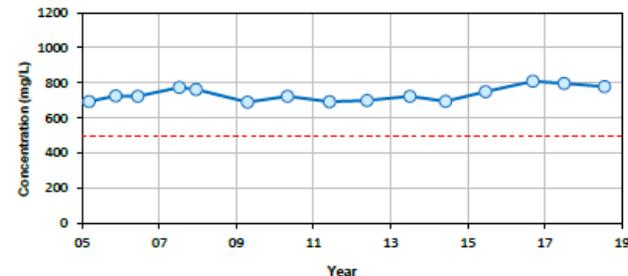
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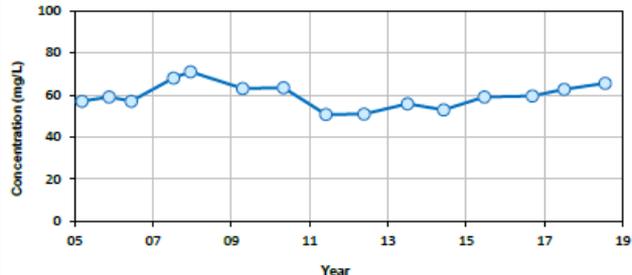
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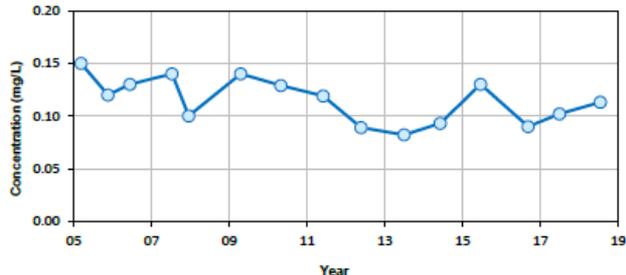
TOTAL DISSOLVED SOLIDS (CALCULATED)



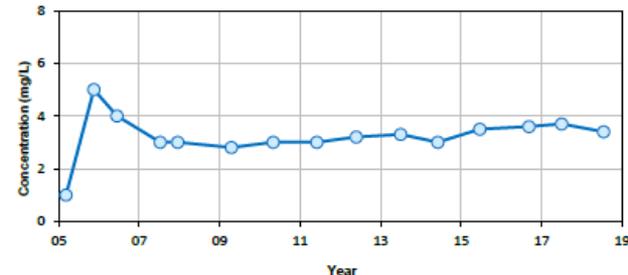
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



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NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
2018 GROUNDWATER QUALITY MONITORING
BEVERLY CHANNEL MONITORING WELLS

HYDROCHEMICAL CONTROL CHARTS
MW-04

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				AS-4		B

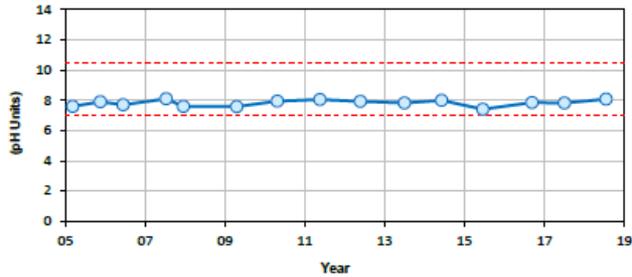
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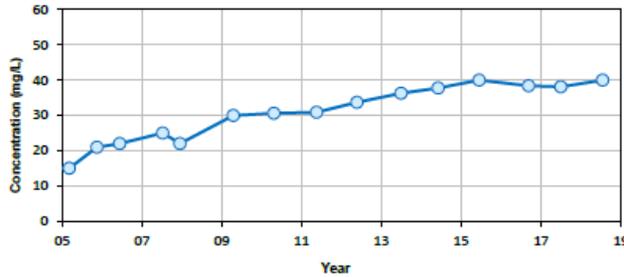
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WorleyParsons Group

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For more information, please contact the project manager at the address below.

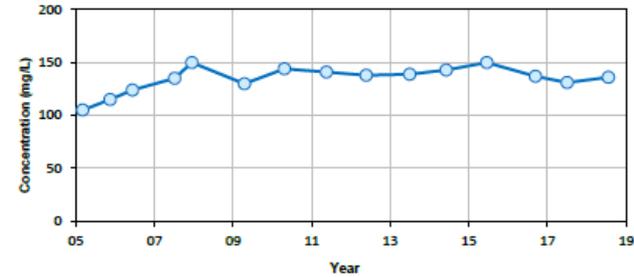
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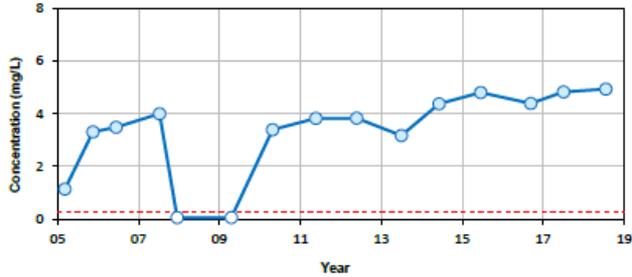
CHLORIDE



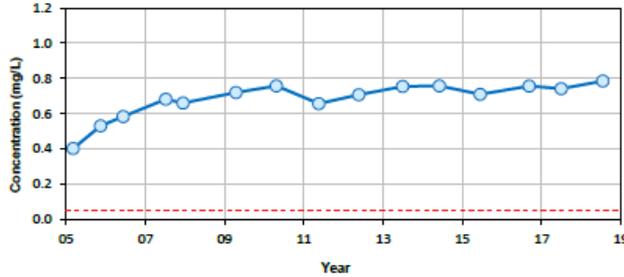
SULPHATE



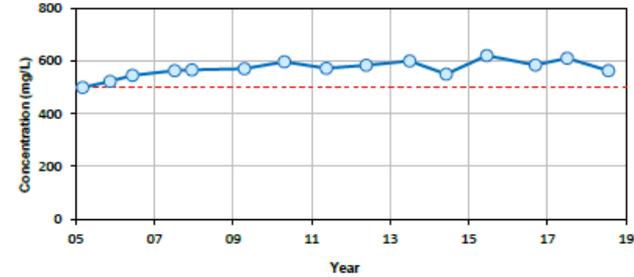
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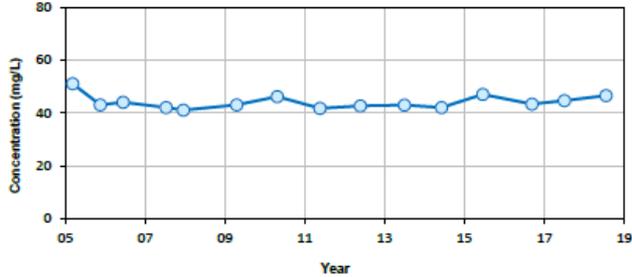
MANGANESE



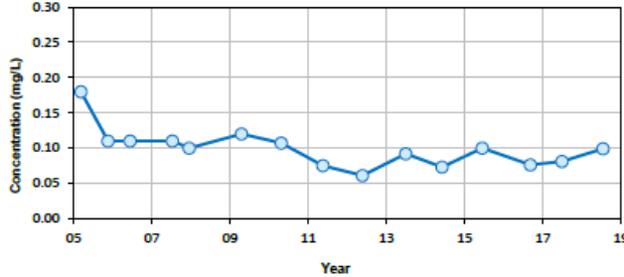
TOTAL DISSOLVED SOLIDS (CALCULATED)



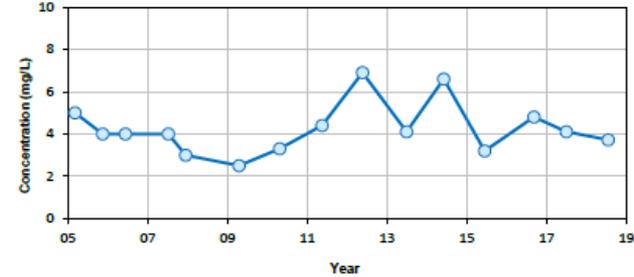
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



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 - Dissolved Organic Carbon: N/A

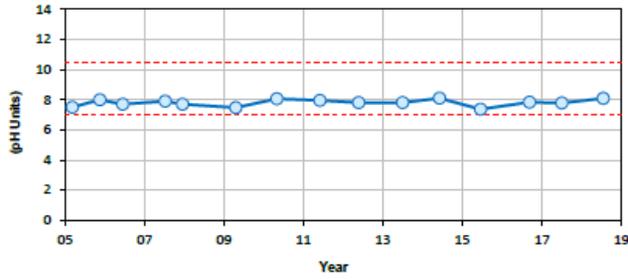
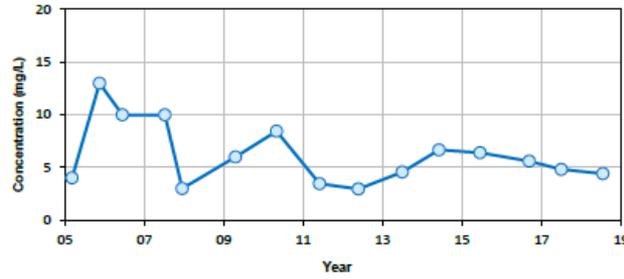
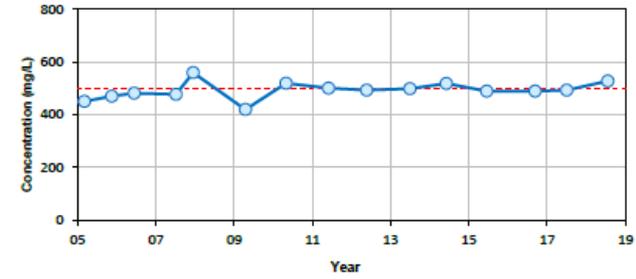
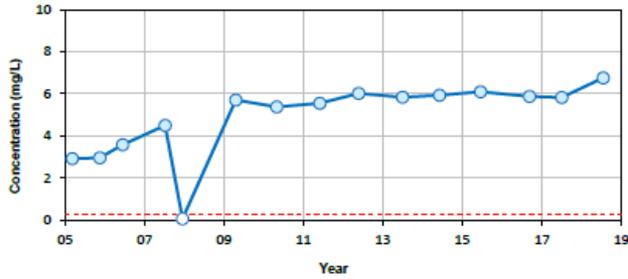
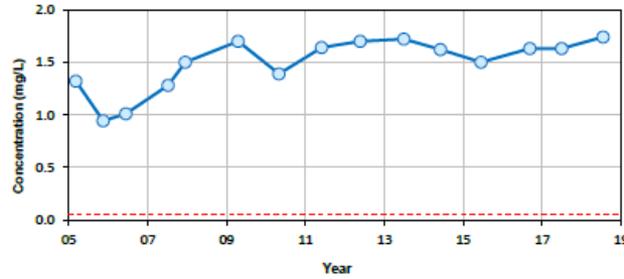
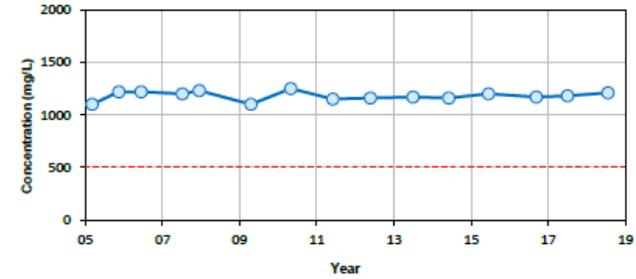
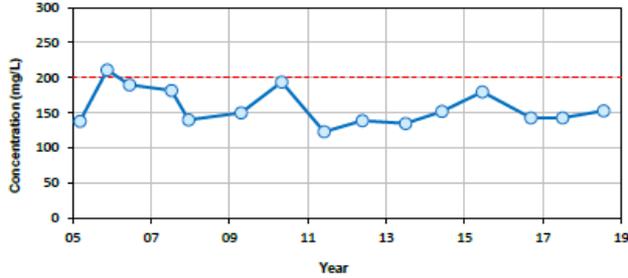
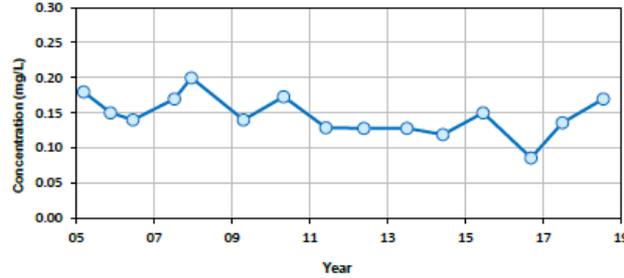
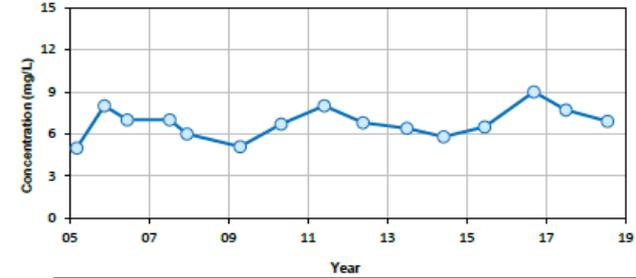
**NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
2018 GROUNDWATER QUALITY MONITORING
BEVERLY CHANNEL MONITORING WELLS**

HYDROCHEMICAL CONTROL CHARTS

MW-05

	Date: 02-Nov-18	Drawn by: DSB	Edited by:	App'd by:
			WorleyParsons Report No. 307075-01608-400	Well No. AS-5

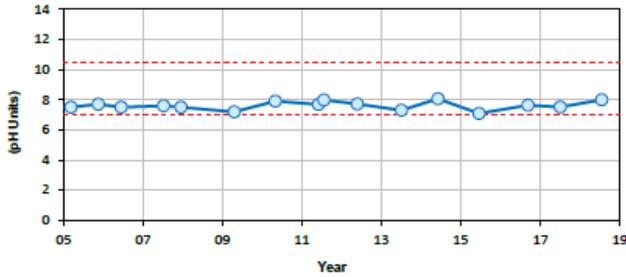
This drawing is prepared solely for the use of our customer as specified in the accompanying report. It is not to be used for any other purpose without the prior written consent of the provider.

PH**CHLORIDE****SULPHATE****IRON****MANGANESE****TOTAL DISSOLVED SOLIDS (CALCULATED)****SODIUM****FLUORIDE****DISSOLVED ORGANIC CARBON**

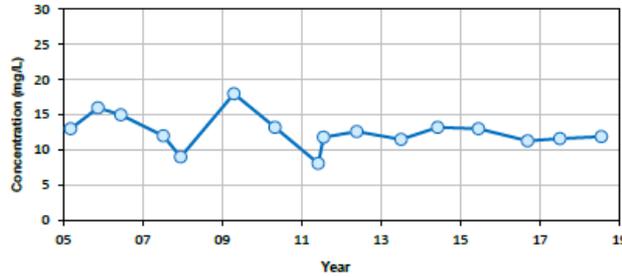
- Notes:**
- Filled symbols denote sample values; unfilled symbols denote values less than detection limit(s)
 - Dashed line between data points indicates data gap of more than two years
 - Canadian Drinking Water AO Guidelines 2017:
 - Canadian Drinking Water MAC Guidelines 2017:
 - pH: 7-10.5 pH Units
 - Iron: 0.3 mg/L
 - Sodium: 200 mg/L
 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Fluoride: 1.5 mg/L
 - Sulphate: 500 mg/L
 - Total Dissolved Solids (Calculated): 500 mg/L
 - Dissolved Organic Carbon: N/A

NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION 2018 GROUNDWATER QUALITY MONITORING BEVERLY CHANNEL MONITORING WELLS			
HYDROCHEMICAL CONTROL CHARTS			
MW-06			
Date: 02-Nov-18	Drawn by: DS	Edited by:	App'd by:
			WorleyParsons Project No. 307075-01608-400
			Well No. AS-6
			Rev B

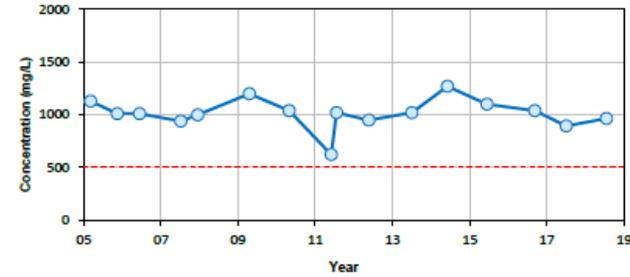
PH



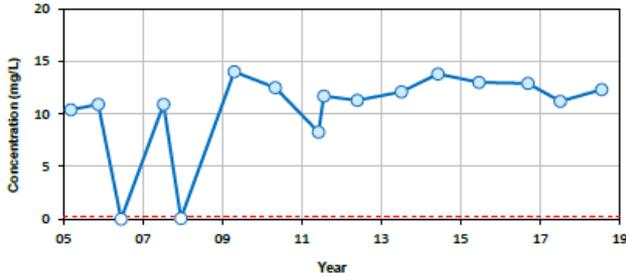
CHLORIDE



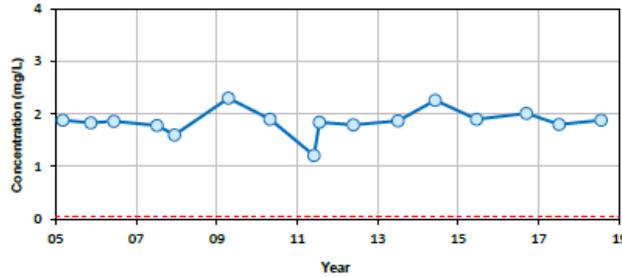
SULPHATE



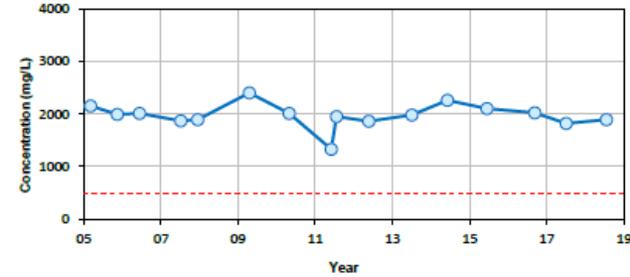
IRON



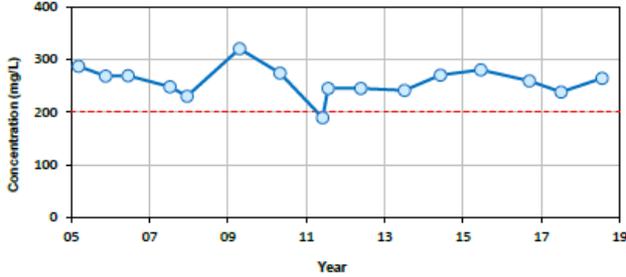
MANGANESE



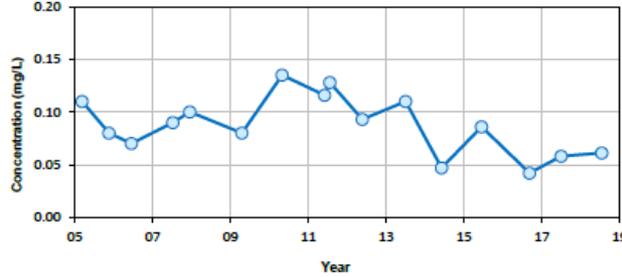
TOTAL DISSOLVED SOLIDS (CALCULATED)



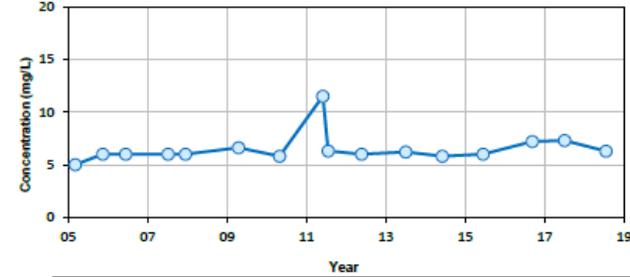
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



Notes:
 - Filled symbols denote sample values; unfilled symbols denote values less than detection limit(s)
 - Dashed line between data points indicates data gap of more than two years
 - --- Canadian Drinking Water AO Guidelines 2017:
 - --- Canadian Drinking Water MAC Guidelines 2017:
 - pH: 7-10.5 pH Units
 - Iron: 0.3 mg/L
 - Sodium: 200 mg/L
 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Fluoride: 1.5 mg/L

- Sulphate: 500 mg/L
 - Total Dissolved Solids (Calculated): 500 mg/L
 - Dissolved Organic Carbon: N/A

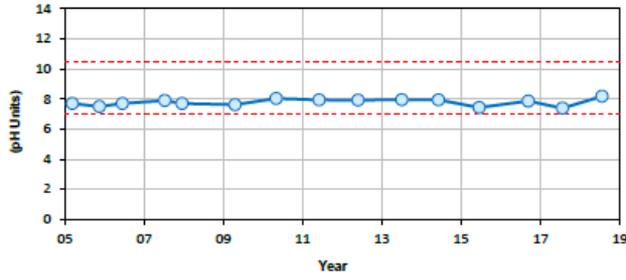
**NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
 2018 GROUNDWATER QUALITY MONITORING
 BEVERLY CHANNEL MONITORING WELLS**

**HYDROCHEMICAL CONTROL CHARTS
 MW-07**

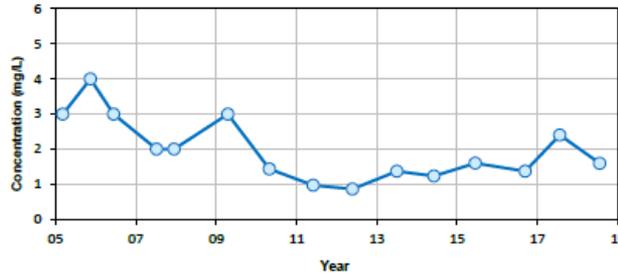
Date: 02-Nov-18	Drawn by: DJS	Edited by: WorleyParsons Project No.	Appr'd by:
		307075-01608-400	REV
		AS-7	B

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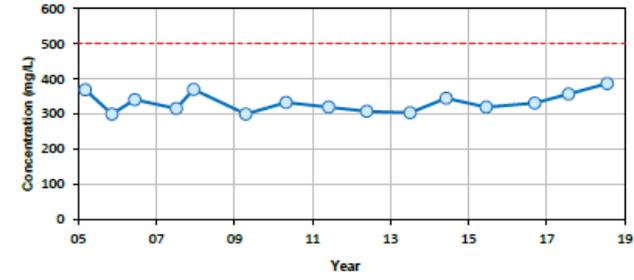
PH



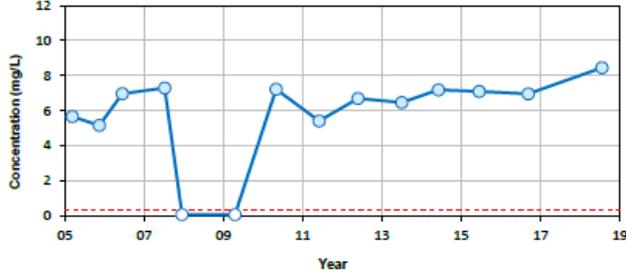
CHLORIDE



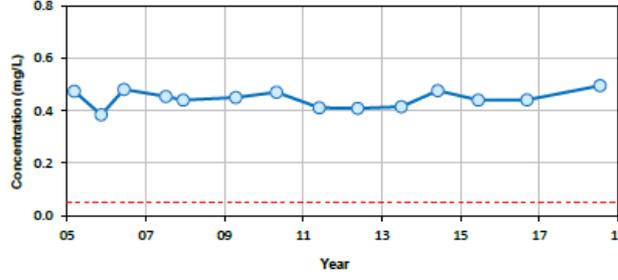
SULPHATE



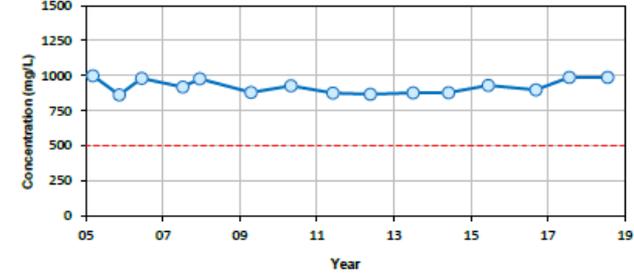
IRON



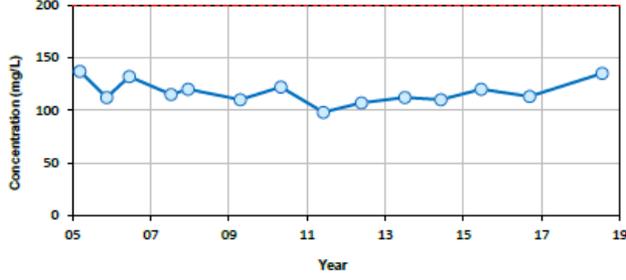
MANGANESE



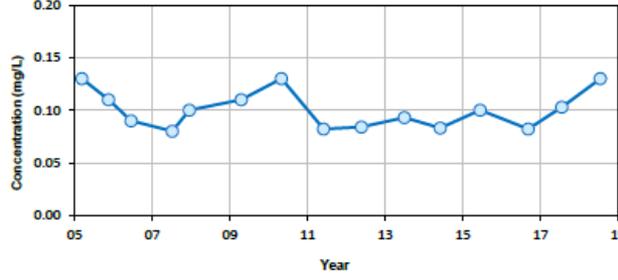
TOTAL DISSOLVED SOLIDS (CALCULATED)



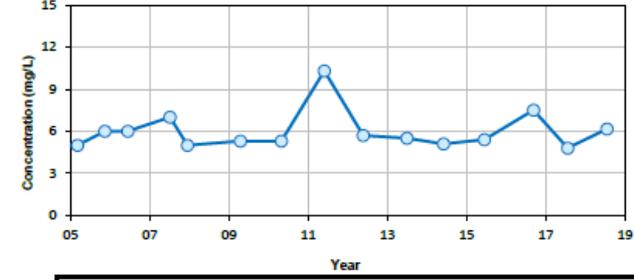
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



Notes:
 - Filled symbols denote sample values; unfilled symbols denote values less than detection limit(s)
 - Dashed line between data points indicates data gap of more than two years
 - - - - Canadian Drinking Water AO Guidelines 2017:
 - - - - Canadian Drinking Water MAC Guidelines 2017:
 - pH: 7-10.5 pH Units
 - Iron: 0.3 mg/L
 - Sodium: 200 mg/L
 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Fluoride: 1.5 mg/L

- Sulphate: 500 mg/L
 - Total Dissolved Solids (Calculated): 500 mg/L
 - Dissolved Organic Carbon: N/A

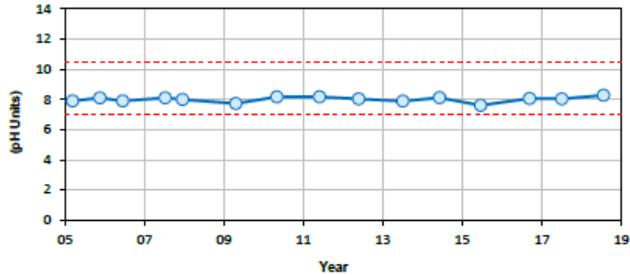
**NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
 2018 GROUNDWATER QUALITY MONITORING
 BEVERLY CHANNEL MONITORING WELLS**

**HYDROCHEMICAL CONTROL CHARTS
 MW-08**

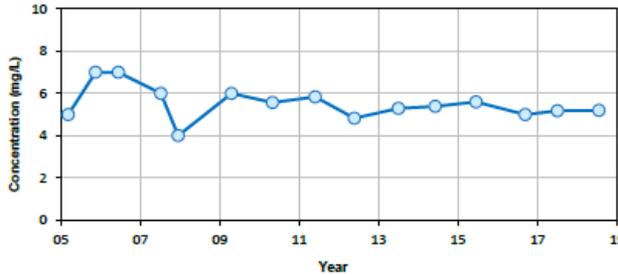
	Date: 02-Nov-18	Drawn by: DS	Edited by:	App'd by:
			307075-01608-400	
WorleyParsons Group		File No.	AS-8	Rev. B

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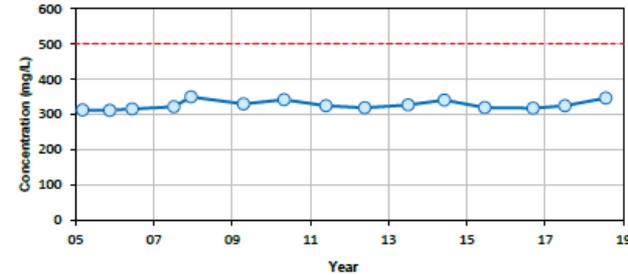
PH



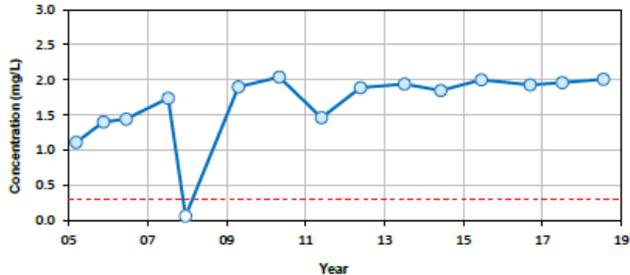
CHLORIDE



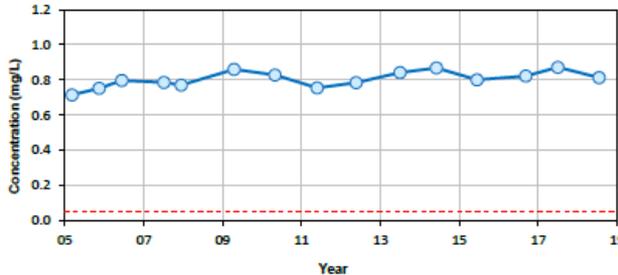
SULPHATE



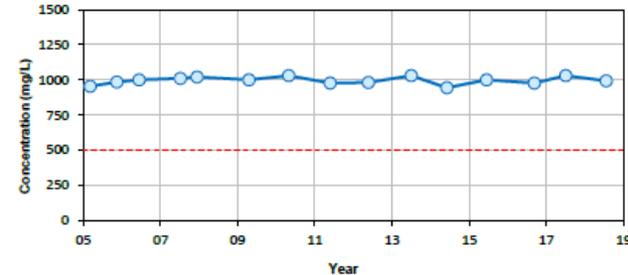
IRON



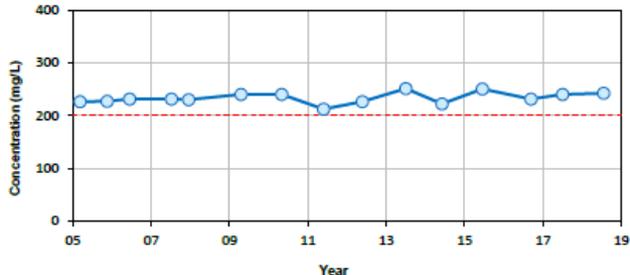
MANGANESE



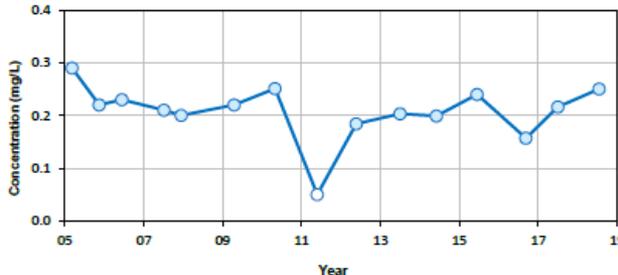
TOTAL DISSOLVED SOLIDS (CALCULATED)



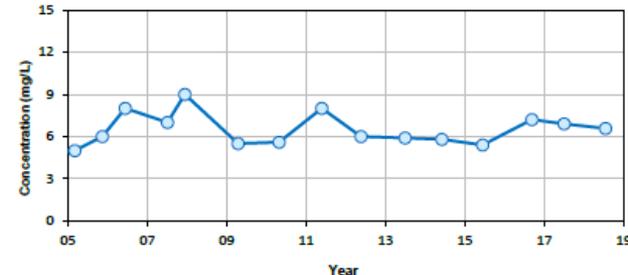
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



Notes:
 - Filled symbols denote sample values; unfilled symbols denote values less than detection limit(s)
 - Dashed line between data points indicates data gap of more than two years
 - --- Canadian Drinking Water AO Guidelines 2017:
 - --- Canadian Drinking Water MAC Guidelines 2017:
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 - Iron: 0.3 mg/L
 - Sodium: 200 mg/L
 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Fluoride: 1.5 mg/L

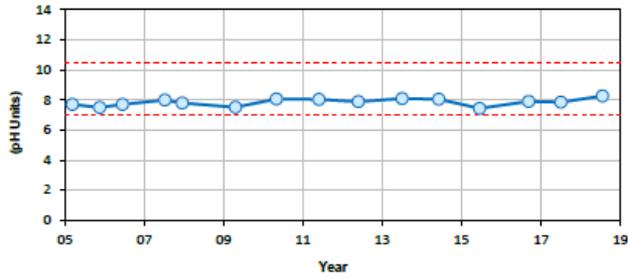
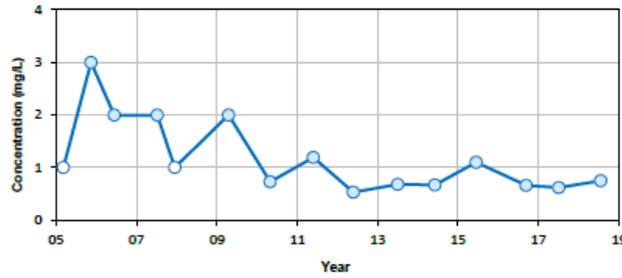
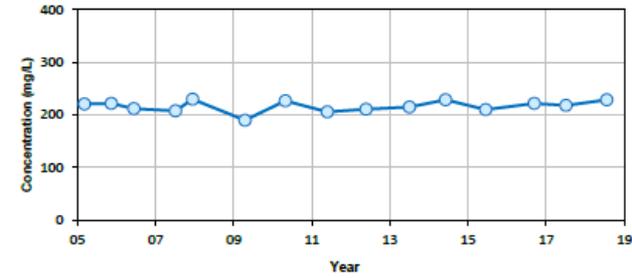
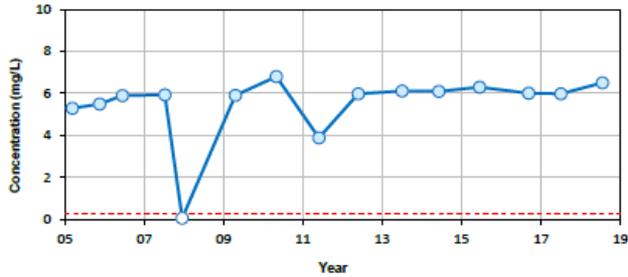
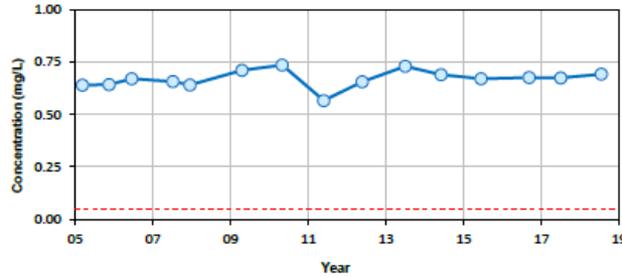
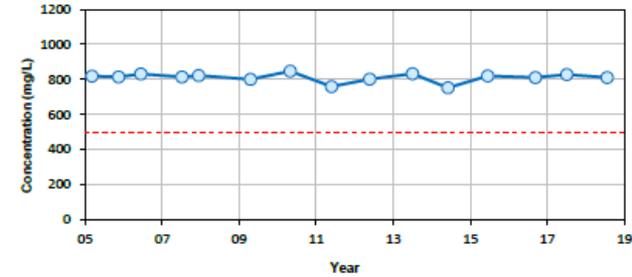
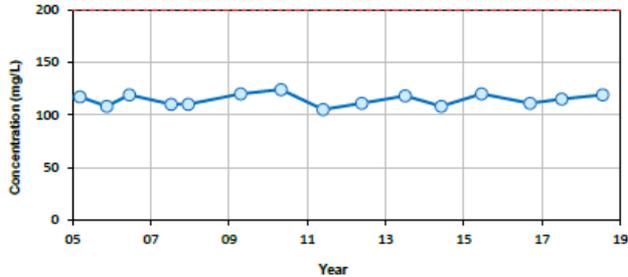
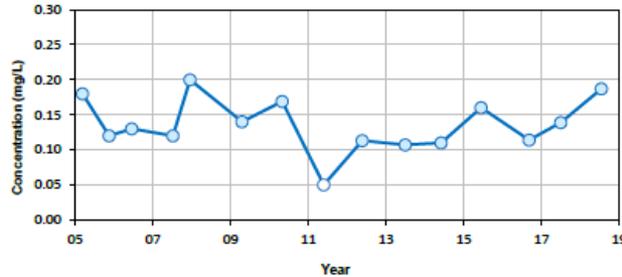
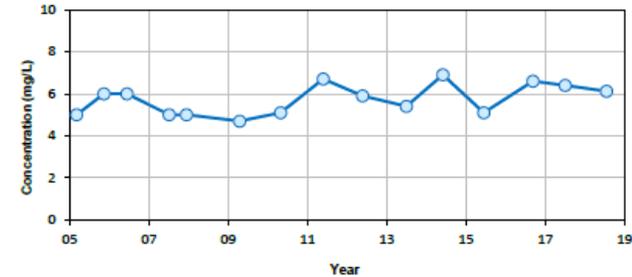
- Sulphate: 500 mg/L
 - Total Dissolved Solids (Calculated): 500 mg/L
 - Dissolved Organic Carbon: N/A

NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
 2018 GROUNDWATER QUALITY MONITORING
 BEVERLY CHANNEL MONITORING WELLS

HYDROCHEMICAL CONTROL CHARTS
 MW-09

	Date: 02-Nov-18	Drawn by: DS	WorleyParsons Project No.:	Appr'd by:
			307075-01608-400	
	WorleyParsons Group		AS-9	B

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PH**CHLORIDE****SULPHATE****IRON****MANGANESE****TOTAL DISSOLVED SOLIDS (CALCULATED)****SODIUM****FLUORIDE****DISSOLVED ORGANIC CARBON**

Notes:
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 - --- Canadian Drinking Water AO Guidelines 2017:
 - --- Canadian Drinking Water MAC Guidelines 2017:
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 - Iron: 0.3 mg/L
 - Sodium: 200 mg/L
 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Fluoride: 1.5 mg/L

- Sulphate: 500 mg/L
 - Total Dissolved Solids (Calculated): 500 mg/L
 - Dissolved Organic Carbon: N/A

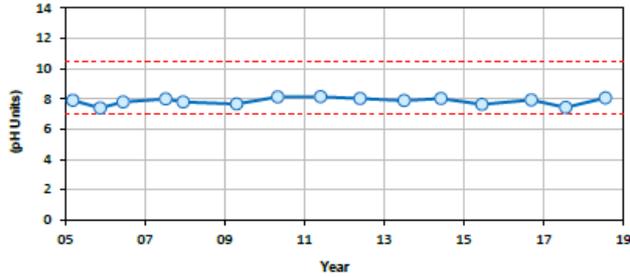
NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
 2018 GROUNDWATER QUALITY MONITORING
 BEVERLY CHANNEL MONITORING WELLS

HYDROCHEMICAL CONTROL CHARTS
 MW-10

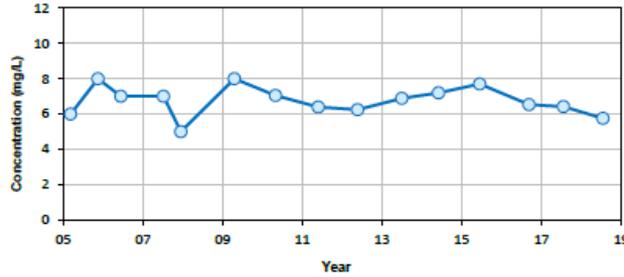
	Date: 02-Nov-18 Drawn by: DS Edited by:	Drawn by: DS Approved by:
		307075-01608-400 Rev:
	A5-10 B	

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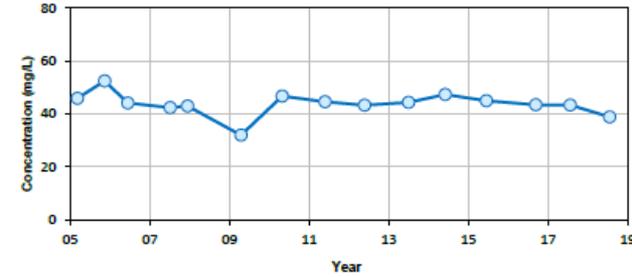
PH



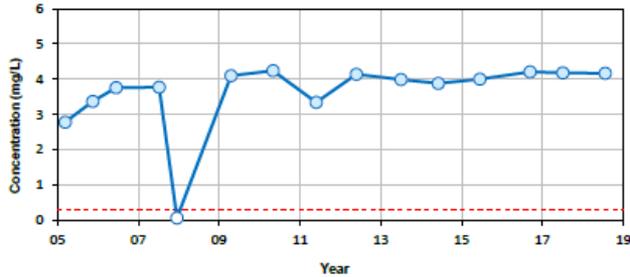
CHLORIDE



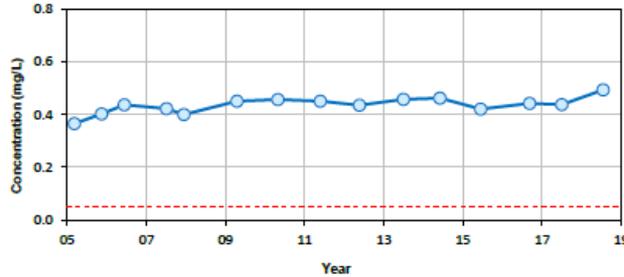
SULPHATE



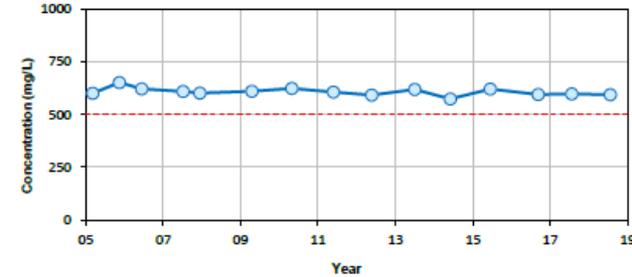
IRON



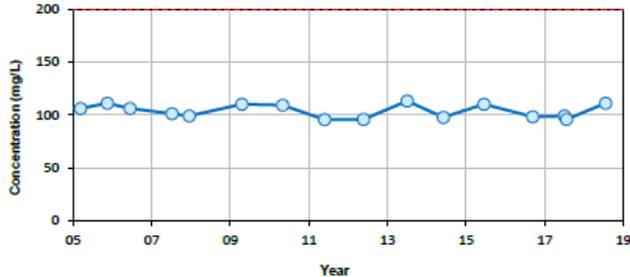
MANGANESE



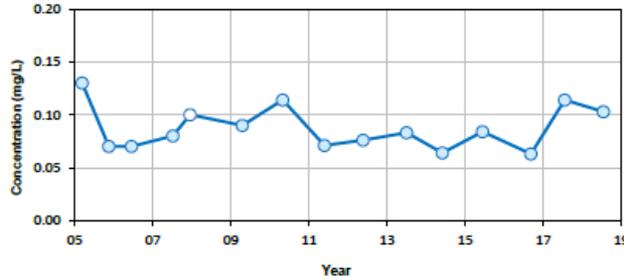
TOTAL DISSOLVED SOLIDS (CALCULATED)



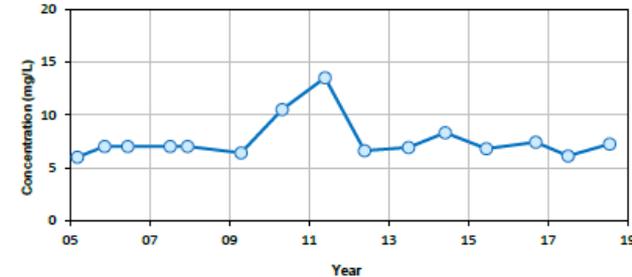
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



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 - --- Canadian Drinking Water MAC Guidelines 2017:
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 - Iron: 0.3 mg/L
 - Sodium: 200 mg/L
 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Fluoride: 1.5 mg/L

- Sulphate: 500 mg/L
- Total Dissolved Solids (Calculated): 500 mg/L
- Dissolved Organic Carbon: N/A

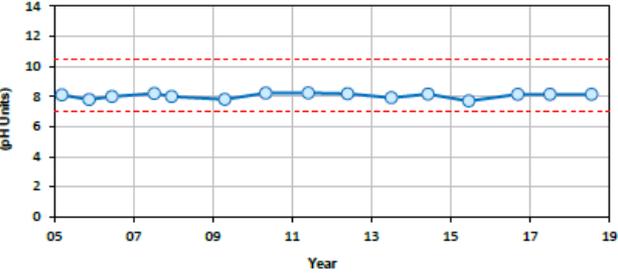
**NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
2018 GROUNDWATER QUALITY MONITORING
BEVERLY CHANNEL MONITORING WELLS**

**HYDROCHEMICAL CONTROL CHARTS
MW-12**

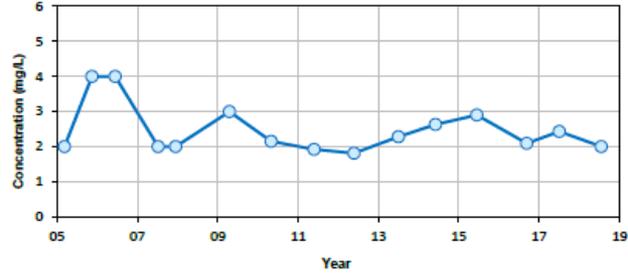
	Date: 02-Nov-18 Drawn by: DS Edited by: WorleyParsons Group Inc. 307075-01608-400	Approved by: B
		Job No. A5-12 Rev. B

* The drawing is prepared solely for the use of our customer as indicated in the accompanying report.
WorleyParsons Group Inc. 307075-01608-400 for environmental control charts for the project.

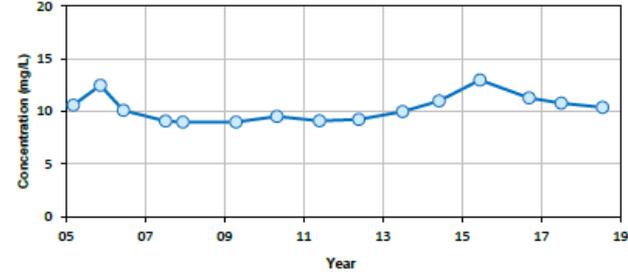
PH



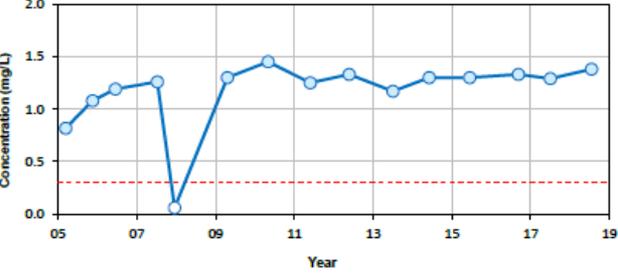
CHLORIDE



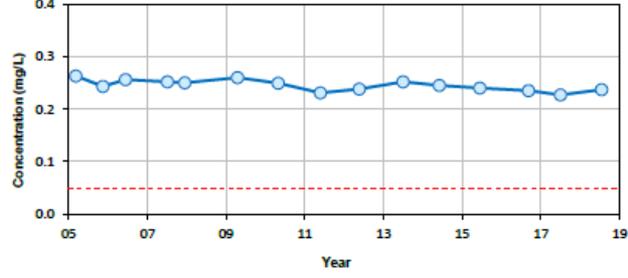
SULPHATE



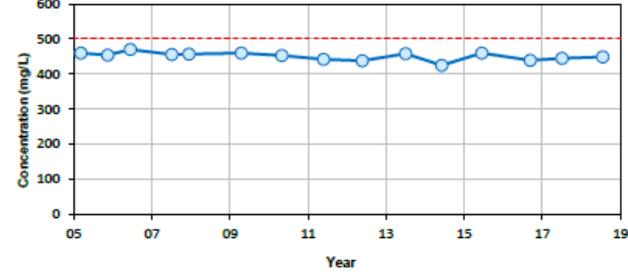
IRON



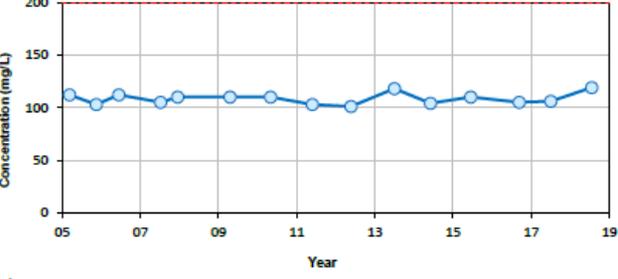
MANGANESE



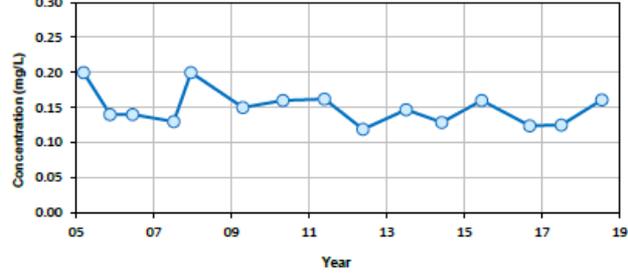
TOTAL DISSOLVED SOLIDS (CALCULATED)



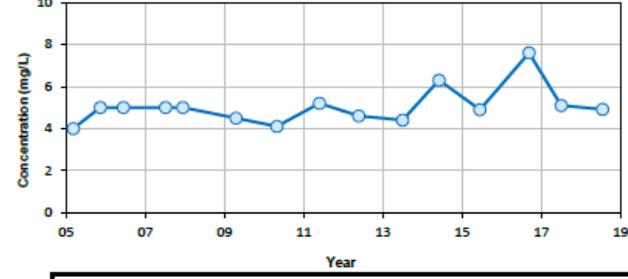
SODIUM



FLUORIDE



DISSOLVED ORGANIC CARBON



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 - Dashed line between data points indicates data gap of more than two years
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 - --- Canadian Drinking Water MAG Guidelines 2017:
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 - Chloride: 250 mg/L
 - Manganese: 0.05 mg/L
 - Fluoride: 1.5 mg/L
 - Sulphate: 500 mg/L
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 - Dissolved Organic Carbon: N/A

**NORTHEAST CAPITAL INDUSTRIAL ASSOCIATION
2018 GROUNDWATER QUALITY MONITORING
BEVERLY CHANNEL MONITORING WELLS**

**HYDROCHEMICAL CONTROL CHARTS
MW-13**

Date: 02-Nov-18	Drawn by: DS	Edited by:	Approved by:
		WorleyParsons Group Inc. 307075-01608-400	
		PID No. A5-13	REV B

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